FACULTY OF AGRICULTURE

Curriculum for Master of Science Programs

Sher-e-Bangla Agricultural University

Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh

June, 2021

Courtesy: Institutional Quality Assurance Cell (IQAC)

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Published by
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Institutional Quality Assurance Cell, SAU
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Year of Publication
June, 2021

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Disclaimer

Every effort has been made to make this curriculum enriched with accurate information and correct entries as recommended by the 77th Academic Council meeting of SAU. However, we apologize for any typographical errors. The SAU reserves the right to alter/cancel course(s) and their contents, admission requirements, etc.

Vice-Chancellor's Message

It is my great pleasure to let you know that IQAC, SAU is preparing an Outcome Based Curriculum for the Master Degree programs of the Faculty of Agriculture, Sher-e-Bangla Agricultural University (SAU). The Sher-e-Bangla Agricultural University was established with a mission to expand the higher agricultural education and committed to promote affective research in various fields of agricultural sciences and to prepare the graduates for offering extension services for the benefit of farming communities of Bangladesh.

The Faculty of Agriculture (FA) of SAU is one of the important faculties of the university which is offering Master Degree in 12 departments and PhD degree in 9 departments.

Presently, SAU is offering postgraduate programs (MS and Ph.D) under a course credit system with the aim to producing researchers, academicians and field level extension specialists in the field of Agriculture to deal with the issues like crop varietal, development, crop production, other technology generation and dissemination. Nearly 213 highly qualified faculty members of which are in the faculty of agriculture shouldering the academic responsibilities plus running research activities of the university. New technologies are being developed by potential research through Sher-e-Bangla Agricultural University Research System (SAURES) while the Outreach program is set to transfer the newly developed technologies to the farmer's field for raising agricultural productivity.

The present edition of the outcome based curriculum of Master Degree programs contains the updated courses and their contents, courses learning outcomes, topic intended learning outcomes as taught in the undergraduate program of the Faculty of Agriculture. I believe that the outline provided in this book will be helpful to all concern teachers and the students. In the long run, it would help to enhance the quality of the post graduate studies in agriculture which would be able to better contribute in providing food security as well as agricultural development of the country.

Appreciation goes to IQAC-HEQEP project, UGC, Ministry of Education and the World Bank for their financial support in the preparation of this Curriculum. I congratulate the IQAC management team, self-assessment committee members and teachers of this University with special thanks to Prof. Mohammed Ali, Head Self-Assessment Committee, Agriculture Faculty and Director, IQAC, Prof. Dr. Md. Asaduzzaman Khan whose tremendous efforts and dedication have made it possible to bring out this important academic document to light.

(Prof. Dr. Md. Shahidur Rashid Bhuiyan)
Vice-Chancellor
Sher-e-Bangla Agricultural University

Dean's Words

We are living in an age of globalization where every day we face new challenges particularly in the field of agriculture. The curriculum plays an important role in achieving the mission and objectives of the university including the intended learning outcomes and overall effectiveness of the programs. So in this age, it is extremely essential to keep updating and re-adjusting course curricula as per the demand of the time.

I sincerely appreciate IQAC management team, who took the initiative to compile an outcome based curriculum of the Master Degree programs of the Faculty of Agriculture.

I am feeling great to present this volume containing Master Degree course details of the Faculty of Agriculture. I am confident that this publication will help our students and others to learn about our academic programs and related matters. It would also serve as a ready reference for those who wish to suggest improvement/addition/deletion of our courses.

I would like to extend my sincere appreciation to the IQAC management team, Self-Assessment committee members of Agriculture Faculty and all teachers involved, including Vice Chancellor, the HEQEP sub project team, UGC, Ministry of Education and the World Bank in the compilation and publication of this important curriculum handbook.

(Prof. Dr. Alok Kumar Paul)
Dean
Post Graduate Studies
Sher-e-Bangla Agricultural University

IQAC Director's Words

The SAU's Institutional Quality Assurance Cell (IQAC) has been working to ensuring the standards of higher education at SAU. The IQAC of SAU is involved in the enhancement of teaching-learning processes, curriculum development, and academic improvement. The Ministry of Education (MoE) with the assistance of the World Bank and UGC has undertaken a Higher Education Quality Enhancement Project (HEQEP) to improve the quality of teaching-learning of the tertiary educational institutions of the country. The Institutional Quality Assurance Cell (IQAC), SAU, took initiative for developing the content based syllabus to outcome based curriculum. A number of training and workshop programs were conducted through IQAC for teachers to develop the outcome based curriculum where curriculum experts were participated. The course content was revised by considering the present agricultural problems and required generic skills of the graduate. Then the departmental courses in outcome based format were submitted to IQAC with approval letter of each departmental academic committee. The updated outcome based curriculum of Master Degree level will allow students to become better post graduates to face the challenges ahead to increase the crop productivity in order to ensure food security of the country. The Sher-e-Bangla Agricultural University has started its academic activities afresh with a course credit system with new course curricula at the Master Degree level in 2003. It has now become essential to update and modernize the curriculum to meet the immediate and long term demand of the country. At this point of view we took the initiative to rearrange, update and upgrade the syllabus of Master Degree of agriculture faculty to outcome based curriculum under the HEQEP-IQAC project. Initially, it was not an easy task to update the whole syllabus of Master Degree programs within the short period, but the difficult task became easy when the chairmen, self-assessment committee members, curriculum committee members of IQAC and teachers of the departments extended their fullest concentration towards developing the outcome based curriculum.

I express my gratitude to the present Vice-Chancellor of the University, previous Vice-Chancellor, Dean, post graduate studies, all academic and members of curricula committee, members of the IQAC-project management team, members of self-assessment committee and academic council.

I like to take this opportunity of conveying my deep sense of gratitude to UGC, HEQEP, MoE and the World Bank for their cooperation and financial support in the preparation of this volume. I am sure that this Master Degree curriculum shall serve as a reference not only to the student of SAU but to all those actively engaged with Agricultural Education system in Bangladesh.

(Dr. Md. Asaduzzaman Khan)
Director, IQAC and Professor
Department of Soil Science
Sher-e-Bangla Agricultural University

Foreword

It is indeed an honor and privilege for me to be a part of curriculum development process. It makes me happy to publish this outcome based curriculum of Master Degree programs conducted by self-assessment committee of Agriculture Faculty and Institutional Quality Assurance Cell (IQAC), SAU. This Master Degree curriculum has been developed in a standard format which contains course learning outcomes (CLO), intended learning outcomes, teaching and assessment strategies.

Self- Assessment Committee gratefully acknowledges and appreciates the devotion of the faculty members for their significant contribution to prepare the curriculum handbook.

I am confident that this academic document will greatly help our students and others to know about our academic programs and related matters. I would like to extend my sincere appreciation to the IQAC management team, self-assessment committee members, HEQEP, UGC, Ministry of Education and the World Bank for their assistance to accomplishing this assignment.

(Prof. Dr. Mohammed Ali)
Head, Self-Assessment Committee
Faculty of Agriculture
Sher-e-Bangla Agricultural University

Content

Overview of Sher-e-Bangla Agricultural University

Sher-e-Bangla Agricultural University (SAU) is situated in the center of the capital city, Dhaka with excellent communication facilities to reach the University. The SAU campus stands on 86.97 acres (35.21 ha) of picturesque land covered by green plantations.
The "Sher-e-Bangla Agricultural University Act 2001" was passed in the National Parliament of Bangladesh on 09 July 2001 through the transformation of the then Bangladesh Agricultural Institute (BAI) into Sher-e-Bangla Agricultural University. The foundation stone of the University was laid by the then Honorable Prime Minister Shiekh Hasina on 15 July 2001. Earlier this Institute was established on December 11, 1938 by Sher-e-Bangla A.K. Fazlul Huq, the then Chief Minister of undivided Bengal as the Bengal Agricultural Institute (BAI). BAI was the oldest and the pioneer agricultural institution in Bangladesh. The figure of this establishment was renamed as the "East Pakistan Agricultural Institute" in 1947. After the independence of Bangladesh in 1971, the name of the institute was accordingly changed to the Bangladesh Agricultural Institute (BAI). Since its inception in 1938, the BAI had been functioning as a "Faculty of Agriculture" under Dhaka University. Meanwhile, with the establishment of Bangladesh Agricultural University (BAU) at Mymensingh in 1961 its academic affiliation was transferred to BAU in 1964 till it's up gradation to Sher-e-Bangla Agricultural University in 2001.

The Sher-e-Bangla Agricultural University was set up with a mission to extend the higher agricultural education and committed to promote sustainable research in diverse areas of agricultural sciences and to offer extension services for the welfare of the farming communities of Bangladesh.

Since its inception the SAU was functioning as a mono faculty university; The Faculty of Agriculture. Later on Faculty of Agribusiness Management in 2007, Animal Science & Veterinary Medicine in 2012 and Fisheries and Aquaculture Faculty in 2016 were established and started functioning.

Overview of the Agriculture Faculty

Since its establishment in 1938 the Bengal Agricultural Institute (BAI) has started functioning as a "Faculty of Agriculture" under Dhaka University. Meanwhile, with the formation of Bangladesh Agricultural University (BAU) at Mymensingh in 1961 its academic function was transferred to BAU in 1964 till it's up gradation to Sher-e-Bangla Agricultural University in 2001. The Faculty of Agriculture (FA) of SAU is one of the important faculties of the university engaged in offering Bachelor of Science in Agriculture B. Sc. Ag. (Hons.) at undergraduate level. Among the fourteen departments, twelve departments (12) of this Faculty and one institute are offering MS degree and 9 departments are offering PhD degree. The Post Graduate academic programs are coordinated by the Dean, Post Graduate Studies. The faculty Post-Graduate programs are being executed by the Dean Executive Committee and Post Graduate Course Monitoring Committee. In

the Departments of Agriculture Faculty, there are 89 Professors, 31 Associate Professors, 79 Assistant Professors and 14 Lecturers.

The 12 departments and one institute are offering MS degrees.

Department	Degree
Department of Agricultural Botany	MS in Agricultural Botany
Department of Agricultural Chemistry	MS in Agricultural Chemistry
Department of Agricultural Extension and Information System	MS in Agricultural Extension
Department of Agroforestry and Environmental Science	MS in Agroforestry
Department of Agronomy	MS in Agronomy
Department of Biochemistry	MS in Biochemistry
Department of Biotechnology	MS in Biotechnology
Department of Entomology	MS in Entomology
Department of Genetics and Plant Breeding	MS in Genetics & Plant Breeding
Department of Horticulture	MS in Horticulture
Department of Plant Pathology	MS in Plant Pathology
Department of Soil Science	MS in Soil Science
Institute of Seed Technology	MS in Seed Technology

Programme Learning Outcomes of Master of Science Degrees of Agriculture Faculty
At the end of the programme, graduates must be able to:

1) Demonstrate advanced knowledge in the relevant field;
2) Apply advanced practical skills in the relevant field;
3) Analyze general and advanced range of specialized theories, concepts, principles and complex information and methods within a relevant field;
4) Generate solutions to problems using scientific and critical thinking skills; manage complex problems or solve issues in a relevant field
5) Conduct research with minimal supervision and adhere to legal, ethical and professional codes of practice; use a wide range of suitable software ICTs to enhance study, research and/or work/practice.
6) Demonstrate leadership qualities, entrepreneurship**,** interpersonal skills , responsibilities and working effectively with peers and stakeholders
7) Communicate clearly the knowledge, skills, and ideas, using appropriate methods to experts, specialists and peers and non-expert range of audience; effectively communicate by defending original research in writing and in Oral presentation.
8) Manage information for lifelong learning; Demonstrate self-advancement through continuous academic and/or professional development.

Master Degree Ordinance

1. Title of the Ordinance

This ordinance shall be called as the "**Ordinance for the Master Degree"** of Sher-e-Bangla Agricultural University (SAU), Dhaka.

2. Application of the Ordinance

This ordinance shall be applicable for the Master Degree of SAU.

3. Awarding of Degree

3.1 The Master Degree is offered by Sher-e-Bangla Agricultural University, Dhaka to a candidate subject to the fulfillment of the academic requirements as per the Rules and Regulations mentioned hereunder and those that will be promulgated by the University authority from time to time.

3.2 The Master degree is offered by the different Departments or by the Faculty/Institute of the University. Any other Department/Faculty/Institute may offer Master Degree with appropriate nomenclature by the recommendation of the Dean, Post Graduate Studies (PGS), Academic Council and approval of the Syndicate.

4. Admission Requirements

4.1 Candidates for admission to Master Degree programme must have a degree on Bachelor of Science in Agricultural disciplines e.g., B.Sc.Ag. (Hons.), B.Sc.Vet.Sci. & A.H., B.Sc.Agril. Econ. (Hons.) etc. or BBA (Agribusiness) or an equivalent degree from a recognized University or Institution. The Equivalence Committee shall assess the eligibility of the candidates with degree other than Bachelor of Agricultural Sciences e.g., B.Sc.Ag (Hons.), B.Sc.Vet.Sci. & A.H., B.Sc.Agril. Econ. (Hons.) etc. or BBA (Agribusiness).

4.2 Candidates for admission are required to apply in a prescribed form of the University and submit it to the Dean, Post Graduate Studies through the Chairman of the relevant Department/Dean or Respective person of the Faculty/Institute. A candidate may give option to all the degree offering Departments in order of preference. Selection shall be made on the basis of candidate's academic merit and option.

4.3 An in-service candidate, if selected for admission, must submit necessary clearance and study leave or deputation for the stipulated period from his/her employer prior to admission. An in-service candidate having scholarship or research fund will get preference for admission.

4.4 Candidates for admission into the Master Degree program shall be selected by an Academic Committee of the respective Department. In case of MBA in Agribusiness, a committee formed by the chairman of the all department of Agribusiness Management Faculty headed by Dean, Post Graduate Studies will select the candidates for admission. Admission to Master degree courses shall finally be approved by the Vice Chancellor on the recommendation of the Dean, Post-graduate Studies. The number of students to be admitted in any Department will be decided by the respective Departmental Academic Committee.

4.5 Candidates may get themselves admitted twice a year prior to the commencement of the semester January and July upon payment of necessary fees as per the University rule. Students other than SAU need to get new registration by paying registration fees.

4.6 A foreign student seeking admission into Master Degree Program shall submit application through respective through proper channel with a certificate of proficiency in the English language. His/her admission shall be processed following the same guidelines as mentioned above.

5. Duration of the Program

An academic year is divided into two academic semesters, viz. January to June and July to December. Each academic semester consists of 26 (twenty six) weeks of which class room teaching will be for 16 weeks, 2 weeks for preparatory leave, 2 weeks for semester final examination, 3 weeks for result publication and 3 weeks for enrollment for the next semester.

5.1 Duration of MS/MBA Program

5.1.1 The usual duration of Master of Science (MS)/Master of Business Administration (MBA) degree program will be of three semesters. A student has to complete the degree within five semesters from the date of his/her enrollment in the respective program. Normally the 3rd semester would be his/her Thesis semester. However, enrollment in the 4th and/or the 5th semester needs prior approval from his/her Supervisory Committee and the Chairman of the respective Department. The Chairman shall report such extension to the Dean, Post Graduate Studies**.**

5.1.2 If a student fails to obtain an MS/MBA degree within 5 (five) semesters from the date of his/her 1st admission to this program his/her admission shall stand cancelled.

5.1.3 A student having an MS/MBA degree or a student after enrollment in MS/MBA courses failed to obtain degree within the stipulated time shall not be allowed for further admission in MS/MBA course(s) of this University. In-service candidates having MS/MBA degree not related to his/her job, serving in Government and/or autonomous institutes may be allowed for admission in MS/MBA courses related to his/her job.

5.1.4 If a student of MS/MBA program on completion of his/her 1st semester fails to obtain GPA 2.5 and willing to change Department, he/she will either get enrolled in the same Department or take fresh admission to any other Department in next immediate semester. However, in case of fresh admission to a Department of his/her choice, the student will have to maintain all the formalities required for fresh admission. A student who will change his/her Department in the 2nd semester will be allowed four (4) semesters to complete MS/MBA program. If a migrated student fails to maintain GPA 2.5 after the completion of the 2nd semester, his/her admission will be cancelled. A student will get only one chance to change his/her Department during MS/MBA program.

6. The Supervisor and Supervisory Committee

The Academic Committee of the respective Department will select Supervisor(s) for enrolled student within 1st semester.

Research work of an MS/MBA degree student shall be supervised by a Supervisory Committee consisting of a Supervisor and a Co-supervisor. In case of external Supervisor, the Co- supervisor must be from the respective Department of this University.

The Co-supervisor shall be proposed by the Supervisor in consultation with the Chairman of the Department. The Chairman shall submit the proposal of Supervisory Committee to the Dean, Post-Graduate Studies for approval within second semester of the students' enrollment.

The Supervisory Committee will be responsible for approving the student's Plan of Course Work (PCW), Outline of Research Work (ORW), assessing progress of the programme and evaluating progress of the Thesis. The PCW and ORW approved by the Supervisory Committee will be endorsed by the Chairman of the Department as well as by the Dean, Post Graduate Studies during 2nd semester.
In case of unavoidable circumstances, changes in the Supervisory Committee may be made on recommendation of the Chairman of the Department and approval by the Dean, Post Graduate Studies.

6.1 Eligibility of the Supervisor and Co-supervisor

A Supervisor and Co-supervisor must have Master or PhD degree. The Supervisor and Co-supervisor should have at least 3 years teaching and/or research experience along with 5 published scientific papers in professional journals with first authorship of at least 2 of them. The supervisor-ship should be approved by the Dean, Post Graduate Studies with recommendation of Chairman of the respective Department.

7. Course Requirements

7.1 Course for MS/MBA Degree

The MS/MBA degree program will be a full time study program and will consist of courses, seminar course and research work. Each student in consultation with the Supervisory Committee will prepare a tentative program of study before the end of the 2nd semester. An MS/MBA degree program must contain minimum of 47 credit hours; at least 30 credit hours for courses, 1 credit hour for seminar course and 16 credit hours for the research work.

Course Credit System: The course credit system involves course work with regular classes, assignments, quizzes, tests and examination during and at the end of each semester. One contact hour in each week shall be considered as one credit hour. A course having one lecture hour per week shall he considered as one credit hour course.

Courses: Out of 30 credit hours of course work, a compulsory course of 18 credit hours must be chosen from the degree offering Department and elective courses of 12 credit hours may be chosen either from degree offering Department or other relevant Departments as recommended by the Supervisory Committee. The courses to be offered in any semester will be determined by the Academic Committee of the respective Department. A particular course shall be offered and evaluated by one or two Course Teacher(s).

Seminar Course: One seminar course carrying one credit hour must be completed before the submission of Thesis. A panel of 3 teachers for each group of enrolled students headed by a Coordinator will be selected by the Dean, Post Graduate Studies to conduct and evaluate the seminar course. One Coordinator will act as Convener of all groups of a respective semester as selected by Dean, Post Graduate Studies.

7.2 Enrollment for MS and MBA Degree

Enrollment: Newly admitted students will be allowed to enroll course(s) by paying required fees on the day of admission. Continuing students will be allowed to enroll course(s) for next semester during 21st week of the present semester paying regular fees and up to 2 weeks of the next semester with late fees. However, a student who fails to enroll within the stipulated time, he/she has to pay readmission fees along with late fees. If a student requires additional semester(s) beyond the minimum requirements to complete his/her degree program he/she has to enroll in each semester paying fees to continue his/her studentship.

A student has to fill up prescribed enrollment form showing the different courses to be offered by the Department before the commencement of each semester. However, he/she may be allowed to enroll up to a maximum 18 and minimum 12 credit hours in a semester recommended by Supervisory Committee.

7.3 Dropping from the program

If a student fails to appear in the classes, tests and final examination for two (2) consecutive semesters from the commencement of his/her study will not be allowed to enroll in the next semester and shall be dismissed from the program.

8. Class Attendance and Stipend

A student has to maintain a minimum of 70% class attendance in all courses in the semester to be eligible for appearing in the final examination and to qualify for stipend, scholarships etc.
Marks for class attendance will be awarded as follows:

Attendance	Marks
90% and above	5.00
85% to <90%	4.50
80% to <85%	4.00
75% to <80%	3.50
70% to <75%	3.00
Less than 70%	0.00

9. Course Examination and Grading

9.1 **Examinations**: There shall be three quizzes, two class test and one final examination for each course in a semester. The class tests shall carry 40% (20% in each test) and the final examination shall carry 40% of the total marks. The remaining 20% of the marks shall be assigned for quizzes (10%), assignment (5%) and class attendance (5%) given by Course Teacher(s).
Final examination of courses will be held centrally in the last month of each semester. The venue and dates of the final examination will be announced by the Controller of Examinations, as advised by the PCMC (Postgraduate Course Monitoring Committee). The duration of final examination shall be of 3 hours. Each student must submit the Examination entry form to the Controller of Examinations through the Chairman of the relevant Department and Dean, Post-Graduate Studies.
A three member Examination Committee will be formed with Chairman and two other members of the respective Department nominated by the Academic Committee and approved by the Dean, Post Graduate Studies. The Chairman of the Department will be the Chairman of the Examination Committee. The Examination Committee will remain valid for four consecutive semesters. The Examination Committee will tabulate the results of the semester. The evaluated answer scripts, question papers of final examination shall be preserved for a minimum period of three (3) years by the Controller of Examinations.

All Examinations will be designed, administered and evaluated by the Course Teacher(s) of the respective course(s). The Course Teacher(s) will submit tabulated grade sheet to the respective Chairman in triplicate. The Chairman will submit the tabulated grade sheet to the Controller of Examinations within 21 days after final examination**.** For seminar course, the Coordinators will submit the grade sheet to the Dean, Post Graduate Studies within 21 days after completion of seminar course. The Dean, Post Graduate Studies will send the tabulated grade sheet to the Controller of Examinations. The Controller of Examinations will publish the results after taking necessary approval of the Dean, Post Graduate Studies, Pro Vice-Chancellor and Vice-Chancellor.

If a student does not fulfill any of the requirements of the course like quizzes, assignment, class tests for reason(s) satisfactory enough to the Course Teacher, he/she may be given another chance to fulfill the requirements before the semester final examination.

9.2 The Controller of Examinations shall keep up to date record of all the grades obtained by a student in individual Academic Record Card. Grades shall be announced by the Controller of Examinations at the end of the each semester. In addition, each student is entitled to get one official transcript of the University record by paying required fees on completion of his/her academic program from the office of the Controller of Examinations on production of statement of clearance from all Departments/ Offices.

9.3 Grading System

Final grades for courses shall be recorded as follows:

Grade	**Grade Points**
A^+	4.0
A	3.75
A^-	3.5
B^+	3.25
B	3.0
B^-	2.75
C	2.5 (Pass)
F	0.0 (Failure)
I	Incomplete
W	Withdrawn

Numerical markings may be made in answer scripts, test etc., but all final grading shall be in the letter grade system to be reported to the Controller of Examinations as detailed below:

Percentage of Marks	**Grade**	**Grade Point**
80 and above	A+	4.0
75 to <80	A	3.75
70 to <75	A-	3.5
65 to <70	B+	3.25
60 to <65	B	3.0
55 to <60	B-	2.75
50 to <55	C	2.5
Below 50	F	0.0

9.4 Course in which the student gets 'F' grade(s) shall not be counted towards credit hour requirements and for the calculation of Grade Point Average (GPA).

9.5 Grade 'I' is given only when a student is unable to sit for the final examination of a course at the end of the semester because of circumstance beyond his/her control. He/she must apply to the Chairman of the concerned Department within one week after the examination to get an 'I' grade in that course. It must be completed within the next two semesters; otherwise, the 'I' becomes 'F' grade. He/she may, however, be allowed to enroll with payment of necessary fees for course. However, the marks obtained in the class tests and quizzes will remain valid for the course.

9.6 "In Progress" shall be recorded for continuation of the Thesis work. However, an 'I' grade shall be recorded for discontinuation of Research Work.

9.7 A student shall withdraw (W) officially from a course within two working weeks of the commencement of the semester or else his/her grade in that course shall be recorded as 'F' unless he/she is eligible to get a grade of 'I'. A student may be permitted to withdraw and change his/her course within the specified period with the approval of his/her Supervisor and or Chairman of the Department and the respective Course Teacher(s***).*** Any course with a grade of 'W' must be completed with an acceptable grade before the thesis defense examination. When a student's academic progress is interrupted by an emergency situation such as serious illness, accident or death of a family member, the student has to submit evidences of such incident within one week after the incidence to the Dean, Post Graduate Studies through the Supervisor and departmental Chairman, he/she may withdraw from the semester. However, he/she has to complete the degree as mentioned in 5.1.

9.8 Students may enroll for non-credit course(s) termed as audit course(s) on recommendation of his/her Supervisor and Chairman of the Department. However, his/her grade for such course(s) will not be counted for calculating GPA, but will be reflected in the transcript.

9.9 Grade Point Average (GPA) and Cumulative Grade Point Average (CGPA): The GPA shall be the quotient of total points divided by total credits; total credits will be the number of credits in semester in which grades A^+, A, A^-, B^+, B, B^- or C will be awarded.

At the end of the each semester, after the grades have been awarded for individual course, GPA of a course shall be calculated by multiplying the credits of the course offered to the students with the numeral value of the grade. For determining the CGPA, the points obtained in all courses shall be divided by the total credits. Fraction marks after two decimal cannot be considered for GPA and CGPA calculation.

10. Qualifying Requirements

The qualifying requirement for graduation is that a student must earn a minimum grade point of 2.5 based on the weighted average in his/her course work.

10.1 A student obtaining F grade in a course may be allowed to repeat the course within next available semester with the prior approval of the Course Teacher(s) and Chairman. Performance in all the Course including all the 'F' grades shall, however, be reflected in the transcript.

11. Conversion of CGPA into Percent Marks

The following formula shall be used to convent the GPA into percent marks which may appear on the transcript:

Y = 79 + 84(x – 3.75); for >3.75 to ≤4.00 Y
= 45 + 20(x – 2.25); for >2.50 to ≤3.75
Where, `x'= Obtained CGPA
Y = Percentage of marks

12. Academic Deficiencies

A student will not be allowed to enroll in the Thesis semester if he/she fails to attain CGPA 2.5 in the courses.

13. Academic Discipline

In case of academic or other indiscipline the Course Teacher(s) may impose any academic penalty including giving 'F' grade after informing the student of the action taken. Additional penalties may be imposed subsequent to review at the Department level or above.

14. Academic Probation

A student fails to maintain GPA/CGPA 2.5 will be barred from offering candidature in any post of Hall or Central Students Union.

15. Boycotting Examination and Adoption of Unfair Means

(i) Students who, in any pretext, either individually or jointly, boycott the examination or leave the examination hall unlawfully will be marked absent.

(ii) If a student found to be adopting unfair means in any examination (including class test etc.) he/she shall be liable to disciplinary actions leading to commutation of the said examination or expulsion from his/her study program for a specified period or from the university as a whole as recommended by the relevant disciplinary committee depending on the nature of the offence.

(iii) A student, expelled for specified period for adopting unfair means, shall not get extra time beyond the maximum limit of 5 (five) semesters to complete his/her study, if allowed readmission.

(iv) A student expelled twice shall be permanently barred from readmission to this University.

16. Postgraduate Course Monitoring Committee (PCMC)

All the Chairman of the Master Degree course offering Departments will be the members of Post-Graduate Course Monitoring Committee (PCMC) with the Dean, Post Graduate Studies as its Convener. The Committee will monitor the overall activities regarding Master Degree course conducted by different Departments. If any anomalies found in conducting the courses and the examinations, the Committee will submit a report regarding the anomalies to the Academic Council for necessary action.

17. Research Requirements

17.1 Research Requirement for MS/MBA Degree

A piece of research work in the field of specialization is a requirement for MS/MBA Programme. The research work should be done under the supervision of students' Supervisory Committee. To be a Supervisor, Teacher or Scientist must have approval from the Academic Council. The student's research topic will be selected by the student under guidance of the Supervisory Committee. An Outline of Research Work (ORW) should be submitted in prescribed form before commencement of the 2nd semester. When the ORW is recommended by the Supervisory Committee endorsed by Chairman of the Department and Dean, Post Graduate Studies, it becomes an obligatory on the part of the student to complete the requirements as approved. The Supervisory Committee with endorsement of the Departmental Chairman and the Dean, Post Graduate Studies may change the program.

18. Submission of the Final Draft Copy of the Thesis

A candidate for the Master degree must submit his/her Thesis embodying the results of his/her research following the style and format approved by the University. The student will submit required number of copies of the Thesis in soft binding form after signed by the members of the Supervisory Committee and submit to the Chairman of the Department within the stipulated period for onward transmission to the Dean, Post Graduate Studies.

19. The student shall certify that the research work has carried out by himself/herself and the work has not been submitted elsewhere for the award of any other degree or diploma. The thesis must be plagiarism tested as per guideline for using Theses plagiarism detection facility of Sher-e-Bangla Agricultural University, Dhaka.

20. Thesis Evaluation and Defence

20.1 The Thesis Evaluation and Defence will carry following marks:

a. Quality of Thesis	300 marks
b. Thesis presentation	100 marks
c. Oral	100 marks
Total	500 marks

20.2 Each Thesis shall be independently evaluated by two (2) Examiners (at least one from outside of this University) to be selected by the Dean, Post Graduate Studies from a four (4) members panel suggested by the relevant Examination Committee of the Department. The Examiners will send the marks to the Dean, Post Graduate Studies. The average of the marks given by the two Thesis Examiners shall be considered as the marks obtained.

20.3 In case of more than 20% variations in marks given by two Thesis Examiners, the third Examiner from the panel of Examiners shall examine the Thesis and the average of two nearest marks shall be taken as final.

20.4 If a Thesis Examiner is absent or not available for some unavoidable reasons, or declines to act as an Examiner, the Dean, Post Graduate Studies may appoint the next person from the proposed panel of Examiners; or in case of non-availability of any person in the panel, the Examination Committee of the respective Department may propose a new panel of Examiners to the Dean, Post Graduate Studies.

20.5 The Thesis defence Examination for each student will be administered by the Examination Committee of the respective Department formed as per section 9.1 and one External Examiner. A two (2) members panel of External Examiner will be sent by the Chairman of respected department to the Dean, Post Graduate Studies for final approval. The Thesis will be presented in front of the Examination Committee with other viewers and the oral examination will be held exclusively by the Examination Committee. After completion of Thesis evaluation and defence, the total marks will be converted into grades according to section 9.3. The submission of the Thesis, Thesis presentation and oral examination must be held in the same semester.

20.6 The defence of the Thesis shall be held at least two weeks before the end of the semester. If one or more members of the Examination Committee express their inability to present during the defence due to some unavoidable reasons, replacement may be made by the Chairman of the Department from the panel with intimation to the Dean, Post Graduate Studies. The date and time of defence shall be announced by concerned Chairman of the Department under intimation to the Dean, Post Graduate Studies.

21. Submission of Final Copy of Thesis

After defence the evaluated Thesis will be returned to the student for necessary corrections (if any) as suggested by the Examiners and five (5) copies duly signed by the Members of the Supervisory Committee to be submitted in hard cover binding to the Chairman of the Department. The Chairman will distribute these copies of Thesis to relevant persons. The student must follow the style, format and other criteria of writing Thesis and must maintain the color of the cover page of the Thesis as approved by the Sher-e-Bangla Agricultural University. Plagiarism of the Thesis must be tested as per guideline for using Theses plagiarism detection facility of Sher-e-Bangla Agricultural University, Dhaka.

22. Publication of Result

After tabulation of marks the Examination Committee will send the result to the Controller of the Examinations for publication taking approval of the Dean, Post Graduate Studies, Pro Vice-Chancellor and Vice-Chancellor.

23. Striking off and Removal of Names

The name of the student shall be struck off and removed from the University on the following grounds:

a) Non-payment of dues within the prescribed period. Postgraduate students residing in the halls of residence shall be subject to the same conditions as follows in the Ordinance regarding Board of Residence and Discipline;
b) Failing to proceed with the program by the exercise of Act. 7.3 of this Ordinance;
c) Failing to make satisfactory progress in his/her program as reported by the Supervisor;
d) Forced to discontinue his/her studies under disciplinary rules;
e) Withdrawn officially from all the courses including Thesis.

24. Academic Fees

Academic fees will be determined and reviewed from time to time by the appropriate authority of the University.

25. Measures Regarding Problems not Mentioned in the Ordinance

Rules and regulations not mentioned in the Ordinance to overcome any problem regarding academic issues and examinations will be resolved in the Academic Council with final approval of the Syndicate.

Department of Agricultural Botany

Course Layout

Sl. No.	Course Code and Title	Cr. Hrs.
A. Compulsory courses		
1	ABOT 501: Plant Morphology and Taxonomy	3
2	ABOT 502: Plant Anatomy	3
3	ABOT 503: Plant Water Relations and Nutrition	3
4	ABOT 504: Plant Growth and Developmental Physiology	3
5	ABOT 505: Plant Metabolism	3
6	ABOT 506: Plant Ecology	3
	Total	**18**
B. Elective Courses		
7	ABOT 507: Cell Physiology	3
8	ABOT 508: Advanced Agroclimatology	3
9	ABOT 509: Plant Growth Regulators	3
10	ABOT 510: Stress Physiology	3
11	ABOT 511: Floral Biology	3
12	ABOT 512: Seed Physiology	3
13	ABOT 513: Biodiversity and Conservation	3
14	ABOT 514: Crop Physiology	3
15	ABOT 515: Economic Botany	3
16	ABOT 516: Agricultural Hazards and their Control	3
17	ABOT 517: Statistical Approach in Agricultural Research	3
18	Or Related Courses Offered by other Departments	3
	Minimum	**12**
C. Seminar Course		
19	ABOT 598	1
D. Thesis Research		
20	ABOT 599	16

Compulsory Courses	**18**
Elective Courses	**12**
Seminar Course	**1**
Thesis Research	**16**
Total	**47**

Curriculum Alignment / Skill Mapping

Curriculum must be aligned with program objectives, program learning outcome and intended learning outcomes through proper skill mapping.

Department of Botany

Courses	Program Learning Outcome							
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ABOT 501	x	x	x	x				x
ABOT 502	x	x	x	x				x
ABOT 503	x	x	x	x				x
ABOT 504	x	x	x	x	x		x	x
ABOT 505	x	x	x	x				x
ABOT 507	x	x	x	x				x
ABOT 508	x	x	x	x			x	x
ABOT 509	x	x	x	x				x
ABOT 510	x	x	x	x				x
ABOT 511	x	x	x	x				x
ABOT 512	x	x	x	x				x
ABOT 513	x	x	x	x				x
ABOT 514	x	x	x	x				x
ABOT 515	x	x	x	x				x
ABOT 516	x	x	x	x				x
ABOT 517	x	x	x	x				x
ABOT 598						x	x	x
ABOT 599					x	x	x	x

Course Code: ABOT 501 Course Title: Plant Morphology and Taxonomy (Compulsory)	**Credit Hour: 03**	**Semester: January- June**	
Rationale: This course is designed to conceptualize fundamental facts and aspects of Plant Morphology and Taxonomy.			
Course Outcomes: • Describe morphological features of different plant groups and evolutionary relationship among them. • Explain modern taxonomic rules, plant classifications and important families of crop plants. • Acquire knowledge on plant conservation and plant preservation and related national and international organizations			
Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Discuss history of plant systematics • Describe different aspects of taxonomy and systematics and their importance	**Plant systematics:** Systematics and modern taxonomy; phases of plant systematics; plant taxonomic categories; sources of taxonomic evidence; methods in experimental taxonomy.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Essay type answer
• Explain different aspects of plant identification and nomenclature	**Plant identification and nomenclature:** Methods of plant identification and nomenclature; codes of ICBN.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Essay type answer
• Describe different systems of plant classification • Discuss about the evolution of classification system • Interpret angiosperm phylogeny • Classify plants on the basis of phylogeny	**Plant classification:** System of classical and modern classification; historical background; evolution of classification systems; basis of classification; classification of plants on the basis of phylogeny and molecular level; origin and evolution of angiosperms, angiospermy phylogenetic group III.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Essay type answer

• Describe morphological features of the crop plants and relationship among them	**Morphology of crop plants:** Morphology of different groups of plants and their phylogenetic relationship; morphological features of crop plants.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Essay type answer
• Name the different crop plant families • Write down the general features of crop families and identify them • Interpret different plants of crop plants • Point out the index of family identification	**Study of plant families:** Features and identification of crop plant families; index of family identification.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Essay type answer
• Acquire practical knowledge on plant conservation and preservation	**Study tour:** Different botanical gardens and national herbarium.	Lecture Discussion Assignment	Presentation

Reference Books

1. G.H.M. Lawrence. 1967. Taxonomy of Vascular Plants. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi
2. V.V. Sivaranjan. 1999. Introduction to the Principles of Plant Taxonomy. 2nd Edn. Oxford & IBH Pub. Co., New Delhi.
3. A.K. Mondal. Advanced Plant Taxonomy. 1975. 2nd Edn. New Central Book Agency (P) Ltd. Delhi, India. A.C. Dutta..
4. V.V. Sivaranjan. 1999. Introduction to the Principles of Plant Taxonomy. 2nd Edn. Oxford & IBH Pub. Co., New Delhi.
5. O. P. Sharma. Plant Taxonomy. 2009. 2nd Edn. McGraw-Hill, New York.
6. 4. B.P. Pandey. 1986. Modern Practical Botany. Vol. II. S. Chand & Company (Pvt.) Ltd., New Delhi.
7. H.C. Gangulee, K.S. Das and C. Dutta.1984. College Botany. Vol. I. New Central Book Agency, India.
8. J.W. Purseglove. 1988. Tropical Crops Dicotyledons. English Language Book Society, Longman, London.
9. J.W. Purseglove.1988. Tropical Crops Monocotyledons. English Language Book Society, Longman, London.
10. K.S. Bilgrami, L.M. Srivastava and J.L. Shreemali.1992. Fundamentals of Botany. Vikas Publishing House Pvt. Ltd., New Delhi.
11. L.S. Cobley and W.M. Steele. 1976. An Introduction to the Botany of Tropical Crops. The English Language Book Society, Longman, London.

Course Code: ABOT 502 **Course Title: Plant Anatomy (Compulsory)**	**Credit Hour: 03**	**Semester: July-December**
Rationale: This course is designed to provide knowledge on internal and organizational structure of higher plants.		
Course Outcomes: • Illustrate development and differentiation of (i) the cell wall (ii) vascular system and (iii) reproductive structures of seed plants. • Acquire knowledge on different tissue systems, the taxonomic and evolutionary variation in xylem and phloem components. • Develop insight on the stelar patterns in stems and roots of vascular plants with (normal and anomalous) and without secondary growth.		

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Explain in details of meristimatic tissues	**Meristem:** Introduction of anatomy and histology, differentiation and specialization, theories of apical organization of tissue system	Lecture Multimedia presentation Discussion Assignment	Quiz/MCQ Short-answer Essay type answer Report
• Discuss the development and functions of different protective structures of plant	**Protective Tissues:** Structure, function and development of epidermis, periderm, hypodermis and exodermis.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Essay type answer
• Elucidate the origin and development of fibres and sclerids	**Mechanical Tissues:** Origin and development of fibres and sclerids.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Essay type answer
• Describe ontogeny and phylogeny of xylem and phloem components	**Conducting Tissues:** Phylogen of tracheids and sieve elements; developmental morphology of trachied, vessel member, sieve-tube member, sieve-tube member and cell.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Essay type answer
• Illustrate secretory tissues and their importance	**Secretory structures:** Important secretory structures, their characteristics and functions; secretory substances of agricultural importance.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Essay type answer

• Draw and explain the anatomy of reproductive parts and storage organs	**Anatomy of reproductive and storage organs:** Anatomy of sepals, petals, fruit wall and seed coats; anatomy of storage organs-tubers and corms.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Essay type answer
• Explain the structural differentiation and development of plants through vascularization • Elucidate the formation of different woods and abscission layer	**Developmental anatomy:** Developmental anatomy, Vascularization in young seedling, adventitious root and graft union; structural differentiation from vegetative to reproductive organs; formation of tension wood and compression wood in relation to stresses; formation of abscission layer.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Essay type answer
• Sketch the anatomical dynamics of crop plants in relation to environment	**Changes of anatomy to environments:** Anatomical adaptability of crop plants to different environments.	Lecture Practical demonstration Discussion Assignment	Quiz/MCQ Short-answer Essay type answer
• Explain the latest findings and information of Plant Anatomy	Latest research findings and information regarding Advanced Plant Anatomy	Assignment	Report

Reference Books

1. Pandey, B.P. 1989. Plant Anatomy. Vol. II. S. Chand & Company (Pvt.) Ltd., New Delhi.
2. Gangulee, H.C., Das, K.S. and Dutta, C.1984. College Botany. Vol. I. New Central Book
3. Agency, India.
4. Evart, R. F. 2006. Esau's Plant Anatomy.2006. John Wiley & Sons, New York.
5. Esau, K. 1965. Plant Anatomy. 2nd Edn. John Wiley & Sons, New York.
6. Dutta, A.C. 1974. Botany for Degree Students. Oxford University Press, Madras.
7. Dutta, A.C. 1975. A Class Book of Botany. Oxford University Press, India.
8. Bilgrami, K.S., Srivastava, L.M. and Shreemali, J.L.1992. Fundamentals of Botany. Vikas Publishing House Pvt. Ltd., New Delhi.
9. Cobley, L.S. and Steele, W.M. 1976. An Introduction to the Botany of Tropical Crops. The English Language Book Society, Longman, London.
10. Langer, R.H.M. and Hill, G.D. 1991. Agricultural Plants. Cambridge University Press, Cambridge.
11. Hunt, R. 1981. Plant Growth Analysis. The Camelot Press Ltd., Southampton. Great Britain.

Course Code: ABOT 503 **Course Title: Plant Water Relations and Nutrition (Compulsory)**	**Credit Hour: 03**	**Semester: January-June**	
Rationale: This course is designed to provide information on plant water relations and nutrition.			
Course Outcomes: • Describe plant water relations, movement of water from the substratum-plant-atmosphere, transpiration and factors affecting those. • Explain mineral nutrition of plants, their availability, absorption mechanism and their roles in metabolism. • Elucidate solute translocation. • Present heterotrophic and other modes of nutrition. • Introduce prospect of soil less culture medium.			
Intended Learning Outcomes (ILOs) The students will be able to -	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Describe structural and functional properties of water in relation to plants • Analyze the process of movement of water from the substratum-plant-atmosphere • Explain water-use efficiency of plants	**Plant water relations:** Structural and functional properties of water in relation to plants; water potential; movement of water from the substratum-plant-atmosphere continuum; transpiration and stomatal functions; transpiration-photosynthesis compromise; water-use efficiency.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Descriptive-answer
• Illustrate different forms of nutrients, organs of nutrient uptake, mechanism of mineral absorption and their function in plant metabolism • Analyze factors affecting nutrient availability and nutrient cycles	**Mineral nutrition of plants:** Sources and forms of plant nutrients; organs of uptake; functions of minerals in plant metabolism; mechanism of mineral salt absorption; mobility of different labelled nutrients in plant body; factors affecting nutrient availability; mineral cycles.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Descriptive-answer
• Illustrate the mechanism of solution/solute transportation within the plant; source-sink relationship	**Translocation of solutes:** Nature of solution in transportation; path of movement; source-sink relationship; solute transport across membranes; trans-cellular movements.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Descriptive-answer

• Elucidate heterotrophic and other modes of nutrition	**Heterotrophic and other modes of nutrition:** Insectivorous plants; epiphytes; parasites.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Descriptive-answer question
• Apply soil less culture medium and proper use of nutrients for crop production	**Scope of soil less culture:** Proper use of nutrients for commercial crop production. Example of soil less cultures are hydroponics water, inorganic, organic, synthetics etc.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Descriptive-answer
• Recent updated information	• Introduce cross-talk between nutrients, plant physiology and soil microorganisms. • Introduce cross-talk between phytohormones-nutrients, signaling molecules-nutrients or phytohormones- signaling molecules –nutrients. • Introduce role of nutrients in enhancing abiotic stress tolerance	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Descriptive-answer Assignment

Reference Books

1. Hemantaranjan A. (Ed). 2003. Advances in Plant Physiology. Scientific Publishers, New Delhi.
2. Salisbury F. and Ross C. 1978. Plant Physiology. Wads Worth Pub Co., Belmont.
3. Taiz L. and Zeiger E. 2002. Plant Physiology.Sinauer Associates, Inc. Publishers, USA.
4. Hopkins W.G. and Huner N.P.A. 2009. Introduction to plant physiology (4th ed.). Hoboken, NJ: John Wiley & Sons.
5. Devlin R.M. and Witham F.H. 1983. Plant Physiology.4thEdn. CBS Publisher and Distribution, Delhi.
6. Pandey S.N. and Sinha B.K. 1990. Plant Physiology. Vikas Publishing House Pvt. Ltd., New Delhi.
7. Jain V.K. 1999. Fundamentals of Plant Physiology. S. Chand and Company Ltd., India.
8. Toshiki Asao. 2012. Hydroponics. IntechOpen. DOI: 10.5772/38594.
9. Malik C.P. and Srivastava A.K. (2002) Textbook of Plant Physilology. Kalyani Publishers, New Delhi.

Course Code: ABOT 504 Course Title: Plant Growth and Development Physiology (Compulsory)	**Credit Hour: 03**	**Semester: July-December**

Rationale: This course is designed to deliver the information regarding physiology behind growth and developmental processes of plant

Course Outcomes:

- Explain different aspects of growth and development.
- Describe plant photomorphogenesis
- Illustrate physiology of ageing and senescence, flowering, fruiting and other aspects of growth and development plant movements, ciradiam rythms.

Intended Learning Outcomes (ILOs) The students will be able to -	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Illustrate growth, differentiation/ development/ morphogenesis in plants and their cellular basis	**Growth and development:** Growth, differentiation and development in plants; cellular basis of growth and morphogenesis; factors affecting vegetative and reproductive growth; growth correlation.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Descriptive-answer
• Describe action spectrum and role of phytochrome in plant morphogenesis; and their molecular basis	**Plant photomorphogenesis:** Action spectrum and role of phytochrome in plant morphogenesis; molecular and photobiological characteristics of phytochrome; mode of action of phytochrome in photomorphogenesis.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Descriptive-answer
• Illustrate different factors affecting ageing and senescence of vegetative and reproductive structures in plants	**Physiology of ageing and senescence:** Physiology of leaf and flower ageing; factors affecting ageing and senescence; abscission of vegetative and reproductive structures in plants.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Descriptive-answer
• Show physiological aspects of flowering in relation to light and termoperiodism	**Physiology of flowering:** Floral induction and morphogenesis; factors modifying photoinduction; nature and mechanism of thermoperiodism in plants.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Essay type answer
• Elucidate physiological aspects of fruit and other yield products	**Physiology of fruiting:** Physiological aspects of fruit, tuber and corn formation; growth, maturation and ripening of fruit.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Descriptive-answer

• Analyze plant movements and circadian rhythms and their variation according to different growing environment/season	**Other aspects of growth and development:** Plant movements; circadian rhythms.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Descriptive-answer
• Recent updated information	Changes in growth pattern or developmental processes with the global climate changes. Approaches to sustain proper growth and development with changing environments towards desired plant productivity.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Descriptive-answer Assignments

Reference Books

1. Hemantaranjan, A. (Ed). 2003. Advances in Plant Physiology. Scientific Publishers, New Delhi.
2. Salisbury F. and Ross C. 1978. Plant Physiology. Wads Worth Pub Co., Belmont.
3. Taiz, L. and Zeiger, E. 2002. Plant Physiology. Sinauer Associates, Inc. Publishers, USA.
4. Hopkins, W.G. and Huner, N.P.A. 2009. Introduction to plant physiology (4th ed.). Hoboken, NJ: John Wiley & Sons.
5. Wareing, P.F. and Phillips, I.D.J. 1981. Growth and Differentiation in Plants. 3rd edn. Pergamon Press, Oxford.
6. Malik, C.P. and Srivastava, A.K. 2002. Textbook of Plant Physiology. Kalyani Publishers, New Delhi.
7. Devlin, R.M. and Witham, F.H. 1983. Plant Physiology. 4thEdn. CBS Publisher and Distribution, Delhi.
8. Pandey, S.N. and Sinha, B.K. 1990. Plant Physiology. Vikas Publishing House Pvt. Ltd., New Delhi.
9. Pessarakli, M. 2001. Handbook of Plant and Crop Physiology. 2nd Edn. Marcel Dekker, Inc. New York.
10. Baskin, C.C. and J.M. Baskin. 2001. Seeds: Ecology, Biogeography, and Evolution of Dormancy and Germination. Academic Press, New York.
11. Tesar, M.B. (Ed.). 1984. Physiological Basis of Crop Growth and Development. Panima Pub. Corp., New Delhi.

Course Code: ABOT 505 **Course Title : Plant Metabolism (Compulsory)**	**Credit Hour: 03**	**Semester: January-June**

Rationale: This course is designed to impart knowledge on complex events of photosynthesis, respiration, and synthesis, degradation and translocation of organic compounds in plants.

Course Outcomes:

- Explain life-sustaining chemical transformations (catabolic and anabolic) within the cells of plants and relationship among them.
- Conceptualize the energy conversion processes and photosynthetic differences in C3, C4 and CAM in plants.
- Acquire knowledge on source-sink relation, secondary metabolites, enzymes and bioenergetics in plants.

Intended Learning Outcomes (ILOs) The students will be able to -	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Elucidate the energy conversion process in photosynthesis • Describe differences among C3, C4 and CAM plants in physiological and ecological points of view	**Photosynthesis:** Photochemical reactions and energy conversion process; carbon assimilation; CO2 concentrating mechanism in C4 and CAM plants; regulation of photosynthesis	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Essay type answer
• Explain different aspects of photorespiration	**Photorespiration:** Photorespiration and phosphoglycolate metabolism and regulation of photorespiration	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Essay type answer
• Show the relationship between source and sink	**Assimilate translocation:** Assimilate allocation and partitioning; source-sink relationship; mechanism of phloem loading and unloading.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Essay type answer
• Describe steps of carbohydrates breakdown in respiration	**Respiration:** Catalobic energy production; respiratory metabolism of carbohydrates.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Essay type answer
• Clarify respiratory metabolism of fats and proteins	**Lipid metabolism:** Respiratory metabolism of fats and proteins; control of respiration during storage and transportation of plants and plant parts.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Essay type answer
• Explain biological nitrogen fixation and protein synthesis	**Nitrogen metabolism:** Biological nitrogen fixation; primary and secondary nitrogen assimilation;	Lecture Discussion Visual presentation	Quiz/MCQ Short-answer Essay type answer

	nitrate and nitrite reductase activities and their relationship with photosynthesis; protein synthesis and protein yield relationship.		
• Illustrate the role of enzymes in plant metabolism • Develop clear concept on bioenergetics	**Enzymes and bioenergetics:** Enzyme classification; enzymatic control in plant metabolism; mode of enzyme action and mechanism of catalysis; biological oxidation and reduction; redox potential; ATP cycle and cell bioenergetics.	Lecture Discussion Visual presentation Feedback Assignment	Quiz/MCQ Short-answer Essay type answer Report
• Account with secondary metabolites and their role in plants	**Secondary metabolites:** Origin, distribution and chemistry of secondary metabolites in plants; role of secondary metabolites in plant metabolism.	Lecture Discussion Feedback	Quiz/MCQ Short-answer Essay type answer

Reference Books

1. Abrol, Y. P. Mohanty and Govindjee (eds.). 1993. Photosynthesis: Photoreactions to Plant Productivity. Oxford & IBH Pub. Co., New Delhi.
2. Bewley, J.D. and M. Black. 1978. Physiology and Biochemistry of Seeds in Relation to Germination. Springer-Verlag, Berlin.
3. Datta, S.C. 1994. Plant Physiology. Wiley Eastern Ltd., Calcutta.
4. Devlin, R.M. and F.H. Witham. 1983. Plant Physiology. 4th edn., CBS Pub., New Delhi.
5. Evans, L.T. (ed.). 1976. Crop Physiology: Some Case Histories. Cambridge University Press.
6. Govindjee (ed.). 1982. Photosynthesis Vol. I & II. Academic Press, New York.
7. Lehninger, A.L., D.L. Nelson and M.M. Cox. 1993. Principles of Biochemistry. Worth Pub. Inc., New York.
8. Salisbury, F.B. and C.W. Ross. 1986. Plant Physiology. 2nd edn. Wordsworth Pub. Co., California
9. Taize, L. and E. Zeiger. 1991. Plant Physiology. Benjamin/Cummings Pub. Co., California.
10. Nobel, P.S. 1999. Physiological and Environmental Plant Physiology. 2nd edn. Academic Press, New York.
11. Milthorpe, F.L. and J. Moorby. 1979. An Introduction to Crop Physiology. 2nd edn. Cambridge University Press, Cambridge.
12. Abrol, Y., P.N. Wattal, A. Gnanam, Govindjee, D.R. Ort and A.H. Teramura (eds.). 1991. Impact of Global Climatic Changes on Photosynthesis and Plant Productivity. Oxford & IBH Pub. Co., New Delhi.
13. Gupta, U.S. 1992. Crop Improvement Volume 1: Physiological Attributes. Oxford and IBH Pub. Co., New Delhi.

Course Code: ABOT 506 **Course Title: Plant Ecology (Compulsory)**	**Credit Hour: 03**	**Semester: July-December**

Rationale: This course is designed to provide fundamental aspects of ecology pertaining to agriculture.

Course Outcomes:

- Describe structures and functions of population, community, ecosystems, and biomes
- Illustrate the importance of the environment for living beings
- Explain the underlying causes of plant distribution over the Earth
- Conceptualize the processes of natural selection and evolution

Intended Learning Outcomes (ILOs) The students will be able to -	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Describe the structure and functions of ecosystem • Explain the relationship between the components of ecosystem	**Ecosystem**: Structural and functional components; flow of energy; biogeochemical cycling; cybernetics and homeostasis; trophic system in agriculture; productivity in natural and agro-ecosystems.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Essay-type answer
• Characterize the properties of a population • Conceptualize the strategies of population regulation	**Population biology**: Competition and other biotic interactions; population regulation and oscillation; carrying capacity.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Essay-type answer
• Illustrate structure of a community • Describe the mode of biological competition • Determine the relations between different communities	**Community**: Spatial and temporal variation in community structures; succession in natural and cultivated habitats; responses of crowding in monoculture; competition in crop mixtures; community response to limiting factors.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Essay-type answer
• Classify biomes and understand their composition • Justify the principles of plant distribution	**Biogeography**: World biomes; phytogeographic principles; conservation of biota.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Essay-type answer
• Interpret the process of natural selection • Evaluate the fundamental processes of evolution	**Natural selection**: Acclimatization and naturalization; forces of selection; fitness and adaptation.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Essay-type answer

Reference Books

1. Abrol, Y., P.N. Wattal, A. Gnanam, Govindjee, D.R. Ort and A.H. Teramura (eds.). 1991. Impact of Global Climatic Changes on Photosynthesis and Plant Productivity. Oxford & IBH Pub. Co., New Delhi.
2. Ambasht, R.S. 1978. A Text Book of Plant Ecology. Students Friends & Co., Varanasi.
3. Ciesla, W.M. 1995. Climate Change, Forests and Forest Management: An Overview. FAO, Rome.

4. Deshmukh, I. 1986. Ecology and Tropical Biology. Blackwell, Oxford.
5. Jackson, A.R.W. and J.M. Jackson. 1996. Environmental Science: The Natural Environment and Human Impact. Longman, Essex.
6. Kormondy, E.J. 1996. Concepts of Ecology. 4th edn. Prentice-Hall of India, New Delhi.
7. Kumar, H.D. 1995. General Ecology. Vikas Publishing House, New Delhi.
8. Lawrence, G.H.M. 1967. Taxonomy of Vascular Plants. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
9. Odum, E.P. 1971. Fundamentals of Ecology. 3rd edn. W.B. Saunders Co., Philadelphia.
10. Rosenberg, N.J., B.L. Blad and S.B. Verma. 1983. Microclimate: The Biological Environment. 2nd edn. John Wiley & Sons, New York.

Course Code: ABOT 507 **Course Title: Cell Physiology (Elective)**	**Credit Hour: 03**	**Semester: January-June**

Rationale: This course is designed to provide knowledge of cell physiology in order to gain critical thinking and skills required for cellular and physiological research.

Course Outcomes:

- Describe the structures and functions of basic cell components, especially macromolecules, cell wall, membranes, organelles, and cytoskeletons.
- Explain how cellular components are used to generate and utilize energy in cells.
- Identify formation and growth of cell wall in relation to cell shape.
- Illustrate how environmental stimuli and hormonal level influence physiological changes of cell, cell resistance and the adjustment.
- Develop the ability to critically analyze and interpret the results of the related scientific literature.

Intended Learning Outcomes (ILOs) The students will be able to -	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Describe cell structural components in relation to their function.	**Functional organization of cell:** Cell organization; biochemistry of cell; structures and functions of cell organelles.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Essay type answer
• Explain how cells respond with variation of environmental stimuli and the importance of phytochrome in plant. • Define hormone and explain the roles of major hormone groups.	**The cell environment:** Temporal organization of the cell; water, gases and pressure in the cell environment; radiation in the cell environment; temperature as a factor in the cell environment.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Essay type answer
• Illustrate the mechanism of membrane transport by pores and pumps: facilitated diffusion, active transport, co-transport.	**Exchange of materials across cell membrane:** The chemical nature and structure of cell membranes; movement of water and solutes across cell membrane.	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short-answer Essay type answer Report
• Explain how energy is generated and utilized inside cells.	**Correlation of energy and matter in the cell:** Cellular enzymes and their dynamics of action; release of energy in cells; oxidation-reduction potentials in cellular oxidation.	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Assignment Short-answer Essay type answer Report

• Discuss cell division, cell growth and differentiation.	**Cell division and growth:** Phases of cell division and growth; process of cellular growth; formation of plasma membrane and cell wall.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Essay type answer

Reference Books

1. Abrol, Y., P. Mohanty and Govindjee (eds.). 1993. Photosynthesis: Photoreactions to Plant Productivity. Oxford & IBH Pub. Co., New Delhi.
2. Bidwell, R.G.S. 1974. Plant Physiology. Macmillan, New York.
3. Datta, S.C. 1994. Plant Physiology. Wiley Eastern Ltd., Calcutta.
4. De Robertis, E.D.P., W. Nowinski and F.A. Shez. 1970. Cell Biology. 5th edn. Saunders Co., Philadelphia, USA.
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11. Salisbury, F.B. and C.W. Ross. 1992. Plant Physiology. 4th edn. Wordsworth Pub. Co., California.
12. Taize, L. and E. Zeiger. 1914. Plant Physiology. 6th edn. Benjamin/Cummings Pub. Co., California.

Course Code: ABOT 508 Course Title: Advanced Agro-climatology (Elective)	Credit Hour: 03	Semester: July-December

Rationale: This course is designed to provide the knowledge about climatic factors around the world as well as Bangladesh, climatic forecasting of extreme condition due to climate change and their manipulation for better agricultural production.

Course Outcomes:

- Describe the climatic features of different location of the world
- Explain/Predict the extremes condition due to climate change
- Apply knowledge to manipulate environment for agricultural production

Intended Learning Outcomes (ILOs) The students will be able to-	Course Content	Teaching-Learning Strategies	Assessment Strategies
• Describe the world climatic features impacting upon vegetable	**Climate and the geography of agriculture:** Characteristics and distribution of agro-climatological types and their impact upon vegetation and crops.	Lecture Discussion Visual presentation	Quiz/MCQ Short-answer Essay type answer
• Compare the distribution of climatic parameters in different areas of Bangladesh. • Investigate the causes of natural calamities and their impact on agricultural production	**Climate of Bangladesh:** Distribution of solar radiation, sunshine hours, temperature, precipitation, atmospheric humidity and evaporation; crop suitability in different areas based on climatic parameters; causes of drought, excessive rainfall, hailstorm and cyclone, and their impacts on crop production.	Lecture Discussion Visual presentation	Quiz/MCQ Short-answer Essay type answer
• Predict the climatic forecasting for crop production and management	**Agro-climatic forecasting:** Atmospheric and soil dryness indices for extremes of temperatures; climatological forecasting system for yield assessment, irrigation scheduling and outbreak of pests and diseases.	Lecture Discussion Visual presentation	Quiz/MCQ Short-answer Essay type answer
• Explain the influence of microclimatic on field crops and forest • Manipulate the microclimate environment for better crop production	**Microclimatic manipulation:** Microclimates of crop fields, orchards and forest and their influence and alteration for better crop production.	Lecture Discussion Visual presentation	Quiz Short-answer Essay type answer

Reference Books

1. Rosenberg, N.J. 1983. Microclimate: The Biological Environment. Wiley-Inter Science.
2. Ganesaraja, V. 2011. Agroclimatology: Principle and Predictions. Associated Pub, New Delhi, India.
3. Merkebu, G. 2013. Agro-Metorlogy and Climatology. Lambert Academic Publishing, Germany.
4. Ambasht, R.S. 1988. A Text Book of Plant Ecology, Nineth Edition. Students' Friends & Co. Varanasi, India.
5. Jones, H.G. Plants and Microclimate: A Quantitative Approach to Environmental Plant Physiology. Third Edition. Cambridge Press.
6. Hyoade, J.O.A. 1983. Introduction to climatology for the tropics. Chichester: John Wiley and sons.

Course Code: ABOT 509 **Course Title: Plant Growth Regulators (Elective)**	**Credit Hour: 03**	**Semester: January-June**

Rationale: This course is designed to provide the knowledge about the responses of plant to plant growth regulators and other plant bio regulators with reference to morphology, physiology and yield of crops.

Course Outcomes:

- Describe the importance and mode of action of plant growth regulators in plants.
- Acquire knowledge about the cellular functions in plants with the interactions of different plant bioregulators.
- Explain the mechanisms of plant adaptation and or adjustment under various environments with plant growth regulators.

Intended Learning Outcomes (ILOs) The students will be able to -	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Discuss plant growth regulators with reference to its classification, movement, active form and cellular concentration.	**Introduction:** Concept, classification and quantification of plant hormones and other growth substances; hormone sensitivity and correlation of growth with hormone concentration.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Essay type answer
• Describe the methods of detection and processes of biosynthesis and movement of auxin, gibberellins, cytokinin, abscisic acid, ethylene in plants. • Discuss physiological functions of different plant growth substances in plants from germination to senescence.	**Auxins, gibberellins, cytokinins, ethylene and abscissic acid:** Bioassay, metabolism and transport; biosynthesis; mechanism of action and physiological functions during growth and development of plant.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Essay type answer
• Explain the functions of uncommon natural growth substances or bio-regulators in numerous plant species to various environments.	**Other growth substances:** Occurrence and role of uncommon natural growth substances - morphactins, brassinosteroids, polyphenols, polyamines, fusicoccin and batasins; jasmonic acid in plants.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Essay type answer
• Demonstrate and compare the effect of exogenous application of plant growth regulators to change the yield of different agricultural crops.	**Use of growth substances:** Application of plant growth regulators in agriculture, horticulture and forestry.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Essay type answer

Reference Books

1. Taiz, L. and Zeiger, E. 1991. Plant Physiology, The Benjamin/Cummings Publishing Company, Inc. California, USA.
2. Salisbury, F. B. and Ross, C. W. 1986. Plant Physiology, CBS Publishing and Distributors, Delhi, India.
3. Hopkins, W. G. and Huner, N. P. A. 2009. Introduction to Plant Physiology, Fourth Edition, Wiley, John Wiley & Sons, Inc.
4. Arteca, R. N. 1997. Plant Growth Substances Principles and applications. CBS, Publishersand Distributors, Daryagonj, India.
5. Parihar, N. S. 1964. Hormonal Control of Plant Growth, Scientific Research Committee, Government of Uttar Pradesh, India.
6. Malik, C. P. and Srivastava, A. K. 1985. Text Book of Plant Physiology, Kalyani Publishers, New Delhi, India.
7. Ranjan, R., Purohit, S. S and Prasad V. 2008. Plant Hormones: Action and Applications, AGROBIOS, India.

Course Code: ABOT 510 **Course Title: Stress Physiology (Elective)**	**Credit Hour: 03**	**Semester: July-December**

Rationale: This course is designed to provide the knowledge about the responses of plant to various stresses and the mechanism of stress tolerance.

Course Outcomes:

- Acquire knowledge on metabolism and other physiological processes that control growth, development and productivity of crop plants under adverse environmental conditions.
- Explain the mechanisms of both abiotic and biotic stress tolerance in crop plants for the development of sustainable new genotypes agricultural as smart teaching techniques with changing climate.

Intended Learning Outcomes (ILOs) The students will be able to -	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Illustrate plant environment and environmental stress, yield variations under stress conditions	**Introduction:** Stress environments and types of stress; basis of yield variation under stress.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Essay type answer
• Explain morphological, physiological, biochemical and molecular changes in plants to water deficit and excess water stress. • Describe the physiological, biochemical and molecular mechanisms of water deficiency and excess water stress tolerance in crop plants	**Water stress:** Development and detection of water deficit in crops; type of injury; tolerance mechanism under drought and water logging conditions.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Essay type answer
• Explain the responses of crop plants to both heat and cold stress. • Explain physiological, biochemical and molecular mechanisms of temperature stress tolerance in crop plants	**Temperature stress:** Nature of injuries in plants under temperature extremes; tolerance mechanism in high and low temperature stress.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Essay type answer
• Describe the causes of salinity intrusion and it's effect on crop plants • Explain the physiological, biochemical and molecular mechanisms salt stress tolerance in crop plants	**Salinity stress:** Nature of stress; type of injury; tolerance mechanism; strategies to overcome salt stresses.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Essay type answer

• Realize the importance of plant nutrients and it's requirement. • Explain the cellular mechanism of nutrient deficiency and toxicity in different crops • Understand the effect and tolerance/resistance mechanism against metal/metalloid stress	**Nutrient stress:** Conditions causing nutrient stress and metal toxicity; mechanism of tolerances.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Essay type answer
• Describe the responses of plants to different light and ray conditions. • Explain the mechanism of irradiation stress tolerance in crop plants	**Irradiation stress:** Effect of light deficit and bright light on plants; resistance to injuries caused by high light intensities; ultraviolet ray and other ionizing radiation as stress.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Essay type answer
• Describe the changes of plants to oxygen deficit conditions. • Explain the mechanism of oxygen deficiency stress tolerance in crop plants	**Oxygen deficiency:** Shoot and root injury under oxygen deficit conditions its tolerance mechanism.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Essay type answer

Reference Books

1. Taiz, L. and Zeiger, E. 1991. Plant Physiology, The Benjamin/Cummings Publishing Company, Inc. California, USA.
2. Salisbury, F. B. and Ross, C. W. 1986. Plant Physiology, CBS Publishing and Distributors, Delhi, India.
3. Hopkins, W. G. and Huner, N. P. A. 2009. Introduction to Plant Physiology, Fourth Edition, Wiley, John Wiley & Sons, Inc.
4. Dwivedi, P. and Dwivedi, R. S. 2005. Physiology of Abiotic Stress in Plants, AGROBIOS, Jodhpur, INDIA.
5. Hemantaranjan, A. 1999. Advances in Plant Physiology, Scientific Publishers, P.O. BOX 91, Jodhpur, India.
6. Gupta, U. S. 2006. Physiology of Stressed Crops, Volume-I, Nutrient Relations, Oxford and IBH Publishers Co. Pvt. Ltd. New Delhi, India.
7. Bora, K. K., Singh, K. and Kumar, A. 2001. Stress and Environmental Physiology, Pointer Publisher, Jaipur, 302003 (Raj), India.
8. Hemnataranjan, A. 2003. Plant and Plant Molecular Biology, Scientific Publishers, P.O BOX, 91 Jodhpur, India.

Course Code: ABOT 511 **Course Title: Floral Biology (Elective)**	**Credit Hour: 03**	**Semester: July-December**

Rationale: This course is designed to provide intrinsic knowledge on floral morphology, developmental processes and physiology behind/involved.

Course Outcomes:

- Explain details of floral morphology.
- Describe phenological/developmental phases of pollen and ovule; process of anthesis, pollination and fertilization.
- Explicate endosperm, embryo, apomixis and polyembryony.

Intended Learning Outcomes (ILOs) The students will be able to -	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Know details about floral morphology	**Floral morphology:** Floral parts, appendages and their variation; evolution of micro- and macro-sporophylls.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Descriptive-answer
• Illustrate different developmental phases and quantify phenological phases of plants	**Phenology:** Phenological phases; quantifying phenological phases.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Descriptive-answer
• Recognize different stages of pollen development	**Pollens:** Development of pollen and male gametophyte; pollen structure.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Descriptive-answer
• Recognize process and stages of ovule development	**Ovules:** Formation of ovule and embryo sac; types of ovule, embryo sac, ovary wall and placentation.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Descriptive-answer
• Describe details about anthesis and pollination; factors affecting them and able to modify/enhance anthesis and pollination processes	**Anthesis and pollination:** Process of anthesis and factors affecting it; anther dehiscence; pollen transfer and artificial pollination.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Descriptive-answer
• Explain prerequisite, process and consequence of fertilization process	**Fertilization:** Pollen-stigma interaction; pollen germination; entry of pollen tubes into embryo sac; fusion of gametes; process and types of fertilization.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer question Descriptive-answer
• Describe the process of different endosperm and embryo formation	**Endosperm and embryo:** Formation of the different types of endosperm and embryo.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Descriptive-answer

• Describe detail about apomixis and polyembryony	**Apomixis and polyembryony:** Types of apomixis; development of embryo in aposporic embryo sac; causes, types and practical implication of polyembryony.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Descriptive-answer

Reference Books

1. Hemantaranjan, A. (Ed). 2003. Advances in Plant Physiology. Scientific Publishers, New Delhi.
2. Salisbury, F. and Ross C. 1978. Plant Physiology. Wads Worth Pub Co., Belmont.
3. Taiz, L. and Zeiger, E. 2002. Plant Physiology. Sinauer Associates, Inc. Publishers, USA.
4. Hopkins, W.G. and Huner, N.P.A. 2009. Introduction to plant physiology (4th ed.). Hoboken, NJ: John Wiley & Sons.
5. Skene, M. 1993. The Biology of Flowering Plants. Discovery Publishing House, New Delhi.
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7. Wareing, P.F. and Phillips I.D.J. 1981. Growth and Differentiation in Plants. 3rd edn. Pergamon Press, Oxford.
8. Malik, C.P. and Srivastava, A.K. 2002. Textbook of Plant Physiology. Kalyani Publishers, New Delhi.
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10. Pandey, S.N. and Sinha, B.K. 1990. Plant Physiology. Vikas Publishing House Pvt. Ltd., New Delhi.
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12. Baskin, C.C. and Baskin, J.M. 2001. Seeds: Ecology, Biogeography, and Evolution of Dormancy and Germination. Academic Press, New York.
13. Maheshwari, P. 1978. An Introduction to the Embryology of Angiosperms. Tata McGraw-Hill Pub. Co., New Delhi.
14. Tesar, M.B. (ed.). 1984. Physiological Basis of Crop Growth and Development. Panima Pub. Corp., New Delhi.

Course Code: ABOT 512 Course Title: Seed Physiology (Elective)	Credit Hour: 03	Semester: July-December

Rationale: This course is designed to provide the knowledge on physiological processes of seed development, germination and it's utilization in production.

Course Outcomes:

- Gather knowledge about the physiology of fruit and seed developed.
- Describe the physiological processes of assimilation and maturity of seed.
- Develop knowledge on seed dormancy and its germination.
- Obtain the concept of seed viability, storage and it's utilization.

Intended Learning Outcomes (ILOs) The students will be able to -	Course Content	Teaching-Learning Strategies	Assessment Strategies
• Illustrate the mechanism of seed development • Show the structure of different seeds	**Seed development:** Development of seeds and fruits; seed structures.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Explain the physiological processes of assimilation and maturation of seed	**Seed growth and maturation:** Source of assimilates; physiological maturity; metabolism during drying and rehydration in orthodox and recalcitrant seeds.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Illustrate the metabolic change during seed germination • Elucidate the causes of dormancy and viability loss	**Dormancy and germination:** Biological role, types, causes and breaking of seed dormancy; control of dormancy and germination; water uptake, soaking injury and solute leakage; causes and metabolic consequences of viability loss.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Discuss the physiological principle of storage and longevity of seed	**Physiology of seed production, utilization and storage:** Viability and longevity of seeds; malting and pre-harvest sprouting in cereals; physiological principles of seed storage; causes and metabolic consequences of viability loss.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer

Reference Books

1. Arnold, R.B. and Snchez, R. 2004. Handbook of Seed Physiology: Application to Agriculture. CRC Press.
2. Dutta, A.C. 1975. A Class Book of Botany. Oxford University Press, India.
3. Taiz, L. and Zeiger, E. 2002. Plant Physiology. Sinauer Associates, Inc. Publishers, USA.
4. Bryant, J.A. 1985. Seed Physiology. Edward Arnold Publishing, London, UK.

Course Code: ABOT 513 **Course Title: Biodiversity and Conservation (Elective)**	**Credit Hour: 03**	**Semester: January-June**

Rationale: This course is designed to provide knowledge about biodiversity and its conservation methods.

Course Outcomes:

- Describe different levels of biodiversity.
- Evaluate the importance of maintaining and conserving biodiversity of an area.
- Explain the causes of biodiversity loss.
- Illustrate the process of biodiversity conservation.

Intended Learning Outcomes (ILOs) The students will be able to -	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Illustrate the causes of diversification in life on the biosphere • Point out the sources of biodiversity	**Sources of diversity**: Natural and artificial selection, random events, variability in population, racial differentiation, isolation, speciation, hybridization, mutation, and other breeding methods.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Essay-type answer
• Show the centers of origin of crop plants • Visualize the mode of spreading of the crops from their origin	**Centers of diversity**: Centers of origin of crop plants, their past and present geographic distribution, trends of future spread and extinction.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Essay-type answer
• Select the genetic resources present in an area • Describe the utility of genetic resources	**Plant genetic resources**: Genetic diversity in agriculture, crop diversity and stability, change in genetic structures, cultivar development, genetic advance and maintenance of diversity.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Essay-type answer
• Evaluate the potential threats of biodiversity • Differentiate between natural and anthropogenic causes of species extinction	**Biodiversity crisis**: Effect of population pressure, causes and rate of extinction, natural and artificial selection pressures, monoculture and modern agriculture.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Essay-type answer
• Explain the process of biodiversity conservation • Plan to utilize appropriate strategies of biodiversity conservation	**Biodiversity conservation**: Principles of conservation and preservation; in situ conservation methods, ex situ conservation methods.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Essay-type answer

Reference Books

1. Ambasta, S.S.P., S.K. Ramachandran, S.K. Kashyapa and S.R. Chand (eds.). 1986. The Useful Plants of India. Publication and Information Directorate, New Delhi, India.
2. Bell, P.R. 1992. Green Plants: Their Origin and Diversity. Cambridge University Press, Cambridge.
3. Collins, W.W. and Qualset, C.O. (eds.). 1999. Biodiversity in Agroecosystems. Lewis Pub., New York.
4. Dastur, J.F. 1977. Medicinal Plants of India and Pakistan. D.B. Taraporevata Sons & Co., India.
5. Hancock, J.F. 2004. Plant Evolution and the Origin of Crop Species. 2nd edn. CABI Pub., Cambridge.
5. Joshi, S.G. 2000. Medicinal Plants. Oxford & IBH Pub. Co., New Delhi.
6. Langer, R.H.M. and G.D. Hill. 1991. Agricultural Plants. Cambridge University Press, Cambridge.
7. Simmonds, N.W. (ed.). 1976. Evolution of Crop Plants. Longman, Essex.
8. Sofo, A. 2011. Biodiversity. InTech, Rijeka, Croatia.

Course Code: ABOT 514 **Course Title: Crop Physiology (Elective)**	**Credit Hour: 03**	**Semester: January-June**

Rationale: The course is designed to produce the knowledge of crop physiology in order to provide the knowledge of physiological process and management related to crop production and crop improvement.

Course Outcomes:

- Realize the importance and mechanisms of water and nutrients uptake and their cellular distribution.
- Explain the processes of solar energy conversion into chemical energy and their metabolism.
- Develop knowledge on physiological mechanisms of plant growth and development.
- Gather knowledge about plant responses to stresses.

Intended Learning Outcomes (ILOs) The students will be able to -	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Understand the importance of radiation and energy balance on crop physiology as well as yield • Evaluate the optimization and modulation of energy balance for better crop production	**Energy balance:** Radiation and energy balance in crop field; energy relation and production factors; limiting factors; optimization and efficiency of crop growth; modification of the energy balance for the improvement of crop production.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Descriptive-answer
• Describe different physiological processes related to better crop production • Show the photosynthetic • and respiratory mechanism	**Physiological basis of crop yield:** Radiation energy load; evaporative demand; crop water use; photosynthetic and respiratory mechanisms; source-sink relation; assimilate translocation, mobilization and partitioning; water-and nitrogen-use efficiency.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Descriptive-answer
• Describe the concept and procedure of ideotype of different agricultural crops	**Plant ideotype:** Concept of plant architecture and ideotype; crop geometry and orientation; modeling of crop ideotypes in important agricultural and horticultural crops.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Descriptive-answer
• Explain different competition pattern. Describe the importance of synergisms and allelopathy.	**Competitive production principles:** Pattern of competition for above and below ground resources; facilitation and the partitioning of light environment; synergisms and allelopathy	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Descriptive-answer

• Describe the physiological process of different economic crops.	**Physiology of crops:** Physiology of cereal, sugar, fibre, oilseed, pulse and horticultural crops.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Descriptive-answer
• Analyze the parameters related to physiology of plant.	**Plant growth analysis:** Classical and functional growth analysis; component and technique of plant growth analysis.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Descriptive-answer

Reference Books

1. Hemantaranjan, A. (Ed). 2003. Advances in Plant Physiology. Scientific Publishers, New Delhi.
2. Salisbury, F. and Ross, C. 1978. Plant Physiology. Wads Worth Pub Co., Belmont.
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11. Taizand, L. and Zeiger, E. 1991. Plant Physiology. The Benjamin/Cummings Pub. Co. Inc., California.
12. Gupta, P. and Kumar, S. 2001. Plant Physiology. East West Press, Delhi.
13. Devlin, R.M. and Witham, F.H. 2000. Plant Physiology. 4thEdn. CBS Pub., Delhi.
14. Pandey, S.N. and Sinha, B.K. Plant Physiology. 2nd Revised Edn. Vikas Pub., New Delhi.

Course Code: ABOT 515 **Course Title: Economic Botany (Elective)**	**Credit Hour: 03**	**Semester: January-June**

Rationale: This course is designed to provide knowledge on economically important crop plants, their productions and prospect of cultivation.

Course Outcomes:

- Categorize the plants based on basic requirements of human being.
- Provide knowledge on the economic importance of lower and higher plants.
- Get acquaintance with the conventional and alternate use of under-utilized crop plants.

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Discuss the importance of different plants and plant products that fulfill the basic needs of people	**Introduction:** Importance of plants and plant products as food, clothing, medicine and shelter.	Lecture Discussion Visual presentation	Quiz Short-answer Descriptive-answer
• Classify the lower plants based on key characteristics • Identify the economically important lower plants for commercially uses	**Cryptograms:** Economically important bacteria, algae, lichens, yeast, bryophytes and pteridophytes.	Lecture Discussion Visual presentation	Quiz Short-answer Descriptive-answer
• Describe the products obtained from gymnosperm • Identify the economically important gymnosperms for commercial uses	**Gymnosperms:** Economically important gymnosperm and their products.	Lecture Discussion Visual presentation	Quiz Short-answer Descriptive-answer
• Explain the industrial value plants and plant parts obtained from angiosperms. • Illustrate the prospect of cultivation of higher plants in Bangladesh	**Angiosperms:** Economically important angiosperms - industrial, medicinal, flavoring, beverage plants and their products.	Lecture Discussion Visual presentation	Quiz Short-answer Descriptive-answer
• Explain the symbolic association between higher and lower plants • Utilize the symbiotic association for better crop production • Compare and contrast the synergism & antagonism	**Symbiosis:** Associations of actinomycetes, bacteria, blue green algae and fungi with pteridophytes and other higher plants.	Lecture Discussion Visual presentation	Quiz Short-answer Descriptive-answer
• Categorize the under-utilized crop plants • Discuss the conventional use of underutilized crops	**Under-utilized crop plants:** Under-utilized crop plants, their conventional and alternate uses and importance.	Lecture Discussion Visual presentation	Quiz Short-answer Descriptive-answer

• Identify the medicinal plants • Discuss the pharmaceutical importance of medicinal plants • Utilize the medicinal plants commercially	**Medicinal plants:** Medicinal plants of Bangladesh and their identification; conventional and alternate uses and importance; chemistry of the alkaloids and other secondary metabolites of pharmaceutical importance.	Lecture Discussion Visual presentation	Quiz Short-answer Descriptive-answer

Reference Books

1. Hill, A.F. 1979. Economic Botany: A Textbook of Useful Plants and Plants Products. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
2. Verma, V. 2009. Textbook of Economic Botany. Ane Books, India.
3. Panshin, A.J. and Zeeuw, C. 1980. Textbook of wood technology. McGraw-Hill Book Co. NewYork, USA.
4. Kochhar, 2009. Economic Botany in the Tropics. Macmillan Publishers India Ltd.
5. Pandey, B.P. 1999. Economic Botany. S. Chand Ltd.
6. Pooja, 2010. Economic Botany. Discovery Publishing House.

Course Code: ABOT 516 **Course Title: Agricultural hazards and their control (Elective)**	**Credit Hour: 03**	**Semester: July-December**

Rationale: This course is designed to provide information on causes and impacts of different kinds of environmental pollution and environmental hazards; waste disposal and remedial measures from damages caused by heavy metals.

Course Objectives

- Realize the causes of environmental pollution and remedial strategies.
- Explain greenhouse effects and reason of ozone layer depletion and approaches.
- Describe waste disposal management and recycle/re-use process.
- Gather knowledge about heavy metal effects and remedy.

Intended Learning Outcomes (ILOs) The students will be able to -	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Explain the effects of different environmental pollutants • Describe the remedy from damaging effects of pollutants	**Aspect of environmental pollution:** Causes and impact of air, water, soil, noise, radiation and other environmental pollution; their effects on vegetation, forest and agriculture; strategies to elucidate with pollution.	Lecture Visual presentation Discussion Visit of affected area Assignment	Quiz/MCQ Short-answer Descriptive-answer Report on field visit
• Describe the factors contributing to green house effects • Explain impacts on global climate and plant community, and its remedy	**The greenhouse effects:** Factors contributing to greenhouse effects; their sources and sinks; impacts of global and local climates on vegetation, forest and agriculture.	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short-answer Descriptive-answer Report
• Describe nature and impacts of various form of wastes on environment • Explain waste disposal and recycling methods	**Waste disposal and management:** Nature of industrial, agricultural, urban and rural wastes; impacts of wastes on the environment and	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short-answer Descriptive-answer Report
• Describe nature and impacts of various form of wastes on environment • Explain waste disposal and recycling methods	**Waste disposal and management:** Nature of industrial, agricultural, urban and rural wastes; impacts of wastes on the environment and agriculture; methods of waste disposal, recycling and re-use.	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short-answer Descriptive-answer Report

• Illustrate the means of damages caused by different natural hazards and the management strategies	**Natural hazards:** Causes and effects of natural hazards like cyclone, hailstorm, tornado, fire, earthquake and landslide; their management.	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short-answer Descriptive-answer
• Explain the mechanisms of heavy metal-induced damages to agricultural products • Describe how to remediate the adverse effects of heavy metals	**Heavy metal effects:** Heavy metal effects on agricultural products and their remedial measures.	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short-answer Descriptive-answer

Reference Books

1. Anjum NA, Pereira MA, Ahmad I, Duarte AC, Umar S, Khan NA (eds). 2012. Phytotechnologies: Remediation of Environmental Contaminants. Taylor and Francis/CRC Press, USA. pp. 7-73. ISBN: 9781439875186; ISBN 10: 1439875189.
2. Simone Morais, Fernando Garcia e Costa and Maria de Lourdes Pereira. 2012. Heavy Metals and Human Health, Environmental Health - Emerging Issues and Practice, Prof. Jacques Oosthuizen (Ed.), InTech, DOI: 10.5772/29869. Available from: https://www.intechopen.com/books/environmental-health-emerging-issues-and-practice/heavy-metals-and-human-health
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4. Mehran Hoodaji, Mitra Ataabadi and Payam Najafi. 2012. Biomonitoring of Airborne Heavy Metal Contamination, Air Pollution - Monitoring, Modelling, Health and Control, Dr. Mukesh Khare (Ed.), InTech, DOI: 10.5772/32963. Available from: https://www.intechopen.com/books/air-pollution-monitoring-modelling-health-and-control/biomonitoring-of-airborne-heavy-metal-contamination
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7. Sung Ju Cho, Jinxiu Ding, Bruce A. Mc Carl and Chin-Hsien Yu. 2011. Economic Impacts of Climate Change on Agriculture: Adaptation and Vulnerability, Climate Change - Socioeconomic Effects, Dr Houshan Kheradm (Ed.). In Tech, DOI: 10.5772/24590. Available from: https://www.intechopen.com/books/climate-change-socioeconomic-effects/economic-impacts-of-climate-change-on-agriculture-adaptation-and-vulnerability
8. Bharat Raj Singh (Ed). 2013. Climate Change - Realities, Impacts Over Ice Cap, Sea Level and Risks. ISBN 978-953-51-0934-1, 522 pages, Publisher: In Tech, Chapters published January 16, 2013 under CC BY 3.0 license.DOI: 10.5772/3459

Course Code: ABOT 517 **Course Title: Statistical Approach in Agricultural Research (Elective)**	**Credit Hour: 03**	**Semester: January-June**

Rationale: This course is designed to impart a solid foundation on experimentation, biometry and interpretation of agricultural research findings.

Course Outcomes:

- Explain Agricultural Research Methodology.
- Develop ability to use of different statistical techniques of data analysis and mean comparison.
- Acquire basic knowledge on thesis and scientific paper writing and presentation.

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Elucidate the different aspects of agricultural research	Research planning, monitoring and evaluation.	Lecture Practical demonstration Discussion	Quiz/MCQ Short-answer Essay type answer
• Explain data collection procedure and tabulation	Data collection and tabulation.	Lecture Visual presentation Discussion Field visit	Quiz/MCQ Short-answer Essay type answer Report
• Collect samples	Sampling, field plot techniques.	Lecture Visual presentation Field visit Discussion	Quiz/MCQ Short-answer Essay type answer
• Acquire knowledge on some important parameters of statistics	Standard deviation, coefficient of variation, standard error, test of hypothesis, analysis of variance.	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short-answer Essay type answer Report
• Prepare layout of agricultural experiments independently • Draw and interpret conclusion	Design of experiments, principles of design, types of design.	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short-answer Essay type answer Report
• Perform correlation and regression analysis	Correlation and regression analysis.	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short-answer Essay type answer Report

• Use multiple comparison techniques	Multiple comparison procedures.	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short-answer Essay type answer Report
• Use computer software for data analysis	Use of computer in data analysis software packages.	Lecture Visual presentation Discussion	Quiz/MCQ Short-answer Essay type answer Report Problem solve
• Interpret experimental results	Interpretation of results.	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short and Essay type answer
• Write and present experimental findings	Writing of seminar paper, assignment, scientific paper and thesis; presentation of experimental findings.	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short and Essay type answer Report

Reference Books

1. Zaman, S.M.H, Rahim, K. and M. Howlader. 1982. Simple Lesson from Biometry. Publication No 54, Bangladesh Rice Research institute, Dhaka, Bangladesh
2. Gomez, K. A. and Gomez, A. A. 1984. Statistical Procedures for Agricultural Research (2^{nd} edn.). John Willey and Sons, Singapore.
3. Steel, R. G. D. and Torrie, J. H. Principles and Procedures of Statistics; A Biometrical Approaches. McGraw Hill Inc. USA.
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5. Gupta, C. B. and Gupta, V. An Introduction to Statistics Methods (8^{th} edn.) Vikas Publishing Pvt. Ltd. New Delhi.
6. Wonnacott, T. H. and Wonnacott, R. J. 1990. Introductory Statistics (5^{th} edn.) John Willey and Sons, New York.
7. Ahamed, A. R. Bhuya, M. A.A., Reza, Z. A. and Hossain, Z. 2015. Methods of Statistics (6^{th} edn.) Bangladesh.
8. Ali, M. A. 1973. Theory of Statistics. Dhaka Book Mart, Banglabazar, Dhaka.
9. Islam, N. N. 2011. An Introduction to Statistics Probability (4^{th} Edn.), Mullicks and Brothers, Dhaka.

Department of Agricultural Chemistry

Course Layout

Sl. No.	Course Code and Title		Cr. Hrs.
A. Compulsory Courses			
1	AGCH 501: Fertilizer Technology and Usage		03
2	AGCH 502: Instrumental Methods of Analysis		03
3	AGCH 503: Colloid Chemistry in Relation to Plant Nutrition		03
4	AGCH 504: Analyses of Fertilizer, Pesticide, Heavy Metals in Plant, Soil and Water		03
5	AGCH 505: Chemistry of Pesticide		03
6	AGCH 506 : Environmental Chemistry		03
	Total		**18**
B. Elective Courses			
7	AGCH 507: Formulation and Safety of Pesticides		03
8	AGCH 508: Chemistry of Manures and Fertilizers		03
9	AGCH 509: Chemistry of Plant Products		03
10	AGCH 510: Mineral Nutrition and Plant Growth		03
11	AGCH 511: Water and Solution Chemistry		03
12	AGCH 512: Chemistry and Technology of Agro-industrial Crops		03
13	AGCH 513: Chemistry of Bio-farming		03
14	AGCH 514: Irrigation Water Quality		03
15	AGCH 515: Nuclear Chemistry and Tracer Techniques		03
16	AGCH 516: Research Methodology for Agricultural Chemistry		03
	Minimum		**12**
C. Seminar Course			
22	AGCH: 598		01
D. Thesis Research			
23	AGCH: 599		16
		Compulsory Courses	**18**
		Elective Courses	**12**
		Seminar Course	**01**
		Thesis Research	**16**
		Total	**47**

Curriculum Alignment / Skill Mapping

Curriculum must be aligned with program objectives, program learning outcome and intended learning outcomes through proper skill mapping.

Department of Agricultural Chemistry

Courses	Program Learning Outcome							
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
AGCH 501	x	x	x	x			x	x
AGCH 502	x	x	x	x			x	x
AGCH 503	x	x	x	x	x		x	x
AGCH 504	x	x	x	x			x	x
AGCH 505	x	x	x	x			x	x
AGCH 506	x	x	x	x			x	x
AGCH 507	x	x	x	x	x		x	x
AGCH 508	x	x	x	x			x	x
AGCH 509	x	x	x	x		x	x	x
AGCH 510	x	x	x	x	x		x	x
AGCH 511	x	x	x	x	x		x	x
AGCH 512	x	x	x	x	x		x	x
AGCH 513	x	x	x	x	x		x	x
AGCH 514	x	x	x	x			x	x
AGCH 515	x	x	x	x	x		x	x
AGCH 516	x	x	x	x			x	x
AGCH 598		x				x	x	x
AGCH 599	x	x	x	x	x	x	x	x

Course Code: AGCH 501 Course Title: Fertilizer Technology and Usage (Compulsory)	Credit Hours: 03	Semester: January -June

Rationale: This course is designed to provide comprehensive and balanced understanding of essential link between industrial manufacturing, chemistry and application techniques of different fertilizers. It is therefore vital for Agricultural chemists to understand flow diagram for industrial productions and its application techniques for variety of fertilizers including essential plant nutrients containing-fertilizers.

Course Outcomes:

- Demonstrate clear idea on different fertilizers' production technology, manufacturing process, quality specification and properties.
- Generalize and adopt manufacturing process of macro and micro nutrient fertilizers
- Summarize and justify different physical and chemical properties of fertilizers
- Predict the economic feasibilities of fertilizer manufacturing in Bangladesh and also formulate the compatibility among different agrochemicals

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Demonstrate the clear concept of raw materials necessary for different fertilizers' manufacture • Predict the present scenario of worldwide fertilizer production	**Fertilizers:** Concepts of fertilizer development; raw materials and reserves	Lecture Demonstration Presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Compose, design and plan the production and refining technology of macronutrient fertilizers • Predict the best macronutrient fertilizers for certain (acidic, alkaline, saline etc.) soil conditions • Explain the mineralogy of potash ores, mining and refining of muriate of potash (MOP)	**N, P and K fertilizers:** Chemistry, production technology, uses, comparative studies and factors influencing choice of nitrogenous and phosphatic fertilizers- urea, DAP, SSP and TSP; field study for manufacturing technology of commonly used nitrogenous and phosphatic fertilizers in Bangladesh; mineralogy of potash ores, mining and refining of muriate of potash (MOP)	Lecture Demonstration Video tapes Factory visit Assignment	Quiz/MCQ Short answer Essay type answer Report
• Describe the concept of secondary and micronutrient fertilizers • Design and plan the production or manufacturing technology of secondary and micronutrient fertilizers	**Secondary and micronutrient fertilizers:** Chemistry and production technology of gypsum, magnesium sulphate, zinc sulphate, borax and ammonium molybdate fertilizers	Lecture Demonstration Factory visit Assignment	Quiz/MCQ Short answer Essay type answer Report

• Justify the appropriate secondary and micronutrient fertilizer for different crops and certain soil conditions			
• Describe mixed, liquid and controlled release fertilizers • Design and plan the production or manufacturing technology of mixed, liquid and controlled release fertilizers • Justify and predict properties, uses, advantages and disadvantages of these fertilizers	**Mixed, liquid and controlled released fertilizers:** Preparation, properties, uses, advantages and disadvantages	Lecture Demonstration Factory visit Assignment	Quiz/MCQ Short answer Essay type answer Report
• Identify the pollutions causing by fertilizer industry • Interpret/employ the remedy, fertilizers pollution	**Pollution related to fertilizer production and use**	Lecture Field visit Assignment	Quiz/MCQ Short answer Essay type answer Report
• Describe ideas about physical and chemical properties of fertilizers • Justify the fertilizers quality depending on different physical and chemical properties • Illustrate the chemical compatibility of fertilizers analyses • Interpret fertilizers quality depending on specification	**Physical and Chemical Properties of Fertilizer:** Particle size, Segregation properties, Granule hardness, Angle of repose, Bulk Apparent specific gravity, Critical relative humidity, Moisture absorption-penetration characteristics, Caking of fertilizers, Chemical compatibility in blends, Dustiness and conditioner adherence, Melting point Physiological acidity and basicity of fertilizers, Salt index **Fertilizer Specification:** Concepts of fertilizer specification. Elements of fertilizer specification and specification of different fertilizers	Lecture Visual presentation Group discussion	Quiz/MCQ Short answer Essay type answer
• Design the cost benefits of fertilizer production	**Economic feasibility of fertilizer**: Feasibility of establishment of fertilizer factory in Bangladesh and their use efficiency	Lecture Case study Group discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Analyze the suitability of different mixed fertilizers	Compatibility among fertilizers with other agrochemicals.	Lecture Demonstration	Quiz/MCQ Short answer Essay type answer

			Report

Reference Books

1. Das, R.K. 1987. Industrial Chemistry, Part-2, Kalyani Publishers, New Delhi, India. Gustafson A. F. 2010. Handbook of Fertilizers. Agrobios, India.
2. Havlin, J.L.; Beaton, J.D.; Tisdale, S.L. and Nelson, W.L. 1999. Soil Fertility and Fertilizers, 6th edition,. Prentice-Hall, Inc., Upper Saddle River, New Jersey, USA.
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6. Olsen, R.A. (Ed.) 1971. Fertilizer Technology and Use. 2nd edition, Soil Science Society of America, Inc. Madison, Wisconsin, USA.
7. UNIDO and IFDC (Eds.) 1998. Fertilizer Manual. Kluwer Academic Publishers. Dordrecht, The Netherlands.
8. Van Slyke. 2010. Fertilizers and Crop Production. Agrobios, India.
9. Van Vuren, J.P.J. 2002. Soil Fertility and Sewage. Agrobios, India.

Course Code: AGCH 502 **Course Title: Instrumental Methods of Analysis (Compulsory)**	**Credit Hours: 03**	**Semester: July- December**

Rationale: This course is designed to enrich knowledge and skill on the instrumental methods and analysis. This course will provide knowledge on the theory of operation, instrumental design, methodology and applications of instrumental techniques of different instruments for

Course Outcomes:

- Demonstrate a clear idea about different scientific methods of different instruments for nutrient analysis and characterization of different plant products
- Generalize the theoretical principles behind modern analytical instrumentation
- Organize knowledge on modern analytical instrumentation with deep idea in its core concepts and how to apply it in a range of situations
- Design the cognitive, technical and creative skills to enable the graduates to apply established knowledge and practice concerning modern analytical instrumentation and measurement techniques to a range of situations

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Explain principles and related theories of colorimetry and spectrophotometry • Criticize, compare and summarize those principles and theories • Predict and outline the methods of colour measurements • Operate colorimeter and spectrophotometer for sample analysis	**Colorimetry and Spectrophotometry:** Principle and theory of spectrophotometry; methods of colour measurement; instrumentation and application of colorimetry and of spectrophotometry	Lecture Demonstration Presentation Group activities Assignment Project discussion	Quiz/MCQ Short answer Essay type answer Group performance Report
• Demonstrate clear concept of the principle and theory of FES, AAS, AFS, ICP, MS and NMR • Diagram the Instrumentation of above principles and theories • Apply and maintain FES, AAS, AFS, ICP, MS and NMR. • Categorize and differentiate the use of individual instrument for specific analytical purpose	**Atomic spectrometry:** Principle and theory of atomic emission and atomic absorption spectrophotometry; instrumentation and application of flame emission spectrophotometer (FES) and atomic absorption spectrophotometer (AAS); interferences in spectrophotometric	Lecture Visual presentation Demonstration Group activities Group practice Project laboratory visit	Quiz/MCQ Short answer Essay type answer Demonstration performance

• Design and generalize these techniques for higher research	analysis; principles, instrumentation application of atomic fluorescence spectrometry (AFS) and inductively coupled plasma spectrometry (ICP). Mass spectrometry: Principles, instrumentation and application of mass spectrometry (MS); hyphenated systems. Nuclear magnetic resonance spectrometry: Theory, instrumentation and application of nuclear magnetic resonance spectrometry		
• Show operation, analytical and maintenance skill of pH meter and conductivity meter • Operate, calibrate and maintain pH and conductivity meter • Describe the principle and analytical procedure of pH and EC determination	**pH and conductivity measurement:** Principle, calibration and maintenance of pH and conductivity meters	Lecture Discussion Demonstration Group activities/ Practice	Quiz/MCQ Short answer Essay type answer Practical examination
• Describe concept of chromatography, working principle of different classes of chromatography, • Predict separation technique and related theories of CC, PC, TLC, IC, GC, HPLC etc. • Organize skill full analytical inference for identification, quantification as well as interpretation • Summarize the working principles of different chromatographic methods • Describe major steps of GC, HPLC operations and analytical procedures	**Chromatography:** Brief history, General Factors, Terminology , Classification, Separation Characteristics Column chromatography: Technique, Major Components, Method of separation, identification, Paper chromatography: phases, basic technique, Types of forces involved, Major steps involved in basic operations and their description, Thin layer chromatography (TLC):	Lecture Demonstration Visual presentation Group activities Group practice Assignment	Quiz/MCQ Short answer Essay type answer Presentation performance Report
• Analyze samples by using CC, TLC, IC, GC and HPLC	Why it is better than CC and PC, Recent advancement, major steps involved in basic operation, Ion chromatography (IC):		

	phases, basic technique, Major steps involved in basic operations and their description, Gas chromatography (GC): Classification, Instrumentation, Basic theory, Different columns and detectors, merits and demerits. High performance liquid chromatography (HPLC), Supercritical fluid chromatography (SFC). High performance anion exchange chromatography (HPAEC): Classification, Instrumentation, Separation process/ theory, merits, demerits.		
• Illustrate and elaborate preliminary knowledge for the maintenance and troubleshooting activities of laboratory instruments	**Laboratory instrumentation:** Maintenance and trouble shooting of laboratory instruments.	Lecture Visual presentation Demonstration Group work Assignment	Quiz/MCQ Short answer Essay type answer Demonstration performance Presentation performance Report

Reference Books

1. Ahuja, S. 2003. Chromatography and Separation Science.Vol.4, Academic Press, California, USA.
2. Chopra, L.S. and Kanwar, J.S. 1991. Analytical Agricultural Chemistry. 4th edition, Kalyani Publishers, Ludhiana, New Delhi. India.
3. Fritz, J.S. and Schenk, G.H. 1987. Quantitative Analytical Chemistry. 5th edition,Prentice Hall, Englewood Cliffs, New Jersey 07632, USA.
4. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G. and Tatchell, A.R. 2016. Vogel's Textbook of Practical Organic Chemistry. 5th edition, 15th impression, Pearson Education Ltd. India.
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6. Patania, V.B. 2004. Spectroscopy. Campus Books Internationl, New Delhi, India.
7. Silverstein, R.M., Webster, F. X., Kiemle, D.J. and Bryce, D. L. 2015. Spectromertric Identification of Organic Compounds. 8th edition, John Wiley & Sons, Inc., Wiley India Pvt Ltd., New Delhi, India.
8. Singh, A.K. 2 013. Encyclopaedia of Applied Spectroscopy. 1st Edition, Centrum Press, New Delhi, India.
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11. Skoog, D.A.; West, D.M. and Holler, F.J. 2001. Fundamentals of Analytical Chemistry. 7th edition

Harcourt Asia Pte Ltd., Singapore.
12. Tuzimski, T. and Sherma, J. 2015. High Performance Liquid Chromatography in Pesticide Residue Analysis. Chormatographic Science Series, V.109, CRC press, Taylor and Francis Group, Tj International Ltd, Padstow, Cornwall, Great Britain.
13. Willard, H.H.; Merritt, L.L. Jr, and Dean, J.A. 1988. Instrumental Methods of Analysis. 7th edition. Wadsworth Publishing Company, Belmont, California, USA.

Course No.: AGCH 503 **Course Title: Colloid Chemistry in Relation to Plant Nutrition (Compulsory)**	**Credit Hours: 03**	**Semester: January-June**

Rationale: Colloid chemistry/ soil colloid plays an important role in the release, transfer, uptake and utilization of plant nutrients by the plant. This course will expertize the students regarding basic and applied knowledge on chemistry of colloids in relation to plant nutrition. Agricultural chemists are then projected to have knowledge on different types of colloids and their relationship between plant soil systems.

Course Outcomes:

- Summarize the nature and types of colloids and their properties
- Generalize the cation and anion exchange in soils and plants
- Interpret the laws governing ionic reactions
- Describe nutrients accumulation and metabolism in plants

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Describe different types of colloids • Illustrate mineralogy of silicate clay and humic colloids • Achieve knowledge about charge development	**Colloid Chemistry:** Nature and types of colloids, properties and mineralogical organization of silicate clay and humic colloids; development of charges of soil colloids	Lecture Visual presentation Discussion	MCQ//Quiz Short answer Essay type answer
• Interpret the cation and anion retentions • Illustrate about nutrient fluxes in soil –plant system	**Nutrients flux in soils and plants:** Nutrients absorption in soil-plant system; movement of nutrients from soil to plant roots. Nutrient uptake mechanism from soil to plant roots. Active and passive ion transport; root cell membrane integrity	Lecture Visual presentation Discussion Assignment	MCQ//Quiz Short answer Essay type answer Report
• Describe cation exchange capacity • Interpret the antagonistic and synergistic inter-action of nutrient ions in soil- plant system	**Cation and anion retention:** Cation selectivity and exchangeable cation with its cation exchange equations; diffuse double layer; specific and non-specific anion retentions; cation and anion exchange. Antagonistic and synergistic interaction of nutrient ions in soil- plant system	Lecture Exercise Visual presentation	MCQ/Quiz Short answer Essay type answer
• Illustrate essential and beneficial nutrients • Summarize the functions of essential nutrient and their deficiencies and toxicities	**Essential and beneficial nutrients:** History of essential nutrients and plant nutrition; available forms of essential plant nutrients, their classification; dissociation of minerals and ionization of nutrients;	Lecture Presentation Exercise	MCQ/Quiz Short answer

	deficiency and toxicity levels of nutrients		
• Evaluate nutrient accumulation and metabolism in plants • Discus about nutrients assimilation	**Nutrient accumulation and metabolism in plants:** Activation, transport and reduction of nutrients- Carbon, nitrogen, phosphorous, sulphur, and other nutrients; biosynthesis of starch, ATP, amino acid protein and their metabolism	Lecture Demonstration Assignment	MCQ/Quiz Short answer Essay type answer Report
• Assess the Laws of ionic reactions	**Laws governing ionic reactions:** Law of Mass action; ratio law and second law of thermodynamics, kinetic and molecular theory of gases and its application to absorption	Lecture Discussion	MCQ/Quiz Short answer

Reference Books

1. Havlin, J.L.; Beaton, J.D.; Tisdale, S.L. and Nelson, W.L. 1999. Soil Fertility and Fertilizers, 6th edition,. Prentice-Hall, Inc., Upper Saddle River, New Jersey, USA.
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4. Marschner, P. 2012. Marschner's Mineral Nutrition of Higher Plants. Third edition. Academic Press. ISBN 978-0-12-384905-2.
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Course Code: AGCH 504 **Course Title: Analyses of Fertilizer, Pesticide, Heavy Metals in Plant, Soil and Water (Compulsory)**	**Credit Hour: 03**	**Semester: January-June**	
Rationale: This course is designed to provide knowledge and updated information on fertilizers, plant, soil and water and their residue analysis			
Course Outcomes: • Operate proper sampling method for collection of commercial fertilizers, crops, agricultural soil and water • Compare and justify different analytical methods • Demonstrate standard methods to analyze soil, water and commonly used fertilizers.			
Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Define sampling and frequency of sampling • Describe the procedures of different sampling • Interpret soil, plant, water, fertilizer and pesticide residue analysis	**Sampling**: Principles, time and frequency of sampling; procedures for obtaining soil, plant, water, fertilizer and pesticide samples; errors in sampling	Lecture Visual demonstration Exercise	Quiz/MCQ Short answer Essay type answer
• State different analytical techniques • Evaluate different analytical techniques • Compare different analytical techniques	**Analytical techniques**: Analytical techniques for titrimetry, colorimetry, flame emission, atomic absorption spectrophotometry, and chromatography	Lecture Problem Based Learning (PBL) Group assignment	Quiz/MCQ Short answer Essay type answer
• Describe the importance of moisture and nutrient content of different fertilizers • Analyze the moisture and nutrient content of major fertilizers in Bangladesh • Evaluate the fertilizer quality in Bangladesh	**Fertilizer analysis:** Moisture and nutrient contents in Urea, SSP, TSP, DAP, MOP, Zinc sulphate and borax	Lecture Demonstration Practice	Quiz/MCQ Short answer Essay type answer
• Identify different group of pesticides • Distinguish different group of pesticide residue in crops or vegetables • Demonstrate the plant tissue analysis for different nutrients	**Pesticide residue and plant analysis:** Residue analysis and identification of different group of pesticides; plant tissue analysis for different nutrients	Lecture Presentation Exercise Demonstration	Quiz/MCQ Short answer Essay type answer

• Heavy metal analysis for different purposes	**Heavy Metal Analysis**: Different heavy metal (like as Cd, As, Pb, Cr etc.) analysis from soil, plant and water	Lecture Demonstration	Quiz/MCQ
• Describe soil macro and micro nutrients	nutrient contents and toxic elements; fractionation of soil macro and micronutrients	Group Discussion	Short answer Essay type answer

Reference Books

1. APHA (American Public Health Association) 2005. Standard Methods for the Examination of Water and Wastewater. 21th edition. AWWA and WEF, Washington, USA.
2. FAO & IITA. 2000. Simple soil, water and plant testing techniques for soil resource management. Proceedings of a training course held in Ibadan, Nigeria, 16-27 September 1996. IITA and FAO of the United Nations, Land and Water Development Division, Rome.
3. Jackson, M.L. 1973. Soil Chemical Analysis. Prentice-Hall of India Private Limited, New Delhi, India.
4. Petersen, L. 2002. Analytical Methods: Soil, Water, Plant Material, Fertilizer, Soil Resources Management and Analytical Services, SRDI, Dhaka.
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9. Leo M.L et.al., 2009. Hand book of pesticides; Methods of Pesticide Residues Analysis. CRC press. ISBN 9781420082456

Course Code: AGCH 505 **Course Title: Chemistry of Pesticide (Compulsory)**	**Credit Hour: 03**	**Semester: July-December**

Rationale: This course is designed to address preparation, chemical properties, metabolism, mode of action, environmental fate and residual effects of pesticides. It will develop the skills, knowledge and expertise of the students to work with chemical pesticides, its compatibility with other agrochemicals and residual effects on the environment.

Course Outcomes:

- Conceptualize advances of different pesticides
- Explain mode of action, storage and uses of different pesticides
- Demonstrate of field performance of different pesticides
- Optimize of MRL level of different pesticides
- Construct of pesticide compatibility with other agrochemicals

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Illustrate and describe the classification of different pesticides • Demonstrate the field performance of pesticides • Implement the different uses of pesticides regarding field performance	**Classification, preparation and field performance of pesticides:** Classification, preparation, properties, field performance, storage, and uses of: Organochlorinated insecticide: Aldrin, Dieldrin, Endosulfan and Heptachlor	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Explain nervous systems and defense mechanism of pests • Describe the enzymes responsible for metabolism of pesticides • Evaluate the importance and role of different enzymes	**Concepts of pesticide metabolism:** Defense system, nervous system; enzymes responsible for metabolism of pesticides and their role; acetylcholinesterase- its action and inhibition	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Formulate the chemistry of different organophosphorus pesticides • Construct the conceptual idea and field application of organophosphorus pesticide	**Organophosphorus insecticide:** Chlorpyrifos, Diazinon, Dichlorvos, Dimethoate, Fenthion, Fenitrothion, Fenvalerate, Imidacloprid, Malathion, Phenthoate and Trichlorfon. Organocarbamate insecticides: Carbaryl, Carbofuradan and Carbosulfan. Synthetic pyrethroids insecticides: Cypermethrin, Deltramethrin, Permethrin	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Categorize different fungicides in respect of present agricultural field application • Scrutinize different	**Fungicides:** Carbendazim, Copper oxychloride, Difenconazole, Edifenphos, Iprodione, Mancozeb, Propiconazole and Propineb.Herbicides: Anilofos,	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report

herbicides in respect of present agricultural field application	Butachlor, 2,4-D, Glyphosate, MCPA, Oxadiazon, Paraquate and Pretilachlor. Acaricide: Dicofol, Ethion, Tetradifon		
• Evaluate the latest research findings and information of advanced technology of chemistry of pesticides	Advanced research findings and information regarding chemistry of pesticide	Assignment	Report

Reference Books

1. Bollag, J.M. and Stotzky, G. (Eds.). Soil Biochemistry. Vol. 8 Marcel Dekker Inc., New York, USA.
2. Green, M.B.; Hartley, G.S. and West, T.F. 1987. Chemicals for Crop Improvement and Pest Management. 3rd edition, Pergamon Press. New York.
3. Hall, J.C.; Hoagland, R.E. and Zablotowicz, R.M. (Eds.) 2001. Pesticide Biotransformation in Plants and Microorganisms. American Chemical Society, Washingto DC, USA
4. Hassall, K.A. 1990. The Biochemistry and Uses of Pesticides. Structure, Metabolism, Mode of action and Uses in Crop Production. 2nd edition, ELBS/Macmillan Press Ltd. Hampshire, UK
5. Mathews, G. A. 1985. Pesticide Application Methods. Longman. England.
6. Ramulu, U.S.S. 1985. Chemistry of Insecticides and Fungicides, 2nd edition. Oxford and IBH Pub. Co., New Delhi. India.
7. Roberts, T. (Ed.) 2000.Metabolism of agrochemicals in Plants. John Wiley and Sons. Ltd., Chichester, England.
8. Tarradellas, J.; Bitton, G and Rossel, D. (Eds.) 1997. Soil Ecotoxicology. Lewis Publishers, Boca Raton, Florida, USA
9. Tomlin, C.D.S. (Ed.). 2003. The Pesticide Manual, 13thedition, British Crop Protection Council, Hampshire, UK.
10. Yu S. J. 2008. The Toxicology and Biochemistry of Insecticides. CRC Press

Course No.: AGCH 506 **Course Title: Environmental Chemistry (Compulsory)**	**Credit Hours: 03**	**Semester: January-June**

Rationale: This course is designed to provide knowledge and update information about the chemistry of the major components of environment; detection and management of environmental pollutants.

Course Outcomes:

- Demonstrate detailed the concept and issues of environmental chemistry.
- Analyze the chemistry of pollution of geosphere, hydrosphere, atmosphere
- Interpret pollution prevention and control measures.

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Distinguish and describe the components and issues related to environmental chemistry • Illustrate factors affecting environmental toxicants and chemical hazards of toxicants	**Concepts and issues of environmental chemistry:** Concept of environment components chemical hazards and toxicants; factors affecting the environmental toxicants. Issues related to environment	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Demonstrate clear concept of Geosphere • Illustrate it formation • Explain the role of ground water in the environmental hazards of geosphere • Predict and explain the hazards related to geosphere, effect of heavy metals, waste and pollutants in geosphere, their degradation and remediation • Evaluate and analyze the degradation of pesticides in the geosphere	**Chemistry of geosphere:** Concept of geosphere, physical formation of geosphere, role of ground water in geosphere, hazards related to geosphere: natural and anthropogenic hazard. heavy metal pollution in soil environment: Source, level, effect on human and environment. Air pollution caused by geosphere. Waste and pollutant in geosphere, degradation of pesticides in the geosphere. Bioremediation	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Discuss the routes, metabolism and toxic effects of environmental pollutants	**Environmental toxicology:** Toxic substances with their routes and metabolism. Biochemical effect of chemical pollutants	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report

• Describe concept of aquatic chemistry, water pollution, its treatment • Illustrate the fate and movement of water pollutants in soil-plant-water system • Generalize different water and waste water treatment procedure	**Aquatic chemistry:** Water pollution: Concept of aquatic chemistry, water pollution, Classification of water pollutant, fate and movement of water pollutant, Water treatment: Concept of water treatment, Classification of water treatment: reverse osmosis, ozone water treatment, electro-dialysis	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Summarize chemical and photochemical reactions, organic and inorganic pollutants in atmosphere • Predict and explain the effect of pollutants on plants and environment	**Atmospheric chemistry:** Chemical and photochemical reactions in the atmosphere; inorganic and organic pollutants with their effects on plants; acid rain, smog and greenhouse gases; ozone layer destruction	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Analyze the potentiality of different hazardous waste. • Apply different remediation techniques for correcting hazardous waste.	**Chemistry of hazardous wastes:** Sources, classification and properties of hazardous agricultural and non-agricultural wastes; fates and effects of agricultural hazardous wastes; hazardous waste reduction and treatment	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Analyze the potentiality of different hazardous waste. • Apply different remediation techniques for correcting hazardous waste.	**Environmental hazard monitoring and legislation:** Environmental protection effects, toxic substances control act, the risk and safety assessment programs for the environment, and international regulations on environmental problem	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report

Reference Books

1. Baird, C. and Cann, M. 2008. Environmental Chemistry. 4th edition. W. H. Freeman and Company, New York, USA.
2. Huang, P.M.; Bollag, J.M. and Senesi, N. (Eds.) 2002. Interactions between Soil Particles and Microorganisms: Impact on the Terrestrial Ecosystem, John Wiley & Sons, Ltd., Chichester, England.
3. Manahan, S.E. 2010. Environmental Chemistry. 9th edition. CRC Press LLC, Boca Raton, Florida, USA.
4. Mansour, M. (Ed) 1993.Fate and Predication of Environmental Chemistry in Soils, Plants and Aquatic Systems.Lewis publishers, Boca Raton, Florida, USA.
5. Rand, G.M. and Petrocelli, S.R. (Eds.) 1985.Fundamentals of Aquatic Toxicology-Methods and Applications.Taylor& Francis Publishers, Frost Road, Suite 101, Bristol.
6. Sarkar, B. (Ed.) 2002. Heavy Metals in the Environment.Marcel Dekker Inc., New York, USA.

Course No. : AGCH 507 **Course Title: Formulation and Safety of Pesticides (Compulsory)**	**Credit Hours: 03**		**Semester :January-June**
Rationale: This course is designed to provide knowledge and update information about the formulation of different pesticides and their safety handling, application and disposal.			
Course Outcomes: • Conceptualize classification of different groups of agrochemicals • Discriminate different pesticide formulations • Illustrate safe handling of different agrochemicals before and after application to minimize applier and environmental hazards • Justify the existing laws and regulations governing the proper use of pesticides			
Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Justify the need of agrochemicals • Classify different groups of agrochemicals	**Introduction:** Needs, general properties and precautions of agrochemicals Grouping of agrochemicals	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Summarize the history of pesticide use in Bangladesh	**History:** Entrance of chemical pesticide in Bangladesh, present status and future predictions.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Explain and compare different types of pesticide formulations. • Categorize different pesticide formulation plants • Describe merits and demerits of different pesticide formulations	**Formulation:** Dust, wettable powder, granules, emulsifiableconcentrates, fumigants, aerosol, capsules and microcapsules, preparation methods, composition, advantages and disadvantages of new-generation formulations: Oil-in-water emulsions, microemulsions, controlled-release formulations, water-dispersible granules	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Describe the role of additives in pesticide formulations.	**Additives:** Surfactants for pesticides: General characteristics, Wetting agents, Dispersion, emulsification, solubilization, bioenhancement, conventional surfactants, recent surfactant developments	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Describe the different routes of entry of agrochemicals in human body	**Routes of exposure:** Route of entry of toxic chemicals in the body	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer

• Discriminate different agrochemicals according to their types of hazard	**Agrochemicals classification:** Classification related to hazard of agrochemicals	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Illustrate safe handling of agrochemicals during packaging, transport, transfer and storage	**Safe handling:** Safe handling during packaging, transport, transfer, storage	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer
• Justify the need of precaution measures before, during and after application of pesticide. • Judge the importance of re-entry after application of pesticide.	**Safe application:** Precautions of before, during and after pesticide application, re-entry	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer
• Justify the need of proper disposal of containers • Select the best ways to manage pesticide waste	**Safe disposal:** Safety measures during disposal of containers and waste	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer
• Classify different personal protective equipment. • Determine different personal protective equipments to prevent poisoning of agrochemicals	**PPE:** Use of personal protective equipment	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Discriminate different symptoms of poisoning • Exercise in first aid treatments	**Pesticide Poisoning:** Poisoning by agrochemicals and its management	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer
• Discriminate different antidotes for pesticide poisoning	**Antidotes:** Antidotes for pesticide poisoning	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Estimate different cause of drift • Plan strategies for reducing drift	**Pesticide drift:** Pesticide chemical drift and its management	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Describe the need and importance of pesticide ordinance. • Criticize the strong and weak points of pesticide	**Pesticide ordinance:** Agro-Chemicals regulations, quality control and management: Pesticide ordinance 1971	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer

ordinance			
• Describe the need and importance of pesticide ordinance and rules • Criticize the strong and weak points of pesticide ordinance and rules	**Pesticide rules:**Agro-chemicals regulations, quality control and management: Pesticide rules 1984	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report

Reference Books

1. Ministry of Law and Justice, Govt. of the Peoples Republic of Bangladesh. 1984. The Pesticide Ordinance, Govt. Press. Dhaka.
2. Ramulu, U.S.S. 1985. Chemistry of Insecticides and Fungicides.Oxford and IBH Pub. New Delhi, India.
3. Srivastva, S.B. 1985. Agrobased Industries and Pesticides Formulations. S.I.R. Institute, New Delhi. India.
4. Tomlin, C.D.S. (Ed.). 2003. The Pesticide Manual, 13th edition, British Crop Protection Council, Hampshire, UK.
5. Valkenburg, W.V. (Ed.) 1972. Pesticide Formulations. Marcel Dekker Inc. New York.

Course Code: AGCH 508 Course Title: Chemistry of Manures and Fertilizers (Elective)	Credit Hour: 03	Semester: July-December

Rationale: This course is designed to provide knowledge and update information on bio-fertilizers and their proper usage in the crop field

Course Outcomes:

- Conceptualize advances of organic wastes and their utilization
- Explain production technology of biofertilizer
- Evaluate different manures and fertilizers in the crop field using nutrient balance sheet
- Investigate the misuse of fertilizers and their fates in the environment

Intended Learning Outcomes (ILOs) The students will be able to-	Course Content	Teaching-Learning Strategies	Assessment Strategies
• Illustrate aerobic and anaerobic decomposition of organic wastes • Identify the losses of plant nutrients • Represent the utilization of cow dung and different sludge	**Decomposition of wastes and Composts:** Aerobic and anaerobic decomposition of wastes; Biodynamics of nutrient elements; possible utilization of cowdung; sewage sludge; industrial and municipal wastes.	Lecture Visual presentation	Quiz/MCQ Short answer
• Describe fertilizer formulation with different types of ingredients • Illustrate production technology of biofertilizer • Design fertilizer application method	**Fertilizer formulation and production technology of biofertilizer:** Fertilizer formulation with different types of ingredients; production technology of biofertilizer; legume-rhizobium and azolla anabaena symbiosis; mycorrhiza and blue green algae in plant nutrition.	Lecture Visual presentation Assignment	Short answer Essay type answer Report
• Analyze the misuse of fertilizers • Prepare nutrient balance sheet • Describe the fate of fertilizers in soil.	**Proper use of fertilizer and preparation of nutrient balance sheet:** Time and methods of fertilizer application; use, overuse and misuse of fertilizers; fate of applied fertilizers in soil; preparation of nutrient balance sheet for the evaluation of manures and fertilizers.	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report

Reference Books

1. Elsas, J.D.V.; Trevors, J.T. and Wellington, E.M.H. (Eds) 1997. Modern Soil Microbiology.Marcel Dekker Inc., New York, USA.
2. Hall, A. D. Fertilizers and Manures.Daya Pub.
3. Ismail, S.A. 1997. Vermicology. The Biology of Earthworms Orient Longman Ltd. Chennai India.
4. Meelu, O.P;Singh, Y. and Singh, B. 2007. Green Manuring for Soil Productivity Improvement. Daya Pub. India.
5. Palaniappan, S.P. and Annadurai, K. 2003. Organic Farming: Theory & Practice, Scientific Publishers, Jodhpur, India.
6. Paul, E.A. and Clark, F.E. 1989. Soil Microbiology and Biochemistry. Academic Press Inc., California, USA.
7. Sathe, T.V. 2004. Vermiculture and Organic Farming.Daya Pub. India.
8. SubbaRao, N.S. 1982. Biofertilizers in Agriculture. Oxford& IBH Publishing Co., New Delhi, India.
9. UNIDO and IFDC (eds.) 1998. Fertilizer Manual. Kluwer Academic Publishing. Dordrecht, The Netherlands.
10. Yawalkar, K.S., Agarwal, J.P. and Bokde, S. 1981. Manures and Fertilizers, 5th edition, Agricultural Publishing House, Nagpur-440010, India.

Course Code: AGCH 509 **Course Title: Chemistry of Plant Products (Compulsory)**	**Credit Hour: 03**	**Semester: July-December**

Rationale: This course is designed to provide knowledge and updated information on various plant originated secondary metabolites. It will describe isolation, purification and structural elucidation of those plant products. This course also will forecast the significant role of plant-derived natural products in agriculture.

Course Outcomes:

- Assess critically and overview of preliminary idea of plant products
- Explain biosynthesis, chemical nature and mode of actions of different secondary metabolites
- Utilize bio-pesticide regarding the significance of agricultural outcomes

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Describe preliminary ideas of natural products • Differentiate primary and secondary metabolites • Explain various classes of primary and secondary metabolites	**Introduction to the chemistry of natural products:** Natural products and sources in nature. Primary and secondary metabolites. Properties and purposes of secondary metabolites. Review of various classes of secondary metabolites. Characteristics of secondary metabolites.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Illustrate extraction, isolation, separation and purification methods of natural products	**Extraction, isolation, separation and purification of secondary metabolites:** Techniques of extraction, isolation, purification and characterization of different bioactive substances from plants	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Justify the importance of natural products in agricultural aspects • Apply natural products in agriculture	**Importance of natural products in agriculture:** The use of natural products in agricultural practices, the impact of natural products on the development of new pesticides, and the future prospects for natural products-based pest management	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Prepare a plan of bio-synthesis of different natural products • Explain different properties and functions of different secondary metabolites	**Bio-synthesis of different natural products:** Biosynthesis, functions, chemical nature and properties, formulations and regulations of nicotine, pyrethrin, azadirachtin chlorophylls, carotenoids, flavonoids, tannins, auxins, gebberellins, cytokinins, abscisic acid, ethylene, phytochrome, vitamins and other biopesticides	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer

• Formulate and design of mode of actions of different natural products • Describe translocation systems of different secondary metabolites	**Mode of actions of natural products:** Mode of action and translocations of nicotine, pyrethrin, azadirachtin, chlorophylls, carotenoids, flavonoids, tannins auxins, gebberellins, cytokinins, abscisic acid, ethylene, phytochrome, vitamins and other biopesticides	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Justify the chemistry of different plant products	**Review of chemistry of plant - derived products:** Structure elucidation of alkaloids, flavonoids and tannins	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer

Reference Books

1. Godfrey, C.R.A. (Ed) 1995. Agrochemicals from Natural Products. Marcel Dekker Inc., New York, USA.
2. Goodwin, T.W. and Mercer, E.I. 1985. Introduction to Plant Biochemistry. 2nd edition. Pergamon Press Ltd., New York.
3. Goodwin, T.W. 1980. The Biochemistry of the Carotenoids. 2nd edition. Chapman and Hall, New York.
4. Lehninger, A.L. 1987. Principles of Biochemistry. CBS Publishers & Distributors, New Delhi, India.
5. James, B. and Varner, J.E. 1985. Plant Biochemistry. Academic Press Inc., New York.
6. Harborne, J.B. 1987. Comparative Biochemistry of the Flavonoids. Academic Press Inc. London.
7. Pandey, S.N. and Sinha, B.K. 1993. Plant Physiology (Revised edition) Vikas Publishing House Pvt. Ltd. New Delhi, India.
8. Whittingham, C.P. 1984. The Chemistry of Plant Processes. Methuen & Co. Ltd., London.

Course No.: AGCH 510 Course Title: Mineral Nutrition and Plant Growth (Elective)	Credit Hours: 03	Semester: January-June

Rationale: Plant growth and development largely depend on the combination and concentration of mineral nutrients available in the soil. Plants often face significant challenges in obtaining an adequate supply of these nutrients to meet the demands of basic cellular processes or even fail to complete their life cycle. This course is designed to provide knowledge and updated information on the principles of plant nutrition specially on nutrient availability, uptake and distribution in plants, its functions in the plant and contributions to growth and yield.

Course Outcomes:

- Generalize the principles of plant nutrition
- Explain nutrient availability in the soil
- Summarize nutrient uptake and distribution in plants
- Explore nutrient functions in plant and contributions to growth and yield

Intended Learning Outcomes (ILOs) The students will be able to-	Course Content	Teaching-Learning Strategies	Assessment Strategies
• Summarize the functions of plant nutrient • Recognize the deficiency and toxicity levels and symptoms	**Essential and beneficial nutrients:** History of the essential nature of nutrients; definition, classification role and principal form of uptake; threshold of deficiency and toxicity levels of nutrients	Lecture Visual presentation Discussion	Quiz MCQ Short answer Essay type answer
• Explain and distinguish the nutrient uptake mechanisms by higher plants • Analyze short and long distance ion transport	**Nutrient absorption and translocation in plants:** Ion absorption/uptake and translocation mechanisms of individual cells and roots (short-distance and long distance ion transport); foliar application of nutrients	Lecture Visual presentation Discussion	Quiz MCQ Short answer Essay type answer
• Evaluate the ways of plant nutritional quality improvements	**Nutrition and quality:** properties determining plant quality; biofortification	Lecture Visual presentation Discussion	Quiz MCQ Short answer Essay type answer
• Point out the relationship between plant nutrition and insect & disease infestation	**Relationship between nutrition, plant diseases and pests:** Diagnosis of deficiency and toxicity of nutrients. Rhizosphere chemistry in relation to plant nutrition. Adaptation of plants to adverse chemical soil conditions Nutrient fluxes in terrestrial agro-ecosystems	Lecture Visual presentation Discussion Assignment	Quiz /MCQ Short and Essay type answer Report
• Elucidate the nutrient metabolism in plant • Demonstrate reduction of nutrients and formation of	**Nutrient metabolism in plants:** Activation, transport and reduction of nutrient ions-nitrogen, sulphur and zinc; biosynthesis of amino acids and	Lecture Visual presentation Discussion	Quiz /MCQ Short and Essay type answer

different compounds in plants	their metabolism	Assignment	Report
• Compare nutrient interactions in plants • Differentiate antagonistic and synergistic interactions of nutrients ions	**Relationships of nutrients:** Antagonistic and synergistic interactions of nutrient ions in soil-plant system	Lecture Visual presentation Discussion Assignment	Quiz /MCQ Short and Essay type answer Report
• Analyze the nutrient-water interactions • Explain the relation between fertilization and water extraction by plant roots	**Nutrient-water interaction:** Physiological effect of nutrients related to water requirement; fertilization and water extraction by plant roots	Lecture Visual presentation Discussion Assignment	Quiz /MCQ Short and Essay type answer Report
• Summarize the growth factors • Predict the response and requirements of nutrients for different crops	**Growth and nutrients requirements:** Biotic and abiotic growth factors; response and requirements of nutrients for different crops; root exudates for plant nutrition	Lecture Visual presentation Discussion Assignment	Quiz /MCQ Short and Essay type answer Report

Reference Books

1. Brady, N.C. and Weil, R.R. 2007. The Nature and Properties of Soils, 14thedn. Pearson Publishing Ltd. USA.
2. Fageria, N.K.; Baligar, V.C. and Jones, C.A. 2012.Growth and Mineral Nutrition of Field Crops, 3rdedition.Marcel Dekker, Inc, New York.
3. Havlin, Z.L.; Beaton, J.D.; Tisdale, S.L. and Nelson, W.L. 1999.Soil Fertility and Fertilizers. 6thedn. Prentice-Hall, Inc., Upper Saddle River, New Jersey, USA.
4. Khan, M.S.;Zaidi, A. and Musarrat, J (Eds). 2009. Microbial Strategies for Crop Improvement. Springer-Verlag,Berlin,Germany.
5. Marschner, H. 1996. Mineral Nutrition of Higher Plants .2nd edition. Academic Press. .
6. Marschner, P. 2012. Marschner's Mineral Nutrition of Higher Plants. 3rd edition. Academic Press. ISBN978-0-12-384905-2.
7. Mortvedt, J.J.; Cox, F.R.; Shuman, L.M. and Welch, R.M. (eds.) 1991. Micronutrient in Agriculture.2nd edition.Soil Science Society of America, Inc. Madison, Wisconsin, USA.
8. Waisel Y., Eshel A. and Kafkafi U. 2005. Plant Roots: The Hidden Half. 3rd edition.Marcel Dekker, Inc, New York.

Course No.: AGCH 511 **Course Title: Water and Solution Chemistry (Elective)**	**Credit Hours: 03**	**Semester: July-December**	
Rationale: This course is designed to provide knowledge and update information on water chemistry and water treatment for sustainable use in different agriculture sectors.			
Course Outcomes: • Judge the water quality for different uses • Discuss of the sources and causes of water pollution and control measures • Explain of the importance of geothermal energy utilization			
Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Describe the qualities parameter of water • Determine the suitability of water for different use.	**Water quality:** Physical, chemical, biological and radiological qualities; quality assessment and criteria for drinking, domestic, livestock, poultry, aquaculture, irrigation and agro-industrial usage; ionic toxicity and plant tolerance	Lecture Visual demonstration	Quiz /MCQ Short and Essay type answer
• Describe sources and causes of water pollution and its control measure	**Water pollution:** Sources and causes of water pollution and its control measure; Transport and hydrochemical processes of pollutions-As, Cd, Pb and Zn, health contamination and safety	Lecture Demonstration Assignment	Quiz /MCQ Short and Essay type answer Report
• Interpret about the different techniques for water purification	**Water treatment:** Water disinfection; physical, chemical and biological processes of water and wastewater treatment	Lecture Presentation Assignment	Qui /MCQ Essay Short and Essay type answer Report
• Describe the causes of corrosion in aqueous system • Explain the role of oxygen in corrosion.	**Water chemistry, material compatibility & corrosion:** Corrosion in aqueous system, deposit formation vs role of zeta potential, distribution of impurities between water and steam.	Lecture Presentation Assignment	Quiz /MCQ Short answer Essay type answer Report
• Select appropriate methods of harvesting water	**Water harvesting:** Development of water harvesting and perspectives, water harvesting systems for agriculture and other usage	Lecture Presentation Assignment	Quiz /MCQ Short answer Essay type answer Report

• Explain the ways means of utilization of geothermal energy	**Geothermal power and water chemistry:** Geothermal energy utilization, chemical composition of geothermal waters, direct use of geothermal waters	Lecture Presentation Assignment	Quiz /MCQ Short answer Essay type answer Report

Reference Books

1. APHA (American Public Health Association) 2005. Standard Methods for the Examination of Water and Wastewater. 21th edition . AWWA and WEF, Washington, USA.
2. Ariyananda, T. N. 2003. Sustainable Rainwater Harvesting and Groundwater Recharge in Developing Countries. Daya Pub.
3. Karanth, K.R. 1987. Groundwater Assessment Development and Management. Tata McGraw-Hill Publishing Company Ltd., New Delhi, India.
4. Sharma, P. 2007. Agricultural Drainage and Water Quality. Daya Pub.
5. Tandon, H.L.S. (Ed.) 1995. Methods of Analysis of Soils, Plants, Waters and Fertilizers. Fertilizers Development and Consultation Organization, New Delhi, India.
6. Venkateswariu S.K. (Ed.). 1996. Water chemistry, industrial and power station water treatment. 1996, New Age International (P) Ltd. India.

Course Code: AGCH 512 **Course Title: Chemistry of Technology of Industrial Crops (Elective)**	**Credit Hour: 03**	**Semester: July-December**	
Rationale: This course is designed to provide knowledge and update information on Agro-industrial crops and their manufacturing process			
Course Outcomes: • Conceptualize advances of rubber derivatives and processing • Explain manufacturing technology of raw sugar • Evaluate tea manufacturing process and their composition • Optimize the different grade of tobacco leaves and their chemical changes			
Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Illustrate different methods of rubber collection • Demonstrate micro tapping puncture method • Compare different kinds of rubber properties	**Exploitation of Hevea:** Evolution of tapping methods; stimulants their methods and practices; microtapping-puncture method; natural and synthetic rubbers; production, properties and uses of synthetic rubbers; rubber derivatives and processing	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Describe recovery and refining process of sugar • Illustrate physical and chemical properties of sugar • Utilize sugar mill by-products	**Manufacturing technology of raw sugar and plantation white sugar:** Sucrose recovery and refining of sugar; physical and chemical characteristics of sugarcane and cane juice; chemistry and utilization of sugar mill by-products; fermentation of molasses products; molasses as a feed for livestock; colour of cane juice; deterioration of sugar during storage	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Apply advanced technology of Tea manufacturing • Describe different kinds of tea and their composition • Evaluate the qualities of tea, aroma and food value	**Chemistry and technology of black tea manufacturing processes:** Withering, rolling, roll breaking and fermentation; biochemical changes; preparation process of green tea; composition of tea leaves and shoots; liquoring qualities, infusion, aroma and food value of tea	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Explain curing process of tobacco leaves • Evaluate the quality of tobacco leaves • Minimize the loss of quality yield of tobacco	**Curing processes of tobacco leaves and characteristic features:** Chemical changes; chemical composition of leaf and its relation to type and quality, fermentation and	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report

leaf	aging processes		
• Illustrate different methods of rubber collection • Demonstrate micro tapping puncture method • Compare different kinds of rubber properties	**Exploitation of Hevea:** Evolution of tapping methods; stimulants their methods and practices; microtapping-puncture method; natural and synthetic rubbers; production, properties and uses of synthetic rubbers; rubber derivatives and processing	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer

Reference Books

1. Barnes, A.C. 1974. The Sugarcane. Intersciences Publishers Inc; New York.
2. Chaudhury, M.S.H. 1989. Tea growing. Ananda Printers, Motijheel, Dhaka.
3. Das, R.K. 1987. Industrial Chemistry, Part-2, Kalayani Publishers, New Delhi, India.
4. Dhingra, K.C. 1984. Hand Book on Rubber and Rubber Goods Industries. Small Industry Research Institute, New Delhi, India
5. Garner, W.W. 1981. The Production of Tobacco. McGraw Hill Book, London.
6. Harler, C.R. 1982. Tea Culture and Marketing of Tea. Oxford University Press, UK 7. Harler, C.R. 1984. Tea Manufacture, Oxford University Press, UK
7. Jain, N.K. (Ed.) 1999. Global Advances in Tea Science. Aravali Books International Pvt. Ltd., New Delhi, India.
8. Mathur, R.B.L. 1987. Hand Book of Cane Sugar Technology. Oxford and IBH Publishing Co. Calcutta. India
9. Shreve, R.N. 1985. Chemical Process Industry. McGraw Hills, New York. USA.

Course Code: AGCH 513 **Course Title: Chemistry of Bio-farming (Elective)**	**Credit Hour: 03**	**Semester: Jan-June/ July-December**	
Rationale: This course is designed to provide knowledge and update information on bio-farming and their chemical properties in Agriculture			
Course Outcomes: • Conceptualize advances of Bio-farming • Explain bio-farming condition in Bangladesh and other countries • Evaluate the role of compost and vermicomposting in Bangladesh Agriculture • Formulate the use of supplemental plant nutrients through fertilizers			
Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Illustrate the potentiality of Bio-farming • Describe the prospect of Bio-farming in Bangladesh • Compare Bio-farming in developed and developing countries • Demonstrate the achievements of bio-farming	**Bio-farming and its achievements:** Status, potential role, scope and prospect of bio-farming in Bangladesh; bio-farming in developed and developing countries; bio-farming achievements in different countries	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Describe the components of Bio-farming • Explain Bio-farming condition in Bangladesh • Analyze microbial, thermal and vermicomposting of different bio-wastes	**Prospect, components and reaction of bio-farming:** Components of bio-farming; bio-farming prospect in Bangladesh; reaction, kinetics involved in microbial, thermal, and vermicomposting of different bio-wastes	Lecture Visual presentation Assignment	Short answer Essay type answer Report
• Discuss the role of organic waste in Bangladesh Agriculture • Use of supplemental plant nutrients through fertilizers • Apply Bio-farming in different crop production	**Role of vermicompost and use of supplemental plant nutrients:** Role of organic waste in Bangladesh agriculture; supplemental plant nutrient uses through fertilizers; bio-farming application in different crop field	Lecture Visual presentation Assignment	Short answer Essay type answer Report

Reference Books

1. Training manual for organic agriculture 2015, Food and Agriculture Organizations
2. Hall, A. D. Fertilizers and Manures. Daya Pub.
3. Havlin, J.L.; Beaton, J.D.; Tisdale, S.L. and Nelson, W.L. 1999. Soil Fertility and Fertilizers 6th edition. Prentice-Hall, Inc. Upper Saddle River, New Jersey, USA.
4. Ismail, S.A. 1997. Vermicology. The Biology of Earthworms Orient Longman Ltd. Chennai India.
5. Meelu, O.P; Singh, Y. and Singh, B. 2007. Green Manuring for Soil Productivity Improvement. Daya Pub. India.
6. Palaniappan, S.P. and Annadurai, K. 2003. Organic Farming: Theory & Practice, Scientific Publishers, Jodhpur, India.
7. Paul, E.A. and Clark, F.E. 1989. Soil Microbiology and Biochemistry. Academic Press Inc., California, USA.
8. Sathe, T.V. 2004. Vermiculture and Organic Farming. Daya Pub. India.
9. SubbaRao, N.S. 1982. Biofertilizers in Agriculture. Oxford & IBH Publishing Co., New Delhi, India.
10. Yawalkar, K.S., Agarwal, J.P. and Bokde, S. 1981. Manures and Fertilizers, 5th edition, Agricultural Publishing House, Nagpur-440010, India.

Course Code: AGCH 514 **Course Title: Irrigation Water Quality (Elective)**	**Credit Hour: 03**	**Semester: Jan-June/July-Dec**	
Rationale: This course is designed to provide knowledge and updated information on quality of irrigation water, identify the different routes of pollutants and their impact on aquatic environment, treatment for purification of those waters against the pollutants for effective harvesting			
Course Outcomes: • Measure the irrigation water quality for different usages • Identify the sources and causes of irrigation water pollution and control measures • Propose the efficient technique for the treatment of irrigation water • Detect different ways of irrigation water harvesting			
Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Discuss the assessment of for different criteria for the judgment of irrigation water quality • Develop the suitability of water for different usages	**Irrigation water:** Water quality: Physical, chemical, biological and radiological qualities; quality assessment and criteria for drinking, domestic, livestock, poultry, aquaculture, irrigational usage; SAR, SSP, EC, pH, RSC, HT etc, agroindustrial usage; ionic toxicity and plant tolerance	Lecture Discussion Presentation Demonstration	Quiz/MCQ Short answer Essay type answer
• Predict the impact of irrigation water on soil quality • Justify the chemical management and reclamation of irrigated soils	**Irrigated soils:** Chemistry, management and reclamation of irrigated soils; salt tolerance and plant growth	Lecture Discussion Visual presentation	Quiz/MCQ Short answer Essay type answer
• Illustrate of different pollutants and their nature of irrigated water • Identify the pollutants and their impact on aquatic environment	**Irrigated water pollution:** Nature and types of water pollutants; sources and causes of water pollution; eutrophication; fate and transport of radionuclides, inorganic and organic pollutants in aquatic environment.	Lecture Discussion Visual presentation	Quiz/MCQ Short answer Essay type answer
• Propose the suitable technique for water purification • Detection of the major parameters of water quality	**Water treatment:** Water disinfection; physical, chemical and biological processes of water and wastewater treatment.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Describe precision agriculture and their usage	**Precision and detection of analytical result and Water harvesting:** Precision and	Lecture Visual presentation	Quiz/MCQ Short answer Essay type

• Construct different ways of water harvesting	detection of water analytical result: Anion-cation balance; measured and calculated TDS to EC ratio. Development of water harvesting and perspectives, water harvesting systems for agriculture and other usage.	Discussion Assignment	answer Report

Reference Books

1. APHA (American Public Health Association) 2005. Standard Methods for the Examination of Water and Wastewater. 21th edition . AWWA and WEF, Washington, USA.
2. Ariyananda, T. N. 2003. Sustainable Rainwater Harvesting and Groundwater Recharge in Developing Countries. Daya Pub.
3. Ayers, R.S. and Westcot, D.W. 1985. Water Quality for Agriculture. FAO Irrigation and Drainage Paper 29 Rev. Rome, Italy.
4. FAO & IITA. 2000. Simple soil, water and plant testing techniques for soil resource management. Proceedings of a training course held in Ibadan, Nigeria, 16-27 September 1996. International Institute of Tropical Agriculture and Food and Agriculture Organization of the United Nations, Land and Water Development Division, Rome.
5. Freeze, R.A. and Cherry, J.A. 1979. Groundwater. Prentice-Hall Inc., Englewood Cliffs, New Jersey.
6. James, D.W.; Hanks, R.J. and Jurinak, J.J. 1982.Modern Irrigated Soils. John Wiley & Sons, Inc. New York, USA.
7. Karanth, K.R. 1987. Groundwater Assessment Development and Management. Tata McGraw-Hill Publishing Company Ltd., New Delhi, India.
8. Lal, R. and Stewart, B.A. (Eds.) 1994. Soil Processes and Water Quality (Advances in Soil Science). CRC Pess, Inc., Boca Raton, Florida, USA.
9. Manahan, S.E. 2005. Environmental Chemistry. 8thedition CRC Press LLC, Boca Raton, Florida, USA.
10. Sharma, P. 2007. Agricultural Drainage and Water Quality. Daya Pub.
11. Todd, D.K. 1980. Groundwater Hydrology. 2ndedition. John Wiley & Sons, Inc. New York.

Course No.: AGCH 515 Course Title: Nuclear Chemistry and Tracer Techniques (Elective)	**Credit Hours: 03**	**Semester: Jan-June/ July-December**	
Rationale: This course is designed to provide knowledge and update information on nuclear chemistry and tracer technique; their properties and use in agriculture.			
Course Outcomes: • Conceptualize different sources of radioactive substances and their interaction with matter • Explain the use of radioisotopes in agriculture • Justify and evaluate regulations related to radioactive substances			
Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Describe the structure of atom and it's stability • Explain decay of atom	**Structure of the atom and decay:** Structure of an atom; stability of atomic nuclei; radionuclides; decay and	Lecture Visual demonstration Exercise	Quiz /MCQ Short and Essay type answer
• Describe different sources of radioactive substances with their application • Illustrate X-ray generation and imaging	**Sources:** Sealed and open sources of radioactive substances. Their application. Generation of X-rays and X-rays imaging.	Lecture Visual demonstration Practice Assignment	Quiz /MCQ Short and Essay type answer Presentation Report
• Interpret the interaction of different radiations with matter and how to shield them.	**Interaction of radiation with matter:** Interaction of alfa, beta and gamma radiations; shielding of radiation.	Lecture Visual demonstration	Quiz /MCQ Short and Essay type answer
• Determine different technique of radiation detection, • Assess detection equipment for radiation protection	**Radiation detection:** Ionization detection, scintillation detection, X-ray imaging and application of detection equipment in radiation protection.	Lecture Visual demonstration Exercise	Quiz /MCQ Short and Essay type answer
• Assess need of radioisotopes for the development of agriculture.	**Application of radioisotopes in agriculture:** Use of radio isotopes for the development of new varieties, use of radiation for product safety.	Lecture Visual demonstration Exercise	Quiz /MCQ Short and Essay type answer
• Illustrate various effects of radiation of human health. • Evaluate the risk of radiation	**Biological effect of radiation:** Effects of radiation in molecular and cellular levels, in humans, deterministic effects, stochastic effects, evaluation risks	Lecture Visual demonstration Exercise	Quiz /MCQ Short answer Essay type answer Report

		Assignment	
• Describe different terminology used in regulation, • Explain the dose limits	**Regulation:** Terminology, Dose limits, legislation	Lecture Visual demonstration	Quiz /MCQ Short and Essay type answer
• Justify the ways of collecting different radioactive waste • Verify different processing and storage systems. • Identify ways of reducing waste	**Radioactive waste:** Collection of different dry and liquid radioactive waste from an institute, Processing and storage of radioactive waste, Reduction of radioactive waste	Lecture Visual demonstration	Quiz /MCQ Short and Essay type answer

Reference Books

1. LaChance, L., Aslam J. and Langer C. 1990. Nuclear techniques in agriculture. IAEA bulletin. Vienna, Austria.
2. International Atomic Energy Agency. 1976. Tracer manual on crops and soils. Vienna, Austria.
3. Brouwer, G. and van den Eijnde J. 2008. Practical radiation protection. Syntax Media. Arnhem, The Netherlands.

Course Code: AGCH-516 **Course Title: Research Methodology for Agricultural Chemistry (Elective)**	**Credit Hour: 03**	**Semester: January-June**	
Rationale: This course is designed to provide knowledge and updated information on research, research methodology and advanced works on Agricultural Chemistry			
Course Outcomes: • Conceptualize about research planning and methodology • Explain experimental design for latest research of Agricultural Chemistry • Interpret different data for advanced research analysis using modern software's • Prepare a Scientific report and Power point presentation following the rules and regulations			
Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Define experiment and experimental design • Describe research methodology • Interpret multiple comparisons test for crop production and residue analysis	**Research, experimental design and multiple comparison test**: Concept, characteristics of research, types of research, units of analysis in research, Research methodology and tests of multiple comparison test	Lecture Reading Assignment Brain storming	Quiz/MCQ Short answer Essay type answer Report
• Identify research topics and problems • Formulate research plan • Describe steps in research project design • Review and selected literature, writing-up the literature reviewed references	**Research planning and literature review**: Steps in planning a research project, steps in formulation of a research problem, consideration in selecting a research problem, practical way of defining a research question, formulate objectives, steps in research project design, key decisions about your research. Develop a theoretical framework, how to structure a literature review? Writing-up the literature	Lecture Problem Based Learning (PBL) Group assignment	Quiz/MCQ Short answer Essay type answer
• Describe experimental designs • Compare different experimental designs	**Data processing:** reviewed references Experimental design and analysis of variance: Simple and factorial experiment-Field plot technique; basic principles of experimental designs; completely randomized design; randomized block design; latin square design and split-plot design; Mean separation test-Duncan's multiple range test; least significant difference.	Lecture Demonstration Practice	Quiz/MCQ Short answer Essay type answer

• Define Correlation and regression	**Correlation and regression analysis:** Exercise and implication.	Lecture Exercise	Quiz/MCQ Short answer
• Describe Correlation and regression • Compare Correlation and regression • Exercise correlation and regression			Essay type answer
• Analyze the data • Exercise different secondary data, used data processing software's • Interpret the results	**Data analysis and presentation**: Collection and analysis of data, transformation, presentation and interpretation of the experimental results using commonly used data processing softwares (R, SPSS and MiniTab).	Lecture Demonstration Group discussion	Quiz/MCQ Short answer Essay type answer
• Define scientific report • Describe scientific report Prepare a scientific report • Evaluate a scientific article	**Report writing and evaluation of Scientific report**: Principles and procedures of scientific report writing. Preparation and evaluation of a scientific report.	Lecture Reading Assignment Seminar	Quiz/MCQ Short answer Essay type answer Presentation Report

Reference Books

1. Anonymous, 2004. A Handbook of Scientific Report Writing. Graduate Training Institute, BAU, Mymensingh.
2. Mondal, M.R.I., Islam, M.S.,Jalil, M.A.B., Rahman,M.M., Alam, M.S. and Rahman, M.H.H. 2011. Krishiprojuktihatboi (Handbook on agro-technology) (5th edition). Bangladesh Agricultural Research Institute, Gazipur.
3. Gowda, C. L. L. and Kaul, A. K. 1982. Pulses in Bangladesh. Bangladesh Agricultural Research Institute, Gazipur and FAO, Rome.
4. Riley, K. W., Gupta, S. C., Seetharam, A. and Mushonga, J. N. 1983. Advances in small millets. Oxford & IBH publishers Co. Pvt. Ltd. New Delhi, India.
5. Kaul, A. K. and Das, M. L. 1986. Oilseeds in Bangladesh. Bangladesh-Canada Agriculture Sector Team, Ministry of Agriculture, Govt. of the Peoples' Republic of Bangladesh, Bangladesh.
6. Miah, A. A., Maniruzzaman, A. F. M. and Rahman, M. M. 1991. Problems and prospects of pulses
7. production. In: Advances in pulses research in Bangladesh. Proceed. Second National Workshop on pulses. Gazipur.

Department of Agricultural Extension & Information System

Course Layout

SL. No.	Course Code and Title		Cr. Hrs.
A. Compulsory Courses			
1	AEIS 501: Agricultural Extension and Communication		3
2	AEIS 502: Agricultural Knowledge and Information System		3
3	AEIS 503: Technology Diffusion		3
4	AEIS 504: Extension Project Development and Management		3
5	AEIS 505: Group Dynamics and Leadership Development		3
6	AEIS 506: Research Methodology in Social Sciences		3
	Total		**18**
B. Elective Courses 12			
7	AEIS 507: Statistics for Socio-Economic Research		3
8	AEIS 508: Agricultural Journalism		3
9	AEIS 509: Psychology of Human Behavior		3
10	AEIS 510: Non-government Organizations in Rural Development		3
11	AEIS 511: Gender Issue and Development		3
12	AEIS 512: GIS and Remote Sensing in Agriculture		3
13	AEIS 513: Adult Education and Rural Training		3
14	AEIS 514: Climate Change and Agriculture		3
15	AEIS 515: Extension Administration, Supervision and Management		3
16	AEIS 516: Communication Skills		3
17	AEIS 517: Community Development		3
18	AEIS 518: Planning, Monitoring and Evaluation of Extension Program		3
19	AEIS 519: Agricultural Environment, Development and Sustainablity		3
20	AEIS 520: Development Communication		3
21	AEIS 521: ICTs for Development (ICT^4D)		3
22	Related Course from other Departments		3
		Minimum	**12**
C. Seminar Course			
23	AEIS 598		1
D. Thesis Research			
24	AEIS 599		16
		Compulsory Courses	**18**
		Elective Courses	**12**
		Seminar Course	**1**
		Thesis Research	**16**
		Total	**47**

Curriculum Alignment / Skill Mapping

Curriculum must be aligned with program objectives, program learning outcome and intended learning outcomes through proper skill mapping.

Department of Agricultural Extension & Information System

Courses	Program Learning Outcome							
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
AEIS 501	x	x	x	x				x
AEIS 502	x	x	x	x				x
AEIS 503	x	x	x	x				x
AEIS 504	x	x	x	x				x
AEIS 505	x	x	x	x				x
AEIS 506	x	x	x	x				x
AEIS 507	x	x	x	x				x
AEIS 508	x	x	x	x				x
AEIS 509	x	x	x	x				x
AEIS 510	x	x	x	x				x
AEIS 511	x	x	x	x				x
AEIS 512	x	x	x	x				x
AEIS 513	x	x	x	x				x
AEIS 514	x	x	x	x				x
AEIS 515	x	x	x	x				x
AEIS 516	x	x	x	x				x
AEIS 517	x	x	x	x				x
AEIS 518	x	x	x	x				x
AEIS 519	x	x	x	x				x
AEIS 520	x	x	x	x				x
AEIS 521	x	x	x	x				x
AEIS 598						x	x	
AEIS 599					x	x	x	x

Course Code: AEIS 501 **Course Title : Agricultural Extension and Communication (Compulsory)**	**Credit Hour: 03**	**Semester: July-December**	
Rationale: This course is designed to provide knowledge on Agricultural Extension in Bangladesh context and extension communication for agricultural development.			
Course Outcomes: • Conceptualize Agricultural Extension in Bangladesh context. • Explain extension communication system. • Compare among different types of communication in real life situation. • Interpret the application of extension communication for agricultural development.			
Intended Learning Outcomes (ILOs): The students will be able to	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Explain communication system and communication process, • Interpret communication fidelity, • Analyze extension communication feedback and its effects	Concept, nature and importance of agricultural communication. Models of communication and its elements-factors affecting fidelity. Feedback-importance and effects.	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Differentiate communication process and learning process, • Generalize media of communication and their roles and functions • Explain socio-psychological approach to mass, group and interpersonal communication,	Communication and learning. Media of communication-mass, group, inter-personal and traditional their types, roles and functions. Social psychological approach to mass and inter-personal communication.	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Distinguish publicity and propaganda, • Explain impact of communication in social change, • Point out the barriers of communication and possible salutary, • Construct communication strategy for agricultural development,	Farm information method-publicity, propaganda and education. Communication and social change. Barriers of communication-social, cultural and psychological. Communication strategy for agricultural development.	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer

• Interpret significant researches in agricultural communication and their implications, • Explain organizational communication in agricultural development, • Point out the features of development communication. • Illustrate principles of rural journalism,	Significant researches in communication and their implications Organizational communication for agricultural development Basic features of development communication Principles of rural journalism.	Lecture Discussion Multimedia presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Evaluate/critically analysis latest advancement in agricultural extension and communication	Latest research findings and information regarding agricultural extension and communication.		

Reference Books

1. C. Leeuwis and A. Van den Ban. 2004. Communication for Rural Innovation: Rethinking Agricultural Extension. Blackwell Science Ltd, London, UK.
2. G. L. Roy. 2006. Extension Communication and Management. Joy Prakashani. Calcutta, India.
3. J. C. Pearson and P. E. Nelson, 2010. Human Communication, McGraw Hill, Newyork, USA.
4. M. A. Kashem. 2004. Fundamentals of Extension Education. BAU. Mymensingh, Bangladesh.
5. M. H. Bhuiyan, M.A.M. Miah, M.G.R. Akanda and M.A. Bashar 2014. Agricultural Extension Education. G-Science Implementation and publication, Dhaka, Bangladesh.
6. O. P. Dahma, O.P. Bhatuagar, (2010), Education and Communication for Development, Oxford & Publishing Co. Pvt. Ltd. New Dehli, India.

Course Code: AEIS 502 **Course Title : Agricultural Knowledge and Information System (Compulsory)**	**Credit Hour: 03**	**Semester: July-December**

Rationale: This course is designed to provide a thorough and informative perspective of Knowledge Management (KM) and its application in Agriculture.

Course Outcomes: After completing the course, students will be able to

- Describe the fundamental and principle of KM and its creation, acquisition, representation, dissemination, use and re-use, management and assessment.
- Explain the core concepts, methods, techniques and tools for computer supported knowledge management (KM).
- Demonstrate the ability to apply KM solutions to agricultural knowledge acquisition and dissemination.
- Demonstrate the ability to use KM tools in agriculture.
- Conduct theory-driven research in the field of Agricultural Knowledge Management.

Intended Learning Outcomes (ILOs) The students will be able to	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Classify different types of knowledge, • Differentiate between data information & knowledge • Explain knowledge management processes	**KM Foundation:** concept, continuum of knowledge, knowledge classification, KM processes, KM solution	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Identify knowledge resources in organization • Distinguish knowledge based on their characteristics • Comprehend different KM cycles and their application	**KM Cycles:** Knowledge reservoirs, knowledge characteristics, KM cycles	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Interpret the knowledge spiral and conversion models • Apply KM principles in organizational setting • Identify requirements for developing KM in organization	**KM Models:** Knowledge spiral, KM conversion model, factors of successful KM in organization, KM architecture	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Distinguish different types of knowledge application systems • Apply techniques for capturing of knowledge • Articulate and use different types of knowledge sharing systems • Articulate and use different data mining techniques for	**KM Impact**: KM impact in organization, KM application, capture, sharing and discovery systems, data mining technique applications	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer

knowledge discovering			
• Determine key factors that determine the suitability of KM solutions • Comprehend the impact of KM characteristics on KM processes • Identify and describe emerging technologies used in KM practices • Analyze the applicability of those technologies in agricultural knowledge management practice	**Emergent KM applications:** Contingency view of KM application, Effect of task characteristics on KM processes, Emergent KM applications	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Differentiate between spatial and attribute data • Identify the areas of GIS application in agriculture	**Introduction to GIS:** Concept, Spatial & attribute data, Vector vs. Raster data, GIS applications in agriculture	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Collect data using GIS techniques • Draw map using GIS tools	**Spatial Data Collection & presentation:** Basic function of GPS, Skills required for GPS application, Concept of Map, Data collection using map, Draw map using GIS	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Compare AKIS in Bangladesh and beyond • Detect current challenges of implementation AKIS in Bangladesh agriculture	**Comparative AKIS:** AKIS in Bangladesh and other countries, Current challenges and future of AKIS	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Apply KM principles in real-world setting	Assignment on KM applications in agriculture	Assignment	Group presentation Report.

Reference Books

1. Becerra-Fernandez, I. and Sabherwal, R.2010. Knowledge Management: Systems and Processes. M.E. Sharpe
2. Kimiz, Dalkir .2005. Knowledge Management in Theory and Practice. Elsevier Ltd.
3. O, Huisman and A. De. Rolf. 2001. Principles of Geographic Information Systems: An introductory textbook. ITC, the Netherlands.

Course Code: AEIS 503 Course Title : Technology Diffusion (Compulsory)	Credit Hour: 03	Semester: Jan-June

Rationale: The course is designed to provide the theories and techniques of diffusion of innovation in agriculture.

Course Outcomes:

- Describe technology and its diffusion process,
- Explain principals and procedure of Research – Extension linkage mechanism,
- Acquaint with opinion leader, diffusion network and change agent in agricultural extension.

Intended Learning Outcomes (ILOs): The students will be able to	Course Content	Teaching-Learning Strategies	Assessment Strategies
• Describe and apply the procedure of technology diffusion in agricultural extension. • Describe the adopter categories and client system in diffusion process. • Compare different types of Research-extension link.	**Concept of technology diffusion and technology generation** • Diffusion process and Innovation-decision process • Models of technology diffusion process • Innovativeness and Adopter categories and generalizations about adopter categories • Measurement of adoption and Management development for farmers • Ecological factors in adoption: Client system constraints in technology transfer Program • The Rise of Diffusion Research Traditions • Converting Research into Practice • Significant Researches in the field of diffusion and adoption conducted in Bangladesh • Research-Extension-Linkage mechanism for technology diffusion; Role of PRA, RRA and FFS in technology identification and dissemination	Lecture Discussion Multimedia presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Explain the roles of opinion leadership in diffusion network. • Prepare training model for development ideal leadership for agriculture development	**Opinion Leadership and Diffusion networks** • Models of Mass Communication flows • Heterophily - Homophily and the flow of communications	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer Report

	• Measuring opinion leadership and Networks links • Characteristics of opinion leaders • Diffusion networks		
• Describe the basic functions of the change agent and their importance in technology diffusion. • Explain the cause of failure of change agent	**The change agent** • Change agent as linkers; change agents' roles • Factors in change agent success • Homophily and change agent contact	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer Report
• Outline the gap analysis in technology transfer	**Consequence of Innovation** • Gap analysis in technology transfer • Group approach in transfer of technology Communication in innovation-decision process	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer Report

Reference Books

1. E.M. Rogers. 2003. Diffusion of Innovations (5th Ed.). Free Press. NewYork.
2. G. L. Roy. 2006. Extension Communication and Management. Joy Prakashani. Calcutta, India.
3. M. H. Bhuiyan, M.A.M. Miah, M.G.R. Akanda and M.A. Bashar 2014. Agricultural Extension Education. G-Science Implementation and publication, Dhaka, Bangladesh.

Course Code: AEIS 504 Course Title: Extension Project Development and Management (Compulsory)	Credit Hour: 03	Semester: July-December	
Rationale: This course is designed to acquaint students with various stages of project cycle so that they can prepare development project and also gain necessary knowledge and skills of managing the project.			
Course Outcomes: • Describe key concepts of development, plan, policy, project and programme • Able to plan project from identifying and analyzing problem to developing log-frame, activity schedule and resource schedule • Explain key concepts of monitoring, evaluation and managing results of development projects			
Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Explain key concepts of development, plan, policy, project and programme • Classify development projects • Compare between project planning and proposal writing • Summarize phases of logical framework approach of project planning • Explain need assessment • Classify different types of needs • Describe procedure of different methods of need assessment • Analyze stakeholders and summarize the findings in a matrix • Analyze the problem, objectives and strategies • Explain elements of log-frame • Construct intervention logic from strategy analysis • Assess importance of	**Project Planning:** a) Concept of project, programme, plan and policy; Classification of projects; Definition of project planning; Difference between project planning and proposal writing; Project planning approaches; Logical Framework Approach; Steps of project planning -Need assessment, Stakeholder, Problem, Objective, Strategy analysis, Log-frame developing, Activity scheduling and Resource scheduling	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer

assumption by using a flow chart • Formulate important assumptions • Develop log-frame from identified problem			
• Mention stages of project cycle • Identify potential projects and prepare project identification document (PID) or project concept paper (PCP) • Explain project feasibility study • Explain technical, financial soundness, management and organizational, environmental, social and political, and economic aspects of project appraisal • Differentiate between financial and economic appraisal • Explain shadow price and Opportunity cost • Identify project costs and benefits • Calculate Net Present Value (NPV), Benefit Cost Ratio (BCR) and Internal Rate of Return (IRR) for a project	b) Definition and steps of project cycle; Details of project identification, feasibility study and appraisal; Definition, objectives, scopes and types of project appraisal; Technical, Environmental, Financial and Economic appraisal; Discounting technique; Calculation of NPV, BCR and IRR;	Lecture Discussion Multimedia presentation, Assignment	Quiz/MCQ Short answer Essay type answer, Report
• Write project proposal from outputs of planning using appropriate pro-forma • Explain approval procedure of development projects in Bangladesh	c) Introduction to Project Pro-forma (DPP, TPP); Project Approval and Revision Procedures	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Explain monitoring and evaluation with areas and tools • Compare and contrast between monitoring and evaluation	**Project Management:** a) Project Monitoring and Evaluation: Definition, areas, tools and purposes of monitoring and evaluation; basic difference between monitoring and	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer

• Describe purpose, rationale and benefits of monitoring and evaluation • Mention types of evaluation • Outline necessity of post evaluation • Classify types of indicators for project evaluation with example • Name principles of extension project evaluation • Describe steps of extension project evaluation • Justify role of IMED in project monitoring and evaluation • Fill-up IMED formats for project monitoring and evaluation • Explain sustainability of development projects	evaluation; rationale for monitoring and evaluation; benefits of monitoring and evaluation; types of evaluation; Post evaluations and its necessity; Different Types of indicators for evaluation; Principles of extension project evaluation; Phases and steps in an evaluation process; Extension project evaluation process; Role of IMED in project monitoring and evaluation; Explanation and exercise of IMED formats; Sustainability of Development Projects		
• Explain indicators and targets with suitable examples • Describe technical characteristics of SMART indicators • Explain characteristics of good indicators with suitable examples • Mention sources of indicators • Analyze factors considered in setting targets • Express targets in different ways • Explain types of rates of change of indicators • Explain Baseline and Endline Surveys	b) Indicators and Targets for Project Monitoring and Evaluation: Concept of indicators and targets; Explanation of SMART indicators; Dimension of indicators; Characteristics of good indicators; Sources of indicators; Target setting for indicators; Factors considered in setting targets; Ways of targets expression; Types of rates of change of indicators; Baseline and Endline Surveys	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer

• Explain components of result chain • Prepare vertical and horizontal result chain from a given activity • Create logic model for a project or a programme or an organization	c) Result Chain and Logic Model: Concepts and component of result chain; Input-Activity-Output-Outcome-Impact; Horizontal and vertical result chain; Definition of logic model, characteristics of good logic model and wording of results	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer

Reference Books

1. Bhuiyan MH, Miah MAM, Akanda MGR, Bashar MA (2014) Agricultural Extension Education, G Science Implementation & Publication, Karwanbazar, Dhaka, Bangladesh.
2. Ray GL (2011) Extension Communication and Management. Kalyani Publishers, New Delhi, India.
3. Sandhu, Anoop Singh (1994) Extension Programme Planning, Calcutta, India: Oxford & IBH Publisher Co. Pvt. Ltd.

Course Code: AEIS 505 **Course Title : Group Dynamics and Leadership Development (Compulsory)**	**Credit Hour: 03**	**Semester: Jan-June**	
Rationale: This course is designed to provide an in-depth knowledge of the concept of group dynamics and theories of leadership, and their application to real-life situations.			
Course Outcomes: • Compare and contrast a selected number of group dynamics and leadership theories. • Characterize different types of groups in organization, and identify their strength and limitations. • Identify and analyze leadership styles in the workplace and group behavior in organization. • Demonestrate appropriate leadership approach in problems-situation.			
Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Classify the different type of groups and their characteristics, • Apply principles of working with group.	**Concept of Group:** Definition, characteristics, factors, reasons exchange theory, classification of a group, groups in organization and principles of working with group.	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Compare and contrast types of group dynamics, • Explain and apply how to mobilize the groups, • Apply different problem solving techniques in group.	**Group Dynamics:** Definition and types of group dynamics, mobilization of group, and group problem solving technique.	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Generalize the concept of committee, • Contrast the advantage and disadvantage of committee, • Classify the different types of committee.	**Participation and Committee:** Concept, advantages and disadvantages, importance, classification.	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Conceptualize theories of leadership, • Differentiate and describe the traits of leadership, • Compare the differences between leader and manager	**Concept & approaches of leadership**: Trait, skills, style, situational (chapter 1,2,3,4,5)	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Elaborate different theories of leadership, • Judge different leadership styles, • Apply leadership	**Leadership Theories:** Contingency, path-goal, leader-member exchange, Transformational, (Chapter 6,7,8,9)	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer

styles in organizational setting,			
• Discuss the leadership ethics, Employ leadership ethics in • group and organization.	**Leadership Ethics:** Team leadership, psychodynamic leadership, and leadership ethics (Chapter 12,13,16)	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Apply insight of different theories of leadership in real world setting.	Assignment of use of leadership, Theories in Agricultural Extension Service	Assignment preparation	Presentation Report.

Reference Books

1. Northouse, P.G. (2013). Leadership Theory and Practice. (6th Edition). Sage Publications, Inc.
2. Robbins, S.P. and Judge, T.A. (2015). Organizational Behavior (15th Edition). Pearson.

Course Code: AEIS 506 **Course Title : Research Methodology in Social Sciences (Compulsory)**	**Credit Hour: 03**	**Semester: January-June**

Rationale: This course is designed to provide basic concepts on scientific social research methods and their approaches. It includes discussions on sampling techniques, research designs and data analysis.

Course Outcomes:

- Explain basic framework of research process, various research designs and techniques
- Ascertain the research gap by addressing literature review in a scientific manner 3. Identify various sources of information for data collection
- Explain the ethical dimensions of conducting applied research Address research problem and develop research proposal
- Analyze data and write scientific report to achieve the project goal

Intended Learning Outcomes (ILOs): The students will be able to	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Describe the concepts of science, research, fact, law and theory • Identify ideal research features/characteristics • Identification of research problems and prioritization techniques of identified problems • Explain types of research • Discuss fundamental basis of research planning • Illustrate the preparation of • standard research proposal	**Social Research:** Concept of science, research, fact, theory and problem; characteristics of research, types of research (qualitative, quantitative); identification and prioritization of researchable problems; steps of conducting social research; preparation of research proposal	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Explain different types of data and variables • Describe hypothesis and research instruments in accordance with the research objectives • Justify validity and reliability test of data collecting instruments • Summarize content analysis	**Data, Variable, Hypothesis and Research Instruments:** Types of data - qualitative, quantitative, discrete and continuous; variable - nature and types of variables; hypothesis - importance, nature and types, formulation and testing; preparation of research instruments; validity, reliability and objectivity in testing research instruments	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Describe methods of data collection	**Methods of Data Collection:** Survey (by using interview schedule, mail questionnaire, email questionnaire, etc.), PRA & RRA; case study and observation	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer

• Illustrate the concept and levels of measurement • Explain different measurement scales and techniques	**Measurement:** Concept of measurement, levels of measurement; validity and reliability of scale, tests and scales; Attitude scales - equal appearing interval scale; summated rating scale cumulative (Guttmann) scale; sociometry, norm-referenced and criterion-referenced techniques of measurement	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Discuss different types of research • Design and procedure of sampling • Organize data collection	**Research Designs:** Types of research designs; sampling procedure – locale, population and sample; methods of sampling; collection of data	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Explain coding, categorization, tabulation and analysis of data • Measure different statistical tests and predict the uses • Describe presentation and interpretation of data • Practice preparation of research report	**Analysis, Presentation and Interpretation of Data:** Categorization, coding and tabulation of data; different statistical tests and their uses; forms of presentation of data; interpretation of data -meaning, needs, techniques and precautions; preparation of research report - format, quoting references, style of writing, using footnotes, citation of references & bibliography; use of graphics (Charts, histogram, pie-graphs, pictures, plates, etc.) in interpretation of data	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer

Reference Books

1. Kothari, C. R. 2004. Research Methodology: Methods and Techniques. New Age International (P) Ltd.
2. Neuman, W. L. and Robson, K. 2011. *Basics of social research: Qualitative and quantitative approaches* (3rd Canadian ed.). Pearson.
3. Bryman, A. 2016. Social Research Methods. Oxford University Press.
4. Keren, G and Lewis, C. 1993. A Handbook for Data Analysis in the Behavioral Sciences: Statistical Issues. Lawrence Erlbaum Associates.

Course Code: AEIS 507 **Course Title : Statistics for Socio-Economic Research (Elective)**	**Credit Hour: 03**	**Semester: January-June**	
Rationale: This course is designed to introduce students with processing and analysis of qualitative and quantitative data for social research.			
Course Outcomes: • Explain data processing • Compare between parametric and non-parametric statistics • Apply knowledge on both descriptive and statistical analysis • Decide appropriate statistical analysis to perform a specific task			
Intended Learning Outcomes (ILOs): The students will be able to	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Describe editing, coding, classification and tabulation for primary data • Differentiate between parametric and non-parametric test • Explain about descriptive statistics	**Processing and Analysis of Data:** Processing of data editing, coding, categorization and tabulation; features of parametric and non-parametric test; frequency distribution; measures of central tendency; measures of dispersion; coefficient of variation; degrees of freedom	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Use different types of t-test • Determine t value and its interpretation	**T-test:** Concept, types (Paired t-test and independent-samples t-test), uses, assumptions and interpretation	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Describe chi-square test • Use different types of chi-square test • Determine of chi-square value and its interpretation	**Chi-square test:** Concept, single classification, two-way classification and two-by-two tables; properties of chi-square distribution; condition for the application of chi-square test.	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Define correlation and its types • Compare between Pearson product moment and Spearman rank correlation • Explain reasons for choosing correlation analysis for conducting research	**Correlation:** definition, Karl Pearson product moment correlation, Spearman's rank correlation; Properties of correlation coefficient, Correlation matrix	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Define regression analysis and its types. • Compare between correlation and	**Regression:** Concept, difference between correlation and regression, multiple regression, stepwise multiple regression; differentiate between enter	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer

regression. • Apply regression equation	method and stepwise method		
• Use statistical software packages for data analysis and interpretation	Hands on statistical software packages	Demonstration Discussion Exercise, Assignment	Report

Reference Books

1. G. L. Roy and S. Mondal. 1999. Research Methods in Social Sciences and Extension Education. Naya Prokash, Calcutta, India.
2. A. M. A. Karim. 2001. Understanding Social Research. M.N. Mallick and Co, Mymensing, Bangladesh.
3. A. R. Ahmed, M.A.A. Bhuiyan, Z. A. Ahmed and M.Z. Hossain. 2004. Methods of Statistics. S. Ahmed and Associates, Manikgonj, Bangladesh.

Course Code: AEIS 508 Course Title: Agricultural Journalism (Elective)	**Credit Hour: 03**	**Semester: July-December**	
Rationale: This course is designed to acquaint the students with the art of journalism with special emphasis on agricultural journalism and its practical implication in agricultural extension work for gearing up agricultural development.			
Course Outcomes: • Acquaint students with the basic and modern concept of Journalism, its ethics and principles • Learn report and feature writing, interviewing covering general and agricultural • Journalism • Explain features of Public Relation			
Intended Learning Outcomes (ILOs): The students will be able to	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Define journalism, agricultural/ farm journalism • Explain cannons of journalism • Summarize ethics of journalism • Describe history of agricultural journalism in Bangladesh • Explain various journalistic and related terms	**Concept of journalism:** Agricultural/farm journalism, Cannons and ethics of journalism, Classification of journalism, History of farm journalism Acquaintance with various journalistic and related terms, online journalism	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Sketch principles of farm journalism • Justify opportunities of farm journalism in Bangladesh • Evaluate role of journalism and mass media in agricultural development	**Farm journalism:** Principles of farm journalism, agricultural journalism, its scope and implication in agricultural extension work	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Classify types of reporting • Describe writing style of farm journalism • Mention general writing tips • Outline six-step writing process • Explain characteristics of good news • Prepare news story following inverted pyramid style • Mention characteristics of feature stories • Explain importance of success stories in disseminating	**Reporting:** Types of reporting, Principles, rules and style of writing news, feature articles, success stories and popular articles for newspapers, magazines, radio and television broadcasts	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer

agricultural innovations • Prepare feature story • Prepare success story • Prepare scripts for radio and television			
• Explain editing • Classify editing • Describe skills required for an editor • Execute editing of a news story • Explain technical editing • Explain cutting copy with example • Execute proof reading of articles	**Editing**: Concept and types of editing, skills for editing, Steps of editing news, Technical editing, cutting copy, fixing wordy writing, Proof reading: Symbols used for proof reading and manner of direction	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Explain processes of public relation • Prepare hand out • Prepare a press release • Describe factors considered in organizing press campaign • Conduct radio / TV interviews	**Public relations:** Key concepts and processes, Preparation of handout, press release, organizing press campaign, radio / TV interviews	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Describe characteristics of good newspaper • Sketch organogram of a newspaper • State functions of different departments of newspaper • Explain functions of different editors • Outline types of reporters Prepare editorial for a newspaper • Analyze role of editorial of a newspaper	**Newspaper:** Types of Newspaper, Characteristics of good newspaper, Organogram of a daily newspaper, Departments of a newspaper, Different types of reporters and editors and their roles, The make-up of a newspaper, Types of editorial, Steps of writing editorial	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer

Reference Books

1. Harcup, Tony (2009), Journalism: Principles and Practice, Thousand Oaks, California: Sage Publications,
2. Helen Sissions (2007), Practical Journalism, Aukland University of Technology, NZ, Sage Publications
3. Mondal, Subin K, Dr. (2010), Hand Book of Farm Journalism,Pulari Publishers
4. Ray. G.L., Mondal,S, (2005), Journalism including Communication, farm and rural journalism, public relations, Kalyani Publishers

Course Code: AEIS 509 **Course Title : Psychology of Human Behavior (Elective)**	**Credit Hour: 03**	**Semester: January-June**	
Rationale: This course is design to provide an advanced understanding on human behavioral characteristics such as attitude, perception, personality and self-development.			
Course Outcomes: • After completing the course, students will be able to • Describe the human and their behavior in work settings, • Interpret human behavior in work, • Apply methods to motivate human in accomplishing organizational goal			
Intended Learning Outcomes (ILOs) The students will be able to	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Describe psychology and human behavior, • Apply methods for analysing human behavior in work,	**Introduction to psychology:** Concept of psychology & human behavior rationale, Methods of studying psychology,	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Describe and measure human attitude & perception, • Evaluate human attitude towards agricultural practices,	**Attitude & perception:** Concept, formation of attitude, measurement of attitude, principles and construction of perception,	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Articulate the basic of personality development, • Apply techniques to develop personality and enhance capacity, • Comprehend and use different self-development methods	**Personality and Self-development:** Concept of personality and self-development, factors of personality, techniques of personality development,	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Differentiate between external and internal forces of group dynamics, • Explain planned social change in agriculture, • Discuss social power and its influence in rural development,	**Group Dynamics:** Concept, Internal & external forces of group dynamics, social change and social power,	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Apply latest theoretical and practice aspects of personality, attitude and perception in explaining human behavior in agriculture,	Assignment on human behavior regarding technology generation and diffusion in agriculture,	Assignment	Report

Reference Books

1. Mishra,B.K. 2008. Psychology: The Study of Human Behavior, PHI Learning Private Ltd. New Delhi.
2. Bhuiyan, M.H., Miah, M.A.M, Akanda, M.G.R and Bashar, M.A. 2014. Agricultural Extension Education. G-Science Implementation and Publication. Dhaka.

Course Code: AEIS 510 **Course Title : Non-governmental Organization in Rural Development (Elective)**	**Credit Hour: 03**	**Semester: July-December**

Rationale: This course is designed to provide an in-depth understanding of NGOs' activities and roles in development.

Course Outcomes:

- Summarize the strategic issues and organizational challenges faced by NGOs,
- Conceptualize the different strategies and approaches commonly adopted by NGOs
- Develop relevant management competencies, leadership skills and analytical capabilities

Intended Learning Outcomes (ILOs) The students will be able to	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• State clearly about NGOs and its types • Differentiate between GOs and NGOs • Evaluate the features of NGOs	**Understanding NGOs:** Concept and meaning of NGOs; difference between GO and NGO; Types of NGOs; Initiation and gradual growth of NGOs in Bangladesh; missions, goals and philosophies of NGOs; criticism of NGOs in Bangladesh	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Identify the activities run by NGOs • Explain NGOs' impact on Bangladesh economy	**Impact of NGOs' Activities in Bangladesh:** Income generation activities of NGOs in Bangladesh; Contribution of NGOs to Bangladesh Economy	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Describe different areas of activities run by selected NGOs	**Rural Development and Farm Management Activities by Selected NGOs:** BRAC, PROSHIKA, RDRS, GKF, DIPSHIKHA, TMSS and CARE	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Provide an overview of the major sources of NGO funds • Outline a strategic approach to financial sustainability • Interpret the main elements of financial information of NGOs	**Mobilising and Managing Financial Resources:** Major sources of NGO funds; Approaches to financial sustainability; Mobilization of non-financial resources	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Create project concept paper • Manage projects of NGOs	**Project Management:** Preparation of project concept paper (PCP); Management and operation of projects by the NGOs; Partnership programs of NGOs with the GOs	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer

• Explain the key strategic issues facing the NGO sector • Criticize the activities done by the different NGOs in Bangladesh	**NGO Management:** The Strategic Issues of NGO management; NGO registration, renewal of registration, rules & regulations; NGO accountability; NGO governance, Apex bodies of NGOs (NGO Affairs Bureau, PKSF, etc.); Steps of NGO formation, Application for establishing NGO, Application for fund collection for NGO from home and aboard	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer

Reference Books

1. Lewis, D. (2014). Non-Governmental Organizations, Management and Development. Routledge. London, UK.
2. Shigetomi, S. (2002). The State and NGOs: Perspective from Asia. Institute of Southeast Asian Studies. Singapore.
3. Fisher, J. (1998). Nongovernments: NGOs and the Political Development of the Third World. Kumarian Press, West Hartford, USA.

Course Code: AEIS 511 **Course Title : Gender Issue and Development (Elective)**	**Credit Hour: 03**	**Semester: January-June**	
Rationale: This course is designed to help students to explore some of the key ideas and issues in Gender Issue and Development, and their implication for policy and practice.			
Course Outcomes: • Acquire knowledge on different gender issue and women empowerment • Explain different gender theory and apply them in research and policy • Describe the role of gender in agricultural development			
Intended Learning Outcomes (ILOs) The students will be able to	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Describe why gender perspective is important in development initiatives • Verify the variety of development perspectives that address gender issues.	**Gender and Development: Concepts and Definitions** : Introduction, Quick definitions, Detailed explanations and further reading-Culture, Gender analysis, Gender Discrimination, Gender Division of Labor, Gender Equality and Equity, Gender Mainstreaming, Gender Needs, Gender planning, Gender Relations, Gender Training, Gender Violence, Sex and Gender, Social Justice, WID/GAD, Women's Empowerment, Women's Human Rights.	Lecture Discussion Multimedia presentation	Lecture Discussion Multimedia presentation
• Construct our understanding of feminist theories, gender issues and development paradigms • Illustrate the impact of these policies on legislation, education, welfare reform, culture and other economic	**Theoretical Perspectives on Gender and Development:** Why Theory? Why Gender? and Why Development?, Feminism and development: Theoretical perspective, Feminist theory and		Lecture Discussion Multimedia presentation
• and social issues affecting women's lives • Analyze the policies of international development and financial institutions and agencies • Discuss alternative approaches and practices to	development: Implication for policy, Research and action, Alternative Approaches to women and development, The women's movement and Development		

women and development.			
• Interpret the importance of gender in agriculture and development • Construct various strategies or policy against different challenges facing in agricultural sector due to gender perspective	**Gender in Agriculture and Development:** Gender, Agriculture and development, Traditional and Modern methods of agriculture and development, Land tenure and Utilization system, Gender Relations in Agricultural division of labor, Agriculture and Mechanization and gender implications, Agriculture and technology from a gender perspective, Policy issues in agricultural development and gender implications, Challenges facing agricultural sector from a gender perspective and measures for redress.	Lecture Discussion Multimedia presentation	Quiz/ MCQ Short answer Essay type answer
• Validate women empowerment in agricultural sector for sustainable development	**Gender and Sustainable Development: Maximizing the Economic, Social and Environmental Role of Women:** Economic and Gender, Women and Economic Growth, Women and Poverty Reduction, Women and Technology, Women and Management, Women Entrepreneurs, Society and Gender, Women and Education, Women and Health, Women and Governance, Environment and Gender, Women and Sustainable Consumption, Women and Sustainable Production, Women and Climate change**.**	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Update with latest theoretical and practical aspects of Gender and Development	Latest Research Findings and Information Regarding Extension Organization and Management	Assignment	Report

Reference Books

1. OECD (2008). Gender and Sustainable Development: Maximizing the Economic, Social and Environmental Role of Women.
2. Reeves, H. and S. Baden, (2000). Gender and Development: Concepts and Definition. BRIDGE (development- gender). Institute of Development Studies, University of Sussex. Report no. 55.
3. Parpart, J.L., M.P. Connelly and V.E. Barriteau, (2000).Theoretical Perspectives on Gender and Development. International Development Research Centre.Ottawa, Canada, ISBN 0-88936-910-0.

Course Code: AEIS 512 Course Title : GIS and Remote sensing in agriculture (Elective)	Credit Hour: 03	Semester: January-June

Rationale: This course is designed to gather knowledge on how GIS and Remote sensing can be applied for the development of agriculture.

Course Outcomes:

- Apply knowledge on GIS
- Explain the fundamental information regarding remote sensing
- Describe how agriculture sector can be benefited through utilize GIS and Remote sensing technique

Intended Learning Outcomes (ILOs) The students will be able to	Course Content	Teaching-Learning Strategies	Assessment Strategies
• Describe about GIS and types of GIS data • Explain the use of GIS in agriculture	**Introduction to GIS** Concept and definition of GIS; Data vs. Information; Spatial data and Attribute data, Uses of GIS in agriculture.	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Describe the use of GPS in collecting spatial data • Prepare a final map from a base map • Describe the importance of map	**Collection and presentation of spatial data** GPS-definition, basic function of GPS, Skill required to use GPS, Advantages and disadvantages of using GPS; Map-definition, components of map, procedure to prepare a map, land utilization mapping, crop suitability mapping.	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Define remote sensing its action process • Describe how remote sensing evolved	**Introduction to Remote sensing** Remote sensing- definition, Electro-magnetic radiation, sensors, passive remote sensing; active remote sensing; remote sensing platform; chronology of remote sensing.	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Describe the use of remote sensing in agriculture • Explain crop status through image	**Remote sensing application in agriculture** Fields of application; Application in agriculture; Monitoring of crop status, Crop yield forecasting, crop identification.	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Update student with latest theoretical and practical aspects of Gender and Development	Latest Research Findings and Information on GIS and Remote sensing in agriculture	Assignment	Report

Reference Books

1. O, Huisman and A. De. Rolf. 2001. Principles of Geographic Information Systems: An introductory textbook. ITC, the Netherlands.
2. Wang, G. and Weng, O. 2012. Remote sensing of natural resources. CRC press, Tailor and Francis group.
3. S. M. M. Haque . 2008. Basic Concept on GIS. A booklet of the training program 'Certificate Course on GIS'. Jahangir Nagar University, Savar, Dhaka, Bangladesh.
4. B. Anderson. 2003. Introduction to Arc View. 2nd edition. University of New Hampshire Cooperative Extension. USA.

Course Code: AEIS 513 Course Title: Adult Education and Rural Development (Elective)	Credit Hour: 03	Semester: July-December

Rationale: This course is designed to acquaint students with key concepts of practical outcome in the form of a policy effective kit that might be of use in giving hints on practical guidance to adult education suited to the rural development in Bangladesh.

Course Outcomes:

- Justify techniques of individual adult learner needs and aspirations.
- Identify appropriate adult learning experiences using for rural development.
- Address ethical challenges through an adult education framework that are shaped by a belief in social justice, equity, and integrity.
- Advocate for effective programs and services that support adult learners' needs for continued rural growth and development.
- Explain scope and hindrance of common rural agricultural development policies in Bangladesh.
- Practice rural poverty dynamics and developments policies.

Intended Learning Outcomes (ILOs) The students will be able to	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Describe the concept, growth and development of adult education • Interpret adult education influence on national development	**Introduction to Adult Education:** The concept of adult education; growth and development of adult education; **a**dult education and national development	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Describe Philosophy of adult education	**Philosophy of Adult Education:** Concept of Philosophy; the role of Philosophy in teaching of adults	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Explain the concept and myths of adult learning	**Adult Learning:** The concept of learning; some myths of adult learning	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Justify administrative structure, policy formulation and planning of adult education in Bangladesh	**Policy and Administrative Structures of Adult Education:** Historical background of adult educational policy formulation and planning in Bangladesh; the administrative structure of adult education in Bangladesh and other countries	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Illustrate adult education practicing different methods • Compare suitable methods within the literate and	**Methods of Teaching Adults:** Adult education practice methods in Bangladesh; methods useful with illiterate and literate groups	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer

illiterate peoples			
• Interpret within the politics and adult education program in Bangladesh • Describe the role of politics on adult education program	**Politics in the Administration of Adult Education:** Relationship between politics and Adult Education; role of politics on Adult Education in Bangladesh	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Justify the level of contributions of adult education program towards farmers development • Illustrate the problem and prospects of adult education program	**Adult Education and Farmers Development in Bangladesh:** Contributions of adult education programs towards farmers' development; problems and Prospects	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Describe the concept, dimensions, programs, strategies and hindrance of rural development based on Bangladesh and international perspectives	**Concept and dimensions of Rural Development:** 'Rural' and 'rural development'; concepts and dimensions of Bangladesh and international rural development; r**ural development institutions, programs, strategies and hindrances in Bangladesh**	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Analyze agricultural policies and rural development regulation in Bangladesh • Explain the scopes and hindrance of rural development policies	**Rural Agricultural Policy and Development**: Analysis of the common agricultural policies and the rural development regulation in Bangladesh; scopes and hindrances of rural policy development in Bangladesh	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Describe poverty dynamics, poverty traps and poverty development policies • Compare between poverty and risk, and poverty and savings	**Rural poverty dynamics:** Rural poverty dynamics; poverty and risk; poverty and saving; uncovering poverty traps and threshold effects; rural poverty development policy	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer

References Books

1. Gasperini, L and Atchoarena, D. 2003. Education for rural development: towards new policy responses. International Institute for Educational Planning.
2. Singh, K. 2009. Rural Development: Principles, Policies and Management. SAGE Publications Pvt. Ltd.. Foley, G. 2004. Dimensions of Adult Learning: Adult Education and Training in a Global Era. Allen & Unwin.
3. Rogers, A. 2010. Teaching Adults. Open University press. Milton Keynes, United Kingdom.
4. Chambers, R. 1983. Rural Development: Putting the Last First. Longman.

Course Code: AEIS 514 **Course Title : Climate Change and Agriculture (Elective)**	**Credit Hour: 03**	**Semester: July-December**	
Rationale: The aim of course is to make students knowledgeable about climate change and climate change management in agriculture			
Course Outcomes: • Explain the climate variability and climate change • Apply tools and processes for assessing climate-related hazards, and • Formulate livelihood adaptation options.			
Intended Learning Outcomes (ILOs): The students will be able to	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Describe climate variability and climate change, • Evaluate vulnerability to climate variability and change, and • Apply participatory tools and processes for assessing climate hazards, vulnerabilities and risks.	**Climate change management:** Understanding climate variability and climate change; Greenhouse effect and its consequences on climate; Climate change scenarios for Bangladesh; Understanding vulnerability to climate variability and change; Future climate change affect the agriculture of drought-prone areas; Impacts of increased climate variability and change on rural livelihoods; Strategic drought management; Understanding the participatory tools and processes for assessing climate-related hazards, vulnerabilities and risks in agriculture; and Identifying key climate risks that have significant impact on communities in general and livelihoods in particular.	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Prepare forecast for adaptation options and building adaptive capacity, • Assess livelihood adaptation options, • Develop drought risk management strategies, and • Formulate policy information for improving adaptive capacity.	**Adaptation and adaptive capacity:** Preparing livelihood adaptation options to manage climate variability and change; Understanding the relevance of adaptation options for livelihood development; Gain understanding of changing livelihood portfolios in drought-prone areas; Describing the	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer

	various types of forecast products; Elaborating how current forecast products may be used for drought risk management; and Understanding rainfall forecasts and their use in decision-making.		
• Describe perception and its influencing factors • Explain relationship between perception and adaption to climate change • Select crop specific adaption strategies.	**Farmers perception and adaptation to climate change:** Perception-concept and definition; Factors influence farmers perception; Relationship between farmers perception and adaptation to climate change; Common adaption practices followed by the farmers; Barriers to adaption.	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Define climate drivers or parameters. • Explain effect of climate change drivers • Compare between effect of climate and non-climate drivers	**Climate change parameters/drivers:** Concept, definition and direct and indirect effects of climate change drivers (Temperature, rainfall, drought, see level rise, salinity etc.) and non-climate drivers (Geological process, land use change, land cover modification, invasive species and pollution).	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer

Reference Books

1. Henson, R. 2007. The Rough Guide to Climate Change. Second Edition, Rough Guides Ltd, New York.
2. Ravindranath, N.H. and Sathaye, J.A. 2003. Climate change and developing countries. Kluwer Academic Publishers, New York.
3. Yu, W.H. et al. 2010. Climate change risks and food security in Bangladesh. Earthscan Publications Ltd. London.
4. Wreford, A., Moran, D. and Adger, N. 2010. Climate Change and agriculture: impacts, adaptation and mitigation. OECDPublications, France.
5. Adger, W. N., Lorenzoni I. and O'Brien, K. L. 2009. Adapting to climate change: thresholds, values, governance. Cambridge University Press, UK.
6. IPCC, 2014: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1132 pp.

Course Code: AEIS 515 Course Title: Extension Administration, Supervision and Management (Elective)	Credit Hour: 03	Semester: July-December

Rationale: This course is designed to provide knowledge to individual learner on practical office administration, leadership abilities, and developing talented supervisory and **management** skills for their subordinates.

Course Outcomes:

- Conceptualize knowledge on extension administration and build the capacity in extension management and supervision.
- Illustrate historical agricultural administration and extension services.
- Explain conflict, principal, theories and management concept of program management.
- Utilize administrative theories in the organizations.
- Practice performance appraisal stress in managing, grievance handling techniques for management of sustainable agriculture
- Analyze change agents and client system problems.

Intended Learning Outcomes (ILOs) The students will be able to	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Compare general and extension administration	**Introduction to Agricultural Extension administration:** Concept, scope and characteristics of extension administration; extension administration vs general administration; historical perspective of agricultural administration with special reference to extension services	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Justify administrative role, function and responsibilities • Illustrate administrative process, techniques and principles	**Process of Functional Administration:** Administrative vs management changes and implementation; administrative role, function and responsibilities; administrative process, techniques and principles applied to agricultural organizations	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Describe concept, rules and principles of supervision	**Introductory to Supervision:** Components of supervision; Rules and principles of supervision, coordination and supervision techniques	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer

• Implement techniques of administrative theories • Describe administrative communication and forces of administration	**Administrative Theories and Communication:** Administrative theories and their implementations; theory of X and Y; decision making and human relationships; management by objective (MBO); administrative communication and analysis of research studies in agricultural administration and their implications to agricultural development and future research; identification of forces affecting administration of agricultural programs	Lecture Discussion Multimedia presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Explain conflict management, grievance handling, and performance appraisal stress • Describe principal theories and management concept of program management for sustainable agricultural development • Analyze change agent and client system problems	**Management and Conflict Management:** Conflict management; principal, theories and management concept of program management; concept and principles of supervision; performance appraisal stress in managing; grievance handling; analysis of change agents and client systems problems; management of sustainable agriculture	Lecture Multi-media presentation Group discussion Exercise practice Assignment	Quiz/MCQ Short answer Essay type answer Report

References Books

1. Clark, R. K. 1977. Basic concepts and theories of administration and supervision as applied to extension-community development programs. Dept. of Continuing and Vocational Education, University of Wisconsin-Madison.
2. Selznick, P. 1984. Leadership in Administration: A Sociological Interpretation. University of California Press; First edition.
3. Drucker, P. F. 2007. Management: Tasks, responsibilities. Transaction Publishers.
4. Eccles, R. G., Nohria, E and James D. 1992. Beyond the Hype: Rediscovering the Essence of Management. Harvard Business School Press.

Course Code: AEIS 516 **Course Title :** **Communication Skills (Elective)**	**Credit Hour: 03**	**Semester: January-June**	
Rationale: This course is designed to provide principles of effective communication and teach students to learn how to communicate more effectively at work.			
Course Outcomes: • Distinguish between formal and informal communication • Apply the key oral and writing skills for effective communication • Overcome the speech and written anxiety and deliver effective communication at work			
Intended Learning Outcomes (ILOs): The students will be able to	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Differentiate formal and informal discourse • Describe the model of human communication • Use the conventions of formal writing and speaking	**Human communication:** Oral and written communication, formal and informal discourse, advantages of studying and writing together, model of human communication, conventions of formal writing and speaking, exploration of thoughts and feelings	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Define and distinguish between types of messages • Apprehend physical attributes of presentation style • Apprehend vocal attributes of presentation style	**Presentation style**: Types of messages & their preparation, physical attributes of presentation style, vocal attributes of presentation style.	Lecture Discussion Multimedia presentation Assignment	Quiz/MCQ Short answer Essay type answer Presentation Report
• Describe the speech anxiety • Use techniques to cope with speech anxiety • Describe writing anxiety • Use techniques to cope with writing anxiety	**Communication apprehension:** Speech anxiety, understanding speech anxiety, coping with anxiety, writing anxiety, understanding written anxiety, coping with writing anxiety	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Apprehend the skills in oral and written communication • Apply the techniques to overcome the barriers of effective communication	**Critical skills for effective communication:** Skills in oral & written communication, communication barriers, techniques of effective communication, importance and listening	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer

Reference Books

1. J.C. Pearson and P.E. Nelson, 2010. Human Communication. McGraw Hill, New York, USA
2. O.P. Dahma, O.P. Bhatuagar. 2010. Education and Communication for Development. Oxford & Publishing Co. Pvt. Ltd. New Delhi, India
3. R.A. Katula, C.A. Martin. 2012. Communication: Writing and Speaking, Brown and Company. Boston, USA

Course Code: AEIS 517 **Course Title : Community Development (Elective)**	**Credit Hour: 3**	**Semester: July-December**

Rationale: This course is developed to gather knowledge on how to build and sustain communities by the learners. It also teaches students how to work within a group, with governmental, political, economic, social structures, policies, and multicultural settings.

Course Outcomes:

- Explain about the rural realities.
- Conceptualize sensitivity and commitment for working with rural communities.
- Utilize the government and voluntary efforts towards rural community development.
- Practice with specific skills and techniques of working with rural communities.

Intended Learning Outcomes (ILOs) The students will be able to	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Describe the concept of community development • Analyze local and global context of community development based on theoretical and participial perspectives	**Theoretical background of community development:** 1. Understanding of community development and social action 2. The local and global contexts of community development 3. Theoretical and practical perspectives of community development 4. Community development method and analysis 5. Elements, process, scope, faith and themes of community development	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Boost up community work • Compare with community participation and politics • Practice working with diversity	**Community work and participation:** 1. Community work, self-determination, community pace and growth in community capacity 2. Community participation and politics 3. Working in community based human services 4. Working with diversity	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Evaluate community development work in Bangladesh and other SAARC countries • Address community development problem in	**Community development in the third world:** 1.Strategies of community development works in Bangladesh and other SAARK countries	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer

Bangladesh and other developing countries	2. Community development problems in Bangladesh and other developing countries		
• Describe community leadership, conflict and management mechanism	**Community management:** 1. Rural and urban community leadership 2. conflict and mechanism of management	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Explain community development by nature • Implement social action process • Identify challenges and future prospects of community development	**Community development by nature:** 1. Cultural, environmental and spiritual aspects of community development and social action 2. Social action processes 3. Challenges and future prospects of community development and social activism	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer

Reference Books

1. Ledwith, M. 2005. Community development: A critical approach. Bristol University Press.
2. Phillips, R. and Pittman, R. P. 2014. An Introduction to Community Development. Routledge.
3. Homan, M. S. 2015. Promoting Community Change: Making It Happen in the Real World. Cengage Learning (6^{th} Ed.).

Course Code: AEIS 518 Course Title: Planning, Monitoring and Evaluation of Extension Program (Elective)	Credit Hour: 03	Semester: July-December	
Rationale: This course is designed to enable students so that they can prepare, monitor and evaluate various extension programs while working in extension organization.			
Course Outcomes: • Acquaint with concepts, principle, models of extension programme planning • Prepare programme using models of programme planning • Describe concepts, tools and techniques of programme monitoring and evaluation			
Intended Learning Outcomes (ILOs): The students will be able to	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Define extension programme • Mention and explain each principle of extension programme planning • Describe models of programme planning • Explain participatory method of programme planning • Interpret various participatory tools of programme planning • Design desired participatory tool for programme planning • Appraise role of extension agents and specialist in extension program planning • Summarize research findings in extension program planning • Develop alternative approaches to program planning	**Extension Program Planning:** Concept; Principles of extension program planning; Program planning model; Peoples participation in program planning; Research in extension program planning; Role of extension agents and specialist in extension program planning; Alternative approaches to program planning	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Explain meaning, purpose and scope of program monitoring • Differentiate between quantitative and qualitative monitoring • Analyze advantages and disadvantages of different tools of monitoring • Prepare monitoring plan with	**Extension Program Monitoring:** Meaning, purpose and scope of monitoring; Quantitative and qualitative monitoring; procedure for monitoring of demonstrations and field days, farmers groups, farmers training, and motivational tours/visits	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer

key indicators for programs like demonstrations, field days, farmers training and motivational tours/visits			
• Explain key concepts and types of programme evaluation • Appraise principles of programme evaluation • Describe steps of extension programme evaluation • Develop appropriate indicators for evaluation • Identify suitable evaluation methodology • Design evaluation framework of extension programs • Prepare evaluation report • Identify and explain reasons of failure of a programme • Justify the role of using MIS in extension program monitoring and evaluation • Describe levels of people's participation • Argue advantages and disadvantages of people's participation in programme planning, monitoring and evaluation	**Extension Program Evaluation:** Basic concepts in evaluation; steps in evaluating extension programs; aspects of evaluation of a training program and a/v aids: total effect of Training, methods and techniques used; instructors, trainee's performance and content; Review of evaluation study of an extension program Why programme fails? Use of management information system (MIS) for effective program, Future extension programs for community development, People's participation in extension programs, levels of participation, Advantages and disadvantages of people's participation, Participatory evaluation	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer

Reference Books

1. Bhuiyan, M.H, Miah, M.A.M, Akanda, M.G.R, Bashar, M.A (2014) Agricultural Extension Education, g-Science Implementation & Publication, Karwanbazar, Dhaka, Bangladesh.
2. Ray, G.L (2011) Extension Communication and Management. Kalyani Publishers, New Delhi, India.
3. Sandhu, Anoop Singh (1994) Extension Programme Planning, Calcutta, India: Oxford & IBH Publisher Co. Pvt. Ltd.

Course Code: AEIS 519 **Course Title : Agri-environment, Development and Sustainability (Elective)**	**Credit Hour: 03**	**Semester: January-June**	
Rationale: The aim of the course is to make students knowledgeable about agri-environmenal management and sustainable agricultural development in the context of climate change.			
Course Outcomes: • Understand the interrelationships between agriculture and environment • Apply agri-environmental management approaches and tools • Evaluate vulnerability, adaptive capacity and resilience in agricultural production, and • Design sustainable development in agricultural sector.			
Intended Learning Outcomes (ILOs): The students will be able to	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Describe the effects of agriculture on environment, • Appraise farming systems and their environmental significance, and • Apply DPSIR and EIA tool to explain agri-environmental management.	**Agriculture and Environment:** Fundamental of environment and agriculture interrelationships**,** Understanding the effects of agriculture on environment, Describing farming systems and their environmental significance, Discussing organic cropping systems from ecological perspectives, DPSIR as a tool for agri-environmental indicators generation, Application of agri-environmental management approaches and tools: Environmental Impact Assessment (EIA).	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Assess sustainable agriculture (SA) and propose a model of SA, • Differentiate climate change adaptation, coping and mitigation, • Illustrate vulnerability, adaptive capacity and resilience, and • Implement climate-smart agriculture.	**Sustainable Agriculture:** Fundamentals of sustainable agriculture (SA); Developing indicators and understanding SA models; Measuring agricultural sustainability; Introduction to climate change; Understanding climate change adaptation; Vulnerability, adaptive capacity and resilience; Understanding climate-smart agriculture (CSA) and implementing CSA.	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Critically analysis sustainable development concept, • Apply sustainable	**Sustainable Development:** Theoretical and conceptual explorations of sustainable development; Sustainable	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer

agricultural development approach, and • Propose good agricultural governance in different contexts.	development- the context of Bangladesh; Fundamental of agricultural governance; Agricultural governance in the context of sustainable intensification of crop production, crop diversification and seed management	Assignment	Report

Reference Books

1. Warren, J. Lawson, C. and Belcher, K. 2008. The Agri-environment. Cambridge University Press, UK.
2. National Research Council, 2010. Toward Sustainable Agricultural Systems in the 21st Century. National Research Council, USA.
3. Brown, K. 2016. Resilience, development and global change. Routledge Publications, New York.
4. Dasgupta, S. and Roy, I. 2011. Good agricultural governance: A resource guide focused on smallholder crop production. FAO, Bangkok.
5. Schulz, R. W. 2011. Environmental Literacy in Science and Society: From Knowledge to Decisions. Cambridge University Press, UK.
6. OECD, 2001. Environmental Indicators for Agriculture (Vol. 3): Methods And Results
7. Henson, R. 2011. The Rough Guide to Climate Change. Penguin Books Ltd, 80 Strand, London. 8. FAO, 2013. Climate-smart agriculture: A sourcebook. FAO, Italy.
8. Adger, W. N., Lorenzoni I. and O'Brien, K. L. 2009. Adapting to climate change: thresholds, values, governance. Cambridge University Press, UK.
9. GIZ, 2014. The vulnerability sourcebook: concept and guidelines for standardised vulnerability assessments. GIZ, Bonn, Germany.

Course Code: AEIS 520 **Course Title : Development Communication (Elective)**	**Credit Hour: 03**	**Semester: July-December**

Rationale: This course is intended to provide an advanced understanding on communication for a new momentum and core areas of development.

Course Outcomes:

- Upgrade specialized knowledge and skills on communication for social change
- Identify the newer approaches to development communication concepts, methods and techniques
- Conceptualize communication strategies for development and
- Impart skills on carrying out research, design, development, implementation, monitoring & evaluation of development communication interventions.

Intended Learning Outcomes (ILOs) The students will be able to	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• State development communication fully • Discuss the values of development communication • Apply the methods of development communication	**Development Communication:** Concept of development, introduction, definition (Quebral's, Lent's and Cybernetic) and meaning of development communication and its historical snippets; the key elements, values and methods used for development communication	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Identify the factors inhibiting development • Cope up with barriers to development	**Issues in Development:** Self-help groups, gender, women and development; climate change and development imperative, social problems, social mobility, problems of caste, ethnicity, and race; health, sanitation and development	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Describe the five areas of development communication practice • Discuss the traits of a development communication practitioner	**Development Communication Practice:** Areas of practice, traits of the development communication experts, types of development workers	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Trace the historical links of development communication with the policy sciences • Define the policy sciences; • Describe the stakeholders of communication policy; and • Enumerate methods of policy • Analysis applicable to	**Development Communication and the Policy Science:** The policy science, dev com and the policy sciences, policy engagement in development communication, stakeholders in communication policy	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer

development.			
• Have an understanding on different theories and models of development communication • Differentiate between diffusion and participatory model	**Theoretical Approaches to Development Communication:** Modernization, dependency and multiplicity theories; the diffusion and participatory models	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Apply knowledge on communication research	**Communication Research Methods:** Definition and elements of research, research process, qualitative and quantitative research methods, tools of data collection, data analysis and report writing	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer

Reference Books

1. Roy, G. L. (2006). Extension Communication and Management. Joy Prakashani. Calcutta, India.
2. Prasad, K. (2009). Communication for Development: Reinventing Theory and Action. B. R. Publications, India.
3. Ongkiko, I. V. C. And Flor, A. G. (2006). Introduction to Development Communication. UP Open University, Quezon City, Philippines.
4. Servaes, J. (2008). Communication for Development and Social Change. Sage Publications Ltd. London, UK.
5. Bhuiyan, M. H., Miah, M. A. M., Akanda, M. G. R. and Bashar, M. A. (2014). Agricultural Extension Education. G-Science Implementation and publication, Dhaka, Bangladesh.

Course Code: AEIS 521 Course Title : ICTs for Development (Elective)	Credit Hour: 03	Semester: July-December

Rationale: This course provides students on how and to what extent, ICTs can help to overcome inequalities and deliver development goals.

Course Outcomes: After completing the course, students will be able to

- Analyze the generic contribution of ICTs to international development,
- Analyze the role of policy, strategy and operational interventions in promoting effective developmental use of ICTs,
- Identify the key roles, challenges and questions in the application of ICTs to specific development goals

Intended Learning Outcomes (ILOs) The students will be able to	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Define the whole and parts of ICT4D • Explain the connection between ICTs and development • Describe the key theories and concepts of relevance of ICT4D	**ICTs for development:** ICT system, Scope of ICTs, Development paradigms, MDGs/SDGs and ICTs, Design-reality gap model,	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Explain the ICT4D value chain model • Categorize the technologies and human infrastructure of ICT4D • Identify key ICT4D stakeholders and policy components • Critique measure of the digital divide	**Foundations of ICTs & development:** ICT4D value chain, Technologies foundation of ICT4D, Ladder of ICT4D roles, Domains of ICT4D policy, social dimension of digital divide,	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Explain the steps of ICT4D strategy • Describe good practice in ICT4D implementation • Identify key determines of ICT4D adoption and use • Summarize key ICT4D evaluation frameworks and issues,	**Implementing ICT4D:** Steps of ICT4D strategy, ITPOSMO checklist, ICT4D technical architecture, Principles for digital development, Diffusion of innovations attributes, ICT4D evaluation,	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Explain key strategies and key foundations for economic growth • Apply a model of ICT4D-enabled change to explain evidence on ICTs and economic growth	**ICTs & economic growth**: CIPSODAR model of key enterprise processes, ICT-enabled change, mobiles and cloth-weaving supply chain,	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer

• Categorise the relationship between ICTs and financial poverty eradication • Outline the sustainable livelihoods framework • Explain the impact of ICTs on gender quality	**ICTs, poverty & livelihoods:** ICTs causal impact on poverty, m-finance infrastructure, Sustainable Livelihoods Framework, Social capital,	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Explain social and human development • Categorize the relationship between ICTs and social development • Outline the capabilities framework • Summarize implications of the relation between ICTs and capabilities	**ICTs & social development:** Health system ICT applications, Information value chain, Education system ICT applications, ICTs and capabilities,	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Explain governance related goals in development • Utilize models to analyze the roles of ICTs in e-accountability and e-democracy initiatives • Analyze the role of motivation and power in e-governance initiatives	**e-Govt. & development:** Good governance and development, e-services challenges, Informational model of the accountability cycle,	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Describe the relationship between ICTs and environmental sustainability • Categorize use of ICTs in disaster management • Interpret analytical models of resilience and e-resilience	**ICTs & environmental sustainability:** Model of ICTs and environmental sustainability, Link between ICTs and pollution, Green ICT initiatives, e-waste management,	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Identify key technologies trends of ICT4D • Explain the technologies, innovations and challenges of Development 2.0.	**The future of ICT4D:** The future of "D", Future of "ICT", Development 2.0, Data-intensive development,	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Analyze how ICTs can foster regional development	Assessment of a regional development goal/initiative using ICTs	Assignment preparation	Group presentation, Report.

Reference Books

1. Heeks, R. 2017. Information and Communication Technology for Development (ICT4D). 1st Ed. Taylor & Francis Group

Department of Agroforestry and Environmental Science

Course Layout

Sl. No.	Course Code and Title		Cr. Hrs.
A. Compulsory Courses			
1	AFES 501: Agroforestry Systems		03
2	AFES 502: Agroforestry Species and Production Technology		03
3	AFES 503: Component Interactions in Agroforestry		03
4	AFES 504: Agroforestry Research Methodology		03
5	AFES 505: Environment and Conservation		03
6	AFES 506 : Climate Change and Adaptation		03
	Total		**18**
B. Elective Courses			
7	AFES 507: Social Forestry		03
8	AFES 508: Economics of Agroforestry		03
9	AFES 509: Land Use Planning in Agroforestry		03
10	AFES 510: Farming Systems		03
11	AFES 511: Medicinal Plants and Non-wood Products		03
12	AFES 512: Wood fuel Production and Marketing		03
13	AFES 513: Urban Forestry		03
14	AFES 514: Biodiversity Conservation and Management		03
15	AFES 515: Soil Conservation and Watershed Management		03
16	AFES 516: Pest Management in Agroforestry		03
17	Related Course/s from other Departments		3
	Minimum		**12**
C. Seminar Course			
18	AFES 598:		01
D. Thesis Research			
19	AFES 599:		16
		Compulsory Courses	**18**
		Elective Courses	**12**
		Seminar Course	**01**
		Thesis Research	**16**
		Total	**47**

Curriculum Alignment / Skill Mapping

Curriculum must be aligned with program objectives, program learning outcome and intended learning outcomes through proper skill mapping.

Department of Agroforestry and Environmental Science

Courses	Program Learning Outcome							
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
AFES 501	x	x	x	x				x
AFES 502	x	x	x	x				x
AFES 503	x	x	x	x				x
AFES 504	x	x	x	x	x		x	x
AFES 505	x	x	x	x				x
AFES 506	x	x	x	x				x
AFES 507	x	x	x	x				x
AFES 508	x	x	x	x			x	x
AFES 509	x	x	x	x				x
AFES 510	x	x	x	x				x
AFES 511	x	x	x	x				x
AFES 512	x	x	x	x				x
AFES 513	x	x	x	x				x
AFES 514	x	x	x	x				x
AFES 515	x	x	x	x				x
AFES 516	x	x	x	x				x
AFES 598						x	x	x
AFES 599					x	x	x	x

Course Code: AFES 501 **Course Title : Agroforestry Systems (Compulsory)**	**Credit Hour: 03**	**Semester: January-June**	
Rationale: This course is designed to provide fundamental concept of Agroforestry and different Agroforestry systems practiced in Bangladesh and as well as in the world with their improvement strategies.			
Course Outcomes: • Broaden students' knowledge about the ecological and socio-economic services of Agroforestry • Explain and evaluate different Agroforestry systems practiced in the world • Analyze the sustainable production and reclamation of degraded land through Agroforestry			
Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Discuss the attributes and implications of Agroforestry • Describe the potentialities and constraints of Agroforestry	**Introduction**: Concept, components, characteristics, attributes and features of Agroforestry; objectives, implication and limitations of Agroforestry; potentials and constraints of Agroforestry; science in Agroforestry	Lecture Interactive discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Explain the • productive and protective role of Agroforestry • Evaluate and manage the services of Agroforestry for sustainable production • Explain the benefits of Agroforestry • Improve soil fertility, carbon sequestration and conserve biodiversity	**Benefits and services of Agroforestry:** Productive and protective roles of Agroforestry ; ecological/environmental and socio-economic consideration of Agroforestry; importance of Agroforestry in improvement of soil fertility; ecosystem services, biodiversity conservation, carbon sequestration, nutrient cycling and sustainable production; reclamation of degraded land through Agroforestry interventions	Lecture Interactive discussion Visual presentation Field visit Assignment	Quiz/MCQ Short answer Essay type answer Report
• Describe different Agroforestry systems in Bangladesh • Apply and explain region specific Agroforestry adoption technologies	**Agroforestry systems and practices:** Major approaches of classification of Agroforestry systems; traditional Agroforestry systems, practices and improvement strategies in Bangladesh	Lecture Interactive discussion Visual presentation Field tour Case study	Quiz/MCQ Short answer Essay type answer Report Presentation
• Categorize the ecological characteristics of tropics and subtropics • Distinguish the	**Agroforestry system in the tropics and subtropics:** Ecological characteristics of tropics and subtropics; distribution of	Lecture Interactive discussion Visual	Quiz/MCQ Short answer Essay type answer

distribution of different Agroforestry systems in the world • Practice suitable Agroforestry systems in the tropics and subtropics	Agroforestry systems and practices in the tropics and subtropics; Agroforestry system in different continents	presentation Assignment	Report
• Compare and contrast the familiar types of Agroforestry systems • Assess the systems to participate equitably in a diversified and sustainable Agroforestry economy	**Overview of global Agroforestry system:** Shifting cultivation, taungua system, and multiple and mixed cropping, alley cropping, home garden, live hedges, wind breaks and shelter belt	Lecture Interactive discussion Visual presentation Field visit	Quiz/MCQ Short answer Essay type answer Report
• Explain the latest research findings and information of Agroforestry systems	Latest research findings and information regarding Agroforestry systems	Assignment	Report

Reference Books

1. Young. (1997). Agroforestry for Soil Management. CAB International, New York, and ICRAF, Nairobi, Kenya, ISBN: 0-85199-189-0.
2. Buck, L.E., Lassoie, J.P. and Fernandes, E.C.M. (1999). Agroforestry in Sustainable Agricultural Systems. CRC Press LLC, New York, NY, ISBN: 1-56670-294-1.
3. Nair, P.K.R. (1993). An Introduction to Agroforestry. Kluwer Academic Publishers, Dordrecht, Netherlands, ISBN: 0-7923-2134-0.
4. Nair, P.K.R. (1989). Agroforestry Systems in the Tropics. Kluwer, Dordrecht, The Netherlands.
5. Huxley, P. (1999). Tropical Agroforestry. Blackwell Science, Oxford, UK, ISBN: 0-632-04047-5.
6. Schroth, G., da Fonseca, G.A.B., Harvey, C.A., Gascon, C., Vasconcelos, H.L. and Izac, A-M.N. (2004). Agroforestry and Biodiversity Conservation in Tropical Landscapes. Island Press, Washington, DC. ISBN: 1-55963-357-3.
7. Dwivedi, A.P. (1992). Agroforestry Principles and Practices. Oxford and IBH publishing co. pvt. Ltd., New Delhi.
8. Wojtkowski, A.P. (1998). The theory and practices of Agroforestry design. Oxford and IBH publishing co. pvt. Ltd., New Delhi.
9. Bhuiya, A.A. (1994). Forest Land Agroforestry: The North Bengal Experience. BARC Winrock International.
10. Chowdhury, M.K. and TejMahat, B.S. (1993). Agroforestry farming system linkage in Bangladesh. BARC Winrock International.
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12. Robinson, D.M. and McKean, S.J. (1992). Shifting Cultivation and Alternatives: An Annotated Bibliography, 1972-1989. CAB International, Wallingford, UK.
13. Lai, R. (1974). Soil erosion and shifting agriculture. FAO Soils Bulletin, **24**: 48-71.

Course Code : AFES 502 **Course Title : Agroforestry Species and Production Technology**	**Credit Hour: 03**	**Semester: January-June**

Rationale: This course is designed to provide knowledge on Agroforestry tree species, their production technology and to assess the biomass production of Multipurpose Tree Species.

Course Outcomes:

- Extend the knowledge of the criteria of suitable Agroforestry species selection for specific sites
- Acquaint with different Multipurpose Tree Species (MPTs) and shrubs and nitrogen fixing trees
- Explain the morphology and production technology of Agroforestry species
- Evaluate the plant productivity and biomass production of Agroforestry species

Intended Learning Outcomes (ILOs) The students will be able to	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Explain the criteria of suitable Agroforestry species • Identify the factors for selecting tree species • Illustrate the practical approaches to species selection for specific sites	**Introduction:** Concept of Agroforestry species; choice and desirable characteristics of Agroforestry species; importance of Agroforestry species; practical approaches to species selection; suitability of tree species for specific sites	Lecture Interactive discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Explain the role and imitations of MPTs in Agroforestry systems	**Multipurpose tree species and shrubs (MPTs):** Definition, desirable characteristics, role of MPTs in Agroforestry systems, limitation of MPTs	Lecture Interactive discussion Visual presentation	Quiz/MCQ Short answer Essay type answer
• Elucidate the role of nitrogen fixing trees in Agroforestry systems • Assess the adaptability of different Nitrogen fixing tree in problem soils of Bangladesh	**N_2 fixing trees and shrubs:** Definition and concept of N_2 fixing trees and shrubs; mechanisms and roles of N_2 fixing trees in Agroforestry systems	Lecture Interactive discussion Visual presentation	Quiz/MCQ Short answer Essay type answer Case study
• Categorize and select the Agroforestry species for various AEZ of Bangladesh • Identify the criteria of different species for timber, fuel, fodder, wood, windbreak, shelterbelt, etc.	**Species for different agro-climate zone:** Concept; choice of species for various agro-climatic zones for the production of timber, fodder, fuel wood, fibre, forest, livehedges, alley cropping and green manuring and wind break and shelter belt; suitability of tree species for specific sites	Lecture Interactive discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report

• Categorize the ideal tree or 'ideotype' for an Agroforestry system • Describe the morphological attributes of Agroforestry tree species • Explain the management, seed certification process of species	**Morphology and production technology of Agroforestry species:** Botany, distribution ecology, uses, ideotypes and production technology of different Agroforestry species and their management; seed certification and storage	Lecture Interactive discussion Visual presentation Field problem identification Practice program planning	Quiz/MCQ Short answer Essay type answer
• Describe the plant productivity • Evaluate the manipulation of photosynthesis for minimizing unfavorable interactions • Determine the light interception in Agroforestry field	**Plant productivity:** Concept and general principle of plant productivity; photosynthesis manipulation in Agroforestry system; root behavior and crown architecture including methods for minimizing unfavorable interactions	Lecture Interactive discussion Visual presentation	Quiz/MCQ Short answer Essay type answer
• Describe the allometric relation in tropical Agroforestry • Illustrate the allometric equation for different trees • Determine the above and below ground biomass	**Biomass production of Agroforestry species:** Concept; role in biomass production; Agroforestry tree mensuration; allometric relation in tropical Agroforestry	Lecture Interactive discussion Visual presentation mathematical problem	Quiz/MCQ Short answer Essay type answer
• Explain the latest research findings and information of species and production technology	Latest research findings and information regarding species and production technology	Assignment	Report

Reference Books

1. Nair, P.K.R. (1993). An Introduction to Agroforestry. Kluwer Academic Publishers, Dordrecht, Netherlands, ISBN: 0-7923-2134-0.
2. Huxley, P. (1999). Tropical Agroforestry. Blackwell Science, Oxford, UK, ISBN: 0-632-04047-5.
3. Dwivedi, A.P. (1992). Agroforestry Principles and Practices. Oxford and IBH publishing co. pvt. Ltd., New Delhi.
4. Alam, M.K. and Mohiuddin, M. (1992). Some potential multipurpose trees for homestead in Bangladesh. BARC Winrock International.
5. Toquebiau, E. (1990). Agroforestry concept. ICRAF, Nairobi.
6. Cannell, M.G.R. (1983). Plant management in agroforestry: manipulation of trees, population densities and mixtures of trees and herbaceous crops. In: Huxley, P. A. (ed.), Plant Research and Agroforestry, pp. 455-486. ICRAF, Nairobi, Kenya.
7. Crutzen, P.J. and Andreae, M.O. (1990). Biomass burning in the tropics: Impact on atmospheric chemistry and biogeochemical cycles. *Science*. **250**:1669-1678.
8. Gardner, F.P., Pearce, B.B. and Mitchell, R.L. (1985). Physiology of Crop Plants. Iowa State Univ. Press, Ames, Iowa, USA.
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10. Jackson, J.E. (1983). Light climate and crop-tree mixtures. In: Huxley, P.A. (ed.), Plant Research and Agroforestry, ICRAF, Nairobi, Kenya. pp. 365-378.
11. Loomis, R.S. and Williams, W.A. (1963). Maximum crop productivity - an estimate. Crop *Science* **3**: 67-72.

Course Code: AFES 503 **Course Title : Component Interactions in Agroforestry (Compulsory)**	**Credit Hour: 03**	**Semester: July-December**

Rationale: This course is designed to provide knowledge on interactions among the components of Agroforestry and microclimate modification through their management.

Course Outcomes:

- Widen students' skill to recognize biological and ecological interactions among the components
- Explain management techniques for efficient use of growth resources for maximizing the overall productivity
- Illustrate the macro and micro climate and their modification

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Describe the concept, resource pool, and types of interactions in Agroforestry system	**Introduction and overview:** Concept and definition of interaction; nature and types of interactions	Lecture Interactive discussion Visual presentation	Quiz/MCQ Short answer Essay type answer
• Illustrate the positive interactions relating to radiation exchange, water balance, nutrient budget between tree and crop • Explain the negative interactions relating to light, water and nutrients between tree and crop • Describe the positive and negative interaction between tree and animal	**Positive and Negative interaction:** Concept and types of positive and negative interactions; description of positive and negative interactions in TCI and TAI	Lecture Interactive discussion Visual presentation	Quiz/MCQ Short answer Essay type answer
• Discuss the ecological factors, light quality and plant response • Explain the short term and long term effects of nutrients • Elucidate and compare the positive and negative impacts of trees and crops for improvement of soil fertility and microclimate modification	**Ecological interaction in Agroforestry:** Concept of ecological interaction; Agroforestry components and their interaction with light, water and nutrients	Lecture Interactive discussion Visual presentation Problem solving Assignment	Quiz/MCQ Short answer Essay type answer Report
• Predict the elements of microclimate, importance of microclimate in determining	**Microclimatic modification in Agroforestry:** Concept and elements of macro and micro climate; modification of	Lecture Multimedia presentation Interactive	Quiz/MCQ Short answer Essay type answer

crop performance • Evaluate the system design and management to optimize resource capture by maximizing positive interactions and minimizing negative ones	microclimate in Agroforestry and its role in tree-crop interaction (positive and negative)	discussion	Report
• Quantify the light interception, water balance and Land Equivalent Ratio • Measure the tree-crop interaction and yield of components	Methods for quantification of tree-crop interactions	Lecture Multimedia presentation Interactive discussion Assignment	Quiz/MCQ Short answer Essay type Report
• Describe the appropriate crop management system for Agroforestry • Depict the tree management practices for maximum production from unit area	Management techniques for efficient use of growth resources for maximizing the overall productivity	Lecture Interactive discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer Report
• Explain the latest research findings and information of Agroforestry species and their interaction	Latest research findings and information regarding Agroforestry species and their interaction	Assignment	Report Presentation

Reference Books

1. Nair, P.K.R. (1993). An Introduction to Agroforestry. Kluwer Academic Publishers, Dordrecht, Netherlands, ISBN: 0-7923-2134-0.
2. Nair, P.K.R. (1989). Agroforestry Systems in the Tropics. Kluwer, Dordrecht, The Netherlands.
3. Huxley, P. (1999). Tropical Agroforestry. Blackwell Science, Oxford, UK, ISBN: 0-632-04047-5.
4. Dwivedi, A.P. (1992). Agroforestry Principles and Practices. Oxford and IBH publishing co. pvt. Ltd., New Delhi.
5. Trenbath, B.R. (1976). Plant interactions in mixed crop communities. In: *Multiple Cropping*, ASA Special Publication No. 27. American Society of Agronomy, Madison, Wisconsin, USA. pp.129-169.
6. Wojtkowski, A.P. (1998).The theory and practices of Agroforestry design. Oxford and IBH publishing co. pvt. Ltd., New Delhi.
7. Toquebiau, E. (1990). Agroforestry concept. ICRAF, Nairobi.
8. Wilken, G.C. (1972). Microclimate management by traditional farmers. *Geographical Review* **62**: 544-566.
9. Singh, R.P., Ong, C.K. and Saharan, N. (1989). Above and below ground interactions in alley cropping in semiarid India. *Agroforestry Systems* **9**: 259-274.
10. Williamson, G.B. (1990). Allelopathy, Koch's postulates, and the neck riddle. In: Grace, J.B. and Tilman, D. (eds.), *Perspectives on Plant Competition*, Academic Press, New York, U.S.A. pp. 143-162.

Course Code: AFES 504 **Course Title : Agroforestry Research Methodology (Compulsory)**	**Credit Hour: 03**	**Semester: July-December**	
Rationale: This course is designed to provide knowledge to the students on the statistical concepts of research, sampling techniques, experimentation and experimental designs in Agroforestry.			
Course Outcomes: • Increase students' ability on statistical concept on research, types and sampling techniques • Elucidate and apply experimental design and different statistical packages • Organize report and thesis by using analytical data of experiment			
Intended Learning Outcomes (ILOs) The students will be able to	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Identify the research, its purpose, desirable qualities and types • Explain the various stages of research • Prepare research plan and project	**Introduction:** Statistical concepts of research: purposes of conduction of research; identification of researchable problem and research planning	Lecture Interactive discussion Visual presentation	Quiz/MCQ Short answer Essay type answer
• Explain the experimental unit, population • Illustrate the types and procedures of sampling techniques • Calculate the sampling size and sampling error • Implement and explain Agroforestry experimentation • Differentiate between field crop and Agroforestry experimentation	**Sampling techniques:** Simple Random Sampling, Stratified Random Sampling, Systemic Sampling and Cluster Sampling. Research issues in Agroforestry ; Steps in experimentation; differences between field crop and Agroforestry experimentation	Lecture Interactive discussion Visual presentation	Quiz/MCQ Short answer Essay type answer
• Discuss the types of experimental design • Elucidate the process of experimental design • Explain the advantages and disadvantages of CRD, RCBD, factorial split plot design, etc. • Select and prepare layout of experimental design and analyze experimental data	**Experimental design:** Types of experimental design; layout and randomization of experiments; Completely Randomized Design (CRD), Randomized Completely Block Design (RCBD), Latin Square Design (LSD), Factorial experiments, Split-plot design, Strip-plot design etc.	Lecture Interactive discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report

• Use proper design for Agroforestry experiment • Compute the CV%, correlation and regression • Calculate the Mean separation by MSTAT and LSD • Interpret the results • Prepare report and thesis by using the experimental data	**Experimental designs in Agroforestry :** Special designs for Agroforestry experiments; data transformation correlation and regression; methods of data collection and calculation; application of statistical computer packages for data analysis and interpretation of results; survey methodology; Thesis/scientific paper writing	Lecture Multimedia presentation Interactive discussion	Quiz/MCQ Short answer Essay type answer Report
• Explain the latest information of Agroforestry research methodology	Latest research findings and information regarding Agroforestry research methodology	Assignment	Report Presentation

Reference Books

1. George, E.P. Box, Hunter, William G., Hunter, J. and Stuart. (1978). Statistics for Experimenters: An Introduction to Design, Data Analysis, and Model Building. New York: Wiley. Box, George E.P.
2. Hunter, William, G., Hunter, J. and Stuart. (2005). Statistics for Experimenters: Design, Innovation, and Discovery (2 ed.).
3. Hoboken, N.J., Wiley and Spall, J. C. (2010). "Factorial Design for Efficient Experimentation: Generating Informative Data for System Identification," IEEE Control Systems Magazine, 30(5):38–53.
4. Pronzato, L. (2008), "Optimal experimental design and some related control problems," *Automatica*, **44**: 303–325.
5. Moore, David, S., Notz and William, I. (2006). Statistics: concepts and controversies (6th ed.). New York: W.H. Freeman. Chapter 7: Data ethics. ISBN 9780716786368.
6. Glantz, Stanton, A. (1992). Primer of biostatistics (3rd ed.). ISBN 0-07-023511-2.
7. Sifri, J. (2014). "How to Use Design of Design, Data Analysis, and Model Building. New York: Wiley.
8. Creswell, J.W. (2008), Educational research: Planning, conducting, and evaluating quantitative and qualitative research (3rd edition), Upper Saddle River, NJ: Prentice Hall. pp. 300.
9. Gomez, K. A. and Gomez, A. A. (1984). Statistical Procedures for Agricultural Research. International Rice Research Institute, John Wiley & Sons, New York. pp. 139-240.

Course Code: **AFES 505** **Course Title**: **Environment and conservation (Compulsory)**	**Credit Hour: 03**	**Semester: January-June**

Rationale: This course is designed to provide knowledge on updated information on environment and values of environmental conservation and pollution management.

Course Outcomes:

- Extend students' knowledge about concept on environment along with its pollution
- Conceptualize on natural resource management
- Demonstrate idea on efficiency and equity implication of biodiversity conservation environmental pollution with management
- Recognize social issues of Bangladesh and reclamation of environment

Intended Learning Outcomes (ILOs) The students will be able to	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Recognize the concept, scope and components of environment • Differentiate the significance of environment, ecology, ecosystem, atmosphere	**Introduction and overview:** Definition, scope and importance of environment; need for public awareness about environment and conservation; concept and components of environment; concept of earth and its segments; terminology related to environment and conservation (environment, ecology, ecosystem, atmosphere etc)	Lecture Interactive discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Scrutinize the natural resources and ecosystem services with their general characteristics • Prioritize the equitable use of different resources of Ecosystems • Illustrate the benefits of Natural resources • Assess the environmental assets and ecosystems: river/forest/grassland/hill/mountain, hill slopes, etc.	**Natural resources and ecosystem services:** Renewable and non-renewable resources; forest resources, water resources, energy resources, food resources, land resources; role of an individual in conservation of natural resources; equitable use of resources for sustainable lifestyles; concept of an ecosystem; structure, functions of ecosystem; producer, consumer and decomposer relationship; energy flow, food chain, food webs and ecological pyramids; different ecosystems (forest, grassland, desert and aquatic ecosystem)	Lecture Interactive discussion Visual presentation Field visit Assignment	Quiz/MCQ Short answer Essay type answer Report
• Construct knowledge and put ideas together in new ways about biodiversity and its resources of Bangladesh • Compose the global and	**Biodiversity and its conservation:** Introduction, definition, different biodiversity; value of biodiversity (consumptive use, productive use,	Lecture Interactive discussion Visual presentation	Quiz/MCQ Short answer Essay type answer Report

national levels of biodiversity • Formulate the conservation strategies with their distribution and types • Criticize the problems and prospects of biodiversity in Bangladesh	social, ethical, aesthetic and option values) biodiversity at global, national and local levels; Bangladesh as a mega-diversity nation; threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts; endangered and endemic species of Bangladesh; conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity	Field visit	
• Elucidate problems and prospects of environmental pollution in Bangladesh • Investigate the cause of different pollution • Analyze the different pollution management techniques • Prioritize the role of an individual in prevention of pollution • Design advanced technologies in disaster management	**Environmental Pollution:** Definition, causes, effects and control measures of: a. Air pollution, b. Water pollution, c. Soil pollution, d. Marine pollution, e. Noise pollution, f. Thermal pollution, g. Nuclear hazards; Solid waste Management: causes, effects and control measures of urban and industrial wastes; role of an individual in prevention of pollution; pollution case studies; disaster management: floods, earthquake, cyclone and landslides	Lecture Interactive discussion Visual presentation Field problem identification and practice Program planning	Quiz/MCQ Short answer Report Presentation
• Illustrate various unsustainable to sustainable development of environmental conservation • Discriminate resettlement and predict rehabilitation problems • Amplify watershed Management	**Social Issues and the Environmental conservation:** From unsustainable to sustainable development; urban problems related to energy; water conservation, rain water harvesting, watershed management; resettlement and rehabilitation of people; its problems and concerns	Lecture Interactive discussion Visual presentation Field tour Case study	Quiz/MCQ Short answer Essay type answer Report Presentation
• Justify environment protection Act • Practice and prescribe national and international environmental laws, treaties and protocols	**Environmental ethics:** Issues and possible solutions; climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust; Environment Protection Act; Air prevention and Control of pollutiony Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act; issues involved in enforcement of environmental legislation; public awareness	Assignment	Report Presentation

• Explain the latest research findings and information of environment and conservation	Latest research findings and information regarding environment and conservation	Assignment	Report Presentation

Reference Books

1. Schaltegger, Stefan, Burritt, Roger, Petersen and Holger. (2003). An Introduction to Corporate Environmental Management: Striving for Sustainability. Greenleaf. ISBN 978-1-874719-65-6.
2. Heng, L.H. (2003). "Globalisation, Business and Environmental Management: to Correct the Broken Compass?" (PDF). Journal Kemanusiaan. ISSN 1675-1930.
3. Gaston, K.J. and Spicer, J.I. (2004). Biodiversity: An Introduction, Blackwell Publishing Company, Malden.
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5. Daniel, B. B. and Edward, A. K. (2007). Environmental science: Earth as a living planet. 6th edition, John wiley & Sons, INC.
6. Spencer, R. W. (2003). The Discovery of Global Warming. ISBN 0-674-03189-X.
7. Michael, B., Colin, R. T. and John, L. H. (2006**)**. Ecology: From Individuals to Ecosystems. ISBN 978-1-4051-1117-1.
8. Paul, M. B. and Linfield, C. B. (2004). Pollution Prevention and Control: Part II Material and Energy Balances. ISBN: 978-87-403-0773-3.
9. Terry, S. (2003). Introductory Climate Science. Global Warming Explained. ISBN:978-87-403-1408-3.
10. Mark, M. (2005). Global Warming: A Very Short Introduction. Oxford University Press, USA.

Course Code: AFES 506 Course Title : Climate Change and Adaptation (Compulsory)	**Credit Hour: 03**	**Semester: July-December**	
Rationale: This course is designed to provide knowledge on issues of climate change, their adaptation and mitigation strategies and action plan.			
Course Outcomes: • Aware with the climate change issues and its impacts in different sectors • Evaluate agroecosystem modeling and research methods in climate change and adaptation • Recognize the National and International climate change adaptation and mitigation tactics, legislations and treaties			
Intended Learning Outcomes (ILOs) The students will be able to	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Discern the concept of climate, climate change, adaptation and interrelationship between adaptation and mitigation • Explain about the impact of climate change in different sectors of Bangladesh	**Introduction and Overview:** Concept of weather, climate and climate change; definition and concepts of vulnerability, resilience and adaptation; climate change impacts on air water and agriculture; climate change and Bangladesh perspective	Lecture Interactive discussion Visual presentation	Quiz/MCQ Short answer Essay type answer
• Recognize the global warming and green house effect • Explain the causes of green house gas emission, reduction process and sequestration • Recognize the Clean Development Mechanisms • Discuss about Bangladesh and Kenya's green house gas mitigation action plan strategies	**Climate Change Mitigation:** Key definitions and concepts of greenhouse gas (GHG); monitoring and verification of emission reduction and sequestration; analysis of typical projects in renewable energy, agriculture and forestry; Reducing carbon Emission from deforestation and forest degradation (REDD/REDD+/REDD++), Clean Development Mechanism (CDM) and voluntary mechanisms such as gold standard; prerequisites for effective low carbon development programmes; inter-linkages between adaptation and mitigation and practical examples such as climate-smart agriculture; Country case study – Bangladesh's and Kenya's country strategy and action plan for greenhouse gas mitigation	Lecture Interactive discussion Visual presentation	Quiz/MCQ Short answer Essay type answer

• Compare and contrast mono-disciplinary, multi-disciplinary and trans-disciplinary approaches • Prepare research proposal on climate change and adaptation	**Research methods in climate change and adaptation:** Approaches in research – mono-disciplinary, multi-disciplinary, inter-disciplinary and trans-disciplinary; Methods of research; Steps in research; scope of research; Proposal writing	Lecture Interactive discussion Visual presentation Problem solving Assignment	Quiz/MCQ Short answer Essay type answer Report
• Congregate knowledge about agroecosystem resilient and human impact on resilience • Explain the Resilience and environmental management in legislation • Assess the climate impact modeling • Describe the different types of agroecosystem management options	**Resilient Agro-ecosystems Description:** Modeling climate change impacts on agriculture; early warning systems; soil nutrient improvement, management and conservation; water catchments; irrigation and conservation; pest and disease resistant crops; pest and disease management; drought, saline, heat and flood tolerant plants and animals; types and breeds of animals and their management	Lecture Multimedia presentation Interactive discussion	Quiz/MCQ Short answer Essay type answer Report
• Interpret various national and international environmental laws, treaties and protocols. • Explain National Adaptation Programmes of Action • Makeplan and measure climate change adaptation • Recognize the case studies in key socio-economic sectors	**Climate Change And Adaptation Policies, Legislations And Treaties:** Conceptualization and delineation of social vulnerability; resource dependency, social resilience and vulnerability; inequality as an indicator of collective social vulnerability; indicators of institutional effectiveness in ameliorating vulnerability; sustainable adaptation and community-based adaptation; adaptation needs and options; international, national, and sectoral assessments, including National Adaptation Programmes of Action (NAPAs); planning and measuring adaptation; insurance and social protection; links between adaptation and development; indigenous knowledge; case studies in key socio-economic sectors	Lecture Multimedia presentation Interactive discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Explain the latest research findings and information of climate change and adaptation	Latest research findings and information regarding climate change and adaptation	Assignment	Report Presentation

Reference Books

1. Daniel, B. B. and Edward, A. K. (2007). Environmental science: Earth as a living planet. 6th edition, John wiley and Sons, INC.
2. Spencer, R. W. (2003). The Discovery of Global Warming. ISBN 0-674-03189-X.
3. Michael, B., Colin, T. and John, L. H. (2006). Ecology: From Individuals to Ecosystems. ISBN 978-1-4051-1117-1.
4. Paul, M. B. and Linfield, C. B. (2004). Pollution Prevention and Control: Part II Material and Energy Balances. ISBN: 978-87-403-0773-3.
5. Terry, S. (2003). Introductory Climate Science. Global Warming Explained. ISBN: 978-87-403-1408-3.
6. Mark, M. (2005).Global Warming: A Very Short Introduction. Oxford University Press, USA.
7. Chang, J.H. (1971). Climate and Agriculture. Aldine Pub. Co. Chicago.
8. Wiesner, C.J. (1970). Climate, Irrigation and Agriculture. Angus and Robertson Sydney.
9. Jackson, I.J. (1977). Climate, Weather and Agriculture in the tropics. ELBS and Longman, London.
10. Rogenberg, N.J., Blad, B.L and Verma. S.B. (1983). Microclimate: The Biological Environment. John Wiley and Sons. New York.

Course Code: AFES 507 **Course Title: Social Forestry (Elective)**	**Credit Hour: 03**	**Semester: January-June**	
Rationale: This course is planned to provide knowledge on social forestry along with its policy, legislation and diverse practices throughout the Bangladesh.			
Course Outcomes: • Extend students' aptitude to understand social forestry • Introduce rules, principles and different practices of social forestry in Bangladesh • Exhibit relationship of social forestry with rural economy and climate change • Explain constrains of social forestry in Bangladesh with probable strategy to overcome			
Intended Learning Outcomes (ILOs) The students will be able to	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Explain the conceptions and principles of social forestry • Justify the characteristics, prerequisites and types of social forestry • Recognize the earlier scenario of social forestry in Bangladesh	**Introduction and overview:** Concept, definition and principle of social forestry; objectives and component of social forestry; evolution, characteristics and types of social forestry; criteria and requisites for social forestry; background of social forestry in Bangladesh	Lecture Interactive discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Distinguish different social forestry practices • Relate with sole forestry or other agricultural practices • Evaluate contribution of social forestry in rural progress	**Different social forestry practices:** Community forestry, farm forestry, urban forestry, interface forestry; relationship of social forestry with forestry, Agroforestry, agriculture and rural development	Lecture Interactive discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Predict about the current situation of social forestry in Bangladesh • Assemble the government activities in increasing social forestry	**Social forestry in Bangladesh:** Interventions and achievements; components as envisaged in the national programmed plantations on government lands reforestation of degraded forests	Lecture Interactive discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Illustrate the prospect of social forestry in enhancing rural socio-economic condition • Appraise constructively about the functions of NGOs in social forestry of Bangladesh	**Social forestry for rural development in Bangladesh:** Scope and opportunities of social forestry for poverty alleviations and rural development gender issues in social forestry; people's participation in social forestry; role of NGOs for social forestry development in Bangladesh	Lecture Interactive discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report

• Categorize the existing rules and policies of social forestry • Evaluate the time dependent rules of social forestry for implementing in Bangladesh	**Social forestry policy and legislation:** Existing social forestry rule and policy; formation of rules for social forestry development in Bangladesh	Lecture Interactive discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Elucidate the policies for executing social forestry • Explicate the role of social forestry in climate change	**Climate Change and Social Forestry:** Policies intervention in social forestry implementation and their role to mitigate climate change for sustainable give of rural areas	Lecture Interactive discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Explain the latest research findings and information of social forestry	Latest research findings and information regarding social forestry	Assignment	Report Presentation

Reference Books/chapters:

1. Divya, M.P. and Parthiban, K.T. (2014***)***. A textbook on social forestry and agroforestry. Satish Serial Publishing. ISBN: 9384988952, 9789384988951.
2. Wiersum, K. F. and Sands, R. (2013***)***. Forestry in a global context. CABI Publishing, CABI. ISBN: 9781780641560.
3. Sharma, B. L. and Vishnoi, R. L. (2000***)***. Perspective on Social Forestry. Daya Publishing House. ISBN: 8170352282, 9788170352280.
4. Tiwari, K. M. (1983***)***. Social forestry for rural development. International Book Distributors.
5. Young. (1997***)***. Agroforestry for Soil Management. CAB International, New York, and ICRAF, Nairobi, Kenya, ISBN: 0-85199-189-0.
6. Nair, P.K.R. (1993***)***. An Introduction to Agroforestry. Kluwer Academic Publishers, Dordrecht, Netherlands, ISBN: 0-7923-2134-0.
7. Huxley, P. (1999***)***. Tropical Agroforestry. Blackwell Science, Oxford, UK, ISBN: 0-632-04047-5.
8. Schroth, G., da Fonseca, G.A.B., Harvey, C.A., Gascon, C., Vasconcelos, H.L., and. Izac, A-M.N (2004***)***. Agroforestry and Biodiversity Conservation in Tropical Landscapes. Island Press, Washington, DC. ISBN: 1-55963-357-3.
9. Dwivedi, A.P. (1992***)***. Agroforestry Principles and Practices. Oxford and IBH publishing co. pvt. Ltd., New Delhi.
10. Bhuiya, A.A. (1994***)***. Forest Land Agroforestry: The North Bengal Experience. BARC Winrock International.

Course Code :AFES 508 Course Title :Economics of Agroforestry (Elective)	**Credit Hour: 03**	**Semester: July-December**	
Rationale: This course is designed to provide fundamental knowledge on Economics of Agroforestry.			
Course Outcomes: • Acquaint with the relation of Agroforestry and economics • Evaluate critically the quantification and valuation of Agroforestry system • Develop students ability to understand relevant principles of financial Agroforestry			
Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Describe concept on general principles of economic analysis and Agroforestry economics • Recognize the implication economic analysis • Explain time value of money	**Introduction:** Concept of economics and Agroforestry economics; general principles of economic analysis; ex-ante and ex-post analysis, opportunity costs; Time value of money; compounding and discounting; terminology related to economic analysis	Lecture Interactive discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Acquire knowledge on different economic analysis related to Agroforestry • Compare cost items and source of benefits of Agroforestry	**Classification of economic analysis:** Financial and economic analysis; other economic analysis related Agroforestry ; cost items and source of benefits of Agroforestry ; tangible and intangible benefits of Agroforestry	Lecture Interactive discussion Visual presentation Mathematical problem solution	Quiz/MCQ Short answer Essay type answer Presentation Calculation
• Illustrate budgeting and functional analysis of Agroforestry • Justify the risk and uncertainty in decision making • Outline the socio-economic analysis of Agroforestry projects • Interpret sensitivity analysis	**Basic principles of economics applied to Agroforestry:** Optimization techniques-planning, budgeting and functional analysis of Agroforestry; role of time, risk and uncertainty in decision making; financial and socio-economic analysis of Agroforestry projects; Internal rate of return; sensitivity analysis	Lecture Interactive discussion Visual presentation Mathematical problem solution	Quiz/MCQ Short answer Essay type answer
• Implement marketing of Agroforestry products. • Operate cost-benefit analysis.	**Principles of financial management:** Harvesting and postharvest handling of Agroforestry products; marketing of Agroforestry products including benefit sharing mechanism; techniques of cost-benefit analysis	Lecture Interactive discussion Visual presentation Field problem identification	Quiz/MCQ Short answer Essay type answer Report

		and practice program planning	
• Discern the various evaluation criteria issues of quantification and valuation of Agroforestry system • Interpret the importance of economic analysis on Agroforestry systems	**Evaluation of Agroforestry system:** Concepts of evaluation and evaluation criteria; evaluation with and without Agroforestry ; quantification and valuation of Agroforestry system; economic analysis of various Agroforestry systems	Lecture Interactive discussion Visual presentation Field problem identification and practice program planning	Quiz/MCQ Short answer Essay type answer Report Presentation
• Gather knowledge about various Agroforestry projects as case studies • Outline marketing and management of Agroforestry products	**Exercises on Agroforestry production relationships**: Preparation of enterprise; partial and complete budgets; application of various methods in formulation and appraisal of Agroforestry projects; case studies on harvesting, postharvest management and marketing of Agroforestry products	Lecture Interactive discussion Visual presentation Problem solving Assignment	Quiz/MCQ Short answer Essay type answer Report
• Explain the latest research findings and information of Economics of Agroforestry	Latest research findings and information regarding Economics of Agroforestry	Assignment	Report

Reference Books

1. Arnold, J.M. (1987*)*. Economic considerations in Agroforestry . In Steppler, H.A. and P.K. Nair, eds. Agroforestry : A Decade of Development ICRAF, Nairobi, Kenya.
2. Desai, S.N. and Bhoi, P.G. (1982*)*. Assessment of Production Potential of Food and Forage under Agroforestry Systems. *Journal of Maharashtra Agricultural University* **7**(1): 33-36.
3. Filius, A.M. (1982*)*. *Economic Aspects of Agroforestry .(Agroforestry Systems)* 1: 29-39.
4. Gupta, T. (1982*)*. The Economics of Tree Crops on Marginal Agricultural Lands with Special Reference to the Hot Arid Region in Rajasthan, India. *International Tree Crops Journal* **2**: 155-194.
5. Harou, P.A. (1983*)*. Economic Principles to Appraise Agroforestry Projects. *Agricultural Administration*, **12**: 127-139.
6. Lubega, A.M. (1987*)*. An Economic Analysis of a Simulated Alley Cropping System for Semi-Arid Conditions Using Micro- computers. *Agroforestry Systems*, **1**: 335-345.

Course Code: AFES 509 **Course Title: Land use Planning in Agroforestry (Elective)**	**Credit Hour: 03**	**Semester: January-June**	
Rationale: This course is designed to deliver different land use planning of Agroforestry systems practiced in Bangladesh.			
Course Outcomes: • Planning and development of land-use systems in Agroforestry • Implement Agroforestry land use systems in institutional premise, D & D and other appraisal tools for Agroforestry systems and land-use planning			
Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Recognize the characteristics and ownership distribution of land in Bangladesh • Describe the combined use of land management policy, the multiple problem of multiple uses of land and tree tenure	**Land and land-use:** Ownership use and characteristics of land, combined use as a land management policy, the multiple problem of multiple uses, land & tree tenure	Lecture Interactive discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Investigate the existing land-use system in Agroforestry • Execute the planning and development of wasteland, fallow land, office/institute premises, bank of water bodies, roadsides, riversides and degraded land, desert land, saline and coastal areas, dry and rocky areas, marshy lands following Agroforestry technologies	**Planning and development of land-use systems in Agroforestry:** Planning and development of wasteland, fallow land, office/institute premises, bank of water bodies, roadsides, riversides and degraded land, desert land, saline and coastal areas, dry and rocky areas, marshy lands following technologies	Lecture Interactive discussion Visual presentation Field tour Case study	Quiz/MCQ Short answer Essay type answer Report Presentation
• Instruct on the designing of windbreaks and shelterbelts at different land use in Bangladesh • Implement the control measures of wind erosion and shifting sand dunes, ravages of wind in farms, houses, roads and other constructions • Contribute knowledge on how to increase yield of different Agroforestry farming systems	**Windbreaks and shelterbelts:** Designing of windbreaks and shelterbelts, coastal windbreaks and shelterbelts, wind erosion control and shifting sand dunes, control ravages of wind in farms, houses, roads and other constructions, increase yield of agricultural and pasturelands	Lecture Interactive discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report

• Demonstrate the best suitable land-use planning for different institutional premises • Compute about today as well as future land-use planning and development of institutional models for aesthetic and production purposes • Assess the effect of different MPTs • Determine the role of nitrogen fixing trees in Agroforestry systems • Recognize the adaptability of different tree species in problem soils of Bangladesh	**Agroforestry in institutional premises:** Land-use system in the institutions today, future planning and development of institutional models for aesthetic and production purposes	Lecture Interactive discussion Visual presentation Field problem identification and practice program planning	Quiz/MCQ Short answer Essay type answer Report Presentation
• Formulate the prediagnostic and diagnostic steps, technology design of Agroforestry system • Criticize knowledge on redesigning of models and their implementations in different farm categories and other places	**D and D and other appraisal tools for Agroforestry systems and land-use planning:** Prediagnostic & diagnostic steps, technology design and redesigning of models and their implementations in different farm categories and other places	Lecture Interactive discussion Visual presentation Field problem identification and practice program planning	Quiz/MCQ Short answer Essay type answer Report Presentation
• Demonstrate the latest research studies and informative data of different Land use Planning in Agroforestry	Latest research findings and information regarding land use planning in Agroforestry	Assignment	Report Writing

Reference Books

1. Barnet, J. (2004). Codifying New Urbanism: How to Reform Municipal Land Development Regulations, Chicago, IL.
2. Southwestern NC Planning and Economic Development Commission, Community Foundation of WNC, & the Lawrence Group Architects of NC, Inc. (2009). Region A Toolbox, A Pilot of the Mountain Landscapes Initiative, Sylva, NC.
3. Walters, D. (2007). Designing Community, Charrettes, Master plans and Form-based Codes, Oxford, UK.
4. Young, A. (1993). Guidelines for Land Use Planning, Food and Agriculture Organization of the United Nations, Rome, Italy.
5. FAO. (1983). Guidelines: land evaluation for rainfed agriculture. Soils Bulletin 52. FA0, Rome. pp. 237.
6. FAO. (1984). Land evaluation for forestry. Forestry Paper 48, FAO, Rome. pp. 123.
7. FAO. (1993). Guidelines for Land-Use Planning. FAO Development Series1. FAO. Rome. pp. 96. 8. Vittal, K.P.R., Singh, H.P., Prasad, J.V.N.S., Rao, K.V., Victor, U.S., MaruthiSankar, G.R.,
8. RavindraChary, G., Singh, G. and Samra, J.S. (2003). Bio-diverse Farming System Models for Dryland Agriculture. An AICRPDA Contribution. CRIDA. Hyderabad. pp. 58.
9. Dewi, S., Johana, F., Ekadinata, A. and Agung, P. (2013) Land-use planning for low-emission development strategies (LUWES). ASB Policy brief 35. Nairobi: ASB Partnership for the Tropical Forest Margins.

Course Code : AFES 510 **Course Title : Farming System (Elective)**	**Credit Hour: 03**	**Semester: January-June**	
Rationale: This course is designed to provide knowledge on general farming system and different Agroforestry farming system practiced in Bangladesh.			
Course Outcomes: • Hypothesize farm and different farming system • Elucidate and evaluate Agroforestry farming systems and management • Analyze the constraints and optimize the opportunities of Agroforestry			
Intended Learning Outcomes (ILOs) The students will be able to	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Explain the concept of farm and farming system. • Paraphrase the basic elements of a farming system • Describe the characteristics and classification of farming system	**Introduction:** Concept of farm and farming system, characteristics and classification of farming system. Basic elements of a farming system	Lecture Interactive discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Differentiate region specific farming system adoption technology across the world	**Farming system worldwide:** Sub-Saharan Africa, Middle east and north Africa, Eastern Europe and Central Asia, South Asia, East Asia and Pacific, Latin America and Caribbean	Lecture Interactive discussion Visual presentation Field visit Assignment	Quiz/MCQ Short answer Essay type answer Report
• Classify the traditional and modern Agroforestry farming systems of Bangladesh • Assess of Agroforestry farming systems practiced in Bangladesh	**Agroforestry farming systems:** Classifications and assessment; traditional and modern Agroforestry farming systems: homestead, cropland, forestland, hill farming system	Lecture Interactive discussion Visual presentation Field tour Case study	Quiz/MCQ Short answer Essay type answer Report presentation
• Identify the constraints of the Agroforestry farming systems of Bangladesh • Acquire knowledge on the opportunities of traditional and modern Agroforestry farming systems practiced in Bangladesh	**Constraints and opportunities of Agroforestry farming system:** Problems of Agroforestry farming system; Traditional and modern Agroforestry farming systems; homestead, cropland, forestland, shifting cultivation, taungya system; measures to overcome the problems	Lecture Interactive discussion Visual presentation Field visit Assignment	Quiz/MCQ Short answer Essay type answer Report
• Explain the latest research findings and information of different Agroforestry Farming systems	Latest research findings and information regarding Farming Systems	Assignment	Report

Reference Books :

1. "India's Role in World Agriculture." Monitoring Agricultural trade Policy. European Commission. (2007).
2. Krishna, K.L. and Kapila, U. (2009). *Readings in Indian Agriculture and Industry*. Darya Ganj, New Delhi: Academic Foundation. ISBN 8171887384
3. Aggarwal, P. K. (2008). Global Climate Change and Indian Agriculture: Impacts, Adaptation, and Migitation. *Indian Journal of Agricultural Sciences*. **10**: 911–19
4. Bhaduri, Anik, Upali, Amarasinghe and Shah, T. (2011). "Future of Irrigation in India."
5. Ranjan, R. and Upadhyay, V.P. (1999). Ecological Problems Due to Shifting Cultivation.
6. Van and René, V. (2006) Cities Farming for the Future Urban Agriculture for Green and Productive Cities. Silang, Cavite, Philippines: International Institute of Rural Reconstruction.
7. Sharma, A.K. (2005) "The Potential for Organic Farming in the Drylands of India." Arid Lands Newsletters.
8. Gulati, Ashok, P. K., Joshi and Landes, M. (2003). "Contract Farming in India: An Introduction.
9. Ramesh, P., Panwar, N.R., Sing, A.B., Ramana, S., Yadav, S.K., Shrivastava, R., SubbaRao, A."Status of Organic Farming in India." www.ias.ac.in.
10. Berkey, C. (1994). Maya Land Rights in Belize and the History of Indian Reservations. Indian Law Resource Center, Washington, DC, USA. pp. 35
11. Cowgill, U.M. (1962). An agricultural study of the Southern Maya Lowlands. American Anthropologist. **64**: 273-286.
12. Kalpagé, F.S.C.P. (1974) Tropical Soil. Macmillan cie, India. PP. 238

Course Code: AFES 511 **Course Title: Medicinal Plants and Non-wood Products (Elective)**	**Credit Hour: 03**	**Semester: July-December**
Rationale: This course is designed to provide proper understanding of Agroforestry in relation to medicinal plants and non-wood products.		
Course Outcomes: • Enrich knowledge on importance of medicinal plants and their conservation • Acquaint with the relation of medicinal plants and non-wood plants to herbal industry • Achieve some practical field experience of medicinal plants • Analyze management practices		

Intended Learning Outcomes (ILOs) The students will be able to	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Differentiate medicinal, aromatic plants and non-wood products • Illustrate distribution of medicinal plants in Bangladesh • Underline the problems of overexploitation • Enlighten the policies for their conservation according IUCN	**Introduction and overview:** Introduction and concept to common medicinal and aromatic plants and non-wood products; importance and need of cultivation; their origin and distribution in Bangladesh; problems of overexploitation and deforestation; rare and endangered species of medicinal and non-wood forest products; policies for their conservation, regeneration and sustainable use; Medicinal Plant Specialist Group of Species Survival Commission (IUCN)	Lecture Interactive discussion Group work Visual presentation Assignment	Quiz /MCQ Short answer Essay type answer Reports
• Demonstrate about the management techniques of medicinal plants • Identify medicinal and aromatic plants based on morphological features	**Morphological features and environment:** Morphological features; climate and soil requirement; nursery technique, transplantation, harvesting and post harvest handling of important medicinal and aromatic plants; Identification based on morphological features; Other important non-wood products specific to South-Asia including Bangladesh	Lecture Interactive discussion Group work Visual presentation Field visit Assignment	Quiz/MCQ Short answer Essay type answer Presentation Report
• Explain the production technology of medicinal plants and non-wood products • Implement the conservation techniques of medicinal and aromatic	**Conservation of medicinal and non-wood products**: Conservation and its techniques- *in-situ, ex-situ* and biotechnological; evaluation and breeding techniques of important medicinal and aromatic plants;	Lecture Interactive discussion Visual presentation Field problem identification	Quiz/MCQ Short answer Essay type answer Report Presentation

plants	production and conservation of some non-wood products	Practice program planning	
• Gain knowledge about different Herbal industry • Summarize the uses of non-wood products in industry and other sectors	**Introduction to herbal industry:** Brief introduction to Ayurveda, Unani, Sidha, Homeopathy, Allopoathy, Naturopathy, Electro homoeopathy, etc; role of medicinal plants used to these systems; non-wood forest products and their uses in industry and other sectors	Lecture Interactive discussion Visual presentation Field problem identification Practice program planning	Quiz/MCQ Short answer Essay type answer Report Presentation
• Recognize important useful parts of medicinal plants used in treating various diseases • Illustrate the importance plants in herbal industry	**Importance of medicinal plants and non-wood forest products:** General introduction and important medicinal plants used in treating various diseases in modern and complementary systems; useful parts of medicinal plants used in treating common diseases; medicinal and aromatic plants in the development of herbal industry; non-wood products in forestry and Agroforestry systems; production techniques and importance	Lecture Interactive discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report Presentation
• Demonstrate the latest research studies and informative data of different Medicinal Plants and Non-wood Products with their production technology	Latest research findings and information regarding medicinal plants and non-wood Products	Assignment	Report Presentation

Reference Books

1. Delang, Claudio, O. (2006). The Role of Wild Food Plants in Poverty Alleviation and Biodiversity Conservation in Tropical Countries. *Progress in Development* Studies **6**(4): 275-286
2. Emery, Marla, Rebecca J. and McLain. (2001). Non-Timber Forest Products: Medicinal Herbs, Fungi, Edible Fruits and Nuts, and other Natural Products from the Forest.Food Products Press: Binghamton, New York.
3. Guillen, Abraham, Laird, Sarah, A. Shanley, Patricia, Pierce and Alan, R. (2002). Tapping the Green Market: Certification and Management of Non-Timber Forest Products.Earthscan.
4. Jones, Eric, T., Rebecca, J., McLain and Weigand, J. (2002). Non Timber Forest Products in the United States. Lawrence: University Press of Kansas.
5. Mohammed, Gina, H. (2011). The Canadian NTFP Business Companion: Ideas, Techniques and Resources for Small Businesses in Non-Timber Forest Products & Services. Candlenut Books: Sault Ste Marie, Ontario

Related Teaching Reference:

6. ITTO. (1991). Status and potential of non-timber products in the sustainable development of tropical forests. ITTO Technical Series No. 11. Yokohama, ITTO.
7. Sayer, J.A. (1991). Using non-timber products to support forest conservation programmes. In ITTO Technical Series No. 11. Yokohama, ITTO
8. Lange, D. (1997). Trade in plant material for medicinal and other purposes: A German case study. *TRAFFIC Bulletin*, 17(1): 20–32.
9. Lange, D. (1998). Europe's Medicinal and Aromatic Plants: Their Use, Trade and Conservation. TRAFFIC International, Cambridge, United Kingdom.
10. Marshall, N.T. (1998). Searching for a Cure: Conservation of Medicinal Wildlife Resources in East and Southern Africa. TRAFFIC International, Cambridge, United Kingdom.

Course Code: AFES 512 **Course Title: Woodfuel production and Marketing (Elective)**	**Credit Hour: 03**	**Semester: July-December**

Rationale: The purpose of this course is to contribute fundamental concept of woodfuel production and marketing in Bangladesh.

Course Outcomes:

- Compare the relation of energy and woodfuel Conclude efficient use of woodfuel
- Identify woodfuel and marketing strategy
- Optimize woodfuel production by using advanced technology

Intended Learning Outcomes (ILOs) The students will be able to	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Distinguish wood, woodfuel and energy source • Elucidate classification of energy source	**Introduction:** Concept of wood, woodfuel; energy sources and classification; woodfuel as an energy source	Lecture Interactive discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Interpret woodfuel strategies • Illustrate the role of woodfuel industries	**Energy situation in Bangladesh:** Woodfuel production programmes and strategies in Bangladesh. Prospects and strategies to develop the woodfuel market and trade. Woodfuel based industrial activities and their contribution to the national economy /rural socio-economy. Woodfuel utilization in rural industries	Lecture Interactive discussion Visual presentation	Quiz/MCQ Short answer Essay type answer Presentation
• Differentiate the technologies of woodfuel and energy source • Recognize the importance and production system of woodfuel • Apply the sustainable resource management	**Technologies for efficient use of woodfuel**: Improved chulli, compressed husk, briquetting and other technologies; comparative advantages of woodfuel (production system) over other resources for sustainable resources management	Lecture Interactive discussion Visual presentation Field problem identification Practice program planning	Quiz/MCQ Essay type answer Short answer Seminar Report Presentation
• Acquaint with the different energy use techniques and management • Measure of wood energy supply system in Bangladesh	**Wood energy in Bangladesh:** Energy use pattern; role of forest biomass, land use, supply of fuelwood; socio-economic aspects; environmental aspects; key issues, constraints and suggested measures	Lecture Multimedia presentation Interactive discussion Assignment	Quiz/MCQ Short answer Essay type answer Report

• Sketch marketing trade of woodfuel • Identify difficulty of woodfuel production • Demonstrate sustainable woodfuel production	**Problems of woodfuel production and marketing:** Woodfuel production and marketing trade in Bangladesh; various problems of woodfuel production and marketing in Bangladesh; solutions for sustainable production and marketing of woodfuel	Lecture Interactive discussion Visual presentation Problem solving Assignment	Quiz/MCQ Short answer Essay type answer Report
• Hypothesize present situation in Bangladesh • Report on visited areas	**Field visit:** Visit to urban and its suburb areas; find out present situation, problems faced by producers and consumers and write a report based on visit	Lecture Multimedia presentation Interactive discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Describe the most recent research findings and details of different interactions among the components of Agroforestry	Latest research findings and information regarding component interactions in Agroforestry	Assignment	Report Presentation

Reference Books

1. Woodfuel in Bangladesh - Production and Marketing - Technical Papers from the National Training Course, Bogra. RWEDP Report 38, 1998
2. Regional Study on Wood Energy Today and Tomorrow in Asia (1997), Field Document: 50.
3. Chapter 2 in Review of Wood Energy Data in RWEDP Member Countries (1997), Field Document 47.
4. Proceedings of The National Workshop in Bangladesh on Wood-Based Energy Systems for Rural Industries and Village Applications,RWEDP Report 34, 1997
5. Biomass Based Energy Systems in Rural Industries and Village Applications - Bangladesh. (1989). Field Document 17.
6. FAO. (1993). More than wood. Forestry Topics Report No. 4. Rome, FAO.
7. Wood-Based Biomass Energy Development for Sub-Saharan Africa: Issues and Approaches (2011). The International Bank for Reconstruction and Development, Washington, DC 20433, USA.

Related Teaching Reference:

1. Pandey, D.N. (2002). Fuelwood Studies in India: Myth and Reality, CIFOR, Bogor, Indonesia. . ISBN: 979-8764-92-7. Xii: 93
2. O'Keefe, P., Soussan, J., Munslow, B. and Spence, D. (1989) .Wood energy in Eastern and Southern Africa. *Annu Rev Energy*, **14**: 445-468
3. Nyadzi, G.I., Otsyina, R.M., Banzi, F.M., Bakengesa, S.S., Gama, B.M., Mbwambo, L. and Asenga, D. (2003). Rotational woodlot technology in northwestern Tanzania: tree species and crop performance. *Agroforestry Systems*, **59**: 253-263.
4. Hosier, R.H. (1989).The economics of smallholder Agroforestry : two case studies. World Dev, **17**: 1827-1839
5. Bradley, P.N., Chavangi, N. and Van Gelder, A. (1985) . Development research and energy planning in Kenya. *Ambio*, **14**: 228-236
6. Bradley, P.N. (1988). Methodology for woodfuel development planning in the Kenyan highlands. J. *Biogeogr*, **15**:157-164
7. Ngugi, A.W. (1988). Cultural aspects of fuelwood shortage in the Kenyan Highlands. J. Biogeogr. 15: 165-170
8. Dewees, P.A. (1989). The woodfuel crisis reconsidered: observations on the dynamics of abundance and scarcity. *World Dev*. **17**: 1159-1172

Course Code: **AFES 513** **Course Title**: **Urban Forestry (Elective)**	**Credit Hour: 03**	**Semester: January-June**	
Rationale: This course is designed to provide knowledge with updated information on composition, structure including importance of Urban forestry.			
Course Outcomes: • Comprehend about different forest and forestry practices • Evaluate the structure and composition of urban forestry • Demonstrate the role of urban forestry for biodiversity and global warming • Hypothesize the ecological and socio-economic services of Urban forestry • Elucidate and evaluate different Urban forestry practiced in the world • Optimize sustainable production and reclamation of degraded land through Urban forestry			
Intended Learning Outcomes (ILOs) The students will be able to	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Illustrate the concept of different forestry practices and their management • Demonstrate the role urban forestry on ecosystem	**Introduction and Overview:** Concept and definition of forestry, social forestry, Agroforestry and urban forestry; values and functions of urban forestry; role of urban forestry in urban ecosystem management	Lecture Interactive discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Illustrate concept of different forest and forestry • Implement sustainable forestry practice for climate change adaptation	**Forest Situation of Bangladesh:** Concept of forest, forestry and forest types of Bangladesh; ecological classification, area, location and important flora and fauna of forest; causes of forest depletion and improvement for sustainable climate change adaptation and mitigation	Lecture Interactive discussion Visual presentation Field tour Case study	Quiz/MCQ Short answer Essay type answer Case study Report Presentation
• Categorize the structure and features of urban forestry • Implement of plant measurement techniques	**Structure and composition of urban forest:** Structure, types and attributes of urban forest; tree canopy assessment; measurement of tree; shrub and ground layer; composition of urban forest for better ecological succession	Lecture Interactive discussion Visual presentation Field tour Case study	Quiz/MCQ Short answer Essay type answer Case study Report Presentation
• Distinguish the structure and functions of arboriculture and urban forestry • Demonstrate tree physiology and management	**Arboriculture and urban forest management:** Understanding of basic tree growth and physiology; tree care and management; urban tree planting and establishment; tree preservation and utility arboriculture	Lecture Interactive discussion Visual presentation Field tour Case study	Quiz/MCQ Short answer Essay type answer Case study Report Presentation

• Conclude the benefits of urban forestry • Formulate the knowledge of urban forestry development • Evaluate planning and measuring climate change adaptation • Elucidate the impact of urban forestry on climate change in different sectors of Bangladesh	**Urban forestry Bangladesh perspective:** State of urban forestry in Bangladesh; location, area and demographics of big cities of Bangladesh in relation to urban forestry with a case study of Dhaka city: economic, social, environmental and cultural benefits of urban forestry, greeneries of Dhaka city; role of government, NGOs, DCC, RAJUK other organizations and volunteers for urban forest development	Lecture Interactive discussion Visual presentation Field visit Assignment	Quiz/MCQ Short answer Essay type answer Report
• Evaluate the characteristic and management of urban forestry at different countries of the world • Illustrate different managements and their role on urban forestry improvement	**Urban forestry Asia and other World perspective:** Urban forestry situation of India, Pakistan, Sri Lanka, Japan and other countries of the world; structure, composition and their management system; pictorial overview of some urban forestry	Lecture Interactive discussion Visual presentation Field tour Case study	Quiz/MCQ Short answer Essay type answer Case study Report Presentation
• Justify the role of urban forestry on climate change mitigation and adaptation • Explain of urban forestry importance for • biodiversity conservation • Acquaint with reducing greenhouse gas emission reduction and sequestration • Capable to write research proposal on climate change and adaptation and importance of urban forestry	**Role of urban forestry for biodiversity conservation and global worming:** Role of urban forestry for climate change adaptation and mitigation; contribution of urban forestry to reduce global warming, biodiversity conservation, ecosystem services and urban forestry	Lecture Interactive discussion Visual presentation Field tour Case study	Quiz/MCQ Short answer Essay type answer Case study Report Presentation
• Explain the latest research findings and information of urban forestry	Latest research findings and information regarding urban forestry	Assignment	Report Presentation

Reference Books

1. Dwyer, J. F., McPherson, E. G., Schroeder, H. W. and Rowntree, R. A. (1992). Assessing the Benefits and Costs of the Urban Forest. *Journal of Arboriculture*, 18(5): 227-234
2. Dwyer, J. F., Schroeder, H. W. and Gobster, P. H. (1991). "The Significance of Urban Trees and Forests: Toward a Deeper Understanding of Values." *Journal of Arboriculture*, **17**(10): 276-84.
3. Konijnendijk, C. C, Nilsson, K., Randrup, T. B. and Schipperijn J. (2005). Urban Forests and Trees-A Reference Books. ISBN 978-3-540-25126-2.
4. Kuo, F. E. (2003). "The Role of Arboriculture in a Healthy Social Ecology." *Journal of Arboriculture*,

29(3).
5. Mansfield, C., Pattanayak, S. K., McDow, W., McDonald, R. and Halpin, P. (2005). Shades of Green: Measuring the value of urban forests in the housing market. *Journal of Forest Economics*, **11**(3): 177-199.
6. Nillsson, K., Randrup, T.B. and Wandell, B.I.M. (2000). "Trees in the Environment". Oxford University Press, New York, NY.

Related Teaching Reference:

1. Pincetl, S. and Gearin, E. (2005). "The reinvention of public green space." *Urban Geography*, **26**(5): 365-84.
2. Rees, W. E. (1997). "Urban ecosystems: the human dimension." *Urban Ecosystems*, **1**(1): 63-75.
3. Simpson, J. R. and McPherson, E. G. (1996). Potential of Tree Shade for Reducing Residential Energy Use in California. *Journal of Arboriculture*, **22**(1): 10-18.
4 . Solotaroff, W. (1911). Shade-trees in towns and cities. John Wiley & Sons, New York.
5 . USDA Forest Service. (2003). Benefits of Urban Trees: Urban and Community Forestry: Improving Our Quality of Life. In Southern Region (Ed.), Urban Forestry Manual. Athens, GA: USDA Forest Service

Course Code : AFES 514 **Course Title : Biodiversity Conservation and management (Elective)**	**Credit Hour: 03**	**Semester: July-December**

Rationale: The course is designed to provide knowledge on Biodiversity Conservation and its management in Bangladesh.

Course Outcomes:

- Conceptualize the conservation of biodiversity and its management
- Apprehend species, genetic and ecosystem diversity
- Acquire knowledge on the impact of climate change on biodiversity

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Describe concept on biodiversity • Realize the importance of biodiversity • Illustrate different biodiversity managements • Explain the importance of different biodiversity on life science	Introduction and overview: Concept of biodiversity, biodiversity conservation; conservation biology, life science and some nomenclature; classification of biodiversity and management	Lecture Interactive discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Competence species and ecosystem diversity scenario • Estimate and quantify species diversity • Distinguish global climate with the distribution of biomes • Describe ecosystem services • Compare different cycles of ecosystem	Species and ecosystem diversity: concept and nature of species and ecosystem diversity; measuring species diversity; Ecosystem and community diversity I; Distribution of biomes and global climate; Ecosystem and community diversity II; Energy, nutrient cycling, and ecosystem services.	Lecture Interactive discussion Visual Field tour Case study	Quiz/MCQ Short answer Essay type answer Case study Report
• Assimilate the knowledge on genetic diversity • Paraphrase natural selection • Explain sexual selection	Genetic diversity and natural selection: Genetic diversity I; Natural and sexual selection; Genetic diversity II; Sexual selection, genetics, and conservation genetics	Lecture Interactive discussion Visual Field tour Case study Assignment	Quiz/MCQ Short answer Essay type answer Case study Report
• Describe the history and pattern of biogeography • Differentiate between the global pattern of biodiversity • Recognize the threats of	Global patterns of biodiversity and island biogeography: History and biogeography; Threats to biodiversity; Overview of threats to biodiversity; overexploitation I; The 6th mass extinction event? "Overexploitation II; Pollution	Lecture Interactive discussion Visual Field tour Case study	Quiz/MCQ Short answer Essay type answer Case study Report

biodiversity • Categorize the threats of biodiversity • Explain the role of pollution • Justify the diversity of biodiversity • Illustrate the role of overexploitation		Assignment	
• Assess the impact of climate change • Explain the collision of detrimental results of invasive species • Describe the ecological impact of climate change • Justify the role of habitat destruction • Predict the effect of habitat destruction of different species • Assess the influence of human population growth on biodiversity	Global climate change: ecological impacts of climate change; invasive species; habitat destruction and fragmentation; cumulative impacts, and human population growth	Lecture Interactive discussion Visual presentation Field visit	Quiz/MCQ Short answer Essay type answer presentation Report
• Gather knowledge about the approaches of biodiversity conservation • Implement Endangered Species Act • Acquaint with CITES and Fine-filter approach • Illustrate the applied population ecology • Perceive legal protection Act at species level. • Analyze ecology with monitoring • Evaluate extinction risk	Approaches to the conservation of biodiversity: approaches to the conservation of biodiversity and historical perspectives; legal protection at the species level; the endangered species Act, CITES, fine-filter approach; applied population ecology I &II: monitoring populations and assessing extinction risk	Lecture Interactive discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Explain the latest research findings and information of biodiversity conservation and management	Latest research findings and information regarding biodiversity conservation and management	Assignment	Report

Reference Books

1. Habron, G. (2003). "Role of Adaptive Management for Watershed Councils". *Environmental Management*. **31** (1): 29–41. doi:10.1007/s00267-002-2763-y.
2. Hershner, Carl, Havens, K. (2009). "Ecosystem Services and Management of Invasive Species in a Changing System: Response to Martin and Blossey". *Conservation Biology*. **23** (2): 497498. doi:10.1111/j.1523-1739.2009.01193.x.
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7. Hamilton, L.S. (1988). The environmental influences of forests and forestry in enhancing food production and food security. Presented at the Expert Consultation on Forestry and Food Production/Security. Rome, FAO.
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9. ITTO. (1993). Tropical forest management. ITTO tropical forest management update, Yokohama, ITTO, **3**:3.
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11. FAO. (1989a). Plant genetic resources: their conservation in situ for human use. 38 pp. Rome, FAO.
12. FAO. (1989b). Review of forest management systems of tropical Asia. FAO Forestry Paper No. 89. Rome, FAO.
13. FAO. (1989c). Forest management for sustainable production and conservation in Indonesia. Ministry of Forestry and FAO, UTF/INS/065/INS: Forestry Studies Field Document No. 12, Jakarta.
14. FAO. (1993a). FAO Forestry resources assessment 1990. Tropical Countries. FAO Forestry Paper 112. Rome, FAO.
15. FAO. (1993b).The challenge of sustainable forest management: what future for the world's forests? 126 pp. Rome, FAO.
16. Young. (1997). Agroforestry for Soil Management. CAB International, New York, and ICRAF, Nairobi, Kenya, ISBN: 0-85199-189-0.
17. Buck, L.E., Lassoie, J.P. and Fernandes. E.C.M. (1999). Agroforestry in Sustainable Agricultural Systems. CRC Press LLC, New York, NY ISBN: 1-56670-294-1.
18. Nair, P.K.R. (1993). An Introduction to Agroforestry . Kluwer Academic Publishers, Dordrecht, Netherlands, ISBN: 0-7923-2134-0.
19. Huxley. P. (1999). Tropical Agroforestry . Blackwell Science, Oxford, UK, ISBN: 0-632-04047-5.
20. Schroth, G., da Fonseca, G.A.B, Harvey, C.A., Gascon, C., Vasconcelos, H.L. and Izac, A-M.N 2004). Agroforestry and Biodiversity Conservation in Tropical Landscapes. Island Press, Washington, DC. ISBN: 1-55963-357-3.

Related Teaching Reference:

1. FAO. (1990). FAO wildlife management for rural development. *Unasylva* **41**:161.
2. FAO. (1991a). Sustainable management of tropical forests. Secretariat Note. FAO Committee on Forest Development in the Tropics. Tenth Session. FO:FDT/91/5. Rome, FAO.
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Course Code: AFES 515 **Course Title : Soil Conservation and Watershed Management (Elective)**	**Credit Hour: 03**	**Semester: January-June**	
Rationale: This course is designed to provide comprehensive idea of soil and water conservation in Agroforestry system			
Course Outcomes: • Broaden students' skill to understand soil conservation and watershed management • Introduce problem soils and watershed of different agro-ecosystem of Bangladesh • Show different practices to overcome problem soils and watershed deterioration • Optimize soil productivity by proper nutrient budgeting in different agro-ecological zone			
Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Comprehend the concept of soil and water conservation • Assess the scope and purpose of soil and water management in Agroforestry system	**Introduction:** Concept of soil conservation and watershed; soil and water management-objectives and scope in relation to Agroforestry systems	Lecture Interactive discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Categorize different types of land • Recognize carrying capacity of diverse ago-ecosystem • Appraise irrigation potential and methods • Describe the perception of integrated watershed management • Optimize the water use efficiency in Agroforestry systems and dry land farming	**Land classification and carrying capacity in different agro ecosystems**: Land classification, carrying capacity of agro-ecosystems; irrigation potential and methods; concepts in integrated watershed management; optimization of water use in Agroforestry systems and dry land farming	Lecture Interactive discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Extend understanding of different agrometrological data • Construe different agrometrological data in relation with crop production	**Interpretation of agrometeorological data for water management**: Concept of agrometrological data (rainfall, temperature, sunshine, humidity); interpretation of these data in relation to crop production	Lecture Interactive discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Point out the problem soils in Bangladesh including saline alkaline and acidic soils • Judge the importance of soil organisms and nitrogen fixation in Agroforestry	**Problem soils and their management**: Study of problem soils in Bangladesh (saline, alkaline, acidic and other soils) and their Agroforestry conservation; soil organisms and nitrogen fixation and Agroforestry importance	Lecture Interactive discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report

• Expand knowledge about different agro-ecosystems in respect to nutrient of soil • Describe organic matter decomposition; nutrient budgeting and soil productivity of different agro-ecosystems	**Nutrient cycling in Agroforestry**: Biogeochemical cycling of nutrients including; organic matter decomposition; nutrient budgeting and soil productivity under different agro-ecosystems	Lecture Interactive discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Elucidate perception and characteristics of watershed • Evaluate causes and impacts of watershed deterioration • Explicate the principles of watershed management • Infer watershed development and management in Bangladesh	**Watershed and its management:** Concept and characteristics of watershed, causes and impacts of watershed deterioration; principles of watershed management, watershed management planning, procedures, inputs requirement and economic analysis; watershed development and management in Bangladesh perspective	Lecture Interactive discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Inspect the quality of water and soil • Analyze different parameters related to soil and water quality	**Field visit:** Calculation of water storage and fluxes in the soil; determination of in situ infiltration rate of soils; measurement and estimation of run off; analysis of soil and plant samples for NPK; study of biogeochemical cycle in Agroforestry systems	Field work Field problem identification Program planning Extension tour	Report
• Explain the latest research findings and information of soil conservation and watershed management	Latest research findings and information regarding soil conservation and watershed management	Assignment	Report

Reference Books

1. Atangana, A., Khasa, D., Chang, S. and Degrande, A. (2014). Agroforestry for soil conservation. In: Tropical Agroforestry. Springer, Dordrecht.
2. Novotny, V. (2003). Water Quality: Diffuse Pollution and Watershed Management. John Wiley & Sons.
3. Ritter, W. F. and Shirmohammadi, A. (2000). Agricultural Nonpoint Source Pollution: Watershed Management and Hydrology. CRC Press. ISBN: 9781566702225.
4. Buck, L.E., Lassoie, J.P. and Fernandes, E.C.M. (1999). Agroforestry in Sustainable Agricultural Systems. CRC Press LLC, New York, NY ISBN: 1-56670-294-1.
5. Young. (1997). Agroforestry for Soil Management. CAB International, New York, and ICRAF, Nairobi, Kenya, ISBN: 0-85199-189-0.
6. Nair, P.K.R. (1993). An Introduction to Agroforestry. Kluwer Academic Publishers, Dordrecht, Netherlands, ISBN: 0-7923-2134-0.
7. Dwivedi, A.P. (1992). Agroforestry Principal and Practices. Oxford and IBH publishing co. pvt. Ltd., New Delhi.
8. Toquebiau, E. (1990). Agroforestry concept. ICRAF, Nairobi.

Course Code: AFES 516 **Course Title: Pest management in Agroforestry (Elective)**	**Credit Hour: 03**	**Semester: July - December**

Rationale: This course is designed to provide a understandable overview of different pests in Agroforestry systems and their control measures

Course Outcomes:

- Widen students' knowledge about various pests of Agroforestry systems
- Explain damaging nature of pests in Agroforestry components
- Determine different eco-friendly methods of pest control
- Recognize environment friendly advanced pest management technology of Agroforestry system

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Develop conception about various pest and insect • Justify different insecticide and pesticide	**Introduction:** Definition of pest, insect, pesticide; classification of insect, pest and pesticide; common pests found in Agroforestry systems	Lecture Interactive discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Recognize different harmful insects of agroforestry systems • Predict about the damaging nature of insect • Realize different techniques to control insects	**Insect problems in Agroforestry systems**: Various insect problems, nature of damage; cultural practices, chemical, biological and other non-chemical methods of control	Lecture Interactive discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Develop understanding relating to different fungi diseases of Agroforestry systems • Check diverse techniques to manage fungi infection	**Fungi problems in Agroforestry systems:** Different fungi problems found in Agroforestry systems and cultural practices, chemical, biological and other non-chemical methods of control	Lecture Interactive discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Expand knowledge concerning different virus diseases of Agroforestry systems	**Virus problems in Agroforestry systems:** Different virus diseases found in Agroforestry systems and cultural practices, chemical, biological and other non-chemical methods of control	Lecture Interactive discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Inspect different measures to control viral infection	latest technologies of controlling virus	Assignment	Report

• Evaluate the importance of integrated pest management (IPM) / integrated crop management (ICM) in Agroforestry systems • Exercise these techniques in Agroforestry practices in favor of better environment	Integrated pest management (IPM) in Agroforestry systems/Integrated crop management (ICM) in Agroforestry systems	Lecture Interactive discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Identify insects and pests of Agroforestry systems • Judge the harmful insect and their control measures in Agroforestry systems	**Field visit:** Identification and familiarization with important insects and pests of Agroforestry systems; handling and use of insecticides and application equipments; collection of 25 specimens of insect-pests of Agroforestry systems	Field work Field problem identification Program planning Extension tour	Report
• Explain the latest research findings and information of pest management technologies in Agroforestry	Latest research findings and information regarding pest management technologies in Agroforestry	Assignment	Report Presentation

Reference Books

1. Atangana, A., Khasa, D., Chang, S. and Degrande, A. (2014). Integrated pest management in tropical agroforestry. In: Tropical Agroforestry. Springer, Dordrecht.
2. Rao, M. R., Singh, M. P. and Day, R. (2000). Insect pest problems in tropical agroforestry systems: Contributory factors and strategies for management. *Agroforestry Systems* **50**(3):243-277.
3. Buck, L.E., Lassoie, J.P and Fernandes, E.C.M. (1999). Agroforestry in Sustainable Agricultural Systems. CRC Press LLC, New York, NY ISBN: 1-56670-294-1.
4. Young. (1997). Agroforestry for Soil Management. CAB International, New York, and ICRAF, Nairobi, Kenya, ISBN: 0-85199-189-0.
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DEPARTMENT OF AGRONOMY

Course Layout

Sl. No.	Course Code and Title		Cr. Hrs.
Compulsory Courses			
1	AGRO 501: Advanced Crop Field Production Technology		3
2	AGRO 502: Sustainable Agriculture and Organic Farming		3
3	AGRO 503: Principles of Seed Technology		3
4	AGRO 504: Applied Weed Science		3
5	AGRO 505: Farming System		3
6	AGRO 506: Crop Physiology and Stress Agronomy		3
		Total	**18**
Elective Courses			
7	AGRO 507: Agro Meteorology		3
8	AGRO 508: Field Experimentation and Crop Modeling		3
9	AGRO 509: Irrigating Water Management		3
10	AGRO 510: Land Management		3
11	AGRO 511: Fodder Production and Grassland Management		3
12	AGRO 512: Hill and Coastal Agriculture		3
13	AGRO 513: Fertilizer Management		3
14	AGRO 514: Post Harvest Technology		3
15	AGRO 515: Seed Technology Practices		3
16	AGRO 516: Agronomic Research		3
		Minimum	**12**
Seminar			
17	AGRO 598		1
Thesis Research			
18	AGRO 599		16
		Compulsory Courses	**18**
		Elective Courses	**12**
		Seminar	**1**
		Thesis Research	**16**
		Total	**47**

Curriculum Alignment / Skill Mapping

Curriculum must be aligned with program objectives, program learning outcome and intended learning outcomes through proper skill mapping.

Department of Agronomy

Courses	Program Learning Outcome							
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
AGRO 501	x	x	x	x				x
AGRO 502	x	x	x	x				x
AGRO 503	x	x	x	x				x
AGRO 504	x	x	x	x				x
AGRO 505	x	x	x	x				x
AGRO 506	x	x	x	x				x
AGRO 507	x	x	x	x				x
AGRO 508	x	x	x	x				x
AGRO 509	x	x	x	x				x
AGRO 510	x	x	x	x				x
AGRO 511	x	x	x	x				x
AGRO 512	x	x	x	x				x
AGRO 513	x	x	x	x				x
AGRO 514	x	x	x	x				x
AGRO 515	x	x	x	x				x
AGRO 516	x	x	x		x			x
AGRO 598						x	x	
AGRO 599					x	x	x	x

Course Code: AGRO 501 Course Title: Advanced Field Crop Production Technology (Compulsory)	Credit Hour: 03	Semester: July-December

Rationale: This course is designed to provide knowledge and updated information on economic importance and advanced production managements of major and minor field crops.

Course Outcomes:

- Conceptualize advanced production managements
- Explain crop production factors and their importance
- Enlighten field management aspects for advanced field crop production
- Optimize crops production by using advanced technology

Intended Learning Outcomes (ILOs) The students will be able to-	Course Content	Teaching-Learning Strategies	Assessment Strategies
• Describe world field crop production scenario • Compare crop production of Bangladesh with world aspects • Interpret reasons of lower yield in Bangladesh	**Crop Production Statistics:** World crop production statistics of major and minor crop sand their comparison with Bangladesh	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Describe yield and quality of crops • Illustrate different agronomic managements and their role on yield improvement • Minimize the yield gaps	**Yield and Quality of Crops:** Yield determinants, concept of yield improvement, agronomic means of improving yield and quality of crops.	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Apply advanced production technology in field crop production • Evaluate role of crop production factors • Explain economic importance of varieties, climate and soil, cultural managements, post-harvest operations and use of crops • Compare different cultivars according to their suitability of production and distribution in cropping pattern • Justify diversification of crop production • Boost up crops production • Implement sustainable crop production • Practice and prescribe effective crop production technologies for	**Cereal crops:** Rice, Wheat, Maize, Kaon, Cheena, Sorghum, Bajra, Jowar **Fibre crops:** Jute, Cotton **Sugarcrop:** Sugarcane **Pulse crops:** Lentil, Chickpea,Grasspea, Mungbean, Blackgram, Cowpea **Oilseedcrops:** Mustard, Groundnut, Soybean, Sesame, Sunflower, Safflower **Narcotic crop:**Tobacco **Beverage crops:**Tea, Coffee **Minor crops:** Kaon, Cheena, Sorghum, Bajra, Jowar	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report

increasing cropping intensity			
• Explain the latest research findings and information of Advanced field crop production technology	Latest research findings and information regarding advanced field crop production technology	Assignment	Report

Reference Books

1. Mondal, M.R.I., Islam, M.S., Jalil, M.A.B., Rahman,M.M., Alam, M.S. and Rahman, M.H.H. 2011. Krishi Projukti Hatboi (Handbook on agro-technology) (5th edition). Bangladesh Agricultural Research Institute, Gazipur.
2. Gowda, C.L.L. and Kaul, A.K. 1982. Pulses in Bangladesh. Bangladesh Agricultural Research Institute, Gazipur and FAO, Rome.
3. Saxena, M.C. and Singh, K.B. (Eds). 1987. The chickpea. CAB International, Wallingford, UK.
4. Riley, K.W., Gupta, S.C., Seetharam, A. and Mushonga, J.N. 1983. Advances in small millets. Oxford & IBH publishers Co. Pvt. Ltd. New Delhi, India.
5. Kaul, A.K. and Das, M.L. 1986. Oilseeds in Bangladesh. Bangladesh-Canada Agriculture Sector Team, Ministry of Agriculture, Govt. of the Peoples' Republic of Bangladesh, Bangladesh.
6. Miah, A.A., Maniruzzaman, A.F.M. and Rahman, M.M. 1991. Problems and prospects of pulses production. In: Advances in pulses research in Bangladesh. Proceed. Second National Workshop on pulses. Gazipur.

Course Code: AGRO 502 Course Title : Sustainable Agriculture and Organic Farming (Compulsory)	Credit Hour: 03	Semester: January - June

Rationale: This course provide knowledge and skill on sustainable agriculture, social and economic infra-structure, biodiversity and sustainability of farming systems, organic farming in sustainable agriculture, soil management, crop management, farm waste management, domestic and industrial wastes management and trend in organic farming.

Course Outcomes:

- Acquaint with sustainable agriculture and organic farming
- Gather knowledge on biodiversity and sustainability of farming systems
- Develop skill on soil management, crop management, farm waste management, domestic and industrial wastes management in organic farming
- Orient with and implement the trend of organic farming

Intended Learning Outcomes (ILOs) The students will be able to-	Course Content	Teaching-Learning Strategies	Assessment Strategies
• Describe about sustainable agriculture • Explain the importance and evolution of sustainable agricultural systems of Bangladesh.	**Sustainable agriculture:** Concept, importance, evolution of sustainable agricultural systems of Bangladesh	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Describe nutrient mining and soil erosion, • Illustrate soil erosion, deterioration of water resources and changes in soil pH and climate change • Describe pest incidence in sustainable agriculture • Analyze the problems of marketing and trading • Interpret the changes in cropping systems	**Factors affecting sustainability in agriculture:** Nutrient mining, soil erosion, deterioration of water resources; changes in soil pH, climate change, pest incidence; problems of marketing and trading; changes in cropping systems	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Evaluate and explain Socio-economic condition of the farming communities and communication • Criticize and Judge market and storage facilities, inputs and credits • Explain the linkage mechanism between research, extension and education, information and support services	**Social and economic infra-structure:** Socio-economic condition of the farming communities, communication, market and storage facilities, inputs and credits, linkage mechanism between research, extension and education, information and support services, land tenure,	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer Report

• Discuss land tenure and national policy related to social and economic infrastructure	national policy.		
• Describe about diversity and biodiversity • Discuss the role of biodiversity in farming systems • Describe the maintenance of biodiversity through creation of micro-environments • Explain the contribution of micro-environments towards sustainability of farming systems.	**Biodiversity and sustainability of farming systems:** Diversity and biodiversity, the role of biodiversity in farming systems, maintenance of biodiversity through creation of micro-environments, properties of micro-environments, contribution of micro-environments towards sustainability of farming systems.	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Describe the principles and practices of organic farming • Explain the components of organic farming • Apply organic farming	**Organic farming in sustainable agriculture:** Concept, principles and practices of organic farming. Components-	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Calculate rooting depth of crops • Apply the ways of replenishing soil organic matter • Recommend special soil management practices for managing soil	**Soil management:** Increasing rooting depth, replenishing soil organic matter, special soil management practices.	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Explain the choice of cultivars, crop diversification, planting time, plant population, regulating time, rate and placement of fertilizers • Select and explain the judicious technique of herbicides and pesticides application for better crop management	**Crop management:** Choice of cultivars, crop diversification, planting, time, plant population, regulating time, rate and placement of fertilizers, herbicides and pesticides.	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Acquaint with animal and crop waste • Describe proper dose and time of animal waste and crop waste application • Explain the effect of farm waste on soil and crop	**Farm waste management:** Animal waste and crop waste, time of application, rate of application, effect of farm waste on soil and crop.	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Compare types and characteristics of domestic and industrial wastes • Explain the ways of waste decomposition in soil • Describe the problems of	**Domestic and industrial wastes management:** Types and characteristics, waste decomposition in soil and associated problems, management of wastes.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer

management of wastes			
• Express the future trend of organic farming • Describe future research needed for the improvement of organic farming.	**Future trend in organic farming.**	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer

Reference Books

1. Arora, R.K. and Rao, V.R. 1995. Proceedings of the South Asia National Coordinators Meeting On Plant Genetics Resourses (E). 10-12 January, 1995.BARC, Dhaka.
2. Bharduraj, K.K. and Gaur, A.G. 1985. Recycling of Organic Wastes. ICAR, New Delhi.
3. Bijoy Singh and Dekhon, G.S. 1979. Nitrate pollution of Groundwater form farm use of Nitrogenous fertilizers-A Review. Agric. Environ. 4: 207-225
4. Chowdhury, Q.I. 2001. Bangladesh State of Biodiversity (Edited). Forum of Environmental Journalists of Bangladesh (FEJB), Dhaka.
5. Dhama, A.K. 1999. Organic Farming for Sustainable Agriculture (2nd Ed.) Pub. Agro-Botanica, New-Delhi, India.
6. Glowka, L. and Others. 1994. A Guide to the Convention on Biological Diversity. IUCN, Switzerland.
7. Hart, R.D. and Sands, M.W. 1991. Sustainable Land Use Systems Research and Development presented at the USDA/ ICAR/ RRC workshop New-Delhi, India.
8. Hossain, S.M.A. and Bari, M.N. 1993. Biodiversity, Environmental Implication and Sustainability of Farming Systems. Farming Systems Training Manual, Bandlasesh Agricultural University, Mymensingh, Bangladesh. Pp: 287-305.
9. Maheshwari, R.C. 1984. Agricultural Residues as a Source of Energy. *In:* Proc. Bioenergy Soc. 1st Conv. Symp. New-Delhi, pp: 127-131.
10. Majid, F.Z. 1983. Aquatic Weeds and Algae, the Neglected Natural Resources of Bangladesh (Booklet), p: 26.

Course Code: AGRO 503 **Course Title : Principles of Seed Technology (Compulsory)**	**Credit Hour: 03**	**Semester: July - December**

Rationale: This course is designed to provide knowledge and skill of different aspect of seed technology- varietal development, seed multiplication, seed processing & preservation, quality assurance- seed quality, pre-harvest to pre-cleaning seed quality control, seed legislation, seed certification, pre and post marketing quality control etc. and seed marketing.

Course Outcomes:

- Conceptualize on seed technology and understand seed quality
- Develop skill on varietal development of seed and seed multiplication
- Acquire knowledge about quality assurance of seed
- Gather knowledge about seed legislation, certification
- Develop knowledge about seed marketing and pre & post marketing quality control of seed

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Show the relation between seed and agriculture, seed and civilization. • Explain the definition of seed, seed morphology, classification of seeds • Describe history and subjects related to seed technology	**Introduction to Seed Technology:** Seed and civilization; seed and agriculture. Definition of seed, seed morphology classification of seeds. Concept of seed technology; subjects related to seed technology.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer Report
• Define variety, importance of varietal development and variety. • Demonstrate and describe plant breeding systems (incl. OP + Hybrid + recombinant) Variety evaluation – DUS, VCU test. • Describe about variety release, registration, novelty. IPR, IPBR.	**Components of Seed Technology:** **(1) Varietal Development:** Definition of a variety, importance of varietal development and variety. Plant breeding systems (incl. OP + Hybrid + recombinant) Variety evaluation – DUS, VCU test. Variety release, registration, Novelty. IPR, IPBR	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer Report
• Describe the factors influencing seed multiplication, multiplication ratio. • Describe and apply about the techniques of seed multiplication, multiplication technique of self and open pollinated	**(2) Seed Multiplication:** Factors influencing seed multiplication, multiplication ratio. Techniques of seed multiplication. Seed multiplication of open pollinated and self pollinated crops. Hybrid, Synthetic and composite seed production.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer Report

crops. • Apply hybrid, synthetic, and composite seed production technology			
• Demonstrate seed processing and preservation • Demonstrate procedure of seed drying, cleaning, grading and treatment. • Illustrate seed packaging and preservation technique • Describe the factors affecting seed longevity and deterioration	**(3) Seed processing and preservation:** Drying Cleaning and grading Seed treatment Seed packaging Preservation	Lecture Visual presentation Discussion Industry visit	Quiz/MCQ Short answer Essay type answer Report
• Describe concept of seed quality, quality class, seed standard and field standard, seed lot and seed sampling • Demonstrate and explain cultivar purity (grow out test, pre- post control) and analytical purity • Determine seed moisture content, germination capacity, seed & seedling vigor, seed size and dormancy. • Assess the different aspect of seed health	**(4) Quality Assurance: Seed Quality:** Concept of seed quality, quality class, seed standard and field standard, seed lot and seed sampling. Purity- cultivar (grow out test, pre-post control) purity and analytical purity. Moisture content of seed. Germination capacity. Seed and seedling vigour. Dormancy. Seed health. Seed size	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer Report
• State the system of pre-harvest to pre-cleaning seed quality control. • Explain the procedure of seed legislation and seed certification • Describe seed ordinance, national seed policy, seed rules. • Describe the procedure of seed certification. • Learn about pre and post marketing quality control of seed**.**	Pre-harvest to pre-cleaning seed quality control Seed Legislation: Seed Certification: Pre and post marketing quality control.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer Report
• Explain seed marketing • Describe the fundamentals of seed marketing. • Criticize the qualities and responsibilities of seed	**(5) Seed Marketing:** Marketing Functions. Seed Sale; quality of Salesmen. Seed extension and promotion.	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer

salesmen. • Illustrate the procedure of seed sale system • Discuss the promotional activities in seed marketing.			Report

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1. Agrawal, R.L. 1988. Seed Technology. Oxford and IBH Publishing Co. New Delhi, Bomby, Calautta.
2. Copeland. L.O. 1976. Principles of Seed Science and Technology. Burgas Pub. Co. USA.
3. Huda, M.N. 2001. Why Quality Seed? Reality and Vision-Bangladesh Context. Lawrynowiez. Team Leader, Bangladesh-German Seed Development Project. Bangladesh.
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Course Code: AGRO 504 Course Title: Applied Weed Science (Compulsory)	Credit Hour: 03	Semester: January- June

Rationale: It is intended to design the course for acquiring knowledge on biology and management of weeds associated with arable crops.

Course Outcomes:

- Describe the main ways in which weeds cause financial losses to crop production and how these losses can be determined
- Explain the major factors that are involved in making decisions about managing weeds in order to reduce the impact of weeds
- Assess the benefits derived from managing weeds

Intended Learning Outcomes (ILOs) The students will be able to	Course Content	Teaching-Learning Strategies	Assessment Strategies
• Define weed biology and ecology • Classify the weeds on the basis of their propagation and adaptation • Describe dynamicity of weed survival	**Weed Biology and Ecology:** Propagation by means of vegetative propagules and seed. Factors related to weed seed production and germination. Bio-diversity of weeds. Dormancy of weed-seed and factors affecting it. Soil as a weed seed bank. Weed adaptation in relation to climatic, edaphic and biotic factors. Crop-weed interference, capability, critical period of weed control and factors affecting it.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer Report
• Define crop husbandry control of weeds • Evaluate the different parameters husbandry control of weeds	**Weed control through crop Husbandry:** Role of seedbed preparation, planting geometry, establishing proper crop stand, crop rotation, hydrology, soil moisture regime and soil fertility in managing weeds	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer Report
• Define biological methods and classify agents of biological control of weeds • Explain the biological control agents with special reference to potentials of allelopathy, a non-chemical way of controlling weeds	**Biological Methods in Weed Management:** History of biological weed control. Biological-based controlling of weeds viz. insects, nematodes, fungi, bacteria and as well as plant-based chemicals. Interaction of Bioherbicides and Herbicides. Allelopathy, classification, types	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer Report
• Describe herbicide formulations and their modes of action to kill weeds • Explain the fates of herbicides after application to	**Herbicidal Methods in Weed Management:** Herbicide formulation and Adjuvant/ Additives. Mode of action of herbicides. Fate of herbicides in soil and plant.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer

plants and soil • Gather knowledge about the selectivity of herbicides and their concerns on environment	Interaction of herbicide, Plant, and Environment. Selectivity of Herbicides.		Report
• Apply knowledge on different intercultural operations. • Minimize yield loss & boost up crop production.	**Integrated Weed Management (IWM):** Definition, importance and basic concepts of IWM. Role of weeds in IWM. Interaction between Weed and Management Practices. Ecological, Eco-physiological approaches of Weed Management.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer Report
• Define herbicide resistance • Discuss the factors and mechanism of developing herbicide resistance. • Describe the consequence of herbicide resistance	**Herbicide Resistance:** Major concept, development of herbicide resistance in weeds. Factor affecting weed resistance to herbicides. Mechanism to develop herbicide resistance. Crop resistance to herbicides, Biotechnology in developing herbicide-resistant crops. Concerns regarding use of herbicide-resistant crops.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer Report
• Describe weed management methods as practiced in Bangladesh	**Weed Management of Major Crops in Bangladesh:** Present status and future strategy of Weed Management in rice, major field crops jute, wheat, sugarcane, cotton.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer Report

Reference Books

1. Robert M. ZimdahlFundamentals of Weed Science, Academic Press 30 Corporate Drive, Suite 400, Burlington, MA 01803, USA
2. Thomas J. Monaco, Stephen C. Weller and Floyd M. Ashton Weed Science Principles and Practices, Fourth Edition,JohnWiley & Sons Inc. USA.
3. V. S. Rao Principles of Weed Science, Second Edition, Science Publishers Inc., USA.
4. Wood Powell AndersonWeed Science: Principles and Applications, West Publishing Company.

Course Code: AGRO 505 Course Title: Farming System (Compulsory)	Credit Hour: 03	Semester: January-June	
Rationale: This course is designed to acquaint with farming system, farming system research development and farming system research methodology			
Course Outcomes: • Gain Knowledge on the farming system and farming system in Bangladesh Understand the determinants of farming system • Learn the farming system research • Prepare farming system research methodology.			
Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Explain farming system Classify farming system • Describe characteristics of farming system	**Farming Systems:** Concept, characteristics, resources, components and enterprises.	Lecture Visual presentation Discussion Assignments	Quiz/MCQ Short answer Essay type answer
• Establish relation among crop -livestock, crop - fish, crop - livestock - fish.	**Interaction of farming systems components:** Interaction of crop - livestock, crop - fish, crop -livestock - fish.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Evaluate components and enterprises of farming system. • Evaluate the interactions between components. • Validate the selection of enterprises for farming system.	**Interaction of components of farming systems:** Interaction of crop -livestock, crop - fish, crop -livestock - fish.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Categorize the determinants of farming system. • Discuss the influence of different factors on farming system.	**Determinants of farming systems:** Physical, biological, economic and socio-cultural	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Explain the chronological development of farming system of Bangladesh. • Classify different types of Farming System in Bangladesh	**Type of farming systems:** Farming system in Bangladesh and other countries	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Define farming system research and development. • Explain the evolution of Systemic Research in Bangladesh • Design the strategies of	**Farming Systems Research and Development (FSRD):** Introduction, concept, importance, categories, processes, characteristics and strategies.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer

farming system research • Describe the characteristics of farming system research			
• Conceptualize the approaches of farming system research and development. • Compare different approaches of farming system research and development trials.	**Category of FSRD Trials:** On-farm, On-station, Component, Technology system, Farmer's Managed and Researcher's Managed Trials.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Describe farming system research methodology. • Describe the way of research site selection and diagnosis the problems present • Select design followed by testing and data analysis • Disseminate technology and study technology adoption	**Farming Systems Research Methodology:** National Methodology, Site selection, Site description, Design and testing, Validation trial, Technology transfer.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Define & classify Farming System. • Describe the characteristics different farming system,	**Farming Systems:** Concept, characteristics, resources, components & enterprises.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Define & objectives of Participatory Research • Explain the modes of farmer's participation. • Describe different components & importance of PRA. • Interpret different methods & techniques of PRA. • Demonstrate transects walk, physical mapping, social mapping, Venn diagram, seasonal calendar, time line, production flow	**Participatory Research:** Concept, objectives & modes of farmer's participation. **Methods & Techniques of (Participatory Rural Appraisal) PRA:** Concept & importance of PRA. Methods of PRA-visualized analysis, intervening, group & team dynamics, direct observation & review of secondary sources,. Techniques, of PRA-transects, physical mapping, social mapping, Venn diagram, seasonal calendar, time line, production flow chart, matrix ranking, preference ranking	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Define, components & importance of SOWT • Explain cropping system • Elucidate the evolution of cropping systems in Bangladesh	SOWT (Strength, Opportunity, Weakness & Threat) **Cropping systems:** Evolution of cropping systems in Bangladesh, its impact on environment; designing, testing & evaluation on cropping systems.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer

Reference Books

1. Chowdhury, M. K., Razzaque, M. A., Alam, A. B. M. M., William, R. D., Gilbert, E. H. and Mallick, R. N. (1993). Methodological guidelines for farming systems research and development in Bangladesh. Bangladesh Agricultural Research Council, Farmgate, Dhaka.
2. Hossain, S. M. A. (1993). Methodology of farming systems research. Farming systems research training manual. Bangladesh Agricultural University, Mymensingh.
3. Hossain, S. M. A., Alam, A. B. M. and Salam, M. U. (1993). Characteristics of Agricultural systems and farming systems of Bangladesh. Farming systems research training manual, Bangladesh.
4. Rudthenberg, H. (1986). Farming systems in the tropics. Clarendon Press, Oxford, U.K.
5. Shaner, W. W., Philipp, P. F. and Schmehl, W. R. (1982). Farming systems research anddevelopment:Guidelines for developing countries. Boulder CO: Westview Press, Colorado, USA.
6. Zandstra, H. G. and Merris, R. A. (1981). A methodology for on farm cropping systems research. IRRI, Los Banos, Philippines.

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1. Hossain, S. M. A. (1988). Evolution of cropping systems in Mymensingh and Comilla region. JSARD Publication No. 2, JICA, Dhaka. Bangladesh.
2. Simmonds, N. W. (1985). Farming systems research – a review. World Bank Technical Paper No. 53, World Bank, Washington.

Course Code: AGRO 506 **Course Title : Crop Physiology and Stress Agronomy (Compulsory)**	**Credit Hour: 03**	**Semester: July- December**

Rationale: This course is designed to provide concepts on growth and developmental processes, different types of stresses & their management for crop production.

Course Outcomes:

- Conceptualize growth & developmental processes and different types of stresses.
- Explain growth analysis and yield factors.
- Enlighten different management practices to optimize growth and to combat different types of stress conditions.

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Explain crop growth, what factors affect it and how it can be manipulated in favour of high yield production.	Growth stages and growth curve, limiting factors of growth, interception of solar radiation, extinction coefficient	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Identify and describe crop developmental processes, what factors affect them and how the developmental processes can be manipulated in favour of achieving high yield.	Developmental processes in plants, Induction of flowering, Switching mechanism, Reproductive growth, fruit and seed development, histognesis.	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Apply knowledge on crop yield function, what are the components or attributes of crop yield, how the production technologies, soil and environmental factors can be manipulated in favour of achieving high yield.	Yield functions, yield components and attributes, factors affecting seed yields, yield correlations.	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Exercise knowledge of different yield function and the physiological attributes such as photosynthesis, respiration, dry matter accumulation	Physiological and biochemical basis of photosynthesis in C3 and C4 plants, Growth analysis, stem, leaf and root growth.	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Explain the concept and scientific basis of partitioning, thermal time, • Describe photothermal time, critical photoperiods for developmental processes, soil plant environment interaction, crop nutrition, harvest index,	Harvest index and partitioning, plasticity of vegetative growth in respect of reproductive growth, duration of reproductive growth, population density, nutrition and other agronomic management for improving yield potential.		

partition factor, presenting yield functions, yield attributes correlations, minimum vegetative mass for reproductive development			
• Conceptualize different types stresses. • Comprehend changes occur in soil and plants under deep water stress. • Acquaint with the management of deep water stress effects in plants.	**Stress Agronomy: Deep water stress:** Concept, crop response to deed water stress, characteristics of flood water, factors affecting survival and morphological change of submerged plants, management of deep water stress in crops.		
• Conceptualize drought. • Comprehend nature, causes and kinds of drought. • Enlighten the basis of drought tolerance. • Exploit the existing technologies to reduce crop losses from drought.	**Drought stress:** Concept, nature, causes and kinds of drought, effect of drought on crops, basis of drought tolerance, available technologies to reduce crop losses from drought.		
• Conceptualize light stress, its nature and causes. • Comprehend crop growth, development and yield mechanisms. • Elucidate the consequences of light stress on crop growth, development and yield mechanisms.	**Light stress:** Nature and causes of light stress, crop growth, development and yield mechanisms due to light intensity and photoperiod.		
• Acquire knowledge about temperature stresses. • Recognize the injuries caused by different types of temperature stresses in plants. • Employ the management practices to combat different types of temperature stresses.	**Temperature stress: High temperature stress:** Concept, high temperature injuries in plants, adaptation features in plants due to high temperature, agronomic manipulations to mitigate crop losses due to high temperature. **Cold stress:** Concept, types of clod shocks, symptoms of cold temperature injuries in plants, management of cold stress in crops.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer Report
• Conceptualize salinity stress, its kinds, occurrence and nature. • Recognize the damages	**Salinity stress:** Concept, kinds of salinity, occurrence, nature and extent of crop damage, salinity management.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer

caused by salinity stress in plants. • Utilize the management practices to combat salinity.			Report
• Delineate heavy metal and heavy metal stress. • Describe the damages caused by heavy metals in plants • Explain the tolerance mechanisms in plants to heavy metals.	**Heavy metal stress:** Concept, plant responses to heavy metals, plants tolerance to heavy metals	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer Report

Reference Books

1. V.E. Hansen, O. W. Israelson and G.E. Stringham, 1980. Irrigation Principles and Practices. Hohn Willey & N.Y. Sons.
2. G.R Squire, (1993). The Physiology of Tropical Crop Production. CAB International. U.K.
3. P.R. Goldsworthy, and N. Fisher, U.S. Gupta, 1975. PysiologicalApects of Dryland Farming.
4. F. P. Gardner, R.B. Pearce, and R. L. Mitchell, 1985. Physiology of Crop Plants. The Iowa State University Press. U.S.A.
5. P.S. Rathore, 2000. Technologies and Management of Field Crop Production. Agrobios (India).
6. Lincoln Taiz and Eduardo Zeiger. 2010. Plant Physiology: International Edition Verlag: Sinauer Associates Inc.,U.S.
7. Lincoln Taiz, Eduardo Zeiger, Ian M. Møller, and Angus Murphy. 2014. Plant Physiology and Development, Sixth Edition.Sinauer Associates, USA.
8. V.K.Jain. 2017. Fundamentals of Plant Physiology. S. Chand Publishing, India.

Course Code: AGRO 507 Course Title: Agrometeorology (Elective)	Credit Hour: 03	Semester: January-June

Rationale: It is intended to design the course for acquiring knowledge of dealing the weather sensitive elements of agricultural production.

Course Outcomes:

- Introduce agrometorology (definitions, aims, scope and importance)
- Describe crop weather relationships with important crops
- Forecast crop yields based on agro climatic and spectral indices

Intended Learning Outcomes (ILOs) The students will be able to-	Course Content	Teaching-Learning Strategies	Assessment Strategies
• Define agrometeorology. • Explain the roles of agrometeorology in agriculture.	**Introduction:** Concept scope and future thrust of agrometeorology; concept of macro, micro and local climate and their role in agriculture	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer Report
• Define crop ecology, macro and micro environment in relation to crop plants. • Describe the roles of micro environment for crop production. • Evaluate the micro environment management effect on crop productivity.	**Environmental implications:** Concept of ecology, environment, macro and micro environment. Properties of micro environment. Contribution of microenvironment in agriculture. Environmental problems. Management of micro environment.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer Report
• Explain the pre-requisites of photosynthesis in crop plants. • Explain the effects of solar radiation, temperature and water towards photosynthetic efficiency of plants.	**Meteorological factors in photosynthesis:** Solar radiation and photosynthesis, temperature and photosynthesis, photosynthesis in relation to CO_2 concentration, water in relation to photosynthesis, turbulence and pre-conditioning in relation to photosynthesis.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer Report
• Describe soil temperature as an important determinant of crop growth and yield. • Show seasonal and daily temperature pattern of soil. • Explain the fates of air temperature rise on crop yield.	**Environmental temperature and crop plants:** Concept and importance, Factors affecting soil temperature, influence of soil temperature in plant life and crop yield. Daily and seasonal pattern of soil temperature. Leaf temperature versus soil temperature. Influence of	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer Report

	elevation on air temperature.		
• Gather knowledge on solar radiation on earth. • Describe the roles of crop canopy for solar energy optimization towards productivity of crops.	**Solar radiation and crop plants:** Short wave radiation, long wave radiation and green house effect, Radiation distribution in a crop canopy, factors affecting radiation distribution with the plant community. Measurement of radiation distribution in plant canopy. Influence of sunlight in agriculture.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer Report
• Describe precipitation and their effects on agriculture. • Define weather and climate. • Differentiate weather and climate. • Discuss the science and factors of cloud formation with their consequences as rainfall or storms on earth. • Illustrate the water harvesting techniques and their efficient use of plant under moisture limiting situation.	**Precipitation and crop plants:** Types or precipitation, influence of rainfall, dew and fog in agriculture. **Weather and climate modification:** Weather modification magic in rainmaking, science in rain making, tornado modification, hail suppression, modification of field microclimate. Techniques of improving, water balance- water balance in the crop root zone, water harvesting and modification of transpiration.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer Report
• Define weather forecasting. • Classify weather forecasting. • Demonstrate the crop yield estimate by exploiting the knowledge of weather forecasting.	**Weather forecasting for agriculture:** Concept, importance, time factor in weather forecast, types of weather forecast and their application in agricultural operations and planning; present status of weather service for agriculture in Bangladesh, methods of crop yield forecasts,	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer Report

Reference Books

1. Murthy, K.R.V. 2018. Basic Principles of Agricultural Meteorology. BS Publication, Hyderabad – 500 095, India pp261.
2. Mahi, G.S. and Kingra, P.K. 2015. Fundamentals of Agrometeorology, Kalyani Publishers, New Delhi.
3. Reddy, S. R. and Reddy, D.S. 2014. Agrometeorology, Kalyani Publishers New Delhi.
4. Mahi, G.S. and Kingra, P.K Comprehensive Agrometeorology.
5. Reddy, S. R. 2014. Introduction to Agriculture and Agrometeorology, Kalyani Publishers, New Delhi.
6. Kees Stigter (Ed.), 2010. Applied Agrometeorology. Springer, xxxviii + 1101 pp.. Obtainable from: Springer Distribution Center GmbH, HaberStr. 7, 69126 Heidelberg, Germany.
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8. Mcfarland, M. J. & Strand, J. F. 1994. Weather-Wise Planning in Farm Management. In: Handbook of Agricultural Meteorology. J. F. Griffiths (ed.), Oxford University Press, Oxford New York, 264-272.
9. Rijks, D., Terres, J.M. & Vossen, P. (Eds.) 1998. Agrometeorological applications for regional crop monitoring and production assessment, Official Publications of the EU, EUR 17735, Luxembourg, 516 pp
10. Rojas, O., Rembold, F., Royer, A. & Nègre, T. 2005. Real-time agrometeorological crop yield monitoring in Eastern Africay. Agron. Sustain. Dev. 25:63-77.

Course Code: AGRO 509 Course Title : Irrigating Water Management (Elective)	Credit Hour: 03	Semester: January- June
Rationale: This course is designed to provide concepts on the management of irrigation water effectively for crop production.		
Course Outcomes: • Acquaint with the soil physical proper influencing soil water relations, different soil water and soil water constants • Gather knowledge on water retention, permeability and water movement in soil • Describe crop water requirement, causes of & plant responses to water deficit • Apply irrigation scheduling and irrigation practices for different crops		

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Describe the history and importance of Irrigation and hydrological cycle. • Acquaint with sources of irrigation water and area under irrigation in Bangladesh • Discuss and efficiently utilize the rainfall and evaporation pattern in Bangladesh for crop production.	**Introduction:** History, Importance of Irrigation, Harmful effect of excess Irrigation, Hydrological Cycle, Source of Water for Crop Plants, Irrigation area in Bangladesh, Rainfall and Evaporation Patten in Bangladesh.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer Report
• Conceptualize soil water, soil water relationship, soil physical properties relating soil water relationship, soil water retention, permeability and infiltration. • Characterize different soil water constants and soil water based on availability to plants. • Explain the water movement in soil under different soil water conditions. • Acquaint with the different techniques of soil water measurement.	**Soil-Water Relationship:** Physical properties influencing Soil Water Relationship, Classification of Soil Water constants, Soil Water Retention, Infiltration, Permeability, Water movement in Soils, Soil Water Measurement.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer Report
• Conceptualize soil-water-plant relationship. • Describe the role of water and transpiration in plants,	**Soil-Water-Plant Relationship:** Role of Water in Plants, Transpiration, Soil Water availability to Plants, Water deficit and Plant	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer

transpiration mechanism and soil water availability to plants. • Explain the plant responses to different water deficit conditions. • Enumerate the water requirement, evapotranspiration and irrigation requirement in plants.	Responses, Water requirement of Plants, Estimation of Evapotranspiration, Irrigation requirement.		Report
• Evaluate different irrigation methods. • Comprehend selecting irrigation method based on crops and locality.	**Methods of Irrigation:** Classification of Irrigation, Surface, Subsurface, Overhead and Drip Irrigation methods. Characteristics of efficient irrigation methods.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer Report
• Comprehend critical stages, frequency, depth and scheduling of irrigation. • Evaluate the efficiency of different irrigation practices. • Exercise knowledge of irrigation scheduling for different crops	**Irrigation Efficiency and Scheduling:** Efficiency of Irrigation practices, Water use and operation of irrigation system. Water saving irrigation managements. Time of irrigation, Critical stages of water need of crops, Criteria for scheduling irrigation, Irrigation scheduling for different crops, Frequency and interval of irrigation, Depth of irrigation.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer Report
• Comprehend synergism of irrigation with fertilizer. • Explain the interaction effect of irrigation and fertilizer on crop growth, yield and quality. • Exercise knowledge of water and fertilizer use efficiency of different crops.	**Irrigation and Fertilizer Use:** Synergism of Irrigation-Fertilizer, Water and Nutrient availability in Soils affecting Crop yield, Irrigation and Fertilizer interaction on Crop growth and yield, Quality of Crops as influenced by Irrigation and Nutrient use, Water and Fertilizer use efficiency of Crops.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer Report
• Gain knowledge on irrigation water quality. • Comprehend the toxic effect of excess nutrients and salinity in irrigation water	**Irrigation Water Quality:** Excess nutrients, salinity, toxic elements	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer Report
• Exercise knowledge of irrigation scheduling for irrigation practices in different crops	**Irrigation Practices in Crops:** Cereal Crops, Pulses, Oilseeds, Fiber Crops, Sugar Crops, Narcotic Crops, Beverage Crops, Tuber Crops, Green	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer

	manuring Crops and Fodder Crops.		Report

Related References:

1. V.E. Hansen, O. W. Israelson and G.E. Stringham, 1980. Irrigation Principles and Practices. Hohn Willey & N.Y. Sons.
2. S.S.Prihar. 1987. Irrigation of field crops: Principles and practices. Publications and Information Division, Indian Council of Agricultural Research, India.
3. P.R. Goldsworthy, and N. Fisher, U.S. Gupta, 1975. Pysiological Apects of Dryland Farming.
4. F. P. Gardner, R.B. Pearce, and R. L. Mitchell, 1985. Physiology of Crop Plants. The Iowa State University Press. U.S.A.
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6. A. Andales, J. L. Chávez, T. A. Bauder. Irrigation Scheduling: The Water Balance Approach.Colorodo State Univ. https://rockingham.ext.vt.edu/content/dam/rockingham_ext_vt_edu/files/crops/irrigation/check-book-irrigation-scheduling.pdf
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Course Code: AGRO 510 Course Title: Land Management (Elective)	Credit Hour: 03	Semester: July-December	
Rationale: This course is designed to helps learners in gaining a comprehensive knowledge to lead in land management industry and the importance of natural resources management, how management of land plays a vital role to nature and in the farm how to manage staffs and teams to implement land management strategies.			
Course Outcomes: • Understand the importance of land management and its challenges • Gain Knowledge key issues and their context in land management • Develop skill song general tasks, instruments and processes of land management particular land management properly			
Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Define the land management • Explain land management • Justify functionalities and tasks of land management.	**Land Management:** Introduction, definition and objectives	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer Report
• Explain Record (Khatian), stages of record preparation, • Objection stage (Rules-30) & Appeal stages (Rules-31). • Last opportunity to correct the record before gazette notification. • Minimize the record correction after final publications. • Describe CS Khatian, SA Khatian, RS Khatian, City Jarip Khatian and mutation process of a land and flat. • Verify the process of proper ownership of land.	**Land Records Preparation and Updating:** Preparation of mouza map-transverse survey, cadastral survey; Preparation of khatian-demarcation of boundary, khanapuri, bujarat, attestation, draft publication, licaring of objection, final junch and printing and publication of hatian.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Evaluate different land service systems and processes	**Land Transfer Registration and Mutation.**	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Explain transparent and automated case management system. • Minimize harassment of service recipients in different service provisions.	**Lana Dispute Adjudication/Resolution**	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer

• Distribute of lands under the land policy • Interpret existing land administration and management structure	**Management of State Land and Water Recourses:** Agriculture; nonagricultural lands, haats, bazaar, forestland, grazing land, vested properties. .	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Differentiate tax rates based on land use	**Land Revenue/ Taxation**	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer

Reference Books

1. S. Kamal, 2015. Land Management and Services in Bangladesh: Governance Challenges and Way-forward, Transparency International Bangladesh, Dhaka.
2. M. A. Islam, 2013. Mutation and Updating of Land Records in Bangladesh. BRAC University, Dhaka.
3. M. Hossain. 2015. Improving Land Administration and Management in Bangladesh, Bangladesh Institute of development Studies (BIDS), Dhaka.
4. Siddiqui, Kamal, Land Management in South Asia: A Comparative Study, The University Press Ltd., Dhaka, 1997

Course Code: AGRO 511 **Course Title : Fodder Production (Elective)**	**Credit Hour: 03**	**Semester: January- June**	
Rationale: This course is designed to provide to provide knowledge on fodder, their sources, management and improvement.			
Course Outcomes: • Conceptualize fodders and their plant sources. • Develop knowledge on growing fodder crops. • Acquire knowledge on managing grasslands, rangelands and pasture lands. • Describe the techniques of improving nutrition and quality of fodder crop for better livestock health.			
Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Learn the history, importance, agroecological distribution of different grasslands.	Introduction Concepts and terminology, history importance, agroceological distribution of grassland, climatic and edaphic adaptations, prospects, limitastions and solutions.	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer
• Enrich knowledge on basic idea of crop establishment, assuring vigorous growth through proper fertilization, water supply; and nutrient recycling, grazing and seed production.	Grassland management: Crop establishment, germination/sprouting, emergence and assuring vigorous growth, fertilization, water supply and nutrient recycling, grazing, seed production.	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Grow and explain the production procedure of Maize, sorhgum, millets, napier grass, sudan grass, barmuda grass, guinca grass, rye grass, pespalum crops	Fodder crop production:Non legume and grasses: Maize, sorhgum, millets, napier grass, sudan grass, barmuda grass, guinca grass, rye grass, *pespalum*,	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer
• Enrich idea about how to grow non legume crops such as cowpea, black gram, mungbean, grasspea, sesbania. sunnhemp, mimosae, alfalfa and clover,	Legume fodders: Cowpea, black gram, mungbean, grasspea, sesbania. sunnhemp, mimosae, alfalfa and clover,	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer
• Grow different fodder crops under intercropping systems	Production of fodder crops under inter cropping systems: Production of different fodder crops as inter crop with maize, sorghum, millets, pigeon pea, Processing, preservation and quality control Making hay and silage, conservation,	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer

	quality attributes of forages, hay and silage.		

References Books

1. Reddy D.V. 2006. Fodder Production and Grassland Management For Veterinarians. Google book. Oxford and IBH Publishing Company Pvt. Limited.
2. Kapa Sarjan Rao. 2005. Fodder production and grassland management. Academa Publishers.
3. John Frame and Scott Laidlaw. 2011. Improved Grassland Management. Amazon,
4. K. Sarjan Rao. 2004. Fodder Production & Grassland Management Books. Academa.
5. Anil Kumar, Khan M A and Subash Singh. 2013. Forages and Fodder: Indian Perspective. Book Vistas, New Delhi, DELHI, *India*.

Course Code: AGRO 512 **Course Title : Hill and Coastal Agriculture (Elective)**	**Credit Hour: 03**	**Semester: July-December**	
Rationale: This course is designed to provide preliminary concepts of Hill and Coastal Farming including their components, types and basic management practices.			
Course Outcomes: • Conceptualize Hill and coastal farming • Acquire knowledge on ecological characters of hill and coastal area and distribution of crop therein • Describe conventional and modern farming practices in hill and coastal area • Acquaint with management practices suitable in hill and coastal area			
Intended Learning Outcomes (ILOs) The students will able to -	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Explain Hill Agriculture • Describe Scope and prospects of Hill farming	Concept and objectives of Hill Agriculture	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer Report
• Gain knowledge on climatic and soil characteristics of Hilly area	Land area and Landscape for Hill Agriculture,		Quiz/MCQ Short answer Essay type answer Report
• Identify suitable crops for hilly area • Characterize suitable crop for hilly area	Crop selection for Hill Agriculture	Lecture Visual presentation Documentary/ Short film presentation Discussion	Quiz/MCQ Short answer Essay type answer Report
• Discuss about specialized management practices adapted in hilly area e.g. Zhum cropping, Terrace cropping Alley cropping, Shifting cropping. • Distinguish profitable farming practices in hilly area	System based production management in hilly area: Zhum cropping, Terrace cropping Alley cropping, Shifting cropping	Lecture Visual presentation, Discussion Documentary/ Short film presentation Field trip	Quiz/MCQ Short answer Essay type answer Report
• Prepare advanced farm management module for hilly area • Develop management strategies for hill farming • Propose new crop/ technology	Development programs on hill agriculture in Bangladesh.	Lecture Visual presentation Discussion Documentary/ Short film presentation	Quiz/MCQ Short answer Essay type answer Report

for hilly area		Field trip	
• Explain coastal agriculture • Discuss about scope and prospects of coastal Agriculture	Concept and Objectives of Coastal agriculture	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer Report
• Gain knowledge on climatic and soil characteristics of coastal area	Land area of Coastal Agriculture	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer Report
• Identify suitable crops for coastal area • Characterize suitable crop for coastal area	Crop selection for Coastal Agriculture	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer Report
• Describe about specialized farming in hilly area e.g. Tolerant cropping, Green Belt establishment, Crop and Shrimp cultivation. • Distinguish profitable/safe farming in coastal region	Land based production management in Coastal area: Tolerant cropping, Green belt establishment, Crop and shrimp cultivation	Lecture Visual presentation Documentary/ short film presentation Field Trip Discussion	Quiz/MCQ Short answer Essay type answer Report
• Prepare advance farm management module for coastal area • Develop management strategies for coastal farming • Propose new crop/ technology/ farming for coastal area	Development programs on coastal agriculture in Bangladesh.	Lecture Visual presentation Documentary/ short film presentation Field Trip Discussion	Quiz/MCQ Short answer Essay type answer Report

Reference Books

1. S. J. Scherr, and J. A. Mcnelly, 2008. Farming with ature: The Science and Practice of Ecoagriculture, Island Press, USA.
2. G. H. Cole, 2014. One Hundred years of Hill farming, Scotforth Books, UK.
3. H. S. Cabugao, 2016. Hill Farming, Arcler Education Inc, Canada
4. K. Ponnusamy, 2011. Integrated Coastal Farming Systems, Lap Lambert Academic Publishing, Latvia.
5. L. Rahman, 2012. Sustainable agriculture for national food security, RDF Research Development Foundation, Dhaka.
6. Handbook of Agriculture, ICAR Publication

Course Code: AGRO 513 **Course Title: Fertilizer Management (Elective)**	**Credit Hour: 03**	**Semester: July-December**

Rationale: This course is designed to provide basic concepts of fertilizers, fertilizer use laws, fertilizer management principles and ways to increase fertilizer use efficiency in relation to crop production.

Course Outcomes:

- Conceptualize fertilizer elements and fertilizer use statistics in Bangladesh
- Acquire knowledge on fate of fertilizer, fertilizer management, fertilizer use guide in different agro-ecological zones
- Describe fertilizer use laws and fertilizer use principles
- Explore ways to increase fertilizer use

Intended Learning Outcomes (ILOs) The students will be able to	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Write functions and toxicity symptoms of plant nutrients, • Classify & calculate fertilizer dose • Describe fertilizer use history and future recommendation of fertilizer in relation to crop production	Fertilizer elements, types of fertilizers, fertilizer use statistics in Bangladesh.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Show nitrogen, phosphorous and potassium cycle. • Describe factors affecting availability of N, P & K fertilizer use • Explain losses of N, P & K and ways to minimize.	Fate of applied fertilizer in crops and soil.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Mention concepts of intensive and extensive cropping • Show the ways to increase soil fertility under intensive cropping. • Apply the ways to increase soil fertility under extensive cropping.	Soil fertility management under intensive and extensive cropping.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Optimize fertilizer doses in different crops. • Explain Agro-ecological zones (AEZs) and cropping systems. • Optimize of fertilizer doses in different AEZs & cropping systems	Determination of optimum fertilizer dose factors influencing fertilizer dose, fertilizer doses in different crops under varying agro-ecological conditions and cropping systems.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer

• Gather knowledge on balanced plant nutrition and different laws of fertilizer application. • Describe different methods of fertilizer application in relation to boost up crop production.	Balanced fertilization, laws of fertilizer application, methods of fertilizer applications.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Apply judicious application of N, P & K fertilizers to combat their losses in relation to boost up crop production. • Describe concepts of fertilizer use efficiency & soil fertility index. • Explain concepts of plant nutrient management and their judicious application in different crops in relation to soil fertility management & uplifting crop production	Principles of fertilizer applications, fertilizer use efficiency, fertilizer management in different crops.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer

Reference Books

1. F.R.G.. 2012. Fertilizer Recommendation Guide, Bangladesh Agricultural Research Council (BARC), Farmgate, Dhaka-1215, 274p.
2. Amanullah and S. Fahad. 2018. Nitrogen in Agriculture, InTech Publishers, 250p.
3. R. N. Issaka. Soil Fertility, InTech Publishers, 250p.
4. J.K. Whalen. 2012. Soil fertility improvement and integrated nutrient management-a global perspective, InTech Publishers, 318p.
5. M.L. Larramendy and S. Solonesky. 2016. Organic fertilizers: from basic concepts to applied outcomes, InTech Publishers.
6. J. J. B. Jones. 2002. Agronomic Handbook: Management of Crops, Soils and Their Fertility, CRC Press

Course Code: AGRO 514 **Course Title : Post Harvest Technology (Elective)**	**Credit Hour: 03**	**Semester: July-December**	
Rationale: This course provides practical knowledge on post-harvest techniques of different agronomic crops			
Course Outcomes: • Illustrate the pre and post harvest management of crops. • Determine the post harvest loss of crops. • Prepare different processing products of crops.			
Intended Learning Outcomes (ILOs) The students will be able to	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Describe and classify Post harvest technology • Explain the steps and importance of Post harvest technology	**Post harvest technology (PHT):** Concept, objective importance. classification & steps of post harvest operations.	Lecture Visual presentation Field visit Discussion Assignment Field work	Quiz/MCQ Short answer Essay type answer Report
• Explain post harvest technologies cereal crops • Measure post harvest technologies of cereal crops • Reduce post harvest loss of cereal crops. • Determine processing products from cereal crops	**PHT of Cereal crops:** Rice, wheat, maize, barley sorghum & millets.	Lecture Visual presentation Field visit Discussion Assignment Field work	Quiz/MCQ Short answer Essay type answer Report
• Explain different methods for preparing processing products of various oil yielding crops. • Extract oil from different oil seed.	**PHT of oil seed crops:** Rapeseed/ mustard, groundnut, sesame, sunflower, soybean, Saflower, nizer, cottonseed, flax, coconut, castor etc.	Lecture Visual presentation Field visit Discussion Assignment Field work	Quiz/MCQ Short answer Essay type answer Report
• Illustrate post harvest techniques of different pulse crops • Exercise technique of to reduce post harvest loss of pulse crops	**PHT of pulse crops:** Lentil, gram, mungbean, black gram, grass pea, pigeon pea, soybean, field pea, cow pea, bush bean etc.	Lecture Visual presentation Field visit Discussion Assignment Field work	Quiz/MCQ Short answer Essay type answer Report
• Describe the physico-chemical properties of grains • Exercise techniques to store grain and seed. • Apply technique for seed drying, cleaning, grading,	Physico-chemical properties of grains, safe moisture content of grains & seeds, theory & methods of grain drying, cleaning, grading, marketing, storing, transportation, parboiling, milling.	Lecture Visual presentation Field visit Discussion Assignment Field work	Quiz/MCQ Short answer Essay type answer Report

marketing, storing, transportation • Perform technique in parboiling, milling of grains.			
• Describe retting, ginning & drying in Jute, cotton, keanf, sunnhemp, mesta, flax fibre extraction • Execute the retting, ginning & drying technique • Prepare different processing products from fiber crops	**PHT of fiber crops:** Jute, cotton, keanf, sunnhemp, mesta, flax (retting, ginning & drying).	Lecture Visual presentation Discussion Demonstration Assignment	Quiz/MCQ Short answer Essay type answer Report
• Describe Sugarcane & sugarbeet-crushing for Sugarcane &sugarbeet-crushing sugar, gurr & syrup manufacture. • Manufacture sugar, gurr & syrup from sugar crops	**PHT of sugar crops:** Sugarcane & sugarbeet-crushing for sugar, gurr & syrup manufacture.	Lecture Visual presentation Demonstration Exercise Discussion Assignment Field work	Quiz/MCQ Short answer Essay type answer Report
• Apply the process of manufacturing tobacco, tea and coffee. • Describe the technique of curing, handling & marketing of tobacco, tea and coffee.	**PHT of narcotic& beverage crops:** Tobacco, Tea & Coffee - curing, handling & marketing.	Lecture Visual presentation Demonstration Discussion Assignment Field work	Quiz/MCQ Short answer Essay type answer Report
• Explore post harvest processes of potato, sweet potato, cassava & yams • Explain the uses of potato, sweet potato, cassava & yams • Execute the storage technique potato, sweet potato, cassava & yams	**PHT of tuber/root crops:** Potato, sweet potato, cassava & yams-storage & use.	Lecture Visual presentation Field visit Discussion Assignment Field work	Quiz/MCQ Short answer Essay type answer Report
• Prepare hay and silage from alfalfa, lucerne, para, napier, grass & cowpea • Prepare green manure	**PHT of forage & green manuring crop:** Alfalfa, Lucerne, para, napier, grass & cowpea- hay & silage preparation. Preparation of green manure.	Lecture Visual presentation Field visit Discussion Assignment Field work	Quiz/MCQ Short answer Essay type answer Report
• Explain rubber manufacture process • Prepare rubber from rubber crop	**PHT of other crops:** Rubber manufacture	Lecture Visual presentation Field visit Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report

		Field work	
• Explore the curing, processing, storing & marketing of onion, garlic, turmeric ginger & cowpea	**PHT of spices & condiments:** Onion, garlic, turmeric & ginger- their curing processing storing & marketing	Lecture Visual presentation Field visit Discussion Assignment Field work	Quiz/MCQ Short answer Essay type answer Report

Reference Books

1. Banerjee, B. (1996). Tea Production and Processing. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Chakraverty, A. (2000). Post harvest technology of cereals, pulses and oilseeds. Third Edition. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
3. Miah W.M.M.A.; Moniruzzaman, F.M., Sattar, M.A., Miah, A.M.A., Paul S.K. and Haque, K.P. (2001). Agricultural Research in Bangladesh in 20th Century. Bangladesh Agricultural Research Conuncil and Bangladesh Academy of Agriculture.
4. Mathur, R.B.L. (1997). hand Book of Cane Sugar Technology. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
5. Martin, J.H.; Leonard, W.H. and Stamp, D.L. (1976). Principles of Field Crop Production. Macmillan Publishing Co. Inc. New York.

Course Code: AGRO 515 Course Title : Seed Technology Practices (Elective)	Credit Hour: 03	Semester: July-December

Rationale: This course is designed to provide knowledge of different aspect of seed technology in Bangladesh- history of seed development, seed organizations and seed systems; seed technological activities in different countries of the world; seeds and seed related international organizations; international seed regulations and seed enterprise development and management.

Course Outcomes:

- Describe seed technological activities in Bangladesh
- Learn about seed technological activities in different countries of the world
- Acquire knowledge on seeds and seed related international organizations all over the world
- Provide knowledge about international seed regulations
- Develop skill on seed enterprise development and management.

Intended Learning Outcomes (ILOs) The students will be able to-	Course Content	Teaching-Learning Strategies	Assessment Strategies
• Describe seeds and Bangladesh agriculture • Express the history of seed development in Bangladesh • Explain the requirement and use of seed in Bangladesh • Verify seed market in Bangladesh • Re organize the seed organization in Bangladesh-Public, Private and Non Government Organizations (NGOs) • Explain the seed system in Bangladesh: seed flow, weakness and opportunities, and future outlook	**Seed Technology in Bangladesh: Introduction:** Seeds in Bangladesh Agriculture, History of seed development, Seed requirement and use, Seed market. **Seed Organizations:** Public, Private, Non Government Organizations (NGOs). **Seed System:** Seed Flow, Weakness and Opportunities, Future Outlook	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer Report
• Explain Historical development and present stats of seed systems in agriculturally developed and developing countries in the worlds	**Seed Technology around the World:** Historical development and present stats of seed systems in agriculturally developed and developing countries: Australia, China, Countries in European Union, India, Indonesia, Japan, Korea, Pakistan, Taiwan and U.S.A.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer Report

• Explain the activities of different international seed related organizations like- Association of Official, Seed Analyst (AOSA), Asia, Pacific Seed Association (APSA), International Centre for Maize and Wheat Improvement (CIMMYT), Food and Agricultural organization (FAO), • Describe about International Federation of Seed Association (FIS), International Centre for Research and Improvement of Semi-Arid Tropics (ICRISAT), International Plant Genetic Resources Institute (IPGRI), • Describe the activity of International Rice Research Institute (IRRI),International Seed Testing Association (ISTA); World Intellectual Property Organization (WIPO).	**Seeds and seed related international organizations:** Association of Official, Seed Analyst (AOSA), Asia, Pacific, Seed, Association (APSA), International Centre for Maize and Wheat Improvement (CIMMYT), Food and Agricultural organization (FAO), International Federation of Seed Association (FIS), International Centre for Research and Improvement of Semi-Arid Tropics (ICRISAT), International Plant Genetic Resources Institute (IPGRI), International Rice Research Institute (IRRI), International Seed Testing Association (ISTA); World Intellectual Property Organization (WIPO)	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer Report
• Acquaint with different international seed regulations • Explain the regulations of - Convention on Biological Diversity (CBD), International Treaty on Plant Generic Resources for Food and Agriculture (IT/PGRF A), Trade Related Aspects on Intellectual Property Rights (TRIPs), • Elucidate the activity of International Union for the Protection of New Varieties of Plants (UPOV), World Trade Organization (WTO) procedure of seed drying, cleaning, grading and treatment.	**International Seed Regulations:** Convention on Biological Diversity (CBD), International Treaty on Plant Generic Resources for Food and Agriculture (IT/PGRF A), Trade Related Aspects on Intellectual Property Rights (TRIPs), International Union for the Protection of New Varieties of Plants (UPOV), World Trade Organization (WTO)	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type Answer Report
• Differentiate between Traditional and organized seed sector	**Seed Enterprise Development and Management**: Introduction: Traditional and	Lecture Visual presentation	Quiz/MCQ Short answer Essay type

• State the (Historical) evolution of seed program, Government service section, Commercial enterprises • Explain the Policies for enterprise development: General consideration, Development of seed policy, Essential pre-requisites, and Enterprise development resource institutions • Conceptualize and explain the technique of Seed enterprise management: Objectives, Organizational structure, Management steps, Genetic resources, Training • Execute the technique of Seed Supply: Quality assurance, Production targets, Organizing seed production, contract growing, Seed pricing • Conceptualize the financial aspect of enterprise management - like seed pricing, credit requirement, calculating financial requirement, approaching bank, banking policy etc	organized seed sector, (Historical) evolution of seed program, Government service section, Commercial enterprises. Policies for enterprise development: General consideration, Development of seed policy, Essential pre-requisites, and Enterprise development resource institutions. Seed enterprise management: Objectives, Organizational structure, Management steps, Genetic resources, Training. Seed Supply: Quality assurance, Production targets, Organizing seed production, contract growing, Seed pricing Credit requirement, Bank credit. Calculating financial requirement. Approaching Bank, Banking policy and balancing.	Discussion	answer Report

References Books

1. Huda, M.N. 2001. Why Quality Seed? Reality and Vision-Bangladesh Context. Lawrynowiez. Team Leader, Bangladesh-German Seed Development Project. Bangladesh.
2. Thomson, H.C. and Kelley, W.C. 1957. Vegetable crops. MeGraw-Hill Book Co. Ltd., New York. Toronto, London.
3. Thomson, J.R. 1979. An Introduction to seed Technology. Leonard Hill Pub.
4. Kent, N.L. 1976. Technology of Cereals. Pergamon press Ltd. Oxford, London.
5. Neme, N.P. 1989. Principles of Seed Certification and Testing. Allied Pub. Ltd. Ahmedabad, Banglaore, Bombay, Calucutta.
6. SCA and BARC. 1987. Proceeding of National Seed Technology Workshop. January 27-28, 1985.
7. SUDA. 1961. The Yearbook of Agriculture, Washington, D.C.
8. Agrawal, R.L. 1988. Seed Technology. Oxford and IBH Publishing Co. New Delhi, Bomby, Calautta.
9. Copeland. L.O. 1976. Principles of Seed Science and Technology. Burgas Pub. Co. USA.

Course Code: AGRO 516 Course Title: Agronomic Research (Elective)	Credit Hour: 03	Semester: January - June

Rationale: This course is designed to acquaint with agricultural/agronomic research and experimental designs, its necessity and justification, experiment set up and execution and finally presentation for criticism/improvement/dissemination of research findings followed by proper documentation.

Course Outcomes:

- Conceptualize agricultural/agronomic research
- Explain significance of National Agricultural Research System (NARS)
- Acquaint with national and international agricultural research institutes,
- Acquaint with experimental design and set up of experiment independently
- Apply research data analyses and interpretation
- Write thesis and scientific paper
- Prepare and present experiment at trading

Intended Learning Outcomes (ILOs) The students will be able to-	Course Content	Teaching-Learning Strategies	Assessment Strategies
• Explain about agricultural/agronomic research & its importance • Justify the formation of NARS • Evaluate the contributions of national organizations through their agricultural/agronomic research • Interpret the research activities done by international organizations	**Agricultural Research System in Bangladesh:** NARS, National and International organizations involved in agronomic research.	Lecture Visual presentation Discussion Assignments	Quiz/MCQ Short answers Essay type answers Reports
• Solve researchable problems • Set up of experiments with appropriate design	**Experimental design:** Types of experiments. Experimental designs appropriate for agronomic experimentation, their merits and demerits.	Lecture Visual presentation Discussion Assignments	Quiz/MCQ Short answers Essay type answers Reports
• Prepare Research Planning • Explain researchable problems • Identify the national • researchable problems and prioritize problems to come up with solution • Collect data from experimental fields	**Research Planning Methodology:** Purpose of conduction research, Research planning, Identification of researchable problems, Prioritization of agronomic problems and their possible solution through agronomic research, Data collection for different crops.	Lecture Visual presentation Discussion	Quiz/MCQ Short answers Essay type answers Reports

• Compare experimental data • Gather knowledge on correlation and regression analysis • Compare among treatment variables following research objectives • Apply statistical packages for experimental data analysis • Justify agronomic research findings and put forward as technology	**Statistical Analysis of Experiments data:** Analysis of variance, Comparison of treatment means. Regression and correlation analysis. Statistical packages for data analysis.	Lecture Visual presentation Discussion Assignments	Quiz/MCQ Short answers Essay type answers Reports
• Write thesis correctly • Prepare scientific paper • Publish scientific paper in national and international journals	**Thesis/ Scientific paper writing:** Structure and procedure of SAU thesis, data interpretation. Write up a scientific paper as assignment.	Lecture Visual presentation Discussion	Quiz/MCQ Short answers Essay type answers
• Design the dissemination of research findings • Prepare effective slides • Present research findings in presence of audience	**Presentation of Research Findings:** Write-up. Slide preparation. Points considered for effective and enjoyable presentation.	Lecture Visual presentation Discussion	Quiz/MCQ Short answers Essay type answers Performance test

Reference Books

1. Anonymous. 1990. Research Planning and Evaluation Training Course Resource Manual, BARC, Dhaka & BARI, Joydebpur.
2. K.A. Gomez and A.A. Gomez. 1984. Statistical Procedures for Agricultural Research. Second Edition, International Rice Research Institute, John Wiley & Sons, New York, pp. 01-340.
3. R.I. Mondal, M.S. Islam, M.A,J. Bhuiya, M.M. Rahman, M.S. Alam and M.H.H. Rahman. 2011. Krishi Projukti Hatboi, 5th Edition, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur.
4. S.C. Panda. 2014. Agronomy, AGROBIOS Publication, New Delhi, India.
5. S.M.H. Zaman, K. Rahim and M. Howlader. 1982. Simple Lessons from Biometry, Bangladesh Rice Research Institute, 170p.
6. V.C. Srivastava. 2014. Modern Principles of Agronomy, AGROBIOS (India).

Department of Biochemistry

Course Layout

Sl. No.	Course Code and Title	Credit Hour
A. Compulsory Courses		
1	BIOC 501: Advanced Chemistry of Carbohydrates, Lipids and Nucleic acids	3
2	BIOC 502: Advanced chemistry of proteins and enzymes	3
3	BIOC 506: Intermediary metabolism and its regulation	3
4	BIOC 508: Molecular biology of genes	3
5	BIOC 509: Biochemistry of Plant Hormones and Biocides	3
6	BIOC 513: Principles of Recombinant DNA Technology	3
	Total	**18**
B. Elective Courses		
7	BIOC 503: Principles of Biochemical Techniques	3
8	BIOC 504: Bioenergetics	3
9	BIOC 505: Comparative Biochemistry	3
10	BIOC 507: Special Topics in Biochemistry	3
11	BIOC 510: Soil Biochemistry	3
12	BIOC 512: Current Topics in Nutrition	3
13	BIOC 514: Animal Hormones	3
14	BIOC 515: Biochemistry of Fishes	3
	Minimum	**12**
C. Seminar Course		
15	BIOC: 598	**1**
D. Thesis Research		
16	BIOC: 599	**16**
	Total	**47**

Curriculum Alignment / Skill Mapping

Curriculum must be aligned with program objectives, program learning outcome and intended learning outcomes through proper skill mapping.

Department of biochemistry

Courses	Program Learning Outcome							
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
BIOC 501	x	x	x	x			x	x
BIOC 502	x	x	x	x			x	x
BIOC 503	x	x	x	x	x		x	x
BIOC 504	x	x	x	x			x	x
BIOC 505	x	x	x	x			x	x
BIOC 506	x	x	x	x			x	x
BIOC 507	x	x	x	x	x		x	x
BIOC 508	x	x	x	x			x	x
BIOC 509	x	x	x	x		x	x	x
BIOC 510	x	x	x	x	x		x	x
BIOC 512	x	x	x	x	x		x	x
BIOC 513	x	x	x	x	x		x	x
BIOC 514	x	x	x	x			x	x
BIOC 515	x	x	x	x	x		x	x
BIOC 598		x				x	x	x
BIOC 599	x	x	x	x	x	x	x	x

Course Code: BIOC 501 **Course title: Advanced Chemistry of Carbohydrate, Lipids and Nucleic acids (Compulsory)**	**Credit Hours: 03**	**Semester: July-December**	
Rationale: The course is designed to provide knowledge on the chemistry of Carbohydrate, Lipids, Nucleic acids and their biological significance**.**			
Course Outcomes: • Acquire knowledge about Carbohydrate, Lipids and Nucleic acids • Use of the acquired knowledge in solving problem of real life in relation to chemistry of lipid and protein			
Intended Learning Outcome (ILOs) The student will be able to-	**Course content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Define carbohydrate • Classify different carbohydrates • Differentiate monosaccharides and their biochemical importance • Discuss chemical nature of oligosaccharides • Compare different polysaccharides • Describe the importance of glycosides and glycosaminoglycans • Explain chemical nature of glycolipids and glycoproteins	**Carbohydrates:** Chemistry of naturally occurring monosaccharides and their biochemical important derivatives: Deoxy and amino sugars. sugar acids and alcohol's. Determination of complete structure of glucose Chemistry of oligosaccharides Chemistry of polysaccharides: storage and structural polysaccharides Plant and bacterial cell wall polysaccharides Chemistry and biological significance of naturally occurring glycosides and glycosaminoglycans Chemistry and function of glycolipids and glycoproteins	Lecture Discussion Visual presentation Assignment	Quiz/MCQ Short answer Descriptive answer Report
• Discuss function of different lipid and their chemical nature • Compare different lipids • Discuss technique of extraction. separation and purification of various lipid • Explain reason of lipid rancidity and preventive measure • Compare lipids present in prokaryotes and eukaryotes.	**Lipids:** Chemistry and function of saturated and unsaturated fatty acids, triacylglycerols. glycerophospholipids and sphingolipids, terpenoids, sterols, carotenoids, tocopherols. Prostaglandin's and thromboxanes. Principles of extraction. separation and purification of various lipid fractions. Chemistry of lipid rancidity Lipoproteins and membrane lipids Comparative distribution of lipids in prokaryotes and eukaryotes.	Lecture Discussion Visual presentation Assignment	Quiz/MCQ Short answer Descriptive answer Report

• Compare different types of DNA and their structural features • Discuss structure of DNA • Explain heredity is controlled by DNA • Describe different Physicochemical properties of DNA • Classify different RNA • Discuss structure and function of RNA • Explain cleavage of nucleic acids • Discuss different method of sequencing of nucleotides • Compare different blotting techniques • Explain DNA fingerprinting	**Nucleic acids:** Eukaryotic and prokaryotic DNA and their structural features. Circular DNA structure Watson-crick model. Structural deviation from the Model: A and Z, DNA. Satellite DNA and their significance. DNA as genetic material: experimental evidence, Physicochemical properties of DNA including optical properties, denaturation, annealing and supercoiling. Histones in DNA staking. Effects of UV light and chemical mutagens on base composition. Types, structure and function of RNA: sedimentation characteristics of different RNAs. Catalytic and other functions of RNA: plasmids, viral nucleic acids. Enzymic cleavage of nucleic acids. Maxam- Gilbert and Sanger's method of sequencing of nucleotides, Southern, Northern and Western blotting, Restriction Fragment Length Polymorphism (RELP) and Polymerase Chain Reactions (PCL).	Lecture Discussion Visual presentation Assignment	Quiz/MCQ Short answer Descriptive answer Report

Reference Books

1. Nelson, D. L and Cox, M. M.2008.Lehningers Principles of Biochemistry, 5th Ed. W. H. Freeman and company, New York.
2. Voet, D. and Voet, J. G. 2011. Biochemistry, 4th Ed. John Wiley and Son Inc.
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6. Bonner, J. and Varner, J. E. 1975.Plant Biochemistry. Academic Press
7. Daves, D.D. 1975. Plant Biochemistry. Black Well Sc Pub Oxford.
8. Elliot, W. H. and Elliot, D. C. 1997. Biochemistry and Molecular Biology. Oxford University Press.
9. Mahler, H. R. and Cordes, E. H. 1971. Biological chemistry, Harper and Harper. West, E. S. and Todd, R. 1971. Text Book of Biochemistry, Semillon Co, N.Y.

Course Code: BIOC 502 **Course title: Advanced Chemistry of Proteins and Enzymes (Compulsory)**	**Credit Hours:03**	**Semester: July-December**	
Rationale: The course is designated to provide knowledge on advanced chemistry of proteins and enzymes			
Course outcomes: • Acquire knowledge on protein and enzyme • Conceptualize mode of action of enzymes with different affecting factors			
Intended Learning Outcomes (ILOs) The students will be able to	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Discuss physical and chemical nature of proteins • Describe function of biologically active natural peptides • Explain different level of structure of protein • Compare different Plasma proteins • Describe the importance of lipoproteins and glycoprotein • Explain chemical nature of toxic plant proteins	**Proteins:** Physicochemical properties of proteins with special reference to colloidal and electrolytic behavior. Structure and biochemical function of biologically active natural peptides Organizational levels of native protein and determination of primary structure Plasma proteins with special reference to lipoproteins and glycoprotein and their biological functions. Cytochromes, Actomyosin, Interferons. Characteristics and functions of seed storage proteins, Lectins and other toxic plant proteins.	Lecture Discussion Visual presentation Assignment	Quiz/MCQ Short answer Descriptive answer Report
• Summarize enzymesaccording to specificity, mode of action • Differentiate zymogens and active enzyme • Outline reason for catalytic efficiency of enzymes. • explain factors affecting enzyme action • Discuss active site of enzyme • Summarize different enzyme in relation with mechanism • Illustrate mode of enzyme action	**Enzymes:** Properties of enzymes with special reference to specificity, mode of action, activation and inhibition. Activation of zymogens. Factors contributing to catalytic efficiency of enzymes. Dependence of enzymatic velocity on substrate and enzyme concentrations. Kinetic treatment of the effect of inhibitors, pH and temperature. Mechanism of bisubstrate reactions. Concept of active site and its determination.	Lecture Discussion Visual presentation Assignment	Quiz/MCQ Short questions Descriptive answer Report

	Mechanisms of action lysozyme and carboxypeptidase. Allosteric enzymes and the models of their action mechanisms. Restriction enzymes, immobilized enzymes and Ribozyme.		

Reference Books

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2. Voet, D. and Voet, J. G. 2011. Biochemistry, 4th Ed. John Wiley and Son Inc.
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6. Dixon. M. and Webb. E.C. 1979. Enzymes. Academic Press.
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Course Code: BIOC 503 **Course title: Principle of Biochemical Techniques (Compulsory)**	**Credit Hours: 03**	**Semester: January-June**	
Rationale: The course is designed to provide knowledge on different techniques used in isolation, identification, estimation of biomolecules and investigation of biochemical processes at biological system.			
Course outcomes: • Acquire knowledge on tissue and cell culture • Implement different separation techniques of tissues • Use the acquired knowledge of different analytical method in investigating biomolecules • Conceptualize modern techniques using in recombinant DNA technology			
Intended Learning Outcomes (ILOs) The students will be able to	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Compare different techniques to study tissue • Discuss tissue and cell culture techniques • Describe cell homogenates • Explain method of cell fractionation.	**General Principles of Biochemical Investigations:** Whole animal studies. Perfusion of isolated organs. Use of plant material. Tissue and cell culture techniques. Preparation of tissue and cell homogenates. Method of cell fractionation	Lecture Discussion Visual presentation Assignment	Quiz/MCQ Short answer Descriptive answer Report
• Compare different Centrifugation Techniques • Identify suitable centrifugation method to determine protein purity • Categorize different Chromatographic techniques. • Recognize appropriate Chromatographic techniques to isolate a biochemical substance. • Describe the principle and use of different Electrophoretic techniques. • Explain the principle and application of chromatographic technique	**Separation methods:** Centrifugation Techniques: Preparative centrifugation Isopycnic, Rate-zonal, Differential and equilibrium isodensity centrifugation,analytical ultracentrifugation Chromatographic techniques: adsorption chromatography, partition chromatography, ion-exchange chromatography, gas-liquid chromatography, permeation chromatography, affinity chromatography, High Performance liquid chromatography (HPLC) General techniques: Special electrophoresis-disc electrophoresis, imminoelectrophoresis, isoelectric focusing, high voltage paper electrophoresis	Lecture Discussion Visual presentation Assignment	Quiz/MCQ Short questions Descriptive answers Report

• Explain principle of Spectroscopic techniques • Compare different types of Spectroscopic technique to measure a specific biomolecule. • Discuss Radioisotope techniques • Scrutinize a laboratory for working with radioisotopes. • Explain dialysis technique.	**Analytical Methods:** Spectroscopic techniques: Basic laws of light absorption, visible and ultraviolet spectropotometry, Spectroflourimetry, flame Spectrophotometry, Mass spectrometry, Nuclear Magnetic Resonance (NMR) Radioisotope techniques: Atomic Stability and radiation, Types of radioactive decay, Detection and measurement of radioactivity and safety aspects. Radioisotopes in biological Sciences. Manometric techniques; Dialysis. Freeze-drying, Polarimetry.	Lecture Discussion Visual presentation Assignment	Quiz/MCQ Short answer Descriptive answer Report
• Exercise Recombinant DNA technology • Explain how DNA fingerprinting used in criminal identification • Recognize latest technology used in recombinant DNA technology	**Bio techniques:** Bioassay techniques: recombinant DNA technology – Biophysical and biochemical techniques used in recombinant DNA work, Restriction enzymes,Gene probes, Preparation of chimeric DNA molecules, Cloning, Blotting and Hybridization. DNA sequencing, Gene mapping	Lecture Discussion Visual presentation Assignment	Quiz/MCQ Short answer Descriptive answer Report

Reference Books

1. Pollister, A. W. (Ed.).1966.Physical Techniques in Biological Research 2nd Edition, New York. Academic Press.
2. Albanese, A.A. (Ed.). 1963.Newer methods of nutritional biochemistry with applications and interpretations. New York. Academic press.
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5. Draper, S. R. (Ed.).1976.Biochemical analysis in Crop Science. Oxford University press. London
6. Morris, J.G. 1974.A Biologists Physical chemistry.2nd Ed. Edward Arnold. London.

Course code: BIOC 504 **Course title: Bioenergetics (Compulsory)**	**Credit Hours:03**		**Semester: July-December**
Rationale: The course is designed to provide knowledge on thermodynamics and energy production and use of energy in metabolism of biomolecules survival and maintenance of biological cell.			
Course outcomes: • Acquire knowledge on application of thermodynamics to biochemical systems • Conceptualize energy production systems in organisms • Describe the movement of different molecules through cell			
Intended Learning Outcome (ILOs) The student will be able to-	**Course content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Describe laws of thermodynamics. • Explain free energy, enthalpy and entropy. Standard free energy change. • Discuss ATP-ADP cycle and its role in the transfer of high-energy phosphates.	**Introduction to Bioenergetics:** Laws of thermodynamics as applied to biochemical systems. Concept of free energy, enthalpy and entropy. Standard free energy change, conventions followed in Biochemistry. Exergonic and endergonic processes, Thermodynamically reversible and irreversible reactions. ATP-ADP cycle and its role in the transfer of high-energy phosphates	Lecture Discussion Visual presentation Assignment	Quiz/MCQ Short answer Descriptive answer Report
• Compare different energy rich compounds. • Explain how the energy compound provides energy on hydrolysis. • Explain how ATP serves as Energy Currency of cells.	**II. Energy-rich Compounds:** Pyrophosphates, acylphosphates, enol phosphates, thiol esters, guanidium phosphates. Structural basis of their high free energy of hydrolysis. ATP as 'Energy Currency' of cells. Energy change and conservation, and storage of energy in cells. Concept of redox potential.	Lecture Discussion Visual presentation Assignment	Quiz/MCQ Short answer Descriptive answer Report
• Describe different components of electron transport chain. • Explain how electron pass through different component. • Explain how ATP produced through electron transport • Differentiate cyclic and non-cyclicphotophosphorylation.	**III. Electron Transport and Oxidative Phosphorylation:** Components of electron transport chain. Mechanism and free energy change of electron transport reactions. Energetics of oxidative phosphorylation and sites of ATP formation. Inhibitors and uncouplers of electron transport chain. Theories of the mechanism of oxidative phosphorylation. Photophosphorylation: Cyclic and non-cyclic	Lecture Discussion Visual presentation Assignment	Quiz/MCQ Short answer Descriptive answer Report

• Summarize transport of molecules across cell membrane • Explain how energy used in transport of molecules • Classify different types of transporter • Explain how saline save thousands of children lives.	**IV. Energy-linked Transport Processes:** Translocation of groups and energy-linked ion-transport. Active transport. Energetics and saturation kinetics of active transport, Genetic evidence for transport systems. Active transport systems in animal tissues and bacteria Na^{+}-k^{+} pump. Active transport of glucose and amino acids. Intracellular transport of Ca^{2+} in animal cells. Action of ionophores	Lecture Discussion Visual presentation Assignment	Quiz/MCQ Short answer Descriptive answer Report

Reference Books

1. Nelson, D. L and Cox, M. M.2008.Lehningers Principles of Biochemistry, 5th Ed. W. H. Freeman and company, New York.
2. Coon, E. E., Stumpf, P. K., Roy, G. B and Doi, H. 1987.Outlines of Biochemistry. John. Wiley and Son Inc.
3. Berg, J. M., Tymoczko, J. L. and Stryer, L. 2012. Biochemistry, 7th ed. W. H. Freeman and Company.
4. Murray, K. M., Granner, D.K., Mayes, P. A. and Rodwell,V. W. 1990. Harpers Biochemistry, 22ndedition, Prentice Hall Intl. Incorp.
5. Mahler, H. R. and Corder,E. H.1971. Biological Chemistry, Harper and Row, Publishers.
6. Lehninger, A. L. 1971.Bioenergetics, 2nd Ed. Benjamin, Menlo Park, California.

Course Code: BIOC 505 **Course Title: Comparative Biochemistry (Elective)**	**Credit hour: 03**	**Semester: January - June**	
Rationale: The course is designated to provide knowledge on comparative Biochemistry of prokaryotes and eukaryotes.			
Course Outcomes: • Acquire knowledge on comparative Biochemistry of prokaryotes and eukaryotes. • Conceptualize the location, function and advance features of different cell organelle.			
Intended Learning Outcomes (ILOs) The student will be able to –	**Course Content**	**Teaching Learning Strategies**	**Assessment Strategies**
• Explain about Prokaryote and eukaryote cell and their organic location, function and activity. • Compare between prokaryotes and eukaryotes • Explain about energy flow in atmosphere	**Comparative Biochemistry:** Introduction and scope of comparative Biochemistry of prokaryotes and eukaryotes Flow of energy and materials in biosphere.	Lecture Discussion Visual presentation	MCQ Short answer Essay type answer
• Discuss similarities in Metabolic design in plant and animal • Explain about transduction transformation and utilization of free energy in metabolic system	**Metabolic design:** Basic similarity of metabolic design. Comparative biochemistry of free energy transduction. transformation and utilization.	Lecture Discussion Visual presentation	MCQ Short answer Essay type answer
• Differentiate about Nitrogen metabolism in plant and animal • Explain about nitrogen storage, creatinine in animal, plant and microorganism. • Illustrate the detail feature of protein synthesis • Compare the protein synthesis in eukaryotes and prokaryotes	**Nitrogen metabolism & Protein:** Comparative aspects of nitrogen storage and excretion in animal. Plant and microorganism. Salient feature of protein synthetic machinery of eukaryotic and prokaryotic organism.	Lecture Discussion Visual presentation	MCQ Short answer Essay type answer
• Differentiate the metabolic pathways of carbohydrates in plant and animals. • Explain about biosynthesis in higher	**Carbohydrate metabolism:** Basic differences in carbohydrate metabolism of animal. Plant and microorganism. Photosynthesis in higher and lower plants. Respiration vs fermentation. Glyoxylate pathway.	Lecture Discussion Visual presentation	MCQ Short answer Essay type answer

and lower plants • Differentiate between respiration and fermentation. • Describe about glycolytic pathway, Pentose phosphate pathway	Pentose phosphate pathway.		
• Compare different lipid metabolism in plant and animals and microorganism • Explain liposome and glyoxysome • Discuss about FA metabolic pathway • Describe sterol metabolic pathway in plant and animal.	**Lipid metabolism:** Salient difference in lipid metabolism in plant, animal and microorganism. Liposome and Glyoxysome their metabolic activity. Fatty acid and sterol metabolism in plants and animals.	Lecture Discussion Visual presentation	MCQ Short answer Essay type answer

Reference Books

1. Donald Voet, Judith G. Voet, Biochemistry. John Wiley and Sons. 1990.
2. J. H. Welsh. Comparative Endocrinology, Wiley Publishers. New York 1964.
3. Marcel Florkin and Howard S. Mason (ed).Comparative Biochemistry. Academic Press. New York. 1964.
4. R.K. Murray, D.K. Grannes, P.A. Mays and V.W. Rodwell. Rodwell. Harper's Biochemistry. Appleton and Lange. A Publishing Division of Prentice Hall. 1988.

Course Code: BIOC 506 **Course title: Intermediary Metabolism and its Regulation (Compulsory)**	**Credit Hours:03**	**Semester: January-June**	
Rationale: The course is designed to provide knowledge of intermediary metabolism and its regulation			
Course Outcomes: • Conceptualize intermediary metabolism of biomolecules • Acquire knowledge about regulation of metabolism • Demonstrate energy production and consumption in plant and animal.			
Intended Learning Outcome (ILOs) The student will be able to-	**Course content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Describe metabolism and aspects of metabolic regulation • Explain carbohydrate synthesis and energy production in different plants	Basic concept and design of metabolism. Experimental approaches in the study of metabolism. General aspects of metabolic regulation. Control of photosynthesis, Hatch-Slack pathway, Crassulacean acid metabolism, Photophosphorylation	Lecture Discussion Visual presentation Assignment	Quiz/MCQ Short answer Descriptive answer Report
• Discuss different carbohydrate metabolism pathways and their regulation • Compare energy production and consumption in different pathways • Explain muscle contraction mechanism	Glycolysis vs Fermentation, respiratory pathway. Energetics and regulation of glycolytic pathway. Glycogenesis. Glycogenolysis and gluconeogenesis and their regulation. Hexose monophosphate pathway, Biochemistry of muscle contraction	Lecture Discussion Visual presentation Assignment	Quiz/MCQ Short answer Descriptive answer Report
• Justify plant can produce carbohydrate from fat but animal cannot • Explain Uronic acid pathway	Glyoxylate cycle and their regulations, Uronic acid pathway	Lecture Discussion Visual presentation Assignment	Quiz/MCQ Short answer Descriptive answer Report
• Summarize importance of TCA cycle in completion of oxidation of food and its amphibolic nature • Compare different types of phosphorylation	Citric acid cycle: Experiments leading to its discovery, its amphibolic nature and regulation. Anaplerotic reactions. Electron transport system and mechanism of oxidative phosphorylation. Organization and site of phosphorylation. Comparative study of photophosphorylation and oxidative phosphorylation.	Lecture Discussion Visual presentation Assignment	Quiz/MCQ Short answer Descriptive answer Report

• Interpret protein metabolism with respect to transformations of amino acids. • Explain nitrogen assimilation and excretion pathway	Nitrogen fixation; metabolic transformations of amino acids. Urea and uric acid synthesis and their regulation. Biosynthesis of essential of essential amino acids. Liposomes and glyoxysomes and their metabolic activity	Lecture Discussion Visual presentation Assignment	Quiz/MCQ Short answer Descriptive answer Report
• Compare fat metabolism in respect of alpha, beta and omega oxidation of fatty acids. • Explain cholesterol metabolism	Oxidative pathways of fatty acids. Biosynthesis of fatty acids, acyl glycerols, phospholipids and cholesterol.	Lecture Discussion Visual presentation Assignment	Quiz/MCQ Short answer Descriptive answer Report
• Describe pathway of purine and pyrimidine bases synthesis	Biosynthesis of purine and pyrimidine bases and their regulation.	Lecture Discussion Visual presentation Assignment	Quiz/MCQ Short answer Descriptive answer Report
• Summarize effect of different hormone on metabolism	Hormonal control of metabolism	Lecture Discussion Visual presentation Assignment	Quiz/MCQ Short answer Descriptive answer Report

Reference Books

1. Nelson, D. L and Cox, M. M.2008.LehningersPrinciples of Biochemistry,5thEd.W. H. Freeman and company, New York.
2. Voet, D.andVoet, J. G. 2011.Biochemistry, 4th Ed. John Wiley and Son Inc.
3. Coon, E.E.,Stumpf, P.K.,Roy, G. BandDoi,H. 1987.Outlines of Biochemistry. John. Wiley and Son Inc.
4. Green, D. E. and Goldberger, R.F.1967.Molecular Insights into the Living Process. Academic. Press, New York,
5. Greenberg, D. M. (ed.) .1967.Metabolic pathways. 3rdEd. Academic Press. New York.
6. Korebs, H. A. and Komberg. H. L. 1957.Energy Transformation in Living Matter, Springer-Verlag, Berlin.
7. Berg, J. M., Tymoczko, J. L. and Stryer,L. 2012.Biochemistry, 7th ed. W. H. Freeman and Company.
8. Morowitz, H. J. 1968.Energy flow in Biology. Academic Press. Now York.

Course Code: BIOC 507 **Course Title: Special Topics in Biochemistry (Elective)**	**Credit hour: 03**	**Semester: January - June**	
Rationale: The course is planned to provide knowledge on some special topics in biochemistry.			
Course Outcomes: • Acquire knowledge on function of cell membrane and its biochemistry. • Gather knowledge on cell division process and different phases. • Conceptualize the function of different human delicate organ. • Acquire knowledge on contemporary disease like AIDS, Inborn error metabolism and memory loss.			
Intended Learning Outcomes (ILOs) The student will be able to –	**Course Content**	**Teaching Learning Strategies**	**Assessment Strategies**
• Discuss the definition, functions and structure of membrane. • Explain the membrane transport system. • Differentiate excitable membrane and sensory systems.	Biological membrane, Membrane transport system, Excitable membrane and sensory systems.	Lecture Discussion Visual presentation Assignment	MCQ Short answer Essay type answer Report
• Describe the function and structure of hemoglobin and myoglobin.	**Oxygen transporters:** Hemoglobin and Myoglobin	Lecture Discussion Visual presentation	MCQ Short answer Essay type answer
• Describe the causes and important of cell differentiation. • Define cell communication. • Classify the types of cell communication. • Discuss the purpose of cell communication. • Explain how complement system work. • Discuss the major functions of the complement system. • Differentiate the components of complement system.	Biochemistry of cell differentiation, Cell communication, The complement system.	Lecture Discussion Visual presentation	MCQ Short answer Essay type answer

• Define atmospheric nitrogen fixation. • Describe the causes of nitrogen fixation. • Discuss the types of nitrogen fixation. • Explain the importance nitrogen fixation.	Biochemistry of nitrogen fixation	Lecture Discussion Visual presentation Assignment	MCQ Short answer Essay type answer
• Discuss the types and role of cell cytoskeleton • Explain the molecular basis of cancer. • Classify the cancer cell. • Describe the characteristics of cancer cells. • Discuss the biochemistry of aging and senescence. • Explain the biochemistry of vision.	Cell cytoskeleton Molecular basis of cancer Biochemistry of aging and senescence Biochemistry of vision	Lecture Discussion Visual presentation	MCQ Short answer Essay type answer
• Define contractile elements. • Explain the function of contractile elements • Discuss the bioluminescence. • Explain the causes of Acquired Immune Deficiency Syndrome (AIDS) • Discuss the causes of inborn error of metabolism • Explain the biology, mechanism and important of memory.	Biochemistry of contractile elements Bioluminescence Acquired Immune Deficiency Syndrome (AIDS) Inborn error of metabolism Biochemistry of memory	Lecture Discussion Visual presentation	MCQ Short answer Essay type answer

Reference Books

1. Albert lehninger. Biochemistry. Worth Publishers, Inc. 1984.
2. Beridge, M. J. The molecular basis of communication within the cell. Sci. An. 253 (4). 142-152. 1985.
3. Charles C. Richardson. Annual Review of Biochemistry. Annual Reviews Inc.1992.
4. DonalVoet and Jidith G. Voet. Biochemistry. John Wiley and Sons. N.Y. 1990.
5. G. P. Talwar. Text Book of Biochemistry and Human Biology. Prentice Hall of India. New Delhi. 1988.
6. Orme- Johnson, W. H. Molecular basis of nitrogen fixation. An. Rev. Biophys. Biophys. Chem. 14, 419-459. 1985.
7. Weinberg. R.A.A. Molecular Basis of Cancer. Sci. Am. 249(5), 126-142. 1983.

Course Code: BIOC 508 Molecular Biology of Genes (Compulsory)	**Credit Hours: 03**	**Semester: January-June**	
Rationale: The course is designed to provide knowledge on different techniques for chromosome, chromatin and gene, Central dogma for the flow of information and regulation of gene expression.			
Course Outcomes: • Acquire knowledge on central drogma • Implement different replication techniques of gene • Use the acquired knowledge of different analytical method in gene regulation and gene expression • Conceptualize translation and transcription			
Intended Learning Outcome (ILOs) At the end of the course student will be able to-	**Course content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Describe different replication techniques. • Compare different methods related to the replication • Explain different steps and molecular tools related to the replication technique.	Replication of DNA. Semiconservative replication of DNA. Meselson-Stahl experiment. autoradiographic demonstration, applicability to single stranded DNA and RNA. Geometric problems in semiconservative replication. Theta replication. Eukaryotic chromosomal DNA. Double Stranded DNA replication. Major enzymic activities involved in DNA replication. DNA polymerases (prokaryotic and eukaryotic), DNA gyrase, ligase, primes, helices and binding proteins. Initiation, elongation and termination of replication, Brief description of replication of eukaryotic chromosome.	Lecture Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Classify different replication process and their application. • Compare different process related to the replication • Summarize different stages of transcription techniques. • Explain molecular techniques related to the transcription. • Select replication techniques for application	Replication process in *E. coli:* Initiation point, unwinding of parental DNA. polymerization, synthesis of primer, Okazaki fragments. Joining of precursor strand. Events at replication fork, Replication for DNA in eucaryotes. Multiple replication forks, histone separation Transcription: Definition, classes of RNA molecules. Features of prokaryotic and eukaryotic MRNA. Trna and RRNA prokaryotic transcription:	Lecture Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report

	Stages of transcription: Binding of RNA polymerase to the DNA template, initiation of polymerization, chain elongation and termination of synthesis, initiation and termination signals Eukaryotic transcription: eukaryotic RNA polymerases. Difference between prokaryotic and eukaryotic transcripts; promoters. caps and tails; Introns and exons, post transcriptional processing, Reverse transcription. RNA self replication		
• Compare different types translation process • Discuss essential components of protein through translation • Explain details about Prokaryotic and Eukaryotic translation technique	Translation Essential components of protein biosynthesis. The Genetic code: characteristics; deciphering the genetic code, codon assignments. Activation of amino acids: Codon-Anticodon recognition. Structure of ribosomes and tRNAs, Prokaryotic ribosome, eukaryotic ribosome, Stage of protein synthesis: initiation, elongation and termination. Energy requirement for protein synthesis; fidelity of translation. Difference between prokaryotic and eukaryotic translation. Protein localization in eukaryotes. Synthesis on membrane- bound ribosomes. Endoplasmic reticulum. Signal hypothesis: Glycoprotein. Inhibitors of protein synthesis	Lecture Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Discuss different gene regulation techniques • Summarize gene regulation and expression system • Explain how translation control in cell	Regulation of Gene expression: The operon model: Lac operon (inducible system), catabolic repression. Trip operon (repressible system), Transposable genetic elements, mechanism of transposition. Translation control: Post translational processing. Feedback inhibition, protein degradation.	Lecture Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report

Reference Books

1. Lehninger Principles of Biochemistry. Nelson and Cocks,3rd edition, Worth Publishers Inc.
2. Lehninger Principles of Biochemistry. Nelson and Cocks,4th edition, Worth Publishers Inc.
3. Lehninger Principles of Biochemistry. Nelson and Cocks,5th edition, Worth Publishers Inc.
4. Biochemistry,J.M. Berg, J. L.Tymoczko and L Stryer,7thedition,W.H.Freeman and Company,2007.
5. Donald Voet and Judith G Voet. Biochemistry. John Wiley and Sons.1990.
6. Eric E. Conn, Paul K. Stumpf. George,Brunening. Roy, H. Dor. Outlines of Biochemistry Joh Wiley and Sons,1987.
7. R. W. Old and S. B. Primose. Principles of Gene manipulation. An introduction to genetic engineering. Blackwell publications 1989.
8. Bruce Alberts, Dennis Bray. julian Lewis, martin Raff, keith Roberts & James D. Watson Molecular Biology of the cells. 2nd edition, Garland Publishing Inc. n. Y. 1989.

Course Code: BIOC 509 **Course Title: Biochemistry of Plant Hormones and Biocides (Compulsory)**	**Credit hour: 03**	**Semester: July - December**

Rationale: The course is designed to provide knowledge and update information about Phytohormones and Biocides; Biochemistry, physiological functions and their application in culture of plant world.

Course Outcomes:

- Conceptualize Phytohormones.
- Acquire knowledge about Phytohormones and biocides and their application on plant world.

Intended Learning Outcomes (ILOs) The student will be able to –	**Course Content**	**Teaching Learning Strategies**	**Assessment Strategies**
• Point out functions, mode of action of auxins, • Express confidence on bioassay of naturally occurring auxins	Biochemistry, physiological functions. mode of action and bioassay of naturally occurring auxins	Lecture Discussion Visual presentation Assignment	MCQ Short answer Essay type answer Report
• Illustrate physiological functions. mode of action and bioassay of naturally occurring gibberellins	Biochemistry, physiological functions. mode of action and bioassay of naturally occurring gibberellins	Lecture Discussion Visual presentation	MCQ Short answer Essay type answer
• Acquaint with and justify the functions, mode of action and bioassay of naturally occurring cytokinins	Biochemistry, physiological functions. mode of action and bioassay of naturally occurring cytokinins	Lecture Discussion Visual presentation Assignment	MCQ Short answer Essay type answer Report
• Exercise the bioassay of naturally occurring ethylene and abscisic acid.	Biochemistry, physiological functions. mode of action and bioassay of naturally occurring ethylene and abscisic acid	Lecture Discussion Visual presentation	MCQ Short answer Essay type answer
• Become more exact about functions. mode of action and bioassay of naturally occurring and synthetic growth retardants	Biochemistry, physiological functions. mode of action and bioassay of naturally occurring Natural and synthetic growth retardants	Lecture Discussion Visual presentation Assignment	MCQ Short answer Essay type answer Report
• Exercise the application of herbicides in field crop	Biochemistry and mode of action and application of herbicides in field crop	Lecture Discussion Visual presentation	MCQ Short answer Essay type answer
• Evaluate the toxicity of organophosphorous pesticides	Biochemistry and mode of action and toxicity of organophosphorous	Lecture Discussion Visual presentation	MCQ Short answer Essay type answer

• Describe the application and the mode of action of insecticides	Biochemistry and mode of action insecticides	Lecture Discussion Visual presentation	MCQ Short answer Essay type answer
• Interpret the mode of action some important fungicides	Biochemistry and mode of action some important fungicides	Lecture Discussion Visual presentation	MCQ Short answer Essay type answer
• Investigate on the application of some important bactericides, nematocides and acaricides	Biochemistry and mode of action some important bactericides, nematocides and acaricides	Lecture Discussion Visual presentation Assignment	MCQ Short answer Essay type answer Report

Reference Books

1. L. Lehninger. 1982. Biochemistry, 2nd Edition, Kalyani Publishers, Lubiana, New Delhi,
2. J.L.Jain.2001. Fundamentals of Biochemistry, 5th Edition, published by Chand & Company Ltd. Ram Nagar, New Delhi, 110055.
3. Lubret stryer.1986. Biochemistry, Published by S.K. Jain for CBS Publishers and Distributors, 485, Jani Bhaban, Bholanath Nagar, Delhi, India, 1986.
4. Amarjit Basra, 2000. Plant Growth Regulators in Agriculture and Horticulture: Their Role and
5. Commercial Uses ,CRC Press, Published December 6, 2000 ,Reference - 264 Pages, ISBN
6. 9781560228967 *Went FW, ThimannKV. 1937. Phytohormones. New York: The Macmillan*
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8. *Srivastava LM .2002. Plant growth and development: hormones and environment. Academic Press. p. 140.* ISBN 0-12-660570-X
9. *Öpik H, Rolfe SA, Willis AJ, Street HE. 2005.* The physiology of flowering plants *(4th ed.). Cambridge University Press. p. 191.* ISBN 978-0-521-66251-2.Osborne DJ, *McManus MT.2005.* Hormones, signals and target cells in plant development. *Cambridge University Press. p. 158.* ISBN 978-0-521-33076-3.
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Related Teaching References and Selected Journals:

1. *Tarakhovskaya ER, Maslov Y, Shishova MF (2007). "Phytohormones in algae". Russian*
2. *Journal of Plant Physiology.* ***54*** *(2): 163–170.*
3. *"Gibberellin formation in microorganisms". Plant Growth Regulation.* ***15****: 303–314.*
4. *Swarup R, Perry P, Hagenbeek D, Van Der Straeten D, Beemster GT, Sandberg G, Bhalerao R, Ljung K, Bennett MJ (July 2007).* "Ethylene upregulates auxin biosynthesis in Arabidopsis seedlings to enhance inhibition of root cell elongation"*. The Plant Cell.* ***19*** *(7): 2186–96.*
5. *Feurtado JA, Ambrose SJ, Cutler AJ, Ross AR, Abrams SR, Kermode AR (February 2004). "Dormancy termination of western white pine (Pinus monticolaDougl. Ex D. Don) seeds is associated with changes in abscisic acid metabolism". Planta.* ***218*** *(4): 630–9.*
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Course Code: BIOC 510 **Course Title: Soil Biochemistry (Elective)**	**Credit hour: 03**	**Semester: July - December**

Rationale: The course is planned to provide knowledge on Soil Biochemistry**.**

Course Outcomes:

- Conceptualize the microbe ecosystem of plant and animal in soils.
- Acquire knowledge on conversion of atmospheric nitrogen to soil nitrogen.
- Implement the knowledge how atmospheric nitrogen use as nutrients for different plants.
- Interpret the activity of soil enzyme on storage and structural polysaccharides.
- Transformation and utility of sulfur and phosphorus in soil.

Intended Learning Outcomes (ILOs) The student will be able to –	**Course Content**	**Teaching Learning Strategies**	**Assessment Strategies**
• Explain the role of Soil-microbe-plant in ecosystem. • Discuss about the formation and degradation of humus	**Biochemistry of Ecosystem:** Soil-microbe-plant animal ecosystem. Biochemistry of formation and degradation of humus	Lecture Discussion Visual presentation Assignment	MCQ Short answer Essay type answer Report
• Describe the soil enzyme and their activity in diverse soil types. • Illustrate the synthesis and breakdown of soil polysaccharides.	**Soil Enzyme & Polysaccharides:** Soil enzyme and their activity in diverse soil types. Synthesis and breakdown of soil polysaccharides.	Lecture Discussion Visual presentation	MCQ Short answer Essay type answer
• Define atmospheric nitrogen fixation. • Describe the causes of nitrogen fixation. • Discuss the types of nitrogen fixation. • Explain the importance nitrogen fixation.	**Nitrogen fixation:** Biochemistry of fixation of atmospheric nitrogen and transformation of soil nitrogen.	Lecture Discussion Visual presentation Assignment	MCQ Short answer Essay type answer
• Describe transformation of sulfur and phosphorus in soil.	**Biochemical Transformation:** Biochemical transformation of sulfur and phosphorus in soil.	Lecture Discussion Visual presentation	MCQ Short answer Essay type answer
• Discuss metabolism of lignin and humic acid.	**Metabolism:** Metabolism of lignin and humic acid	Lecture Discussion Visual presentation	MCQ Short answer Essay type answer

• Explain the soil microbe Relationship	**Soil microbe Relationship**	Lecture Discussion Visual presentation	MCQ Short answer Essay type answer

Reference Books

1. A. Douglas Melaren and George H. Peerson. Soil Biochemistry. Edward Arnold (Publishers) Ltd. London. 1988.
2. C.N. Lewis and M. Randell. Thermodynamics, MeGraw – Hill, New York, 1983.
3. J. A. Quastel, Soil Metabolism. The Royal Institute of Chemistry of Great Britain and Ireland, London, 1974.
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Course Code: BIOC 512 Current Topics in Nutrition (Compulsory)	**Credit Hours: 03**	**Semester: July- December**

Rationale: The course is designed to provide knowledge and update information on food value and their nutritional status, calorific value of different classes of food, balanced diet and basic four foods, co-enzyme activity of vitamins and micronutrients, protein-calorie malnutrition, nutritional management.

Course Outcomes:

- Acquire knowledge on food value
- Compare foods on the basis of nutrition , vitamins and micronutrients
- Implement of acquired knowledge to face malnutrition and nutritional deficiency
- Demonstrate statistical representation about current scenario of nutritional status
- Conceptualize of nutrition education and public health

Intended Learning Outcome (ILOs) At the end of the course student will be able to-	**Course content**	**Teaching Strategies**	**Assessment Strategies**
• Describe different nutrients and their role • Compare different foods based on their nutritional aspect • Explain caloric value and balance diet for healthy life	Introduction to food and nutrition for individual and community goal; Nutrients in health and disease. Central role of energy in living system; Energy requirement according to age, sex and physiological state. Nutritive and calorific value of different classes of foods. Balanced diet and Basic four foods guide	Lecture Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Contrast different vitamins, minerals and their biochemical function in human body • Implement of nutritional management in different kinds of diseases	Vitamin as coenzyme in biological system; Micronutrients (Vitamins and minerals) in energy transduction system; Effect of energy deficiency on the utilization of other nutrients Protein energy malnutrition: Marasmus and Kwashiorkor. Role of cholesterol.	Lecture Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Discuss about different methods of nutritional management and its implementation to lead a good health life • Explain details about Nutritional requirement in different stages of life	Nutritional management of diabetes mellitus and cardiovascular disease. Obesity and its implication for health. Infant nutrition, nutrition in pregnancy and lactation. Geriatric Nutrition. Nutrition education to combat malnutrition.	Lecture Discussion Assignment	Quiz Class test Short answer Essay type answer Report

• Summarize nutritional rules and laws. • Represent statistical information on the current scenario of nutritional aspects	Assessment of nutritional status in a community. Nutritional surveillance and National Nutrition Policy. Nutritional consideration in Agricultural Policy	Lecture Discussion Assignment	Quiz Short answer Essay type answer Report

Reference Books

1. Robinson, Corinne H. Nutrition and Diet, Therapy. MeMillan Publishing Co. 1985.
2. Robinson, Corinne H. Normal and Therapeutic Nutrition. Macmillan Publishing Co. 1987.
3. Swasminathan (Vol-1 & Vol-2), M., Hand Book of Food and Nutrition. Ganesh and Company. Madras, India. 1977.
4. Mitchell, Helen S. Nutrition in Health and Disease. J.B. Lippincott Company. Philadelphia 1976.
5. Maclaren, Donald S. Nutrition in the community. John Wiley and Sons 1976.
6. Walker, Ann F. Applied Human Nutrition. Ellis Horwood Limited, West Susscx, England 1990.
7. Human Nutrition and Dietetics, S. Davidson,A.P. Meiklejohn and R. Passmore, Edinburgh and London: E. & S. Livingstone Ltd. 1959

Course Code: BIOC 513 **Course Title: Principles of Recombinant DNA Technology (Compulsory)**	**Credit Hours: 03**	**Semester: January-June**

Rationale: The course is designed to provide knowledge on recombinant DNA technology, host, vector, restriction enzyme etc. related to design recombinant DNA.

Course Outcomes:

- Acquire knowledge on determination of desired base sequences and identification of specific clones by hybridization
- Conceptualize recombinant DNA technology
- Implement the knowledge on recombinant DNA technology
- Interpret different molecular tools

Intended Learning Outcome (ILOs) At the end of the course student will be able to-	**Course content**	**Teaching Strategies**	**Assessment Strategies**
• Describe genes and its elements • Conceptualize of recombination • Define and explain transformation, translation and conjugation • Discuss the types of recombination mechanisms.	**Rearrangement of Genes:** Mutation; Sexual reproduction: Fusion, Meiosis, Diploidy, Haploidy, Acquisition of genetic information by prokaryotes : transformation, transduction and conjugation; Mobile genetic element: lysogenic phage plasmids, Transposable elements or transposons; Types of recombination mechanisms site: specific recombination, homologous recombination. transposition (Holliday mechanism), illegitimate recombination.	Lecture Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Illustrate different techniques of recombination • Construct different vectors, hosts with desire DNA • Categorize different chromosomal clones. • Select the appropriate methods of gene cloning • Familiar with different molecular tools related to the recombinant DNA technology.	**Creation of Recombinant DNA molecules.** Recombinant DNA methodology:donors,vectors, restriction endonucleases, Synthesis of complementary DNA; Cloning of DNA: safe hosts, safe vectors; drug resistance plasmids; integration of cDNA with vector DNA, preparation of genetically pure, clonal population of recipient cells; Construction of chromosomal clones: genomic libraries, fragmentation of DNA, Cloning of	Lecture Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report

	DNA fragment-using plasmids, phage lambda, cosmids		
• Identify specific cloning hybridity • Define and explain mRNA and cDNA cloned with synthetic oligonucleotides	**Chromosome Walking** Identification of specific clones by hybridization: with mRNA, with the cloned cDNA, with synthetic oligonucleotides	Lecture Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Discuss different analysis method of DNA probing	**Analysis of DNA and RNA:** Analysis of chromosomal DNA (Southern blot) Analysis of RNA (northern blot) Determination of base sequence.	Lecture Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Implement techniques of gene cloning in biological sciences	**Practical benefits from Gene Cloning.** In agriculture, medicine and industry	Lecture Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Explain the latest research findings and information of advanced crop production and improvement technology	Latest research findings and information regarding advanced crop production and improvement technology	Lecture Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report

Reference Books

1. Robert H. Tamarin 1996. Principles of Genetics 5th edition. W. M.C. Brood Publishers.
2. Watson, J. D. M. Gilman, J. Witowski and M Zoller 1992 Recombinant DNA 2nded New York. Freeman.
3. Wu. R.L. Grossman and K. Moldave eds. 1989. Recombinant DNA Methodology. San Diego Academic Press.
4. Karl Drlica understanding DNA and Gene Cloning. A Guide for the Curious John Wiley and Son. 1984.
5. Hardy, K. G. Plasmid- A Paractical Approach 1987. IRL Press Ltd.
6. Kerby, L.T. 1990. DNA Fingerprinting. An introduction New York Stockton Press.
7. Biochemistry,J.M. Berg, J. L.Tymoczko and L Stryer,7thedition,W.H.Freeman and Company,2007.
8. Lehninger Principles of Biochemistry. Nelson and Cocks,5th edition, Worth Publishers Inc.2007.

Course Code: BIOC 514 **Course Title: Animal hormones (Compulsory)**	**Credit hour: 03**	**Semester: January - June**	
Rationale: The course is designed to provide knowledge and update information about animal hormones and its implication to develop animal health through metabolic activities of hormones.			
Course Outcomes: • Conceptualize animal endocrinology • Acquire knowledge about endocrine glands, sources of hormones and its functions • Develop animal health through the manipulation of different hormones			
Intended Learning Outcomes (ILOs) The student will be able to –	**Course Content**	**Teaching Learning Strategies**	**Assessment Strategies**
• Acquaint with the mammalian endocrine system • Determine relationship between primary and secondary messengers • Gather basic concept on animal hormones	Organization of mammalian endocrine system. Basic concept of hormones, Relationship between primary and second messengers.	Lecture Discussion Visual presentation Assignment	MCQ Short answer Essay type answer Report
• Classify hormones based on general features • Acquaint with structural similarities and mechanism of action of hormones	General features of hormone classes based on structural similarities, action mechanism. Mechanism of hormone action.	Lecture Discussion Visual presentation	MCQ Short answer Essay type answer
• Familiar withchemical nature of hormones • Evaluatephysiological and biochemical action of the different hormones:	Chemical nature, regulation of secretion. Physiological and biochemical action of the different hrmones:	Lecture Discussion Visual presentation Assignment	MCQ Short answer Essay type answer Report
• Identify and explain Pituitary hormone • Defends chemistry and biological importance of hormones	Pituitary hormone. prolactin and gonodotrophins. oxytocin and vassopressin: thyroxine and triiodothyroxine	Lecture Discussion Visual presentation	MCQ Short answer Essay type answer
• Justify the significance of medullary and cortical hormones • Locates the sexsteroid other than male and female endocrine gland	Hormones of Adrenal gland: Epinephrine and norepinephrine, Glucocorticoid, Mineralocorticoid and sexsteroid	Lecture Discussion Visual presentation Assignment	MCQ Short answer Essay type answer Report
• Identify and explain the male hormonal integrity	Male hormones: Androgen, testosterone, androstenedione	Lecture Discussion Visual presentation	MCQ Short answer Essay type answer

• Illustrate Parathyroid hormonal activity	Parathyroid hormone and calcium metabolism.	Lecture Discussion Visual presentation	MCQ Short answer Essay type answer
• Categorize gastro intestinal secretion and their integration	Hormones GIT: Gastrin, cholecystokinin, endorphins. secretin etc.	Lecture Discussion Visual presentation	MCQ Short answer Essay type answer
• Acquaint with and justify the Female hormonal system and their implication	Female hormones: Estrogen, progesterone, Estradiol	Lecture Discussion Visual presentation	MCQ Short answer Essay type answer
• Illustrate the chemistry and physiological action of pancreatic hormones	Hormones of pancreas: insulin and glucagon.	Lecture Discussion Visual presentation Assignment	MCQ Short answer Essay type answer Report

Book References:

1. Guiton J. 1990. Human Physiology, 2nd Edition,Pergamon Press. Oxford. London, New York. Paris.
2. A. L. Lehninger. 1982. Biochemistry,2nd Edition, Kalyani Publishers, Lubiana, New Delhi,
3. J.L.Jain.2001. Fundamentals of Biochemistry, 5th Edition, published by Chand & Company Ltd. Ram Nagar, New Delhi, 110055.
4. Lubret stryer.1986. Biochemistry, Published by S.K. Jain for CBS Publishers and Distributors, 485, Jani Bhaban, Bholanath Nagar, Delhi, India, 1986.
5. Neave N. 2008. Hormones and behaviour: a psychological approach. Cambridge: Cambridge Univ. Press. ISBN 978-0521692014.
6. Nussey S, Whitehead S. 2001. Endocrinology: an integrated approach. Oxford: Bios Scientific Publ. ISBN 978-1-85996-252-7.
7. Marieb, Elaine (2014). Anatomy & physiology. Glenview, IL: Pearson Education, Inc. ISBN 978-0321861580

Related Teaching References and Selected Journals**:**

1. Beato M, Chavez S, Truss M. 1996. "Transcriptional regulation by steroid hormones". Steroids. **61** (4): 240–251
2. Hammes SR (2003). "The further redefining of steroid-mediated signaling". Proc Natl Acad Sci USA. **100** (5): 21680–2170.
3. Enard J (1992). "Mammalian hormones in microbial cells". Trends Biochem. Sci. **17** (4): 147–50.
4. Janssens PM. "Did vertebrate signal transduction mechanisms originate in eukaryotic microbes?". Trends in Biochemical Sciences. **12**: 456–459.
5. Heyland A, Hodin J, Reitzel AM (2005). "Hormone signaling in evolution and development: a non-model system approach". BioEssays. **27** (1): 64–75
6. Ruhs, Stefanie; Nolze, Alexander; Hübschmann, Ralf; Grossmann, Claudia (July 2017). "30 YEARS OF THE MINERALOCORTICOID RECEPTOR: Nongenomic effects via the mineralocorticoid receptor." The Journal of Endocrinology. **234** (1): T107–T124. .

Course Code: BIOC 515 **Course Title: Biochemistry of Fishes (Elective)**	**Credit hour: 03**	**Semester: July - December**	
Rationale: The course is planned to provide knowledge on basic carbohydrate, fat and protein in fish, and their energy requirement. Finally the content will provide detailed idea about digestion and absorption of carbohydrate, fat and protein in fish.			
Course Outcomes: • Acquire knowledge on metabolism of nutrients in Fishes. • Learn about antioxidant and toxicity of fishes.			
Intended Learning Outcomes (ILOs) The student will be able to –	**Course Content**	**Teaching Learning Strategies**	**Assessment Strategies**
• Discuss metabolism. Basal metabolism. Weight-metabolism relationship.	**Metabolism:** Concept of Maintenance metabolism. Basal metabolism. Weight-metabolism relationship.	Lecture Discussion Visual presentation Assignment	MCQ Short answer Essay type answer Report
• Describe the regulation of carbohydrate metabolism in fishes. • Explain the role of carbohydrate in energy supply. • Describe the importance of gluconeogenesis	**Metabolism of carbohydrates:** Regulation of carbohydrate metabolism. Role of carbohydrate in energy supply. Role of gluconeogenesis.	Lecture Discussion Visual presentation	MCQ Short answer Essay type answer
• Describe the metabolic energy of protein. • Discuss the qualitative and quantitative requirement of amino acids and protein. • Determine the nutritional value of protein.	**Metabolism of protein:** Metabolic energy of protein. Qualitative and quantitative requirement of amino acids and protein. Evaluation of nutritional value of protein.	Lecture Discussion Visual presentation Assignment	MCQ Short answer Essay type answer Report
• Discuss the fat and fatty acid. • Explain the biological oxidation of fatty acids • Explain how oxidation occurred by oxygen and lipoxygenase. • Categorize the biosynthesis of essential fatty acids, polyenes, triglycerides and prostaglandin's.	**Metabolism of lipids:** Requirements of fat and fatty acids. Biological oxidation of fatty acids: epoxidation, hydroxylation, oxidative fusion. Oxidation by oxygen and lipoxygenase. Biosynthesis of essential fatty acids, polyenes, triglycerides and prostaglandin's. Toxic constituents of oxidized lipid and its effect on fish.	Lecture Discussion Visual presentation	MCQ Short answer Essay type answer
• Define antioxidant • Classify different types of antioxidant • Explain the biochemical	**Antioxidant:** Types of Antioxidant. Biochemical mechanism of antioxidant action. Synergists. Concept of free radicals and their	Lecture Discussion Visual presentation	MCQ Short answer Essay type answer

mechanism of antioxidant action. • Describe free radicals and their reaction mechanism. • Discuss vitamins and minerals in fish nutrition.	reaction mechanism. Vitamins and minerals in fish nutrition.		
• Define toxins • Classify toxins • Determine the biochemical effects of toxins on fish. • Explain how can hormone control fish metabolism.	**Toxins:** Types of toxins Biochemical effects of toxins on fish. Hormonal control of fish metabolism.	Lecture Discussion Visual presentation	MCQ Short answer Essay type answer

Reference Books

1. Donald Voet, Judith G. Voet. Biochemistry John Wiley and Sons, 1990.
2. Lehninger, A. L. Principles of Biochemistry. Worth Publishers Inc, 1984.
3. Mahler, H. R. and E. H. Cordes. Biological Chemistry, Harper and Harper, 1971.
4. Williams, R. T. (ed.). The Biochemistry of Fishes, London. Cambridge University Press, 1951.
5. Halver, J. E. Fish nutrition. 2nd Ed. Academic Press, 1988.
6. Harper, B. nutrition of Pond Fishes. Cambridge University Press, 1990.
7. Gunstone, F. D. and norris, F. A. Lipids in Foods, Chemistry, Biochemistry and Technology. Pergamon Press, 1983.
8. Hudson, B. J. F. Food Antioxidant. Elsevier Science Publishers Ltd, 1990.

Department of Biotechnology

Course Layout

Course Code	Course Title	Credit Hour
Compulsory Courses		**18**
BIOT-501	Cellular and Molecular Biology	3
BIOT-502	Techniques in Biotechnology	3
BIOT-503	Nucleic Acids and Protein Biosynthesis	3
BIOT-504	Recombinant DNA Technology	3
BIOT-505	Molecular Plant Breeding	3
BIOT-506	Regulation of Gene Expression	3
Elective Courses		**12**
BIOT-507	Plant Cell, Tissue and Organ Culture	3
BIOT-508	Research Methodology and Data Analysis	3
BIOT-509	Applied Genetic Engineering	3
BIOT-510	Animal Biotechnology	3
BIOT-511	Fisheries Biotechnology	3
BIOT-512	Food and Industrial Biotechnology	3
BIOT-513	Environmental Biotechnology and Biosafety	3
BIOT-514	Bioinformatics and Computational Biotechnology	3
BIOT-515	Enzymology and Enzyme Biotechnology	3
	Related Courses Offered by the Departments	
Research Semester		
BIOT-598	Seminar	1
BIOT-599	Research work for Thesis	16
	Total Cr. Hr.	**47**

Curriculum Alignment / Skill Mapping

Curriculum must be aligned with program objectives, program learning outcome and intended learning outcomes through proper skill mapping.

Department of Biotechnology

Courses	Program Learning Outcome							
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
BIOT 501	x	x	x	x				x
BIOT 502	x	x	x	x				x
BIOT 503	x	x	x	x				x
BIOT 504	x	x	x	x				x
BIOT 505	x	x	x	x				x
BIOT 506	x	x	x	x				x
BIOT 507	x	x	x	x				x
BIOT 508	x	x	x	x				x
BIOT 509	x	x	x	x				x
BIOT 510	x	x	x	x				x
BIOT 511	x	x	x	x				x
BIOT 512	x	x	x	x				x
BIOT 513	x	x	x	x				x
BIOT 514	x	x	x	x				x
BIOT 515	x	x	x	x				x
BIOT 598						x	x	
BIOT 599					x	x	x	x

Course Code: BIOT- 501 **Course Title:** Cellular and Molecular Biology	**Credit Hour: 3**	**Semester: July-December**	
Rationale: The course is designed to study the basic structure of cell and molecular concept of cell biology			
Course Learning Outcomes: • Acquire knowledge on cell structure, cell cycle and chromosome structure and replication • Illustrate mutation at gene and chromosome levels • Enrich knowledge on mobile genetic elements • Explain viral, bacterial and other microbial genetics • Comprehend the whole genome projects of different model organisms			
Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Compare between prokaryotic and eukaryotic cell • Explain prokaryotic and eukaryotic cell structures and functions	**Ultra-structure of cell:** Prokaryotic and eukaryotic cell, organelles, their structure and functions	Lecture Visual presentation Interactive discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Illustrate eukaryotic cell cycle and their phases • Describe regulation of cell cycle	**Cell Cycles:** Eukaryotic cell cycle, phases of cell cycle, regulation of cell cycle	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report
• Recognize the components of chromosomes • Differentiate between DNA and RNA • Interpret mode of DNA replication	**Chromosome Structure and Replication:** Components of chromosomes: DNA, RNA, histone and non-histone proteins, chromatin structure and functions, DNA replication: mode of replication, replication forks, okazaki fragments	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Define chloroplast and mitochondrial genome • Analyze their structure and function	**Extra chromosomal DNA:** Chloroplast and mitochondrial genome, structure and function	Lecture Visual presentation Interactive discussion Assignment	Quiz/MCQ Essay type answer Short answer Report
• Classify different mutations • Discuss about gene mutation and chromosomal aberrations • Describe mutagens and	**Gene and Chromosome Mutation:** Definition and types of mutation, gene mutation and chromosomal aberrations, mutagens, molecular basis of	Lecture Interactive discussion Assignment	Quiz/MCQ Essay type answer Short answer Report

molecular basis of mutation	mutation		
• Gather knowledge on viral genetics • Elucidate structure and infection cycles of eukaryotic viruses • Discuss the functions of different gene products.	**Viral Genetics:** Bacteriophages, genome organization and its expression, life cycle of Lambda and M13, viruses of eukaryotes: structure and infection cycles, functions of different gene products	Lecture Interactive discussion Visual presentation	Quiz/MCQ Essay type answer Short answer Report
• Optimize knowledge on conjugation, transformation and transduction • Illustrate *E. coli* recombination system and mutants of *E. coli* in genetic engineering • Describe on Plasmids, their replication, copy number and compatibility	**Bacterial Genetics:** Conjugation, transformation and transduction. E coli recombination system and genes involved in important mutants of E coli in genetic engineering. Plasmids, their replication, copy number and compatibility	Lecture Discussion Visual presentation Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Enrich knowledge on Mobile/transposable genetic elements in prokaryotes and eukaryotes • Identify mobile genetic elements in plants and animals.	**Dynamic Genomes:** Mobile/transposable genetic elements in prokaryotes and eukaryotes, studies in plants and animals	Lecture Discussion Visual presentation Assignment	Quiz/MCQ Essay type answer Short answer Report
• Gather knowledge on genome sequencing and annotation • Acquire knowledge on *Arabidopsis*, rice, and human genomes	**Genome sequencing of model organisms**: Definition of genome sequencing and annotation, *Arabidopsis*, rice, *Brassica* and human genome and their perspectives	Lecture Interactive discussion Visual presentation	Quiz/MCQ Essay type answer Short answer Report Oral presentation

Reference Books

1. Gupta, P. K. 2016.Elements of Biotechnology (2nd Edition). Rastogi Publications, Meerut, India.
2. Singh, B. D. 2013.Biotechnology Expanding Horizons (4th Edition). Kalyani Publishers, New Delhi, India.
3. Dubey, R.C. 2006. A Text Book of Biotechnology (1st Edition). S.Chand and Company Ltd., New Delhi, India.
4. Watson, J. D., Baker, T. A., Bel, S. P., Gall, A., Levine,M. and Losick, R. 2004.Molecular Biology of the Gene (5th Edition).Pearson Education, Singapore.
5. Kumar, H. D. 2005. Modern concepts of Biotechnology. Vikas Publishing House Pvt. Ltd., New Delhi, India.

Course Code: BIOT- 502 **Course Title:** Techniques in Biotechnology (Compulsory)	**Credit Hour: 3**	**Semester: July-December**	
Rationale: The course layout is constructed to know the basic techniques used in biotechnology.			
Course Objectives: • Optimize knowledge on different ways of sterilization and disinfection in tissue culture technique • Implement centrifugation and electrophoresis techniques for molecular research • Enrich knowledge on spectroscopic and chromatographic techniques • Demonstrate the DNA, RNA and protein extraction protocols • Illustrate the methods of PCR, gene sequencing, probe preparation and different hybridization techniques			
Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Classify different types of sterilization and disinfection techniques • Apply these techniques on cellular and molecular biology works	**Sterilization and Disinfection:** Definition, types, techniques and their applications	Lecture Visual presentation Interactive discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Implement centrifugation techniques in advanced cell biology • Compare between continuous and zonal rotors • Interpret differential and equilibrium isodensity centrifugation and ultracentrifuge • Explain fractionation of cells	**Centrifugation techniques:** Theory and application of centrifugation, concept of continuous and zonal rotors, differential and equilibrium isodensity centrifugation and ultracentrifuge function of cells.	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report
• Illustrate starch, agarose and polyacrylamide gel electrophoresis technique • Classify different types of electrophoresis techniques • Implement SDS-PAGE electrophoreses technique in molecular biology • Interpret iso-electric focusing for protein separation.	**Electrophoresis Techniques:** Theory, applications and types of starch, agarose and polyacrylamide gel electrophoresis, SDS-PAGE electrophoreses, iso-electric focusing of protein	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation

• Optimize knowledge on chromatography • Distinguish different types of chromatography	**Chromatography Techniques:** Theory, applications and types of chromatography- paper, thin layer (TLC), gel filtration, ion-exchange, affinity, reverse-phase chromatography and HPLC.	Lecture Visual presentation Interactive discussion Assignment	Quiz/MCQ Essay type answer Short answer Report
• Classify spectra and spectroscopy • Describe on nature and effects of electromagnetic radiations • Interpret UV and visible spectrophotometry, atomic absorption, nuclear magnetic resonance and mass spectrophotometry • Acquire knowledge on basic principle of FACS	**Spectroscopic Techniques**: Definition and types of spectra and spectroscopy, nature and effects of electromagnetic radiations, theory and applications of UV and visible spectrophotometry, atomic absorption, nuclear magnetic resonance, mass spectrophotometry, principle and application of FACS (fluorescent activated cell sorting)	Lecture Interactive discussion Assignment	Quiz/MCQ Essay type answer Short answer Report
• Demonstrate the extraction procedure of plasmid DNA, genomic DNA and RNAs • Implement DNA and RNA extraction method in molecular work	**DNA and RNA Extraction:** Isolation of plasmid DNA, genomic DNA and RNAs	Lecture Discussion Visual presentation Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Enrich knowledge on protein extraction methods • Judge the purification and activity assay	**Protein extraction:** Methods, purification and activity assay	Lecture Discussion Visual presentation Assignment	Quiz/MCQ Essay type answer Short answer Report
• Conceptualize on probe preparation • Illustrate probe labeling and nick translation. • Evaluate the application of probes in molecular work	**Molecular probes:** Probe preparation, labelling, nick translation, application of probes	Lecture Interactive discussion Visual presentation	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Classify molecular techniques • Apply PCR techniques on molecular biology • Describe and differentiate among PCR, Southern, Northern and Western blotting techniques • Explore gene sequencing	**Molecular Techniques: PCR,** DNA sequencing, Southern, Northern and Western blotting	Lecture Visual presentation Interactive discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation

technique			

Reference Books

1. Gupta, P. K. 2016.Elements of Biotechnology (2nd Edition). Rastogi Publications, Meerut, India.
2. Singh, B. D. 2013.Biotechnology Expanding Horizons (4th Edition). Kalyani Publishers, New Delhi, India.
3. Dubey, R.C. 2006. A Text Book of Biotechnology (1st Edition). S.Chand and Company Ltd., New Delhi, India.
4. Watson, J. D., Baker, T. A., Bel, S. P., Gall, A., Levine,M. and Losick, R. 2004.Molecular Biology of the Gene (5th Edition).Pearson Education, Singapore.
5. Sambrok, J., Fritsch, E. F. and Maniatis, T. 1989. Molecular Cloning: A Laboratory Manual (2nd Edition).Cold Spring Harbor Laboratory Press, NewYork, USA.

Course Code: BIOT- 503 **Course Title:** Nucleic Acids and Protein Biosynthesis (Compulsory)	**Credit Hour: 3**	**Semester: January- June**	
Rationale: The course is designed to provide the basic ideas on nucleic acids and protein biosynthesis.			
Course Outcomes: • Explain the physical and chemical structures of nucleic acids particularly DNA and RNA • Outline the genetic code, structure and biosynthesis of protein • Illustrate the mechanisms of transcription and translation			
Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Obtain knowledge on nucleic Acids • Illustrate chemical structure and base composition of nucleic acids • Explain properties of polynucleotides	**Nucleic Acids:** Concept, chemical structure and base composition of nucleic acids, properties of polynucleotides	Lecture Visual presentation Interactive discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Illustrate primary, secondary, and tertiary structure of DNA and Watson and Crick model of DNA • Analyze and estimate denaturation, renaturation and annealing of DNA, hairpin structure of DNA, super coiled DNA, base pairing, hydrogen bonds	**Deoxyribonucleic acid (DNA):** Primary, secondary and tertiary structure of DNA, Watson and Crick model of DNA, denaturation, renaturation and annealing of DNA, hairpin structure of DNA, super coiled DNA, base pairing, hydrogen bonds, sugar phosphate chain conformations	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report
• Distinguish primary, secondary and tertiary structure of RNAs • Evaluate the ribonucleic acid (RNA) with their function • Characterize the types of RNA	**Ribonucleic Acid (RNA):** Primary, secondary and tertiary structure of RNAs, Functions of mRNA, rRNA and tRNA, sedimentation characteristics of different RNAs, RNA as an enzyme	Lecture Visual presentation Interactive discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Design genetic codon, anti-codon, and genetic code • Interpret properties of genetic code, reading frames and open reading frames	**Genetic Code:** Definition, Codon, anti-codon, deciphering of genetic code, properties of genetic code, reading frames, open reading frames	Lecture Visual presentation Interactive discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation

• Classify different categories of proteins • Exemplify structure and chemistry of amino acids • Decipher peptide synthesis • Explain specialized roles of Amino Acids	**Proteins:** Classification of proteins, structure and chemistry of amino acids, peptide synthesis, specialized roles of amino acids, primary, secondary and tertiary structure of amino acids	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report
• Obtain knowledge on central dogma • Discuss the processes of transcription in prokaryotes and eukaryotes	**Transcription:** Define central dogma, DNA as template of transcription, transcription process in prokaryotes and eukaryotes	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Illustrate structure of prokaryotic and eukaryotic ribosome • Exemplify activation of amino acids • Depict stages of protein synthesis: Initiation, elongation and termination • Differentiate between prokaryotic and eukaryotic translation	**Translation:** Structure of prokaryotic and eukaryotic ribosome, activation of amino acids, codon-anticodon recognition, synthesis of aminoacyl-tRNA, stages of translation for protein synthesis: initiation, elongation and termination, difference between prokaryotic and eukaryotic translation.	Lecture Visual presentation Interactive discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation

Reference Books

1. Gupta, P. K. 2016.Elements of Biotechnology (2nd Edition). Rastogi Publications, Meerut, India.
2. Dubey, R.C. 2006. A Text Book of Biotechnology (1st Edition). S.Chand and Company Ltd., New Delhi, India.
3. Watson, J. D., Baker, T. A., Bel, S. P., Gall, A., Levine,M. and Losick, R. 2004.Molecular Biology of the Gene (5th Edition).Pearson Education, Singapore.
4. Kumar, H. D. 2005. Modern concepts of Biotechnology. Vikas Publishing House Pvt. Ltd., New Delhi, India.
5. Winnacker, E. L. 2003. From Genes to Clones: Introduction to Gene Technology. Panima Publishing Corporation, New Delhi, India.
6. Arora, M. P. and Sandhu, G. S. 2004. Genetics (5th Edition).Himalaya Publishing House, New Delhi, India.

Course Code: BIOT- 504 **Course Title:** Recombinant DNA Technology (Compulsory)	**Credit Hour: 3**	**Semester: January- June**

Rationale: The course is constituted based on the basic principles, methods and application of recombinant DNA technology.

Course Outcomes:

- Optimize knowledge on recombinant DNA technology and its application
- Interpret restriction endonucleases and its application on genetic engineering
- Illustrate the DNA library construction and use of marker genes
- Enrich knowledge cloning and expression vector
- Describe the PCR technique and its application
- Conceptualize on protection of biotechnological invention

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Obtain knowledge on gene and gene function • Capitalize recombinant DNA technology	**Introduction:** Definition, history of recombinant DNA technology, gene and gene function	Lecture Visual presentation Interactive discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Classify restriction endonucleases • Explain nomenclature, recognition sequence and cleavage patterns • Illustrate restriction modification systems	**Restriction endonucleases:** Types of endonucleases, nomenclature, recognition sequence, cleavage patterns, restriction modification systems	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report
• Construct chimeric DNA and cloning vectors • Gather knowledge on good vector and good host. • Distinguish *E. coli* vector and plasmids. • Describe bacteriophage vectors: cosmids and shuttle vectors	**Construction of chimeric DNA and cloning vectors:** Properties of a good vector, properties of a good host, *E. coli* vector, plasmids: pBR322 vector, bacteriophage vectors: cosmids, shuttle vectors	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Interpret different expression vectors • Compare among different expression vectors	**Expression Vectors: Ex**pression vector for Baculovirus, PET43 vector of E. coli, expression vectors for high level of expression of cloned genes	Lecture Visual presentation Interactive discussion Assignment	Quiz/MCQ Essay type answer Short answer Report

• Construct genomic and cDNA library • Differentiate between genomic and cDNA library • Illustrate gene cloning method • Implement recombinant Clones for crop improvement	**DNA libraries and DNA/Gene Cloning:** Steps in DNA cloning, genomic library, cDNA library, selection of recombinant clones, selectable and scorable marker genes	Lecture Interactive discussion Assignment	Quiz/MCQ Essay type answer Short answer Report
• Exemplify polymerase chain reaction (PCR) technique and gene amplification • Utilize and analyze PCR technology in molecular work	**Amplification of gene by PCR:** Definition and history of PCR, basic components for PCR reactions, cycling conditions and steps, reverse transcripted PCR, real time PCR, multiplex PCR with applications, rolling circle amplification.	Lecture Interactive discussion Visual presentation	Quiz/MCQ Essay type answer Short answer Report
• Describe on IPR, patenting of DNA, gene and genome sequence • Obtain idea on MTA, biosafety and cartagena protocol • Protect national biotechnological inventions	**Protection of Biotechnological Inventions:** IPR, patenting of DNA sequence, gene and genome sequence, and biotechnological inventions, concept of MTA, biosafety, cartagena protocol, national biosafety guideline	Lecture Discussion Visual presentation Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation

Reference Books

1. Dubey, R.C. 2006. A Text Book of Biotechnology (1st Edition). S.Chand and Company Ltd., New Delhi, India.
2. Watson, J. D., Baker, T. A., Bel, S. P., Gall, A., Levine,M. and Losick, R. 2004.Molecular Biology of the Gene (5th Edition).Pearson Education, Singapore.
3. Kumar, H. D. 2005. Modern concepts of Biotechnology. Vikas Publishing House Pvt. Ltd., New Delhi, India.
4. Winnacker, E. L. 2003. From Genes to Clones: Introduction to Gene Technology. Panima Publishing Corporation, New Delhi, India.
5. Sambrok, J., Fritsch, E. F. and Maniatis, T. 1989. Molecular Cloning: A Laboratory Manual (2nd Edition).Cold Spring Harbor Laboratory Press, NewYork, USA.

Course Code: BIOT- 505 **Course Title:** Molecular Plant Breeding (Compulsory)	**Credit Hour: 3**	**Semester: July- December**

Rationale: The course is designed to study the practical application of molecular marker for crop improvement.

Course Outcomes:

- Optimize knowledge about the morphological, molecular marker and their application.
- Classify different molecular markers on the basis of function.
- Design different molecular markers and their synthesis technology.
- Describe plant breeding and different methods of breeding for self and cross pollinated crops.
- Explain about mapping population and chromosome map.
- Construct molecular linkage map in crops.
- Implement marker assisted selection techniques for crop improvement.

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Recognize different markers system	**Introduction to markers:** Definition, scope and importance of morphological, biochemical and DNA markers	Lecture Visual presentation Interactive discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Classify morphological and biochemical markers	**Morphological and Biochemical markers:** Physical appearance of different phenotypic traits, isozyme and protein markers	Lecture Visual presentation Interactive discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Distinguish among molecular Markers • Identify different molecular markers • Describe different molecular markers on crop improvement • Criticize merits and demerits of different molecular markers	**Molecular Markers and their Applications:** Definition and types of molecular markers, DNA fingerprinting and it steps, description of molecular marker systems: RFLP (Restriction fragment length polymorphism), SSLP (Simple sequence length polymorphism), AFLP (Amplified fragment length polymorphism), RAPD (Random amplification of polymorphic DNA), VNTR (Variable number tandem repeat), Microsatellite polymorphism or SSR (Simple sequence repeat), SNP (Single nucleotide polymorphism), STR (Short tandem repeat), EST	Lecture Visual presentation Interactive discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation

	(Expression Sequence Tag), Advantages and disadvantages of different molecular markers and their applications		
• Design different oligomer • Apply different primer for PCR and other molecular techniques • Evaluate the status of primer synthesis companies and availability of primer under Bangladesh condition.	**Primer Designing:** Principle of oligomer synthesis, primer designing for cloning of specific genes, Oligocalculator, Primer synthesis for RAPD, SSR and other DNA markers, primer synthesis companies and availability of primer under Bangladesh condition	Lecture Visual presentation Interactive discussion Assignment	Quiz/MCQ Essay type answer Short answer Report
• Explain plant breeding • Analyze the different method of breeding approaches in self and cross pollinated crops.	**Basic concept of Plant Breeding:** definition, brief history and achievement , breeding methodology for self and cross pollinated crops, heterosis breeding	Lecture Visual presentation Interactive discussion Assignment	Quiz/MCQ Short answer Report
• Distinguish between mapping population and molecular map for crop improvement • Construct mapping population and molecular map for crop improvement	**Mapping population and construction of molecular map:** F_2 Population, Recombinant Inbred Lines (RIL), Near Isogenic Lines (NIL), Construction of genetic maps using RAPD, RFLP, AFLP, SSR, SNP etc	Lecture Visual presentation Interactive discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Classify different types of chromosome maps	**Types of Chromosome Maps:** Genetic maps, physical maps and cytogenetic maps	Lecture Visual presentation Interactive discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Develop knowledge on marker assisted selection • Interpret the knowledge of marker assisted selection in crop improvement • Illustrate QTL mapping and gene pyramiding techniques	**Marker Assisted Selection :** Definition, scope, utilization of molecular markers in plant breeding, germplasm conservation and characterization, hybridity test of F_1 hybrid, DNA fingerprinting of released varieties, phylogenetic relationship, QTL mapping, Gene Pyramiding	Lecture Visual presentation Interactive discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation

Reference Books

1. Gupta, P. K. 2016.Elements of Biotechnology (2nd Edition). Rastogi Publications, Meerut, India.
2. Singh, B. D. 2013.Biotechnology Expanding Horizons (4th Edition). Kalyani Publishers, New Delhi, India.
3. Dubey, R.C. 2006. A Text Book of Biotechnology (1st Edition). S.Chand and Company Ltd., New Delhi, India.
4. Watson, J. D., Baker, T. A., Bel, S. P., Gall, A., Levine,M. and Losick, R. 2004.Molecular Biology of the Gene (5th Edition).Pearson Education, Singapore.
5. Kumar, H. D. 2005. Modern concepts of Biotechnology. Vikas Publishing House Pvt. Ltd., New Delhi, India.
6. Sambrok, J., Fritsch, E. F. and Maniatis, T. 1989. Molecular Cloning: A Laboratory Manual (2nd Edition).Cold Spring Harbor Laboratory Press, NewYork, USA.
7. Guimaraes, E. P., Ruane, J., Scherf, B. D., Sonnino, A. and Dargie, J.(Editors) 2009. Marker-Assisted Seclection: Current Status and Future perspectives in Crops, Livestocks, forestry and Fish.FAO, Rome, Italy.

Course Code: BIOT- 506 **Course Title:** Regulation of Gene Expression (Compulsory)	**Credit Hour: 3**	**Semester: January- June**	
Rationale: The course is formulated to provide knowledge on the regulation pattern of prokaryotic and eukaryotic gene expression			
Course Outcomes: • Comprehend the introductory mechanism of gene expression • Explain of transcription, translation and gene regulatory machineries • Construct of gene expression for both prokaryotic and Eukaryotic organism • Evaluate post-transcriptional and translational modification of gene • Illustrate gene silencing technique • Apply and analyses the role of genome editing technique in crop improvement			
Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Explain Mendelian and molecular concept of gene • Illustrate different parts of a gene	**Gene structure:** Mendelian and molecular concept of gene, parts of a gene: regulatory region and elements, UTRs, coding region- exons, introns, termination signal	Lecture Interactive discussion Assignment	Quiz/MCQ Essay type answer Short answer Report
• Define promoters: enhancers and silencers, suppressor and regulatory machineries • Explain General transcription factors and associated factors • Evaluate the role of RNA polymerases in transcription.	**Transcription regulatory machineries:** Promoters: enhancers and silencers, suppressor, co- suppressor, activators, mediators, general transcription factors and associated factors, sigma factors, role of RNA polymerases in transcription, terminators	Lecture Interactive discussion Assignment	Quiz/MCQ Essay type Report
• Illustrate prokaryotic and eukaryotes gene regulation • Conceptualize on specific genes expression	**Regulation of Gene Expression:** Prokaryotic gene regulation- Operon concept, lac operon and tryptophan operon, Steps of regulation of gene expression in eukaryotes, expression of specific genes, regulation of ribosomal RNA genes, protein localization.	Lecture Discussion Visual presentation	Quiz/MCQ Short answer Essay type answer
• Explain transcriptional modifications in gene regulation	**Post transcriptional Modifications:** 5′ capping, RNA splicing, alternate RNA splicing, polyadenylation	Lecture Discussion Visual presentation	Quiz/MCQ Short answer Essay type answer
• Describe different types of post translational modifications	**Post translational modifications:** Phosphorylation, Ubiquitination, Methylation, Glycosylation, Proteolysis, N-acetylation,	Lecture Discussion Visual presentation	Quiz/MCQ Short answer Essay type answer

	Lipidation, Nitrosylation, S-palmitoylation		
• Obtain knowledge on gene silencing • Interpret RNAi technology • Illustrate RNAi mechanism for gene silencing • Apply RNAi as a tool against animal and human diseases	**Gene Silencing:** Definition, processes of gene silencing, RNAi technology, Types of RNA involved in RNAi, small RNAs, biogenesis of MiRNA, Transcriptional and translational regulation of gene expression by MiRNA and SiRNA, Difference between SiRNA and MiRNA, RNAi as a tool against plant, animal and human diseases.	Lecture Interactive discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Describe the genome editing process in gene regulation. • Interpret the mechanism of genome editing for crop mutation. • Apply and analyses the role of genome editing technique of agricultural development.	**Genome Editing:** Definition, History, Mechanisms and process of genome editing, CRISPR/cas 9 method of genome editing, application of genome editing in agriculture, Present status and future prospect of genome editing in agriculture.	Lecture Interactive discussion Assignment	Quiz/MCQ Short answer Essay type answer Report

Reference Books

1. Singh, B. D. 2013.Biotechnology Expanding Horizons (4th Edition). Kalyani Publishers, New Delhi, India.
2. Dubey, R.C. 2006. A Text Book of Biotechnology (1st Edition). S.Chand and Company Ltd., New Delhi, India.
3. Watson, J. D., Baker, T. A., Bel, S. P., Gall, A., Levine,M. and Losick, R. 2004.Molecular Biology of the Gene (5th Edition).Pearson Education, Singapore.
4. Kumar, H. D. 2005. Modern concepts of Biotechnology. Vikas Publishing House Pvt. Ltd., New Delhi, India.
5. Winnacker, E. L. 2003. From Genes to Clones: Introduction to Gene Technology. Panima Publishing Corporation, New Delhi, India.
6. Arora, M. P. and Sandhu, G. S. 2004. Genetics (5th Edition).Himalaya Publishing House, New Delhi, India.

Course Code: BIOT- 507 **Course Title:** Plant Cell, Tissue and Organ Culture	**Credit Hour: 3**	**Semester: July- December**	
Rationale: The course is prepared to provide knowledge on the basic principle of tissue culture and its application in agriculture.			
Course Objectives: • Design a tissue culture laboratory and preparation of culture media • Acquire knowledge on callus induction, Plant regeneration and embryogenesis • Describe the anther and embryo culture technology and its application in crop improvement • Create of somatic hybrid to overcome the cross-incompatibility barrier • Utilize of secondary metabolite for industrial use			
Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Conceptualize on tissue culture	**Introduction:** History, scope and importance of tissue culture	Lecture Interactive discussion Assignment	Quiz/MCQ Essay type answer Short answer Report
• Design plant tissue culture laboratory • Prepare plant tissue culture media • Maintain plant tissue culture laboratory	**Laboratory organization and culture media:** Lab designing and basic requirements, laboratory equipments, laboratory safety and daily maintenance, culture media: nutrient composition and function, types of culture media, preparation and storage	Lecture Interactive discussion Assignment	Quiz/MCQ Essay type answer Report
• Classify different types and growth patterns of callus • Differentiate between organogenesis and somatic embryogenesis process	**Callus induction, regeneration and embryogenesis:** Definition, origin, types and growth patterns of callus, organogenesis, route of somatic embryogenesis development patterns of embryo	Lecture Discussion Visual presentation	Quiz/MCQ Short answer Essay type answer
• Define meristem culture • Distinguish advantages and disadvantages of meristem culture • Utilize meristem culture technique for disease free plantlet production	**Meristem Culture**: Definition, culture media, explants, virus elimination, plantlet regeneration, application of meristem culture	Lecture Interactive discussion Problem solving exercise Class room exercise Lab visit	Quiz/MCQ Short answer Essay type answer

• Express haploid culture technique • Apply haploid culture technique for plant regeneration • Confirm ploidy level of different plants • Generalize haploid culture technique for crop improvement	**Haploid culture and its application:** Introduction, sources of haploid materials, *in vitro* regeneration of haploid, ploidy level confirmation, diplodization of chromosome, application and limitations of haploid culture.	Lecture Interactive discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Define somatic hybridization • Interpret somatic hybridization technique • Select somatic hybrid cells and culture somatic hybrid • Create new genome through somatic hybrid • Evaluate the application of somatic hybrid in crop improvement • Express cybrid and cybridization	**Somatic hybridization:** Introduction and definition, isolation of protoplast, somatic hybridization technique, selection of somatic hybrid cell, regeneration and culture of somatic hybrid cell, cybridization and application.	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Compare between somatic and zygotic embryogenesis • Explain production techniques and potential use of artificial seeds	**Artificial seeds:** Introduction, somatic and zygotic embryogenesis, artificial or synthetic seeds, steps involve in synthetic seed production, potential use of artificial seeds	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Classify and characterize secondary metabolites • Interpret different methods for secondary metabolite production • Identify different factors influenced large scale production of secondary metabolite	**Secondary metabolite production:** Introduction, classification and major characteristics of secondary metabolites, cell culture for secondary metabolite production, elicitor and biotransformation as methods of secondary metabolite production, genetically engineered plant cell used for the production of secondary metabolite, factors influencing large scale production	Lecture Discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type Report

Reference Books

1. Razdan, M.K.2004.Introduction to Plant Tissue Culture (2nd Edition).Oxford and IBH Publishing Co. Pvt. Ltd., NewDelhi, India.
2. Bhuiyan, M.S.R. and Hoque, M. E. 2018. Introduction to Plant Tissue Culture. (2nd Edition). Z. N. Shahana and M. D. Nesa, SAU, Dhaka.
3. Gamborg, O. L. and Phillips, G.C.(Editors) 2010. Plant Cell, Tissue and Organ Culture: Fundamental Methods. Narosa Publishing house, New Delhi, India.
4. Kumar, H. D. 2005. Modern concepts of Biotechnology. Vikas Publishing House Pvt. Ltd., New Delhi, India.

Course Code: BIOT- 508 **Course Title:** Research methodology and Data Analysis	**Credit Hour: 3**	**Semester: January-June**	
Rationale: This course is designed to provide knowledge on biotechnological research and experimental designs. Justification of experiment, execution of research and finally presentation of dissertation.			
Course Outcomes: • Conceptualize biotechnological research • Acquaint with experimental design and set up of experiment independently • Analyze and interpret research data • Write manuscript • Prepare slide for presentation of experimental findings • Write Scientific paper for publication			
Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Set up of experiments with appropriate design • Distinguish different experimental design. • Explain their merits and demerits	**Experimental Design:** Types of experiments, experimental designs appropriate for biotechnological experimentation, their merits and demerits	Lecture Discussion Visual presentation	Quiz/MCQ Essay type answer Short answer Report
• Identify the national researchable problems and with solution • Explain researchable problems • Prepare Research Planning • Collect data from experimental fields	**Research Planning Methodology:** Identification of researchable problems. Prioritization of biotechnological problems and their possible solution Purpose of conduction research, Research planning Data collection and hand note preparation.	Lecture. Visual Presentation Discussion	Quiz MCQ. Short questions. Broad question
• Compare experimental data • Gather knowledge on correlation and regression analysis • Compare among treatment variables following research objectives • Calculate and analysis experiment al data • Apply Statistical packages for experimental data analysis	**Statistical Analysis of Experiments data:** Analysis of Variance. Comparison of treatments. Regression and correlation analysis. Statistical packages for data analysis	Lecture. Visual presentation. Discussion Assignments	Quiz MCQ. Short questions. Broad question
• Write up thesis or dissertation correctly • Prepare scientific paper • Publish scientific paper in national and international journals	**Thesis/Scientific paper writing:** Structure and procedure of SAU thesis, interpretation of data. Write-up scientific paper, Referencing and citation styles	Lecture. Visual presentation. Discussion	Quiz MCQ. Short questions. Broad question

• Know referencing and citation styles			
• Prepare quality slides • Dissemination of research findings to public domain	**Presentation of Research Findings:** Write-of research abstract Slide preparation, Manner, gesture, attitude at the time of presentation.	Lecture. Visual presentation. Discussion	Quiz MCQ. Short questions. Broad question Performance test
• Understand plagiarism and its importance • Avoid plagiarism • Avoid research misconduct • Know ethical issues of research and publication	**Plagiarism and research ethics:** Definition, concepts and importance, cases of plagiarism, techniques to avoid plagiarism, plagiarism checker, prevention of plagiarism, research misconduct, ethical issues of research and publication.	Lecture. Visual presentation. Discussion	Quiz MCQ. Short questions. Broad question

Reference Books

1. Anonymous.1990. Research Planning and Evaluation Training Course Research Manual,BARC Dhaka & BARI. Joydebpur
2. K.A. Gomez and A.A Gomez.1984. Statistical Procedures for Agricultural Research. Second Edition.Insternational Rice Research Inssitute. John Wiley & Sons. New York.pp, 01-340.
3. R.I. Mondal M.S. Islam. M.A.J.Bhuiya M.M.Rahman. M.S Alam and M.H.H. Raham 2011 Krishiprojukti Hatboi.5th Edition. Bangladesh Agricultural Research Institute. Joydebpur. Gazipur
4. s.c. Panda. 2014. Agronomy. AGROBIOS Publication. New Delhi. India.
5. S.M.H.Zaman.k.Rahim and M. Howlader.1982. Simple Lessons from Biometry, Bangladesh Rice Research Institute. 170P.
6. V.C. Srivastava. 2014 Modern Principles of Agronomy. AGROBIOS (India)

Course Code: BIOT- 509 **Course Title:** Applied Genetic Engineering	**Credit Hour: 3**	**Semester: July- December**	
Rationale: The course is constructed to study the advancement of genetic engineering with diversified applications.			
Course Objectives: • Conceptualize of transgenesis and GMO • Explain different methods of genetic transformation • Assemble genetic engineering technology for transgenic plant development especially on biotic and biotic resistance. • Disseminate the genetic engineering technique for creation of transgenic fish, animal and recombinant vaccine. • Apply bioengineering tools for molecular farming. • Generalize the idea of merit and demerit regarding of GMO to public domain.			
Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Develop knowledge on basic concept of genetic engineering	**Introduction:** Definition, basic concept of genetic engineering and its importance	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Classify different methods for genetic transformation • Illustrate and compare among different methods for genetic transformation	**Methods for Genetic Transformation**: Introduction, different methods of gene transfer, direct methods: particle bombardment, polyethylene glycol (peg) mediated transformation, electroporation, microinjection, lipofection, *Agrobacterium* mediated gene transfer, transformation in *planta*.	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Implement Genetic Engineering techniques for crop improvement	**Genetic Engineering in Plants:** Herbicide tolerance, biotic (virus, bacteria, fungus and pest) resistance, abiotic (salt, drought and submergence stress) resistance, genetic manipulation for flower pigmentation.	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Apply genetic engineering techniques for fish and animals improvement	**Genetic Engineering in Fish and Animals:** Production of transgenic animal and fish, molecular basis of disease resistance, dairy products and milk quality.	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation

• Explain genetic engineering techniques for medicine and diseases diagnosis • Describe production techniques of insulin monoclonal antibodies and their applications	**Genetic Engineering in Medicine:** Commercial synthesis of insulin, gene therapy, disease diagnosis, production of monoclonal antibodies and their applications, DNA vaccines.	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Conceptualize on bioengineered crops • Explain production techniques of industrially important chemicals like therapeutic agents, primary and secondary metabolites. • Utilize biomass of food, fuels and chemicals	**Molecular Farming:** Introduction, bioengineered crops and other organisms to produce industrially important chemicals, therapeutic agents, primary and secondary metabolites, biomass utilization of food, fuels and chemicals	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Criticize on production and use of GMO	**GMO Debate:** Ethics and issues regarding genetically modified organisms, Religious and social acceptance of GMOs.	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report

Reference Books

1. Singh, B. D. 2013.Biotechnology Expanding Horizons (4th Edition). Kalyani Publishers, New Delhi, India.
2. Dubey, R.C. 2006. A Text Book of Biotechnology (1st Edition). S.Chand and Company Ltd., New Delhi, India.
3. Watson, J. D., Baker, T. A., Bel, S. P., Gall, A., Levine, M. and Losick, R. 2004.Molecular Biology of the Gene (5th Edition).Pearson Education, Singapore.
4. Kumar, H. D. 2005. Modern concepts of Biotechnology. Vikas Publishing House Pvt. Ltd., New Delhi, India.
5. Winnacker, E. L. 2003. From Genes to Clones: Introduction to Gene Technology. Panima Publishing Corporation, New Delhi, India.
6. Arora, M. P. and Sandhu, G. S. 2004. Genetics (5th Edition).Himalaya Publishing House, New Delhi, India.
7. Sambrok, J., Fritsch, E. F. and Maniatis, T. 1989. Molecular Cloning: A Laboratory Manual (2nd Edition).Cold Spring Harbor Laboratory Press, NewYork, USA

Course Code: BIOT- 510 **Course Title:** Animal Biotechnology	**Credit Hour: 3**	**Semester: January –June**

Rationale: The course layout is designed to know the fundamental issues of animal Biotechnology.

Course Objectives:

- Describe animal cell, Cell types, cell fusion etc.
- Acquire knowledge on animal breeding especially *in vitro* fertilization, embryo transfer, nuclear transplantation and cryopreservation.
- Utilize molecular marker for genetic analysis and gene mapping in different animals.
- Implement Immunological and serological methods for animal health and antimicrobial drugs sensitivity tests.
- Develop vaccines and hybridoma methods for monoclonal and polyclonal antibodies and their application.
- Apply transgenic animals for production of better quality meat milk.

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Memorize history and scope for animal biotechnology	**Introduction:** History and scope for animal biotechnology	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Differentiate between somatic cell and germ cell • Describe different types of cell cultures	**Animal Cell Technology:** Somatic cell and germ cell, spermatogenesis and sperm technology, types of cell culture-primary and established culture, cell lines and cell fusion	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Apply Artificial insemination techniques • Interpret *In vitro* fertilization (IVF) and embryo transfer (ET) • Utilize multiple ovulation wit embryo transfer (MOET) techniques for animal improvement	**Artificial Animal Breeding:** Artificial insemination, transplantation, *In vitro* fertilization (IVF) and embryo transfer (ET), multiple ovulation with embryo transfer (MOET), nuclear transplantation, cryopreservation of spermatozoa	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Classify different types of molecular marker • Implement molecular marker for genetic analysis and gene mapping of animals	**Molecular Markers and their applications:** Definition and types: RAPD, RELP, AFLP, EST, SNP and Microsatellites, Application of molecular marker in animal population genetic analysis and gene mapping of animals	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation

• Discuss on animal health and biotechnology • Assess and evaluate antimicrobial drugs and their sensitivity tests	**Immunology and Serology:** Animal health and biotechnology, Antimicrobial drugs and their sensitivity tests, Human pathogenic viruses.	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Conceptualize on vaccine development • Utilize antigens for vaccine development • Discriminate between monoclonal and polyclonal antibodies and analyze their applications in antibody engineering.	**Vaccines and Hybridoma Technology:** Concepts in vaccine development, selection of target antigens for vaccine development, Production of monoclonal and polyclonal antibodies and their applications, antibody engineering	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Define and separate different gene transfer methods	**Transgenesis and Transgenic Animals:** Cell transformation, vectorless gene transfer: calcium mediated, electroporation, electrofusion, microinjection, gene transfer through vectors: adenoviruses, bacculoviruses	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report
• Recognize and conclude the use of transgenic animals • Criticize the ethical issues of transgenic animal	**Application of transgenic Animals:** Animals as models for human diseases, live-stock improvement, bovine growth hormone, silk worm as bioreactors, ethics of transgenic animals	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report

Reference Books

1. Dubey, R.C. 2006. A Text Book of Biotechnology (1st Edition). S.Chand and Company Ltd., New Delhi, India.
2. Watson, J. D., Baker, T. A., Bel, S. P., Gall, A., Levine,M. and Losick, R. 2004.Molecular Biology of the Gene (5th Edition).Pearson Education, Singapore.
3. Kumar, H. D. 2005. Modern concepts of Biotechnology. Vikas Publishing House Pvt. Ltd., New Delhi, India.
4. Winnacker, E. L. 2003. From Genes to Clones: Introduction to Gene Technology. Panima Publishing Corporation, New Delhi, India.
5. Arora, M. P. and Sandhu, G. S. 2004. Genetics (5th Edition).Himalaya Publishing House, New Delhi, India.
6. Guimaraes, E. P., Ruane, J., Scherf, B. D., Sonnino, A. and Dargie, J.(Editors) 2009. Marker-Assisted Seclection: Current Status and Future perspectives in Crops, Livestocks, forestry and Fish.FAO, Rome, Italy.

Course Code: BIOT- 511 **Course Title:** Fisheries Biotechnology	**Credit Hour: 3**	**Semester: July- December**

Rationale: The course is designed to know the different aspects of fisheries biotechnology.

Course Objectives:

- Optimize knowledge on the present status and future prospect of fish biotechnology.
- Manipulate chromosome, induce breeding and sex reservation to develop mono sex, sterile androgenesis and gynogensis type of fish.
- Apply molecular markers for polymorphism study, genetic analysis and QTL mapping in fish.
- Enrich knowledge on cryopreservation of fish, spermatozoa and embryos.
- Maintain fish cell lines for different studies of diseases and toxicology
- Diagnose fish and shrimp diseases occurred by pathogenic microorganisms
- Produce transgenic fish by studying different gene transfer methods
- Detect pathogenic microbes and toxins in fish and fishery products

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Express and write present scenario of fish biotechnology	**Introduction:** Present scenario of fish biotechnology, scope and importance	Lecture Visual presentation Interactive discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Manipulate ploidy level of fish for its improvement • Discriminate gynogenesis and androgenesis of fish	**Chromosome manipulation:** Ploidy and chromosome manipulation in fishes: gynogenesis and androgenesis	Lecture Visual presentation Interactive discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Analyze and implement synthetic hormones for induced breeding • Manipulate and predict monosex fish for economic importance	**Induced Breeding and Sex Reversion in Fish:** Synthetic hormones for induced breeding, manipulation of sexual phenotypes: production monosex fish of economically importance, production of sterile fish	Lecture Visual presentation Interactive discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Discuss cryopreservation technique for fish genetic improvement and future research	**Gene Banking/Cryobanking:** Definition and concept, cryobanking/ cryopreservation of fish and shell fish spermatozoa, eggs, embryos and cell lines.	Lecture Visual presentation Interactive discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation

• Apply the basic techniques of fish cell culture and prepare culture media • Maintain and apply fish cell lines.	**Fish cell culture and cell lines:** Development and maintenance of fish cell lines, culture media, application of fish cell lines	Lecture Visual presentation Interactive discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Explain among different molecular markers • Identify and distinguish on different molecular markers • Implement different molecular markers on crop improvement • Criticize merits and demerits of different molecular markers	**Molecular markers and their Applications:** RAPD, RFLP, AFLP, EST, SNP, minisatellites and microsatellites, application of molecular markers in fish population genetic analysis and gene mapping for fish stock improvement, QTL mapping and marker assisted selection for fish breeding.	Lecture Visual presentation Interactive discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Illustrate immunoglobulins synthesis and humoral B-cell immunoglobulins • Diagnose fish and shrimp pathogens through molecular technique • Recognize and point out genetically modified micro-organisms as probiotics and their prospect in aquatic biotechnology.	**Immunogenetics in fish and shrimp:** Immunoglobulins synthesis, humoral b-cell immunoglobulins, molecular diagnosis of fish and shrimp pathogenes, DNA vaccines, genetically modified micro-organisms as probiotics and its prospect in aquatic biotechnology.	Lecture Visual presentation Interactive discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Describe different methods of trangenesis • Investigate and evaluate genetically modified fishes for better growth and development, disease resistance and ornamentation • Survey and point out regulations procedure of transgenic fish • Assess and predict ethics and risks for transgenic fish development and culture	**Transgenesis:** Methods of gene transfer in fishes, Zebra fish as model for transgenesis, genetically modified fishes for better growth and development, disease resistance and ornamentation, transboundary regulations for transgenic fish, ethics and risks for transgenic fish development and culture.	Lecture Visual presentation Interactive discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Utilize biotechnological tools to detect pathogenic microbes and toxins in fish and fishery products • To acquire knowledge on the production of various biomaterials from marine fish and other organisms.	**Applications of fisheries biotechnology:** Biotechnological detection of pathogenic microbes in fish, shrimp and fishery products, biosensors for toxins, identification of biomaterials like bioactive compounds and drugs, biofuel, cosmetics from marine fish and other	Lecture Visual presentation Interactive discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation

	organisms.		

Reference Books

1. Gupta, P. K. 2016.Elements of Biotechnology (2nd Edition). Rastogi Publications, Meerut, India.
2. Singh, B. D. 2013.Biotechnology Expanding Horizons (4th Edition). Kalyani Publishers, New Delhi, India.
3. Dubey, R.C. 2006. A Text Book of Biotechnology (1st Edition). S.Chand and Company Ltd., New Delhi, India.
4. Watson, J. D., Baker, T. A., Bel, S. P., Gall, A., Levine,M. and Losick, R. 2004.Molecular Biology of the Gene (5th Edition).Pearson Education, Singapore.
5. Kumar, H. D. 2005. Modern concepts of Biotechnology. Vikas Publishing House Pvt. Ltd., New Delhi, India.
6. Winnacker, E. L. 2003. From Genes to Clones: Introduction to Gene Technology. Panima Publishing Corporation, New Delhi, India.
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Course Code: BIOT- 512 **Course Title**: Food and Industrial Biotechnology (Elective)	**Credit Hour: 3**	**Semester: January-June**

Rationale: The course is outlined to study the application of biotechnology in food industry.

Course Outcomes:

- Introduce biotechnological approaches in food industries in Bangladesh
- Produce and ferment cheese, yogurt and fermented foods
- Synthesize food additives: organic acids, amino acids, food flavor ants, pigments, probiotics, etc
- Implement biotechnology in food preservation
- Generalize industrial products such as spiraling, yeast, antibiotics (penicillin), insulin, alcoholic beverage (wine) etc
- Discuss safety and necessity of genetically manipulated (GM) food products

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• State scope, importance and present status of food and industrial biotechnology under Bangladesh conditions	**Introduction:** Scope, importance and present status food and industrial biotechnology in Bangladesh	Lecture Visual presentation Interactive discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Concept of traditional and modern biotechnology products • Manufacture cheese and Yogurt, fermented vegetables and fruits	**Traditional biotechnology (fermentation) Products:** Concept of traditional and modern biotechnology, biotechnological approaches for manufacture of yogurt, cheese, fermented foods, fermented vegetables and fruits, alcoholic beverages.	Lecture Visual presentation Interactive discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Explain, identify and produce food additives • Distinguish different types of food additives • Apply probiotics as a food additives	**Food additives:** Production of additives: organic acid (acetic acid, lactic acid and citric acid) Amino acids (glutamic acid, lysine, threonine, arginine, arginine and histidine), food flavourants and pigments, Probiotics as functional food additive: Define probiotics, identify potential probiotics, role of probiotics.	Lecture Visual presentation Interactive discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Apply biotechnology tools in food preservation	Biotechnology tools used for food preservation: Recombinant Antifreeze Protein (rAFP), Bacteriocins, Chelating agents, Fermentation starter culture, food irradiation	Lecture Visual presentation Interactive discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral

			presentation
• Discuss production, formulation technology of mushrooms, spirullina and yeast etc.	**Biotechnology-Based Small Industries:** Production, formulation and commercialization of single cell proteins (mushroom, spirullina and yeast), biofertilizer and biopesticide	Lecture Visual presentation Interactive discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Synthesize alcohol (ethanol), alcoholic beverages (wine), antibiotics (penicillin), vitamin (B12) and insulin	**Industrial Products:** Microbial synthesis of alcohol (ethanol), alcoholic beverages (wine), antibiotics (penicillin), vitamin (b12), insulin, interferon, vaccine	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Acquire knowledge on necessity and safety of GM foods • Have in-depth insight of nutitional status of GM food and feeds	**Genetically Manipulated (GM) Food Products:** Concept, Need for GM foods, types and application, ethical issues of concern – safety of GM foods. Different GM foods: golden rice, green factories, super bananas, transgenic multivitamin corn, transgenic oilseed crop, bio cassava, modified potatoes and fish (salmon), Nutritionally-enhanced GM feed crops.	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation

Reference Books

1. Gupta, P. K. 2016.Elements of Biotechnology (2nd Edition). Rastogi Publications, Meerut, India.
2. Singh, B. D. 2013.Biotechnology Expanding Horizons (4th Edition). Kalyani Publishers, New Delhi, India.
3. Dubey, R.C. 2006. A Text Book of Biotechnology (1st Edition). S.Chand and Company Ltd., New Delhi, India.
4. Watson, J. D., Baker, T. A., Bel, S. P., Gall, A., Levine,M. and Losick, R. 2004.Molecular Biology of the Gene (5th Edition).Pearson Education, Singapore.
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7. Guimaraes, E. P., Ruane, J., Scherf, B. D., Sonnino, A. and Dargie, J.(Editors) 2009. Marker-Assisted Seclection: Current Status and Future perspectives in Crops, Livestocks, forestry and Fish.FAO, Rome, Italy.

Course Code: BIOT- 513 **Course Title:** Environmental Biotechnology and Biosafety	**Credit Hour: 3**	**Semester: January-June**

Rationale: The course is designed to know the environmental biotechnology and different aspects of biosafety regulation mechanism under Bangladesh perspective.

Course Outcomes:

- Optimize knowledge on basic idea of environmental biotechnology.
- Explain the biotechnological detection of environmental pollution.
- Apply methods of bioremediation to reduce environmental pollution
- Analyze the different methods of biodegradation.
- Interpret the environmental health via such as biogas, biofuels, bioenergy, biofertilizer, bio-pesticides and IPM.
- Implement regulatory mechanism of biosafety in respect of international and national context.
- Criticize biosafety guidelines for releasing of GMO under Bangladesh condition.
- Survey and recognize the ethical concepts and public awareness regarding GMO.

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Describe environmental biotechnology • Summarize biosafety and risk assessment	**Introduction:** Definition, Present status and future prospect of Environmental Biotechnology, Biosafety and risk contaminant	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Classify environmental pollutants • Predict and calculate environmental pollution through Lux Reporter gene technology	**Biotechnological detection of environmental pollutants:** Classification of environmental pollutants- organic and inorganic, Cell biology in environmental monitoring, bioluminescent “lux reporter gene” technology, types of biosensor, environmental application of biosensors	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Define bioremediation, methods of bioremediation • Summarize advantages and disadvantages of bioremediation • Execute and implement genetically engineered microbes in bioremediation of wastes	**Bioremediation:** Definition, *in situ* and *ex situ* methods of bioremediation, phyto-bioremediation, advantages and disadvantages of bioremediation, genetically engineered microbes (GEM) in bioremediation of pollutants.	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Classify different types of biodegradation • Estimate and analyze	**Biotechnology of biodegradation**: Aerobic vs anaerobic degradation, bio-oxidation of phenolic compounds,	Lecture Visual presentation	Quiz/MCQ Essay type answer

biodegradation of herbicides and pesticides	biodegradation of herbicides and pesticides	Discussion Assignment	Short answer Report Oral presentation
• Explain the impact of bio-products for environmental health • Apply and analyze different biological methods for improvement of environment	**Bio-products for better environmental health:** Biological control of insects and pests, biopesticide/insecticide, IPM, biofertilizers, bio-energy and bio-fuels, biogas as energy source	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Interpret biofarming and green house technology • Recognize and conclude the demerits of UV radiation, green house effect and acid rain	**Biofarming and Green House Technology:** Rural biotechnology with special reference to biofertilizers, organic farming, UV radiation, green house effect and acid rain, their impacts and biotechnological approaches for management	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Explain and outline biosafety regulatory mechanism • Implement regulatory mechanism of biosafety in respect of international and national context. • Criticize biosafety guidelines for releasing of GMO under Bangladesh condition.	**Biosafety:** Risk for animal and human health, food safety, allergies, biosafety regulations: guidelines for environmental release of GMOs, mechanism of implementation of biosafety guidelines at institutional, national and international level, national biosafety guideline and policy, Cartagena protocol and its implementation, transboundary guidelines for import and shipment of GMOs/LMOs	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Survey and recognize the ethical concepts and public awareness regarding GMO	**Ethics:** Ethical issues, Public awareness, perception and acceptance of products of biotechnology, growers and consumers interest	Lecture Discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type Report

Reference Books

1. Gupta, P. K. 2016.Elements of Biotechnology (2nd Edition). Rastogi Publications, Meerut, India.
2. Singh, B. D. 2013.Biotechnology Expanding Horizons (4th Edition). Kalyani Publishers, New Delhi, India.
3. Dubey, R.C. 2006. A Text Book of Biotechnology (1st Edition). S.Chand and Company Ltd., New Delhi, India.
4. Watson, J. D., Baker, T. A., Bel, S. P., Gall, A., Levine,M. and Losick, R. 2004.Molecular Biology of the Gene (5th Edition).Pearson Education, Singapore.
5. Kumar, H. D. 2005. Modern concepts of Biotechnology. Vikas Publishing House Pvt. Ltd., New Delhi, India

Course Code: BIOT- 514 **Course Title:** Bioinformatics and Computational Biotechnology	**Credit Hour: 3**	**Semester: July-December**	
Rationale: The course is designed to know the bioinformatics and computational biotechnology for advanced molecular biology.			
Course Outcomes: • Define bioinformatics and its different terminology. • Describe and report the information flow specially DNA and RNA structure and its function. • Justify the data base biological information and tools for synthetic biology. • Integrate and hypothesize the biological data for network establishment, mining and work flow. • Align and organize the pair of sequence especially for DNA and Protein to study the homology.			
Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Memorize bioinformatics and its objectives	**Introduction to Bioinformatics:** Importance, Objectives of bioinformatics, kind of data used, multiplicity of data and data mining	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Illustrate the structure of DNA and RNA • Distinguish between DNA and RNA • Judge the role of DNA for gene construct	**The Information on Molecules and Information Flow:** Basic components, basic chemistry of nucleic acids, structure of DNA, structure of RNA, genes- the functional elements in DNA	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Classify the different structure of amino acids and protein	**Proteins- Their Structural Profiles and Properties:** Amino acids and protein structure, secondary structure elements, tertiary structure, quaternary structure, protein folding, protein function, proteins- purification and characterization	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Compare different types of databases for synthetic biology • Discuss the functional aspect of protein •	**Databases for Biological Information:** Types of databases, relational databases, object oriented databases, data integration, data analysis, reference list of the major bioinformatics databases and tools	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation

• Rearrange and formulate data bank for networking and management of workflow	**Managing Biological Databanks:** Submission of data, carnation of databases, establishing databases on networks, integration of databases, mining of databases, management of workflow	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Align and organize the pair of sequence specially for DNA and protein to study the homology.	**Alignment of Pairs of Sequences:** Sequence analysis of biological data, models for sequence analysis and their biological motivation, methods of alignment, applications of dot matrices, methods for optimal alignments, using gap penalties and scoring matrices, sensitivity and specificity, illustrative examples	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Analyze and estimate different data retrieval tools such as OMIM, Pubmed, LocusLink, SRS.	**Data Retrieval Tools:** NCBI, Online Mendelian Inheritance in Man (OMIM), PubMed, Taxonomy Browser, LocusLink, Sequence Retrieval Systems (SRS)	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Hypothesize and develop of nucleotides sequence alignment by using FASTA, BLAST and others software	**Tools for Sequence Alignment:** FASTA, BLAST, Filtering and gapped BLAST, PSI-BLAST, comparison of running time for various programs, ORF finder	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Explain proteomics and microarray • Evaluate and recognize the proteomics and microarray tools in molecular biology	**Proteomics and Microarray:** Proteome analysis, tools for proteome analysis, metabolic pathways, genetic networks, definition of microarray and its use in molecular biology	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation

Reference Books

1. Dubey, R.C. 2006. A Text Book of Biotechnology (1st Edition). S.Chand and Company Ltd., New Delhi, India.
2. Watson, J. D., Baker, T. A., Bel, S. P., Gall, A., Levine, M. and Losick, R. 2004.Molecular Biology of the Gene (5th Edition).Pearson Education, Singapore.
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Course Code: BIOT- 515 **Course Title:** Enzymology and Enzyme Biotechnology	**Credit Hour: 3**	**Semester: January-June**

Rationale: The course layout is constructed to study fundamental of enzymology and enzyme biotechnology.

Course Outcomes:

- Define and memorize the different terms of enzymology.
- Illustrates the enzyme kinetics and catalyzed reaction.
- Explain the enzyme regulation and its activities.
- Design the drugs through enzyme engineering.

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Describe history and classification enzymes • Discriminate enzyme, anti-enzymes, iso-enzymes, co-enzymes and co-factors	**Introduction:** History, occurrence and distribution, classification, nomenclature and properties of enzymes, application of enzymes, anti-enzymes, iso-enzymes, isolation and purification of enzymes, active sites and nature of active sites, identification of functional groups at active sites, co-factors, co-enzymes, enzyme specificity, substrate concentration, enzyme-substrate complex	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Illustrate Michaelis-Mentor hypothesis • Calculate the Michaelis-Mentor equation and determine K_m and V_{max} value • Evaluate the role of temperature, p^H and other factors in enzyme catalyzed reactions	**Kinetics of Enzyme Catalyzed Reactions:** Michaelis-Mentor hypothesis, transformation of Michaelis-Mentor equation and determination of K_m and V_{max}**,** ping-pong mechanisms, enzyme catalyzed by temperature, p^H, temperature co-efficient	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Distinguish Inhibitors and activators • Recognize the regulatory mechanism of enzyme activity	**Regulation of Enzyme Activity:** Substrate inhibition and activation, enzyme inhibition, irreversible and reversible inhibition, enzyme induction and repression, covalent modification, isoenzymes.	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation
• Describe enzyme immobilization and its advantages • Interpret the different methods of enzyme	**EnzymeTechnology**: Immobilization of enzymes: definition, advantages of using immobilized enzymes, methods of enzyme immobilization: adsorption, covalent bonding, cross-	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report

immobilization in cell biology	linking,encapsulation, immobilization of cells, properties of immobilized enzymes, enzyme stabilization.		Oral presentation
• Develop knowledge on enzyme engineering • Design and evaluate the efficiency of drug for mankind	**Enzyme engineering and Drug designing**: Enzymes as analytical device: biosensor, biochip- the biological computer, drug designing by blocking enzyme activity, hormone receptors, and inhibition of nucleic acid synthesis.	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Essay type answer Short answer Report Oral presentation

Reference Books

1. Gupta, P. K. 2016.Elements of Biotechnology (2nd Edition). Rastogi Publications, Meerut, India.
2. Singh, B. D. 2013.Biotechnology Expanding Horizons (4th Edition). Kalyani Publishers, New Delhi, India.
3. Dubey, R.C. 2006. A Text Book of Biotechnology (1st Edition). S.Chand and Company Ltd., New Delhi, India.
4. Watson, J. D., Baker, T. A., Bel, S. P., Gall, A., Levine, M. and Losick, R. 2004.Molecular Biology of the Gene (5th Edition).Pearson Education, Singapore.
5. Kumar, H. D. 2005. Modern concepts of Biotechnology. Vikas Publishing House Pvt. Ltd., New Delhi, India.
6. Winnacker, E. L. 2003. From Genes to Clones: Introduction to Gene Technology. Panima Publishing Corporation, New Delhi, India.
7. Arora, M. P. and Sandhu, G. S. 2004. Genetics (5th Edition).Himalaya Publishing House, New Delhi, India.

Department of Entomology

Courses Layout

Sl. No.	Course code and Title	Cr. Hrs.
A. Compulsory courses		
1	ENTO 501: Insect Taxonomy	3
2	ENTO 502: Insect Ecology	3
3	ENTO 503: Insect Physiology	3
4	ENTO 504: Biological Control	3
5	ENTO 505: Insecticide Toxicology	3
6	ENTO 506: Integrated Pest Management	3
	Total	**18**
B. Elective courses		
7	ENTO 507: Insect Morphology	3
8	ENTO 508: Economic Entomology-I	3
9	ENTO 509: Host Plant Resistance	3
10	ENTO 510: Medical Entomology	3
11	ENTO 511: Pesticide Management	3
12	ENTO 512: Industrial Entomology	3
13	ENTO 513: Vertebrate Pests	3
14	ENTO 514: Economic Entomology-II	3
15	ENTO 520: Research Methodology & Data Analysis	3
16	PLPA 511: Plant Virology	3
17	AGCH 505: Chemistry of Pesticides	3
18	Related Courses from other Departments	3
	Minimum	**12**
C. Seminar		
19	ENTO 598	1
D. Thesis Research		
20	ENTO 599	16

Compulsory courses	**18**
Elective courses	**12**
Seminar	**1**
Thesis Research	**16**
Total	**47**

Curriculum Alignment / Skill Mapping

Curriculum must be aligned with program objectives, program learning outcome and intended learning outcomes through proper skill mapping.

Department of Entomology

Courses	Program Learning Outcome							
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ENTO 501	x	x	x	x				x
ENTO 502	x	x	x	x				x
ENTO 503	x	x	x	x				x
ENTO 504	x	x	x	x				x
ENTO 505	x	x	x	x				x
ENTO 506	x	x	x	x				x
ENTO 507	x	x	x	x				x
ENTO 508	x	x	x	x				x
ENTO 509	x	x	x	x				x
ENTO 510	x	x	x	x				x
ENTO 511	x	x	x	x				x
ENTO 512	x	x	x	x				x
ENTO 513	x	x	x	x				x
ENTO 598						x	x	
ENTO 599					x	x	x	x

Course Code: ENTO 501 **Course Title: Insect Taxonomy (Compulsory)**	**Credit Hour: 03**	**Semester: January-June**

Rationale: This course is designed for focusing the updated information on diversity of insects and related arthropods. This course is useful for anyone considering a career in entomology, museum based careers, and for any student interested in advanced taxonomy and systematics, biodiversity, evolution, insect morphology, and applied aspects of insect identification.

Course Outcomes:

- Gain an appreciation of insect amazing diversity around the world, especially the most diverse Orders.
- Gain an appreciation for the biodiversity informatics and its many uses in biology.
- Interpret the principles of systematics and apply the role of phylogeny in classification.
- Perform how to properly curate and preserve insect specimens, and database and disseminate information associated with them.
- Develop skills to utilize relevant literature for insect identification and be able to synthesize information from multiple sources to understand the classification of a group of insects.
- Become proficient with diagnostic identification keys in a variety of formats, and be able to distinguish key morphological characters in different insect families.
- Illustrate the role of molecular data in identification and taxonomy.

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching Learning Strategies**	**Assessment Strategies**
• Explain what insect systematic & taxonomy are all about.	**Introduction**: Introduction; Importance of taxonomy; identifying insects; what is an insect diagnostician? Value of insect diagnostics; taxonomic organizations in support of biodiversity.	Lecture Visual presentation Discussion Educational & research organization visit	Quiz/MCQ Short answer Essay-type answer Report evaluation Presentation performance
• Articulate the role of modern phylogenetic methods in insect classification	**Taxonomy and systematics:** Terms and definitions; cladistics methods, application of cladistics methods	Lecture, Visual presentation, Discussion, Problem solution by group work	Quiz/MCQ Short answer Essay type answer Assignment
• Interpret how to read a phylogenetic tree, • What kinds of data are used to estimate trees, • How those data are analyzed, and • What it means to be monophyletic, • Moreover, explain species concepts and methods for species delimitation.	**Principles of Zoological classification:** Kinds of classification; phyletic lineages; components of classification; Linnaean hierarchy; concepts of species; polytypic species; subspecies; other infraspecific groups; superspecies	Lecture Visual presentation Discussion Question and Answer	Quiz/MCQ Short answer Essay type answer Lab-exam

• Equip and furnish a state of the art insect diagnostic laboratory.	**Equipping a diagnostic laboratory:** Introduction; Basic tools and supplies for handling samples; Communication devices; Microscopes and microscopy; Sample holding equipment and supplies; References and resources; Photographic equipment and methods; Obtaining samples and making a reference collection	Lecture Visual presentation Discussion, Lab work Visits of Insect Taxonomy Laboratory at different educational & research organizations	Quiz/MCQ Short answer Essay type answer Report writing & presentation
• Collect adult insects in terrestrial & aquatic habitats and properly curate specimens and database specimen metadata • Furthermore, practice multiple collecting techniques and explore insects in their natural environments • Curate a portion of their collected material and make an insect collection emphasizing collecting diversity	**Taxonomic collection:** Species registry; collecting ways; data of collection; preservation of collected arthropods; curating; preparation of specimens--relaxing insects, mounting, storage; Cataloguing of specimens; arrangement of the specimens; maintaining quality of collection; making a reference collection	Lecture Visual presentation Discussion Lab work Field collection of insects by group	Quiz/MCQ Short answer Essay type answer Evaluation of submitted taxonomic collection of insects
• Demonstrate valuable collection and preservation techniques and be able to distinguish key. morphological characters in different insect lineages • Utilize diagnostic identification keys effectively to identify lower taxonomic levels in a variety of formats.	**Insect Identification Techniques:** Naming arthropods—history, colloquial names, common names, scientific names; Identification tools— descriptive keys, dichotomous keys, illustrated keys, matrix-based keys, molecular diagnostics, sight identification; Diagnostic non-typical samples—phenotypic variations, sexual dimorphism; diagnostic insect damage, signs and symptoms, eggs and pupae; unusual insects; taxonomic characters	Lecture Visual presentation Discussion Group work	Quiz/MCQ Short answer Essay type answer Presentation
• Perform to present and publish taxonomic information in the recognized journals in an effective manner.	**Taxonomic publications:** kinds of taxonomic publications; preparations of taxonomic publications; taxonomic paper	Lecture Visual presentation Discussion Group work	Quiz/MCQ Short answer Essay type answer Presentation
• Synthesize information from multiple taxonomic sources (primary literature, internet) to understand the natural history	**Reference works in taxonomy:** Biological abstracts, Nomenclature Zoologicus; Entomology Abstracts; Review of Agricultural	Lecture Visual presentation Discussion,	Quiz/MCQ Short answer Essay type answer

of a group of insects	Entomology; Review of Medical and Veterinary Entomology; Publications on International Commission on Zoological Nomenclature; Guides to Journals; Books; Latin and Greek terminology in taxonomy; Latin abbreviations, Latin words; Linnaean signs; Taxonomy and biodiversity on the web	Group work Assignment	Report
• Solve taxonomic problems and describe how species and other taxa are named and described	**Zoological nomenclature:** Origin of the code; biocode; phylocode; International Code of Zoological Nomenclature; Rules of nomenclature; status of electronic publications	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Classify insects into different orders and families based on the similarities and differences that exist among them. • Additionally, illustrate the different features of families of major orders of insects.	**Insect Classification:** General classification of insects; Order—Orthoptera, Blattodea, Isoptera, Hemiptera, Thysanoptera, Coleoptera, Neuroptera, Hymenoptera, Lepidoptera, Siphonaptera, Diptera	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Name and briefly describe the latest developments in insect biodiversity research, e.g., biodiversity informatics, DNA barcoding	**Newer trends in taxonomy:** morphological approach; immature stages and embryological approach; ecological approach; behavioral approach; cytological approach; biochemical approach; numerical approach; differential systematics	Lecture, Visual presentation, Group work	Quiz/MCQ, Short answer, Essay type answer

Reference Books

1. Bland, R.G. and Jaques. H.E. 2010. How to Know the Insects. 3rd edition. Waveland Press, Inc. 409p.
2. Gibb, T. 2015. Contemporary Insect Diagnostics: the Art and Science of Practical Entomology. Elsevier-Academic Press. 336p.
3. Johnson, N.F. and Triplehorn, C.A. 2004. Borror and DeLong's Introduction to the Study of Insects. 7th edition. Cengage Learning. 888p.
4. Kapoor, V.C. 2013. Theory and Practice of Animal Taxonomy. 7th edition. Oxford & IBH Co. Pvt. Ltd. India.
5. Mayr, E, Linsley, E.G. and Usinger, R.L. 1953. Methods and Principles of Systematic Zoology. McGraw-Hill, New York. 328p.
6. Mayr, E. and Ashlock, P.D. 1991. Principles of Systematic Zoology. McGraw-Hill Inc. USA.
7. Romoser W.S. and J.G. Stoffolano, Jr. 1998. The Science of Entomology. 4th Edition. WCB McGraw-Hill Science. 624p.
8. Schuh, R.T. and Brewer, A.V.Z. 2011. Biological Systematics: Principles and Practices. 2nd edition. Comstock Publishing Associates- a division of Cornell University Press. USA.
9. Whitfield, J.B. and Purcell, A.H. 2013. Daly and Doyen's Introduction to Insect Biology and Diversity. 3rd edition. Oxford University Press. New York.

Course Code: ENTO 502 Course Title: Insect Ecology (Compulsory)	Credit Hour: 03	Semester: January - June

Rationale: This course is designed to teach the students about basic concept of ecology, insect population growth, population estimation and dynamics, population regulation and community description.

Course Outcomes:

- Acquiring knowledge on concepts of ecology, ecological system, energetic, processes and succession
- Understanding insect population growth, basic models, carrying capacity, life tables and survivorship curves, r- and k-strategies.
- Understanding insect population estimation absolute and relative methods
- Population dynamics, factors affecting dispersal, migration and seasonality in insects and mechanisms of achieving seasonality.
- Gaining knowledge on biotic factors, interspecific interactions, prey-predator interactions and defense mechanisms of insect against predators/parasitoids
- Learning community ecology, diversity, assessment of diversity, biogeography, co-evolution and conservation principles and pest management ecology.
- Apply ecological knowledge on insect pest management

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Understand basic concepts of ecology • Discuss ecosystem and its components • Describe energy conversion and utilization in ecosystem, food chain, food web and trophic level • Interpret biogeochemical cycles in ecosystem • Illustrate community and succession	History and definition, basic concepts. Environment, habitats and niches. Ecological systems - concept and components of ecosystem, terrestrial and aquatic ecosystem. Ecological energetic - energy conversion and utilization, energy flow in the ecosystem, food chain, food web and trophic level. Ecological process-biogeochemical cycling. Community- nature, structure and influences. Ecological succession - types, causes and process	Lecture Interactive discussion Multimedia presentation Individual assignments group work and presentation Field visits	Quiz/MCQ Short answer Essay type answer Report
• Describe insects population growth, carrying capacity and environmental resistance • Express insect life tables, survivorships curves, r-and k-strategies • Approximate insect population in field by different methods • Interpret factors affecting dispersal, migration and seasonality of insect	Basic concepts of abundance -Population growth basic models - Exponential vs Logistic models; Discrete vs Continuous growth models. Concepts of carrying capacity, environmental resistance and optimal yield. Vital Statistics -life tables and their application to insect biology. Survivorship curves. r- and k-strategies. Population estimation -Absolute and relative methods. Population dynamics-factors affecting abundance-environmental factors, dispersal and migration, Seasonality in insects.	Lecture Interactive discussion Multimedia presentation Individual assignments group work and presentation Field visits	Quiz/MCQ Short answer Essay type answer Report

• Analyze mechanisms of achieving different seasonality of insects	Classification and mechanisms of achieving different seasonality- Diapause (Quiescence)- aestivation, hibernation		
• Describe the effect of food on distribution and abundance of insect • Illustrate interspecific interactions of insects • Categorize the defense mechanisms of insect against predators/ parasitoids	Biotic factors- Food as a limiting factor for distribution and abundance, nutritional ecology. Interspecific interactions- Basic factors governing the interspecific interactions- Classification of interspecific interactions. Competition- Lotka- Volterra model, concept of nicheecological homologues, competitive exclusion. Prey-predator interactions- Basic model- Lotka-Volterra Model, Volterra's principle. Functional and numerical response. Defense mechanisms against predators/parasitoids -Evolution of mimicry, colouration, concept of predator satiation; evolution of life history strategies	Lecture Interactive discussion Multimedia presentation Individual assignments group work and presentation Field visits	Quiz/MCQ Short answer Essay type answer Report
• Discuss community ecology and organization of communities • Calculate diversity of insect in ecosystem • Illustrate coevolution and conservation principles of insect • Express biogeography of insect in natural and agroecosystem • Apply ecological knowledge on insect pest management	Community ecology - concept of guild, organization of communities. Relative distribution of organisms, concept of diversity. Assessment of diversity, coevolution and conservation principles, biogeography. Diversity- stability debate, relevance to pest management. Pest management as applied ecology	Lecture Interactive discussion Multimedia presentation Individual assignments group work and presentation Field visits	Quiz/MCQ Short answer Essay type answer Report

Reference Books

1. Chapman, J.L. and Reiss, M.J. 1998. Ecology: Principles and Applications. Second Edition. Cambridge University Press, UK. 330 pp.
2. Krebs, C.J. 1998. Ecological Methodology. Second Edition. Harper & Row, New York. 620 pp.
3. Krebs, C.J. 2001. Ecology: The Experimental Analysis of Distribution and Abundance. Fifth Edition. Benjamin Cummings Publishing Company, New York. 654pp.
4. Price, P.W., Denno, R.F., Eubanks, M.D., Finke, D.L. and Kaplan, I. 2011. Insect Ecology: Behavior, Populations and Communities. Cambridge University Press. 801pp.
5. Schowalter, T.D. 2016. Insect Ecology: An Ecosystem Approach. Fourth Edition. Academic Press. Elsevier. 774pp.
6. Speight, M.R., Hunta, M.D. and Watt, A.D. 2008. Ecology of Insects: Concepts and Application. Wiley-Blackwell Publishers. 640pp.

Course Code: ENTO 503 Course Title: Insect Physiology (Compulsory)	Credit Hour: 03	Semester: January-June

Rationale: This course is designed to develop knowledge on embryonic development in insects; integument and moulting; physiology of digestive; respiratory, circulatory, excretory and nervous system; reproduction; growth and metamorphosis; muscular system and locomotion in insects: insect nutrition; endocrine organs and hormone; exocrine glands, pheromones and defensive secretion in insects; insect behavior and sex determination in insects

Course Outcomes:

- Acquire knowledge on embryonic development, growth and metamorphosis in insects; integument and moulting process of insects;
- Gain knowledge on physiology of digestive; respiratory, circulatory, excretory; reproductive system and reproduction; muscular system and locomotion; nervous system and sense organs; and nutrition of insects;
- Attain knowledge on endocrine organs and hormone in insects; exocrine glands, pheromones and defensive secretion in insects;
- Acquire knowledge on behavior of insects;
- Gain knowledge on sex determination in insects.

Intended Learning Outcomes (ILOs) The students will be able to -	Course Content	Teaching Learning Strategies	Assessment Strategies
• Define embryology of insect; • Draw and describe the shape and structural parts of insect egg; • Illustrate the phases of early embryonic development of insects;	Embryonic development in insects	Lecture Visual presentation Discussion	Quiz /MCQ Short answer Essay type answer
• Define metamorphosis of insect and related terms; • Describe types of metamorphosis found in insects; • Compare nymphs and larvae of insects; hemimetabola and holometabola; • Illustrate the characteristics of larvae and pupae of insects; • Categorize and describe types of larvae and pupae found in insects; • Elucidate the influence of physiological and weather factors on growth and development of insects.	Growth and metamorphosis of insects	Lecture Visual presentation Discussion Demonstration Field visit Assignment	Quiz /MCQ Short answer Essay type answer Report

• Define integument of insect; • Explain basic parts of integument of insects and cuticular modifications; • Define moulting and describe the secretion of moulting hormone and moulting process of insects;	Integument and moulting process of insects	Lecture Visual presentation Discussion Assignment	Quiz /MCQ Short answer Essay type answer Report
• Describe male and female reproductive system and reproduction of found in insects; • Illustrate the modes of reproduction; spermatogenesis and oogenesis of insects; • Describe structural parts of respiratory system and respiration; circulatory system and circulation; excretory system and excretion; muscular system and locomotion of insects; • Illustrate the types of neuron and nervous system found in insects; • Elucidate the mechanism of nerve impulse transmission through an axon; • Define sense organ of insect; classify and describe the mechanoreceptor, chemoreceptor and photoreceptor of insects; • Define nutrition and describe nutritional requirement and role of nutrition in insects;	Physiology of digestive; respiratory, circulatory, excretory; muscular system and locomotion; nervous system and sense organs; reproductive system and reproduction; nutrition of insects	Lecture Visual presentation Discussion	Quiz /MCQ Short answer Essay type answer
• Define endocrine system of insect; • Classify and describe anatomical organization of endocrine system of insects; • Define hormone; classify and describe hormones found in insects; • Elucidate endocrine functions in insects and hormones in insect pest control. • Define exocrine system of	Endocrine organs and hormone in insects; exocrine glands, pheromones and defensive secretion in insects	Lecture Visual presentation Discussion Assignment	Quiz /MCQ Short answer Essay type answer

insect; classify and describe kinds of endocrine glands; • Define pheromone; classify and describe pheromones found in insects; • Differentiate exocrine and endocrine system of insects.			
• Concept of insect behavior; illustrate kinds and biological functions of insect behavior.	Insect behavior	Lecture Discussion	Quiz /MCQ Short answer Essay type answer
• Define terms regarding sex determination; describe the mechanism of sex determination; • Classify and describe the parthenogenesis according to the behavior of the chromosomes.	Sex determination in insects	Lecture Visual presentation Discussion	Quiz /MCQ Short answer Essay type answer

Reference Books

1. Tembare, D.B. 1984. A Text Book of Insect Morphology, Physiology and Endocrinology. S. Chand and Co. Ltd., Ramnagar, New Delhi.
2. Chapman, R.F. 1982. The Insects: Structure and function. 3rd edition. The English Language Book Society and MacMillan India Ltd., Bangalore, India.
3. Novak, V.J.A. 1966. Insect Hormones. Methuen and Co., London.
4. Johnson, N.F. and Triplehorn, C.A. 2004. Borror and DeLong's Introduction to the Study of Insects. 7th edition. Cengage Learning.
5. Pathak, S.C. and Sethi, Y.N. 1986. Recent Advances in Insect Physiology, Morphology and Ecology. Todays and Tomorrow's Printers and Publishers. New Delhi.
6. Wigglesworth,V.B. 1979. The Principles of Insect Physiology. English Language Book Society, England.

Course Code: ENTO 504 Course Title: Biological Control (Compulsory)	Credit Hour: 03	Semester: July-December

Rationale: This course is designed to develop knowledge on concept and status of biological control and its ecology; natural enemies-adaptability, foreign exploration and importation; maximizing biological control through research; microbial control of insect pests, evaluation of performance of natural enemies.

Course Outcomes:

The students will be able to-

- Acquire knowledge on concept and status, importance, scope and ecology of biological control;
- Gain knowledge on natural enemies of insect pests;
- Attain knowledge on adaptability of introduced biological control agents; modern foreign exploration and importation of natural enemies; maximizing biological control through research;
- Acquire knowledge on insect pest control using microbial agents;
- Gain knowledge on evaluation of the performance of natural enemies.

Intended Learning Outcomes (ILOs) The students will be able to -	Course Content	Teaching Learning Strategies	Assessment Strategies
• Define biological control and related terms; • Explain scope, importance and limitations of biological control; • Describe history and present status of biological control • Criticize advantages and constraints of biological control as compared with chemical control	Concept, history, principles and present status of biological control	Lecture Visual presentation Discussion	MCQ/Quiz Short answer Essay type answer
• Define fostering pests; • Compare upset and resurgence of pests • Illustrate the recipes for fostering pests • Analyze pesticide syndrome-diagnosis and suggested prophylaxis	Fostering pest through misuse of chemicals	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Categorize and describe predatory insects under the orders of Coleoptera, Neuroptera, Hymenoptera, Diptera, Hemiptera, Odonata etc. • Categorize and describe parasitic insects under the	Insect pests and their natural enemies: predatory insects, parasitoids, pathogenic microorganisms of insect pests, natural enemies of weeds	Lecture Visual presentation Discussion Field visit Assignment	Quiz/MCQ Short answer Essay type answer Report

orders of Hymenoptera, Diptera etc. • Categorize and describe pathogenic microorganism against insect pests and natural enemies of weeds; • Illustrate desirable characteristics and qualities of effective biological control agents			
• Clarify biological control, natural control and population phenomenon; • Compute and predict the extent of natural biological control; • Define and illustrate fortuitous biological control	Biological control: ecology and fortuitous biological control	Lecture Visual presentation Discussion	MCQ/Quiz Short answer Essay type answer
• Classify and describe host selection process by biological control agents, adaptability dependent factors. • Explain competitive displacement; • Argue the variability and fitness of natural enemy; • Describe and evaluate adaptabilities of natural enemies	Adaptability of introduced biological control agents	Lecture Visual presentation Discussion Assignment	MCQ/Quiz Short answer Essay type answer Report
• Formulate the planning and preparation of program, inventory research & investigation on foreign exploration and importation of selected species of natural enemies	Modern foreign exploration and importation of natural enemies	Lecture Visual presentation Discussion Assignment	MCQ/Quiz Short answer Essay type answer Report
• Define and contrast systematics and biological control; • Analyze conservation and augmentation of natural enemies; • Formulate the management of pest population by manipulating densities of both hosts and parasitoids through periodic releases	Maximizing biological control through research: systematic and biological control, conservation and augmentation of natural enemies, pest management through manipulation of hosts and parasitoids	Lecture Visual presentation Discussion	MCQ/Quiz Short answer Essay type answer

• Define microbial control; • Classify and characterize entomo-pathogenic microorganisms; • Illustrate insect diseases as natural occurring factors; • Elucidate biological control of weeds by introduced natural enemies	Microbial control of insect pests: Characteristics of insect pathogens. Insect diseases as naturally occurring mortality factors. Biological control of weeds by introduced natural enemies	Lecture Visual presentation Discussion Assignment	MCQ/Quiz Short answer Essay type answer Report
• Classify the evaluation methods of performance of natural enemies; • Experiment population sampling methods for evaluation of performance of natural enemies.	Evaluation of performance of natural enemies:	Lecture Visual presentation Discussion Assignment	MCQ/Quiz Short answer Essay type answer Report

Reference Books

1. Burges, H.D. 1981. Microbial Control of Pests and Plants. Academic Press. 950p.
2. Coppel, H.C. and Martius, J.W. 1977. Biological Insect Pest Suppression. Sringier Varleg. 324p.
3. Debach, P. 1979. Biological Control by Natural Enemies. Cambridge Univ. Press. 323p.
4. Ganfar, S.M., Waller, F.H. and Marsh R. 1985. Parasitic Pests and Predators. Elsevier. 575p.
5. Huffaker, C.B. 1974. Biological Control. Plenum/Rosetta Edition. 551p.
6. Huffaker, C.B. 1980. New Technology of Pest Control. John Willey and Sons. 500p.
7. Huffaker, C.B. and Messenger, P.S. 1976. Theory and Practices of Biological Control, Academic Press. 950p.
8. Metcalf, R.L. and Luckman, W.H. 1982. Introduction to Insect Pest Management. Willey Interscience Publication. 440p.
9. Novolzhilov, K.V. 1973. Microbial Methods for Biological Control of Pest of Agricultural Crops. Oxonian Press. 70p.
10. Steinhaus, E.A. 1967. Insect Microbiology. Hafner Publication Co. 763p.
11. van Emden, H.F. 1996. Pest Control. Cambridge Univ. Press.

Course Code: ENTO 505 Course Title: Insecticide Toxicology (Compulsory)	Credit Hour: 03	Semester: January-June	
Rationale: To orient the students with structure and mode of action of important insecticides belonging to different groups, development of resistance to insecticides by insects, environmental pollution caused by toxic insecticides and their toxicological aspects.			
Course Outcomes: • Outline the history of insecticides and their toxicological aspects • Recognize the major classes of insecticide and understand their mode of action • Describe processes involved in toxicodynamics of insecticides • Become aware of the limitations of insecticide use such as resistance and environmental contamination • Predict, evaluate and assess health and environmental risks to insecticides. • Develop a basic understanding on performing insect bioassays			
Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching Learning Strategies**	**Assessment Strategies**
• Describe scope of insecticide toxicology • Explain history of chemical control; • Recognize pesticide use and pesticide industry in Bangladesh	Definition and scope of insecticide toxicology; history of chemical control; pesticide use and pesticide industry in Bangladesh	Lecture Interactive discussion Multimedia presentation Individual assignment Group work and presentation Field visits	Quiz/MCQ Short answer Essay type answer Report
• Discuss bioorganic chemistry and organic functional groups • Explain uptake and distribution of insecticide • Summaries determination of toxicity, Contrast acute and chronic toxicity	Bio-organic chemistry and physiology; organic functional groups ,amino acids and protein, fatty acids and lipids, enzymes and coenzymes, energy metabolism, excitable membrane and chemical communication. General concept of insecticide toxicology, uptake and distribution of insecticides, determination of toxicity; acute and chronic toxicity	Lecture Interactive discussion Multimedia presentation Individual assignment Group work and presentation Field visits	Quiz/MCQ Short answer Essay type answer Report
• Classify insecticides and acaricides • Differentiate Structure and mode of insecticides of different groups	Classification of insecticides and acaricides based on mode of entry, mode of action and chemical nature. Structure and mode of action of organochlorines, organophosphates, carbamates, pyrethroids,, neonicotinoids, tertiary amines, oxadiazines, phenyl pyrazoles, insect growth regulators, attractants, fumigants,	Lecture Interactive discussion Multimedia presentation Individual assignment Group work and presentation Field visits	Quiz/MCQ Short answer Essay type answer Report

	microbials, botanicals, new promising compounds, etc.		
• Discuss joint action of insecticides • Recognoze the factors affecting toxicity of insecticides • Explain insecticide compatibility and phytotoxicity	Principles of toxicology; evaluation of insecticide toxicity; joint action of insecticides- synergism, potentiation and antagonism; factors affecting toxicity of insecticides; insecticide compatibility, selectivity and phytotoxicity	Lecture Interactive discussion Multimedia presentation Individual assignment Group work and presentation Field visits	Quiz/MCQ Short answer Essay type answer Report
• Express metabolism of insecticides. • Illustrate pest resistance to insecticides, mechanisms of resistance and resistance management • Analyse Pest resurgence	Insecticide metabolism; pest resistance to insecticides; mechanisms and types of resistance; insecticide resistance management and pest resurgence.	Lecture Interactive discussion Multimedia presentation Individual assignment Group work and presentation Field visits	Quiz/MCQ Short answer Essay type answer Report
• Interpret Insecticide residues and their environmental impact • Employ insecticide act in Bangladesh, registration procedure • Operate safety measures of insecticides	Insecticide residues, their significance and environmental implications. Insecticide Act, registration and quality control of insecticides; safe use of insecticides; diagnosis and treatment of insecticide poisoning	Lecture Interactive discussion Multimedia presentation Individual assignment Group work and presentation Field visits	Quiz/MCQ Short answer Essay type answer Report
• Demonstrate insecticide formulations and mixtures • Apply bioefficasy of insecticide and bioassay techniques • Estimate probit analysis, toxicity to beneficial insects • Operate pesticide appliances	**Practical** Insecticide formulations and mixtures; quality control of pesticide formulations; laboratory and field evaluation of bioefficacy of insecticides; bioassay techniques; probit analysis; evaluation of insecticide toxicity and joint action. Toxicity to beneficial insects. Pesticide appliances. Working out doses and concentrations of pesticides; visit to toxicology laboratories. Good laboratory practices	Lecture Interactive discussion Multimedia presentation Individual assignment Group work and presentation Field visits	Quiz/MCQ Short answer Essay type answer Report

Reference Books

1. Chattopadhyay, S.B. 1991. Principles and Procedures of Plant Protection. Oxford & IBH Publishing Company, New Delhi, India. 600pp.
2. Gupta, H.C.L. 1999. Insecticides: Toxicology and Uses. Fourth Edition, Agrotech Publication, Udaipur, India. 382pp.
3. Ishaaya, I. and Degheele, D. 1998. Insecticides with Novel Modes of Action: Mechanism and Application. Springer-Verlag Berlin Heidelberg, New York. 405pp.
4. Matsumura, F. 1985. Toxicology of Insecticides. Plenum Press, New York. 612 pp.
5. Perry, A.S. Yamamoto, I., Ishaaya, I. and Perry, R.Y. 1998. Insecticides in Agriculture and Environment: Retrospects and Prospects. Springer-Verlag Berlin Heidelberg, New York. 275 pp.
6. Prakash, A. and Rao, J. 1996. Botanical Pesticides in Agriculture. CRC Press, Taylor and Francis Group, Florida. 476 pp.
7. Yu, S.J. 2014. The Toxicology and Biochemistry of Insecticides, Second Edition. CRC Press, Taylor and Francis Group, Florida. 380 pp.

Course Code: ENTO 506 **Course Title: Integrated Pest Management (Compulsory)**	**Credit Hour: 03**	**Semester: July -December**

Rationale: This course is designed to provide theoretical and practical knowledge on pest management in the field by utilizing several tactics, analyzing pest problems, determine pest management options with their benefit and limitations, nurturing beneficial insects, and make appropriate recommendations using IPM techniques.

Course Outcomes:

- Characterize the major components of pest management strategies and compare their relative merits for important pests and crops
- Reflect the relationship between crop intensification and the need for integrated approaches to crop protection
- Develop different pest control models, and apply different computerized decision-making tools to analyze potential interactions in a complex crop-pest situation
- Apply different range of sampling techniques for data collection and analyses, interpret results and report on the outcome

Intended Learning Outcomes (ILOs) The students will be able to -	**Course Content**	**Teaching Learning Strategies**	**Assessment Strategies**
• Identify different types of pest • Explain all options of pest control strategies • Describe and analyze the pest control tactics in past	Pest and management, History of pest control	Lecture Visual presentation Discussion Demonstration Field visit Exercise Group work Assignment	Quiz/MCQ Short answer Essay type answer Report
• Develop integrated pest management program for major crop pests	Philosophy, basic principles and guidelines of integrated Pest management	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Explain and justify integrated pest management program for major crop pests • Apply pest management options taking ecofriendly approaches	Ecological basis of pest management	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Demonstrate and describe technique of sampling • Interpret the economics of pest control	The economics of pest management, the quantitative basis of Pest management sampling and measures	Lecture Visual presentation Discussion Demonstration Exercise Assignment	Quiz/MCQ Short answer Essay type answer Report

• Compare and justify different models in pest management techniques in integrated pest management	Analysis and modeling, in pest management	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Predict and hypothesize different control options in integrated pest management	Pest control tactics: cultural mechanical biological, genetic and legal control	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Describe and justify the importance of host plant resistance in pest management • Evaluate and formulate different pest control tactics in integrated pest management	Host plant resistance, use of semio-chemicals and insecticides, biotechnology and integrated pest management	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Argue and predict the role of extension work in successful IPM program	Training needs for IPM, Role of extension entomology in IPM, Present status and prospects of integrated pest management in Bangladesh	Lecture Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report

Reference Books

1. Dhawan, A.K., Singh, B., Bhullar, M.B. and Arora, R. 2013. Integrated Pest Management. Scientific Publishers, India. 749p.
2. Kogan, M. 1986. Ecological Theory and Integrated Pest Management Practice. John Wiley & Sons, New York.
3. Metcalf, R. L. and Luckmann, W. H.1994. Introduction to Insect Pest Management. 2nd edition. Wiley & Sons, New York.672p.
4. Pedigo, L.P. and Rice, M.E. 2009. Entomology and Pest Management. 6th edition. PHI Learning Private Ltd. India. 784p.

Course Code: ENTO 507 Course Title: Insect Morphology (Elective)	**Credit Hour: 03**	**Semester: July-December**	
Rationale: To orient the students with external morphology of the insect's body such as head, thorax and abdomen, their appendages and functions, internal organs and their structures and sense organs			
Course Outcomes: • Acquire knowledge on insect's body wall, integumentary structures, body tagmata, sclerites and segmentation • Gain knowledge on structures and functions of cephalic, thoracic and abdominal appendages of insects • Understand structures and functions of digestive, circulatory, respiratory, excretory and nervous system of insect. • Construct structures of reproductive system and its function • Classify embryonic and post development of insects • Describe different types of larvae and pupae • Gain knowledge on mechanoreceptors, chemoreceptors, audiotory and photoreceptors			
Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching Learning Strategies**	**Assessment Strategies**
• Describe structures of insect integument and special structures developed from the body wall. • Illustrate body tagmata, sclerites and segmentation of the insect body.	Insect body wall structures, cuticular outgrowths, colouration, special integumentary structures, body tagmata, sclerites and segmentation	Lecture Interactive discussion Multimedia presentation Demonstration Group work and presentation	Quiz/MCQ Short answer Essay type answer
• Explain origin and structure of insect head • Separate various mouthparts of insects • Demonstrate different antennae of insect • Illustrate tentorium and sclerites of insect neck region	Head- origin, structure and modification of insect head, tentorium and neck sclerites. Mouthparts and their modifications. Structures, types and functions of antennae	Lecture Interactive discussion Multimedia presentation Demonstration Group work and presentation	Quiz/MCQ Short answer Essay type answer
• Distinguish thoracic tergum, sternum and pleuron • Draw wing structures with various veins • Categorize various types of insect wings • Interpret flying mechanism of insects • Separate modified legs of insects	Thorax- thoracic areas, structures of tergum, sternum and pleuron, wing's structure, venation, modification and coupling apparatus, mechanism of flight, structures and modification of legs	Lecture Interactive discussion Multimedia presentation Demonstration Group work and presentation	Quiz/MCQ Short answer Essay type answer

• Identify segments and appendages of abdomen • Demonstrate genital organs of insect • Recognize modified genitalia and appendages of abdomen	Abdomen- segmentation and appendages of insect abdomen; genitalia and their modifications	Lecture Interactive discussion Multimedia presentation Demonstration Group work and presentation	Quiz/MCQ Short answer Essay type answer
• Describe the structures digestive, circulatory, respiratory, excretory and nervous system of insects • Illustrate development of various system • Interpret the functions of different system	Structures of digestive, circulatory, respiratory, excretory and nervous system of insect, their development and functions. Structures and functions of reproductive system	Lecture Interactive discussion Multimedia presentation Demonstration Group work and presentation	Quiz/MCQ Short answer Essay type answer
• Explain embryonic and post embryonic development of insects • Demonstrate different metamorphosis in insects • Categorize larvae and pupae of insects	Metamorphosis- embryonic and post- embryonic development; types of metamorphosis; types of larva and pupa	Lecture Interactive discussion Multimedia presentation Demonstration Group work and presentation	Quiz/MCQ Short answer Essay type answer
• Recognize sense organs of insects • Draw the structures of various sense organs • Illustrate the functions of sense different organs in insects	Sense organs- structures and functions of mechanoreceptos, chemoreceptors, auditory and photoreceptors	Lecture Interactive discussion Multimedia presentation Demonstration Group work and presentation	Quiz/MCQ Short answer Essay type answer

Reference Books

1. Chapman, R.F. 2013. The insects: Structure and Function. Fifth Edition. Cambridge University Press, Cambridge. 963 pp.
2. Richards, O.W. and Davies, R.G. 1977. Imm's General Text Book of Entomology. Tenth Ed. Chapman and Hall, London. 940 pp.
3. Snodgrass, R.E.1994. Principles of Insect Morphology. CBS Publishers and Distributors, New Delhi, India. 667 pp.
4. Tembhare, D.B. 1997. Modern Entomology. First Edition. Himalaya Publishing House, Mumbai, India. 623 pp.
5. Wigglesworth, V.B. 1972.The Principles of Insects Physiology. Methuen and Co., London. 805 pp.

Course Code: ENTO 508 Course Title: Economic Entomology -I (Elective)	Credit Hour: 03	Semester: July - December

Rationale: This course is designed to provide practical knowledge on economics of pest attack of major crop pests, their nature of damage and their control measures, transmission of insect borne diseases in plants, crop loss assessment due to pest, estimation of economic threshold and Cost-benefit analysis

Course Outcomes:

- Obtain knowledge on pest management methods for major agronomic and horticultural crops, forest plants, storage products
- Acquire knowledge on establishing & maintaining factors considering to control the insect pests
- Develop and implement IPM program for insect, mite and other vertebrate pests of important crops and stored products
- Obtain knowledge on crop loss assessment in pest infested field and estimation of economic threshold

Intended Learning Outcomes (ILOs) The students will be able to -	**Course Content**	**Teaching Learning Strategies**	**Assessment Strategies**
• Recognize amount and degree of damage of a pest depends on the different factors and • Explain the factors considering to control the insect pests • Illustrate of economic threshold (ET), economic injury level (EIL) and general equilibrium position (GEP)	Economics of pest attack and control	Lecture Visual presentation Discussion Demonstration Field visit Group work	Quiz/MCQ Short answer Essay type answer Report
• Identify and describe nature of damage of major insect, mite and other vertebrate pests of field crops, horticultural crops,	Survey and identification of major insect, mite and other vertebrate pests of field and horticultural crops, and stored products	Lecture Visual presentation Discussion Demonstration Field visit Group work	Quiz/MCQ Short answer Essay type answer Report
• Apply integrated pest management (IPM) program for major crop pests	Development of IPM program for a cereals, fibers, vegetables and fruit plants	Lecture Visual presentation Discussion Demonstration Field visit Group work	Quiz/MCQ Short answer Essay type answer Report

• Demonstrate and describe mass rearing technique of predators and parasitoids for biological control	Mass culture of bio-control agents	Lecture Visual presentation Discussion Demonstration Field visit Group work	Quiz/MCQ Short answer Essay type answer Report
• Identify and describe plant disease vectors of major crops and prescribe their control measures	Identification of insects carrying disease organisms of major crops of Bangladesh	Lecture Visual presentation Discussion Demonstration Field visit Group work	Quiz/MCQ Short answer Essay type answer Report
• Utilize different traps and poison baits used in pest monitoring and IPM	Study on commonly used traps and poison baits for monitoring and management insect pests	Lecture Visual presentation Discussion Demonstration Field visit Lab exercise Group work	Quiz/MCQ Short answer Essay type answer Report
• Demonstrate and estimate crop loss assessment due to pests and analysis cost-benefit ratio	Crop loss assessment in pest infested field Estimation of economic threshold and Cost-benefit analysis	Lecture Visual presentation Discussion Demonstration Field visit Group work	Quiz/MCQ Short answer Essay type answer Report
• Acquaint with organizations related to entomological research	Field visit to different research institute to survey major insect and mite pests of crops	Lecture Visual presentation Discussion Lab and field visit Assignment	Quiz/MCQ Short answer Essay type answer Report

Reference Books

1. Atwaland A.S. and Dhaliwal. G. 2007. Agricultural Pests of South Asia and Their Management. Kalyani Publishers, New Delhi, India. 487p.
2. Singh, A., Sharmaand O.P. and Garg. D.K. 2005. Integrated Pest Management Principle and Applications. CBS Publishers and Distributors, Delhi, India.
3. Hill, D.S. 2008. Agricultural Insect Pests of the Tropics and Their Control. Cambridge University Press, New York, USA.
4. Hill, D.S. 1990. Pests of Stored Products and Their Control. CBS Publishers and Distributors, New Delhi, India.
5. Singerl, M.V. and Richard. C.R. 2000. Manual of Fruit Insects. Biotech Books, Delhi, India.
6. Alam. M. Z 1969. Insect pests of vegetables and their control in East-Pakistan. Agric. Res. Inst., Dacca Farm. Dacca.
7. Nayar, K.K., Ananthakrishnan T.N. and David, B.V 1993.General and Applied Entomology. Tata

McGraw Hill Publ. Co., New Delhi, India.
8. Singh. H.1984. Household and Kitchen Garden Pests Principles and Practices. Kalyani Publishers, New Delhi, India.
9. Ghosh, S.K. and Durbey, S.L. 2010. Integrated Management of Stored Grain Pests. International Book Distributing Co., New Delhi, India.
10. Awasthi. V.B. 2009. Introduction to General and Applied Entomology. Scientific Publishers, Jodhpur, India.
11. Zahirul, I. and David C. 2012. Rice Pests of Bangladesh Their Ecology and Management. The University Press Limited, Dhaka, Bangladesh. 422p.

Course Code: ENTO 509 Course Title: Host Plant Resistance (Elective)	Credit Hour: 03	Semester: January-June

Rationale: This course is designed to developed knowledge on types, basis, mechanisms and genetics of resistance in plants to insects and role of plant resistance in pest management.

Course Outcome

- Obtain knowledge on history and importance of resistance, principles, classification, components, types and mechanisms of resistance.
- Acquire knowledge on Insect-host plant relationships
- Discuss on Chemical ecology
- Achieved knowledge on factors affecting expression of resistance
- Illustrate knowledge on genetics of plant for Resistance to pests and role of plant resistance in pest management.

Intended Learning Outcomes (ILOs) The students will be able to	Course Content	Teaching Learning Strategies	Assessment Strategies
• Obtain knowledge on history of plant resistance • Criticize advantages and constraints of Plant Resistance in Pest Management • Obtain knowledge on principles of host plant resistance • Classify different types of resistance • Elucidate different component of plant resistance • Illustrate the mechanism of resistance	History and importance of resistance, principles, classification, components, types and mechanisms of resistance	Lecture Visual presentation Discussion, Assignment	Quiz/MCQ Short answer Essay type answer Report
• Obtain knowledge on host plant interaction • Acquire knowledge on host plant selection • Illustrate different theories of plant resistance	Insect-host plant relationships; theories and basis of host plant selection in phytophagous insects	Lecture Visual presentation Discussion, Assignment	Quiz/MCQ Short answer Essay type answer Report
• Describe tritrophic relations of host plant resistance • Categorize and describe different volatiles of resistance • Clarify and describe different secondary plant metabolites to insect resistance • Elucidate the role of secondary plant metabolites to insect resistance • Demonstrate the reasons for	Chemical ecology; tritrophic relations, volatiles and secondary plants substances; basis of resistance. Induced resistance - acquired and induced systemic resistance	Lecture Visual presentation Discussion, Assignment	Quiz/MCQ Short answer Essay type answer Report

host plant resistance • Obtain knowledge on Induced resistance - acquired and induced systemic resistance.			
• Elucidate different factors which affects on plant resistance • Discuss different biotypes which affects plant resistance and measures to combat them.	Factors affecting plant resistance including biotypes and measures to combat them	Lecture Visual presentation Discussion, Assignment	Quiz/MCQ Short answer Essay type answer Report
• Describe the screening techniques for resistant of plant • Illustrate different steps to develop resistance varieties • Exploitation of wild plant species • Illustrate the gene transfer technique • Give successful examples of resistant crop varieties in India and world.	Genetics of Resistance	Lecture Visual presentation Discussion, Assignment	Quiz/MCQ Short answer Essay type answer Report
• Role of biotechnology in plant resistance to insects	Role of biotechnology in plant resistance to insects	Lecture Visual presentation Discussion, Assignment	Quiz/MCQ Short answer Essay type answer Report
• Describe the benefit of host plant resistance as a management tool.	Host plant resistance in insect pest management	Lecture Visual presentation Discussion, Assignment	Quiz/MCQ Short answer Essay type answer Report
• To screen the techniques for measuring resistance; • Can measure the plant characters and working out their correlations with plant resistance; • Can Test of resistance inimportant crops; • Demonstrate the bioassay of plant extracts of susceptible/resistant varieties; • Demonstrate of antibiosis, tolerance and antixenosis.	Screening techniques for measuring resistance; measurement of plant Characters and working out their correlations with plant resistance; testing of resistance in important crops; bioassay of plant extracts of susceptible/resistant varieties; demonstration of antibiosis, tolerance and antixenosis.	Lecture Visual presentation Discussion, Assignment	Quiz/MCQ Short answer Essay type answer Report

Reference Books

1. Dhaliwal, G.S. and Singh, R. 2004. Host Plant Resistance to Insects: Concepts and Application. Panima Publishing Corporation, New Delhi.
2. Maxwell, F.G. and Jennings, P.R. 1980. Breeding Plants Resistant to Insect Pests. John Wiley and Sons New York.
3. Panda, N. 1980. Principles of Host Plant Resistance to Insect Pests. Allenheld, London.
4. Panda, N. and Khush, G. S. 1995, Host Plant resistance to Insects. IRRI, Biddles Ltd. Guildford, UK.
5. Pedigo, L.P. and Marlin, E.R. 2009. Entomology and Pest Management, 6th Edition, Person Education Inc., New Jersey, U.S.A.
6. Sadasivam, S. and Thayumanavan, B. 2003. Molecular Host Plant Resistance to Pests. Marcel Dekker Inc. New York.
7. Saleem, M.A. 2005. Insecticide Resistance and Management. B. Z. University Press, Multan, Pakistan.
8. Painter, R.H. 1951. Insect Resistance in Crop Plants. Mc Millan Co., N.Y
9. Leach, J.G. 1997. Insect Transmission of Plant Diseases. Biotech Books, New Delhi, India.
10. Jha, L.K. and Sensarma, P.K. 2008. Forest Entomology. APH Publishing Corporation, New Delhi, India.
11. Ghosh, M.R. 1989. Concepts of Insect Control. Wiley Eastern Ltd., New Delhi, India.

Course Code: ENTO 512 Course Title: Industrial Entomology (Elective)	Credit Hour: 03	Semester: January - June

Rationale: This course approaches both unconventional and conventional insect products, such as honey, silk and lac. It also investigates different aspects of the production of these insects, related processes, problems and utilities.

Course Outcomes:

- Characterize the major components of industrial entomology
- Develop and use silkworm in sericulture industry
- Apply honeybee rearing techniques in field and utilize bee products
- Utilize lac insects in shellac making industry

Intended Learning Outcomes (ILOs) The students will be able to -	Course Content	Teaching Learning Strategies	Assessment Strategies
• Explain and understand the necessity of silkworm rearing • Describe and analyze silkworm external and internal anatomy at different stages of its growth and development • Execute different species of silkworm rearing • Point out different components in silk • Hypothesize silkworm race improvement • Describe and sketch mulberry production and its management	Sericulture: Economic importance; Larval morphology and anatomy of silkworm; External morphology and descriptions of digestive system, glands and reproductive system; Rearing techniques of mulberry-and eri silkworm; Composition of silk; Technique of race improvement; Moriculture-varieties, cultivation and management practices	Lecture Visual presentation Discussion Demonstration Field visit Exercise Group work Assignment	Quiz/MCQ Short answer Essay type answer Report
• Explain and understand the necessity of silkworm rearing • Describe and analyze silkworm external and internal anatomy at different stages of its growth and development • Execute different species of silkworm rearing • Point out different components in silk • Hypothesize silkworm race improvement • Describe and sketch mulberry production and its	Sericulture: Economic importance; Larval morphology and anatomy of silkworm; External morphology and descriptions of digestive system, glands and reproductive system; Rearing techniques of mulberry-and eri silkworm; Composition of silk; Technique of race improvement; Moriculture-varieties, cultivation and management practices	Lecture Visual presentation Discussion Demonstration Field visit Exercise Group work Assignment	Quiz/MCQ Short answer Essay type answer Report

management			
• Explain and understand the importance of lac insect • Describe and analyze lac insect's external and internal anatomy at different stages of its growth and development • Select and perform different species of lac insect rearing • Estimate and utilize lac insect products	Lac-culture, economic importance, biology, culture techniques and lac products	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report

Reference Books

1. Ananthanarayan, S.K. 2012. Silk Reeling. Biotech Book, New Delhi, India.
2. Aruga, H. 1994. Principles of Sericulture. CRC Press. 266p.
3. Awasthi, V.B. 2009. Introduction to General and Applied Entomology. Scientific Publishers, Jodhpur, India.
4. Graham, J.M. 1992. The Hive and the Honey Bee. Dadant and Sons, Hamilton, Illinois
5. Hossain, M.S., Islam, M.N. and Karim, Z. Beekeeping for Better Yield. Ministry of Agriculture, Bangladesh.
6. Jabde, P.V. 2005. Text Book of Applied Zoology, Vermiculture, Apiculture, Sericulture, Lac-Culture, Agricultural Pests and Their Controls. Discovery Publishing Group, India.
7. Kozmus, P., Noc, B. and Vrtacnik, K. 2017. No Bees, No life. Beebooks LLC, Slovenia.
8. Kumar, K.K., Ramani, R. and Sharma, K.K. 2002. Recent Advances in Lac Culture, ILRI, Namkum, Ranchi, India. 290p.
9. Mishra, R.C. 1995. Honey Bees and their Management in India. ICAR Publication, New Delhi. Ananthanarayan, S.K. 2008. Silk Culture. Biotech Book, New Delhi, India.
10. Omkar, O. 2017. Industrial Entomology. Springer, Singapore. 469p.
11. Paul, B., Kumar, S. and Das, A. Lac cultivation & their host trees found in Bastar Forest Division. Plant Sciences Feed, 3 (1): 8-12.
12. Singh, S. 1971. Beekeeping in India. ICAR, New Delhi, India. 13. Veda, K. 1997. Silkworm Rearing. Science Pub Inc. 302p.

Course Code: ENTO 513 **Course Title: Vertebrate Pests**	**Credit Hour: 03**	**Semester: July -December**

Rationale: This course is designed to provide both theoretical and practical knowledge on vertebrate pests those attack on major crops of fields, orchards and storage; their classification, nature of damage and their control measures, transmission of this pest borne diseases in human, crop loss assessment due to rodents, estimation of economic threshold and cost-benefit analysis

Course Outcome

- Obtain knowledge on vertebrate pest management methods for major agronomic and horticultural crops, forest plants, storage products.
- Acquire knowledge on establishing & maintaining factors considering to control the vertebrate pests.
- Obtain knowledge on crop loss assessment in rodent infested field, orchards and storage
- Develop and implement IPM program for vertebrate pests of important crops and stored products.

Intended Learning Outcomes (ILOs) Students will be able to -	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Recognize the Concepts of Vertebrate pests	Concepts of Vertebrate pests	Lecture Visual presentation Discussion Demonstration Field visit Group work	MCQ/Quiz Short answer Demonstration performance Report Assignment
• Recognize and describe The biotic community or Ecosystem	The biotic community or Ecosystem	Lecture Visual presentation Discussion Demonstration Field visit	MCQ/Quiz Short answer Demonstration performance Report Assignment
• Recognize and describe Ecological Life-history Studies	Ecological Life-history Studies, biology of rodents	Lecture Visual presentation Discussion Demonstration Field visit	MCQ/Quiz Short answer Demonstration performance Assignment
• Recognize and describe the Ecology and Behaviour of rodents	Ecology and Behaviour of rodents; introduction, habitat, population dynamics (Competition, predation, weather and reproduction etc.)	Lecture Visual presentation Discussion Demonstration Field visit	MCQ/Quiz Short answer Demonstration performance Assignment
• Identify and describe different Vertebrate pests and Characteristics of rodent pest	Classification of Vertebrate pests and Characteristics of rodent pest such as gnawing, burrowing, new object reaction etc.	Lecture Visual presentation Discussion Demonstration	MCQ/Quiz Short answer Demonstration performance Report

		Field visit Group work	Assignment
• Recognize and describe Damage to field crops	Damage to field crops (cereals, sugarcane, fibers, vegetables, fruit plants and others	Lecture Visual presentation Discussion Demonstration Field visit Group work	MCQ/Quiz Short answer Demonstration performance Report Assignment
• Demonstrate and Apply different technique of damage assessment in different crop fields	Techniques for rodent studies: Objectives of Assessment; Method of damage assessment in different crop fields	Lecture Visual presentation Discussion Demonstration Field visit Group work	MCQ/Quiz Short answer Demonstration performance Report Assignment
• Identify and describe the rodent pests of Bangladesh in major crops and house hold product	Identification of rodent pests of Bangladesh	Lecture Visual presentation Discussion Demonstration Field visit Group work	MCQ/Quiz Short answer Demonstration performance Report Assignment
• Utilize different traps and poison baits used in pest monitoring and IPM	Control of rodent pests : principle of control; types of control – non chemical and chemical control and integrated pest management	Lecture Visual presentation Discussion Demonstration Field visit Lab exercise Group work	MCQ/Quiz Short answer Demonstration performance Report Assignment
• Demonstrate and estimate crop loss assessment due to pests and analysis cost-benefit ratio	crop loss assessment in pest infested field; Cost-benefit analysis	Lecture Visual presentation Discussion Demonstration Field visit Group work	MCQ/Quiz Short answer Demonstration performance Report Assignment
• Acquaint with organizations related to entomological research	Field visit to different research institute to survey major vertebrates pests of crops	Lecture Visual presentation Discussion Lab and field visit Assignment	MCQ/Quiz Short answer Report Viva-voce

Reference Books

1. Buckle, A.P. and Smith, R.H. 2015. Rodent Pests and their Control. 2nd Edition. CABI, UK. 434p.
2. Ghosh, S.K. and Durbey, S.L. 2010. Integrated Management of Stored Grain Pests. International Book Distributing Co., New Delhi, India.
3. Hill, D.S. 2008. Agricultural Pests of the Tropics and their Control. Cambridge University Press, New York, USA.
4. Hill, D.S. 1990. Pests of Stored Products and their Control. CBS Publishers and Distributors, New Delhi, India.
5. Singerl, M.V. and Richard, C.R. 2000. Manual of Fruit Pests. Biotech Books, New Delhi, India.
6. Singh, H. 1984. Household and Kitchen Garden Pests: Principles and Practices. Kalyani Publishers, New Delhi, India.

Course Code: ENTO 520 Course Title: Research Methodology and Data Analysis (Elective)	Credit Hour: 03	Semester: July-December

Rationale: This course is designed to develop knowledge on statistical concepts and components of entomological research; purposes and planning; qualities and classification of research; steps in experimental research; sampling techniques; layout and randomization of experiments; types of experimental design; factorial experiments; data transformation, correlation and regression analysis; survey methodology, methods of data collection, calculation and processing of data; statistical computer packages for analysis of experimental data and interpretation of research results; instructions in Thesis/Dissertation, scientific paper writing.

Course Outcomes:

- Acquire knowledge on statistical concepts and components of entomological research; purposes of conducting research, planning of research and identification of researchable problems; qualities and classification of research; steps in experimental research;
- Gain knowledge on sampling techniques-simple random sampling, stratified random sampling, systemic sampling, and cluster sampling;
- Attain knowledge on basic principles of experimental design, layout and randomization of experiments; types of experimental design; factorial experiments;
- Acquire knowledge on data transformation, correlation and regression analysis;
- Gain knowledge on survey methodology, methods of data collection, calculation and processing of data;
- Acquire knowledge on instructions in Thesis/Dissertation, scientific paper writing;
- Acquire knowledge on statistical computer packages for analysis of experimental data and interpretation of research results.

Intended Learning Outcomes (ILOs) The students will be able to -	Course Content	Teaching Learning Strategies	Assessment Strategies
• Define research and illustrate the purposes and desirable characteristics and qualities of research; identify the researchable problems; • Classify the research; characterize and differentiate the basic and applied research; • Characterize and explain the various stages of research	Statistical concepts and components of entomological research; purposes of conducting research, planning of research and identification of researchable problems; qualities and classification of research; steps in experimental research	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer Report
• Define population, sampling and other related terms • Classify sampling techniques and elucidate simple random sampling, stratified random sampling, systemic sampling, cluster sampling and other sampling techniques	Sampling techniques-simple random sampling, stratified random sampling, systemic sampling, and cluster sampling	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report

• Explain basic principles of experimental design, layout and randomization of experiments • Classify the experimental design; and describe Completely randomized design (CRD), Randomized completely block design (RCBD) and Latin square design (LSD); compute the problems on CRD, RCBD and LSD; describe the missing plot techniques • Classify the factorial experiments and describe the split and strip plot design; and compute the problems on split and strip plot design	Basic principles of experimental design, layout and randomization of experiments; types of experimental design; factorial experiments	Lecture Visual presentation Discussion Field visit Assignment	Quiz/MCQ Short answer Essay type answer Report
• Describe the necessity and types of data transformation • Define correlation and regression analysis; describe the characteristics and uses of correlation and regression analysis	Data transformation, correlation and regression analysis; analysis of variance	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer Report
• Classify survey methods; describe the methods of data collection; calculate and process the collected data	Survey methodology, methods of data collection, calculation and processing of data	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Formulate and describe the instructions in Thesis/ Dissertation and scientific paper writing	Instructions in Thesis/Dissertation, scientific paper writing	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Analyze the experimental data using suitable statistical computer packages • Interpretate the research results	Statistical computer packages for analysis of experimental data and interpretation of research results	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer Report

Reference Books

1. Fowler, J. Cohen, L. and Jarvis, P. 1998. Practical Statistics for Field Biology. Wiley Interscience, John Wiley and Sons Inc., New York. 272pp.
2. Gomez, K.A. and Gomez, A.A. 1984. Statistical Procedures for Agricultural Research. Wiley Interscience, John Wiley and Sons Inc., New York. 691pp.
3. Mason, R.L., Gunst, R.F. and Hess, J.L. 2003. Statistical Design and Analysis of Experiments. Wiley Interscience, John Wiley and Sons Inc., New York. 746pp.

4. Montgomery, D.C. 2012. Design and Analysis of Experiments. Wiley Interscience, John Wiley and Sons Inc., New York. 612pp.
5. Shalabh, H.T. 2009. Statistical Analysis of Designed Experiments. Third Edition, Springer, New York. 624pp.
6. Snecdecor, G.W. and Cochran W.G. 1989. Statistical Methods. Blackwell Publishing Professional, State Avenue, Ames, Iowa. 524pp.
7. Steel, R.G.D. and Torrie, J.H. 2007. Principles and Procedures of Statistics. McGraw-Hill Book Company, New York.
8. Zaman, S.M. Rahim, H.K. and Howlader, M. 1982 Simple Lessons from Biometry. Bangladesh Rice Research Institute, Joydebpur, Gazipur, Bangladesh. 169pp.

Department of Genetics and Plant Breeding

Course Layout

Sl. No.	Course Code and Title	Cr. Hrs
A. Compulsory Courses		
1	GEPB 501: Genetics and Embryology	3
2	GEPB 502: Principles of Plant Breeding	3
3	GEPB 503: Biometrical and Population Genetics	3
4	GEPB 504: Advanced Cytogenetics	3
5	GEPB 505: Molecular Genetics	3
6	GEPB 506: Breeding for Field Crops	3
	Total	18
B. Elective Courses		
7	GEPB 507: Advanced Heterosis Breeding	3
8	GEPB 508: Experimental Design and Data Analysis	3
9	GEPB 509: Development of Physiological Genetics	3
10	GEPB 512: Breeding for Horticultural Crops	3
11	GEPB 514: Chromosome Engineering and Molecular Plant Breeding	3
12	GEPB 515: Plant Tissue Culture	3
13	GEPB 517: Molecular Ecology	3
14	GEPB 518: Genomics and Bioinformatics	3
15	Or Related course from other Departments	3
	Minimum	**12**
C. Seminar Course		
16	GEPB 598	01
D. Thesis Research		
17	GEPB-599	16

Compulsory Courses	**18**
Elective Courses	**12**
Seminar Course	**01**
Thesis Research	**16**
Total	**47**

Curriculum Alignment / Skill Mapping

Curriculum must be aligned with program objectives, program learning outcome and intended learning outcomes through proper skill mapping.

Department of Genetics and Plant Breeding

Courses	Program Learning Outcome							
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
GEPB 501	x	x	x	x	x		x	x
GEPB 502	x	x	x	x	x	x	x	x
GEPB 503	x	x	x	x	x		x	x
GEPB 504	x	x	x	x	x		x	x
GEPB 505	x	x	x	x	x	x	x	x
GEPB 506	x	x	x	x	x		x	x
GEPB 507	x	x	x	x	x		x	x
GEPB 508	x	x	x	x	x	x	x	x
GEPB 509	x	x	x	x			x	x
GEPB 512	x	x	x	x			x	x
GEPB 514	x	x	x	x		x	x	x
GEPB 515	x	x	x	x			x	x
GEPB 517	x	x	x	x			x	x
GEPB 518	x	x	x	x				x
GEPB 598						x	x	
GEPB 599					x	x	x	x

Course Code: GEPB 501 Course Title: Genetics and Embryology (Compulsory)	Credit Hour: 03	Semester: July-December

Rationale: This course is designed to provide fundamental in-depth knowledge on genetics and embryology in relation to improvement of the crop plants.

Course Outcomes:

- Conceptualize Mendelism and its modification.
- Explain multiple alleles, incompatibility, sex determination, mutation, linkage, crossing over, apomixis, extranuclear inheritance and their use in plant breeding.
- Discuss the structure of DNA and RNA, their replication, protein synthesis, transcription, translation, genetic code, gene regulation and silencing.
- Interpret the gametophytic generation of angiosperm; development of male and female gametes, fertilization and formation of fruits, seed and embryo.
- Convey the message about factors affecting embryo abnormalities and degeneration; problem associated with interspecfic hybridization in relation to development and ways to circumvent them.
- Explain the apomixis and polyembryony – basis of cytology and implication.

Intended Learning Outcomes (ILOs) The students will be able to-	Course Content	Teaching-Learning Strategies	Assessment Strategies
• Explain the Pre-Mendelian, concept • State and explain the Mendel's Laws of inheritance with their modifications • Discuss with their application on penetrance, expressivity, phenocopies, pleiotropism, xenia and metaxenia	Critical review of Mendelism Gene expression, penetrance and expressivity, phenocopies and pleiotropism, xenia and metaxenia	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Explain concept of multiple allele • Express the characteristics of multiple allele with examples • Explain the multiple alleles in human blood group and the donor-recipient compatibility • Represent the self sterility and self incompatibility in *Nicotiana* • Explain pseudoallelism with example • Illustrate the complementation test to determine whether two independently isolated mutations with the same phenotype have affected the same or different genes	Multiple alleles; inheritance of multiple alleles, self incompatibility	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer

• Describe the cytoplasmic or extra-chromosomal inheritance • Explain maternal effect with examples • Narrate the characteristics of chloroplast and mitochondrial genome • Compare and contrast the nuclear and extra-nuclear genomes • Explain the function of chloroplast and mitochondrial genes • State the male sterility with different mating system • Classify different types of male sterility • Sketch the transfer of male sterility to a new strain	Extranuclear inheritance; mitocondrial and chloroplast genomes, male sterility and its use in plant breeding	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer
• Explain concept and history of mutation • Classify types of mutation on different basis • Demonstrate chromosomal mutation with their effects or syndrome • Express the molecular basis of gene mutation including substitution mutation • Explain the action mechanism of physical and chemical mutagens • Sketch the excision-repair pathways after DNA damage	Molecular basis of mutation, mutagens and its action mechanism at molecular level	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer
• Explain the concept, history and structure of DNA • Demonstrate replication in prokaryote and eukaryote • Sketch the patterns of DNA replication	Fine structure of DNA and RNA and their replication in prokaryotes and eukaryotes	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Describe the RNA, their types, central dogma of genetics • Explain genetic code, its degeneracy and wobble rule	Genetic code, basis of cryptoanalysis, codon assignment, characteristics of genetic code, anticodon and wobble hypothesis	Lecture Visual presentation Discussion, Assignment	Quiz/MCQ Short answer Essay type answer

• Describe the steps of control of gene expression in prokaryote and eukaryote • Explain the negative and positive control of *lac* operon • Illustrate the constitutive mutations in operon • Explain the cis- and trans-control of transcription including core promoter elements and transcription factors in eukaryote • Clarify the cis-regulation by DNA methylation and trans-regulation by hormones	Gene regulation at transcriptional and translation level		
• Explain the genetics of sexual and growth phase of angiosperm and apply the knowledge in crop improvement	Gametophytic generation of angiosperm	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Explain the process of development of anther, sporogenous tissue, microspores, pollen grain and male gamete • Explain the cause of male sterility	Development of anther, microsporogenesis and microgametogenesis	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Explain the process of development of ovule, megaspore, female gametophyte (embryo sac) and female gamete • Explain types of ovule.	Development of carpel, ovule, megaspore, female gametophyte and female germ unit	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Explain the genetics of sexual and growth phase of angiosperm and apply the knowledge in crop improvement	Gametophytic generation of angiosperm	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Explain the process of development of anther, sporogenous tissue, microspores, pollen grain and male gamete • Explain the cause of male sterility	Development of anther, microsporogenesis and microgametogenesis	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report

• Explain the problem associated with distant hybridization in respect to pre and post fertilization • Apply the knowledge to circumvent them in relation to the development of embryo • Take the measure to overcome pre and post fertilization in relation to the development of embryo	Problem associated with distant hybridization	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Explain pathway, mechanism and genetics of apomixis • Compare between sexual and apomictic reproduction • Identify apomictic plant and perform apomixis breeding • Explain developmental process of different type of polyembryony • Describe genetic aspects of polyembryony	Apomixis and polyembryony - basis of cytology and implication and its molecular aspects	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Explain the latest research findings and information of genetics and embryology	Latest research findings and information regarding genetics and embryology	Assignment Group work Presentation Research Organization visit	Report Presentation performance

Reference Books

1. Brooker J.B. 2018. Genetics: Analysis and Principles 6th Edition. New York NY: McGraw Hill Education.
2. Benjamin A. P. 2016. Genetics: A Conceptual Approach Sixth Edition
3. Hartwell L., Goldberg M.L., Fischer J., Hood L. 2005.Genetics: From Genes to Genomes 6th Edition. McGraw-Hill Education.
4. Gupta, P.K. 2005. Genetics. Rastogi Publications.
5. Johri B.M., Ambegaokar K.B., Srivastava P.S. 1992. Comparative Embryology of Angiosperms, Volumes 1-2. Springer-Verlag.
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7. Griffiths A.J.F, Miller JH, Suzuki DT, et al. 2000. An Introduction to Genetic Analysis. 7th edition.
8. Jerling A.S.L. 1992. Apomixis in Plants. CRC Press.
9. Nelson D.L. 2005. Lehninger's Principles of Biochemistry.
10. Freeman W.H., Russell P.J. 1996. Essential Genetics. Blackwell Scientific Publ.
11. Schleif R.1986. Genetics and Molecular Biology. Addison-Wesley Publ. Co.

Course Code: GEPB 502 Course Title: Principles of Plant Breeding (Compulsory)	Credit Hour: 03	Semester: July- December

Rationale: This course is designed to provide fundamental in-depth knowledge on principle of plant breeding in relation to improvement of the crop plants.

Course Outcomes:

- Explain the scope, aims and evolutionary aspects of plant breeding.
- Narrate genetic makeup, behavior, consequence of self and cross pollinated crop plants.
- Express the views on plant genetic resources, their use, management and intellectual property rights.
- Interpret gene action, and genetic structure of self and cross pollinated crops.
- Compare conventional and advanced breeding methods of self and cross pollinated as well as asexually propagated crops.
- Explain the variety trail, registration and release procedures.

Intended Learning Outcomes (ILOs) The students will be able to-	Course Content	Teaching-Learning Strategies	Assessment Strategies
• Interpret the scope and area of plant breeding. • Narrate the strategy and goal of plant breeding	Aims, objectives and scope of plant breeding	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Illustrate the history of breeding for different crop plants • Demonstrate the evolutionary aspect of modern cultivar of different crop plants	Evolutionary pattern of crop plants	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Narrate the activities of conservation and management of PGR • Criticize the policies and procedures of IPR and participatory plant breeding	Sources of variability-plant genetic resources (PGR), their use and management, and intellectual property rights and participatory plant breeding	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Explain the genetic structure, consequence of SP and CP and vegetative propagated crops • Justify and evaluate the role pollination behavior in developing crops varietal types	Genetic structure of self (SP) and cross (CP) pollinated crops	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer

• Narrate the different types of gene action for SP and CP • State the importance and application of gene actions in crop plants • Explain how the gene actions play role in phenotypic and genotypic variations, heritability and genetic gain • Dissect the application of gene action in selection and breeding procedure	Gene action- additive, dominance and interaction	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Explain and narrate the principles of deferent breeding methods of SP and CP and asexually propagated crops • Illustrate the breeding methods with their applications and limitations • Design and plan a breeding program for developing pure line, open-pollinated and hybrid, synthetic and composite varieties of the crops • Describe and justify the application the modern techniques viz. Polyploidy breeding, mutation breeding, genetic engineering, MAS, etc. in improvement of the crops • Narrate the conventional and modern breeding strategies in developing biotic and abiotic resistance / tolerance varieties of the crops	Breeding for self pollinated, cross pollinated and asexually propagated crops. Polyploidy breeding, mutation breeding, genetic engineering etc. Marker assisted selection (MAS), breeding for biotic and abiotic stress tolerance in crops	Lecture Visual presentation Discussion Visiting of Field & research stations Demonstration of hybridization Selection procedure at field/lab research data collection procedure	Quiz/MCQ Short answer Essay type answer
• Narrate importance of sex expression in relation to crop improvement • Explain the genetic mechanisms of sex expression in crop plants • Make a plan stepwise the whole procedure of variety release	Sex expression and its use in crop improvement Variety release. Maintenance breeding	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer

• Describe how to maintain the released varieties of SP and CP crops			
• Explain the latest research findings and information of principles of plant breeding	Latest research findings and information regarding principles of plant breeding	Assignment Group work Presentation Research organization visit	Report Presentation Performance

Reference Books

1. Singh, B.D. 2006 Plant Breeding-Principles and Methods. 7th Edn. Kalyani Publishers., New Delhi
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13. Simmonds NW. 1990. Principles of Crop Improvement. English Language Book Society.
14. Singh P. 2002. Objective Genetics and Plant Breeding. Kalyani Publishers.
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Course Code: GEPB 503 Course Title: Biometrical and Population Genetics (Compulsory)	Credit Hour: 03	Semester: January-June

Rationale: This course is outlined to provide a good deal of information on various biometrical techniques in relation to assessment of variability, selection of elite genotypes, choice of desirable parents and breeding procedure for improvement of crop plants.

Course Outcomes:

- Describe different biometrical principles and techniques used in assessment of genetic parameters.
- Enumerate the selection procedure of elite genotypes from diverse genetic population.
- Explain the desirable features of parents and segregating liens in breeding programs.
- Conceptualize the different mating designs and their applications used in crop improvement programs.
- Explain varietal adaptability and G×E interactions.
- Conceptualize the population structure and analyze the gene and genotypes frequency in populations.

Intended Learning Outcomes (ILOs) The student will able to-	Course Content	Teaching – Learning Strategies	Assessment Strategies
• Estimate the frequency of gene and genotypes • Determine genetic similarities and distances	**Gene in populations**: Frequency of gene and genotypes, genetic similarity and genetic distance	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Define the polymorphism • Describe the classification of polymorphism	**Polymorphism**	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Analyze the different methods of analysis the different quantitative characters • Illustrate different biometrical methods related to advance statistics	**Quantitative genetic analysis and biometrical approach**	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Describe the different types of gene action • Estimate the Mather Scaling test	**Additive and dominance effect of gene**: Components of means, components of variation, testing the additive–dominance model and scaling test	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Define allelic and non-allelic gene action • Estimate heterosis and its biometrical basis	Non-allelic interaction and genetic analysis- biometrical basis of heterosis.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Describe the genetic divergence and genetic distance • Determine the genetic distance among the genotypes	**Multivariate analysis of genetic divergence**	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer

• Illustrate different types of heritability • Estimate the heritability and determine the factors influencing heritability • Describe the advantages and limitations of heritability • Define co-heritability and genetic advance and their advantages and disadvantages	**Heritability and genetic advance:** Types of heritability, estimation of heritability, factor influencing heritability, advantages, limitations, co-heritability, genetic advance, advantages and disadvantages	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Illustrate the transmissible, and conducting effect and non-transmissible interaction effect • Determine the patterns for measurement of genotype-environment interactions • Conclude G×E interactions implications	**G×E interaction:** Transmissible and conducting effect, non-transmissible interaction effect, patterns for measurement of G×E interaction and implications	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Illustrate the main points of stability and adaptation • Find out causes of adaptation • Describe different models of stability and its analysis • Interpret the application of stability in crop improvement	**Analysis of adaptation and stability:** Main points of stability, adaptation, causes of adaptation, models of stability analysis and application in crop improvement	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Analyze the top cross and polycross • Describe Line × Tester analysis	**Analysis of gene interaction and variance components:** Top cross, polycross design and Line Tester analysis	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Illustrate the different types of diallel cross, main features and advantages and disadvantages • Differentiate full and half diallel • Describe the different approaches of diallel analysis • Compute partial diallel analysis	**Diallel Mating Design and analysis:** Types of diallel cross, main features, advantage, disadvantage, difference between full and half diallel, approaches of diallel analysis, Hayman's Graphical Approach, Griffing's Numerical Approach and partial diallel analysis	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Discuss on different types of combining ability • Interpret the result of combining ability, heritability and heterosis • Describe the merits and demerits of combining ability	**Combining ability:** Types and estimation of combining ability, interpretation of results, combining ability and heritability, combining ability and heterosis, merits and demerits	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer

• Explain biparental mating design and its features • Describe the different methods of North Carolina Design • Compare the different North Carolina Design • Describe the merits and demerits of biparental mating design	**Biparental Cross:** Main features, design of biparental mating, North Carolina Design-1, North Carolina Design-2, North Carolina Design-3, comparison of three design, merits and demerits	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Describe correlated response • Illustrate the selection index	**Correlated response and selection index**	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Explain the latest research findings and information of Biometrical and Population Genetics	Latest research findings and information regarding biometrical and population genetics	Assignment Group work Presentation Research organization visit	Report

References Books

1. Barry G. Hall 2011. Phylogenetic Trees Made Essay A how -To Manual Fourth Edition. Sinauer Associates, Inc.
2. David J Glass 2014. Experimental Design for Biologists. 2nd ed. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
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5. Falconer DS & Mackay J. 1998. Introduction to Quantitative Genetics. Longman.
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7. Mather K & Jinks JL. 1983. Introduction to Biometrical Genetics.
8. Chapman & Hall. Nadarajan N & Gunasekaran M. 2005. Quantitative Genetics and Biometrical Techniques in Plant Breeding. Kalyani.
9. Naryanan SS & Singh P. 2007. Biometrical Techniques in Plant Breeding. Kalyani.
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11. Singh RK & Choudhary BD. 1987. Biometrical Methods in Quantitative Genetics. Kalyani.
12. Weir DS. 1990. Genetic Data Analysis. Methods for Discrete Population Genetic Data. Sinauer Associates.
13. Wricke G & Weber WE. 1986. Quantitative Genetics and Selection in Plant Breeding. Walter de Gruyter.
14. Nadarajan N & Gunasekaran M. 2005. Quantitative Genetics and Biometrical Techniques in Plant Breeding. Kalyani.
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16. Singh RK & Choudhary BD. 1987. Biometrical Methods in Quantitative Genetics. Kalyani.

Course Code: GEPB 504 Course Title: Advanced Cytogenetics (Compulsory)	Credit Hour: 03	Semester: January-June

Rationale: This course is designed to provide basic and applied knowledge on advanced cytogenetics in relation to agricultural crops.

Course Outcomes:

- Explain the concept, scope, and application of cytogenetics in crop improvement
- Describe about structural and numerical variation in chromosomes, their genetic consequences and role in speciation.
- Interpret haploid and polyploid, their cytogenetic behaviour and role in crop improvement.
- Accomplish knowledge on evolution of major crops.
- Elucidate the alien gene transfer through chromosome manipulation.
- Explain the cytogenetical basis of self-incompatibility and male sterility with their application in plant breeding.

Intended Learning Outcomes (ILOs) The students will be able to-	Course Content	Teaching-Learning Strategies	Assessment Strategies
• Interpret the cell, chromosome and genetically important cell organelles • Narrate the role of chromosome in Biological world • Describe the morphology of a chromosome • Explain the roles of DNA and RNA and differentiate between DNA and RNA State the components and types of DNA • Describe the chemical structure of DNA and RNA. • Illustrate the conversion of DNA packages into chromosomes • Describe Watson and Crick's three--dimensional model	Concept, scope, and application of cytogenetics in crop improvement	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Narrate the genes and chromosomes • Express the terminologies related to variations in chromosome structure • State the principles associated with variations in chromosome structure • Classify the different types of structural variation in	Structural variation in chromosomes and their genetic consequences	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer

chromosome • Describe different structural variation with examples • Narrate the effects of chromosomal changes on the phenotype of the organism			
• Explain the principles and terminology associated with variations in chromosome numbers • Classify the different types of numerical changes of chromosome • Illustrate the development of aneuploids • State the effects of chromosomal variation on the phenotype of the organism. • Explain the cytogenetic consequences of aneuploids • Specify the application of polyploidy in agriculture	Numerical variation in chromosome and their cytogenetic consequences	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Describe the permanent inversion in chromosome • Explain Robertsonian translocation in heterozygotic condition • Illustrate translocation heterozygotes create in new speciation • Explain the different examples of speciation's	Permanent inversion in chromosome and translocation heterozygosity, their role in speciation	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Narrate the terminology and importance of haploids in Plant breeding • Compare and contrast between haploid and diploid • Illustrate stages in plant life cycle where haploid induced • Explain the origin occurrence and production of haploids • Demonstrate the meiotic behaviour of haploids • Explain phenotypic effects of haploidy • Narrate the processes leading to production of haploid plants • Describe the factors affecting	Haploid – its production, behavior and use in plant breeding	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer

the development of haploid plants *in vitro* • Explain the application of haploid in plant breeding • Show the production of doubled haploids and justify the applications of DHs in plant breeding			
• State the concept and types of the polyploidy • Illuminate the origin and occurrence of auto and allo-polyploids in natures. • Explain phenotypic effects of auto and allopolyploids • Describe the advantages and disadvantages of auto- and allopolyploidy • Narrate the use of autopolyploid in plant breeding • Explain the importance in evolution and ultimate fate • Describe the role of polyploidy in crop improvement	Polyploids-autopolyploids and allopolyploids, cytogenetic behavior and their role in crop improvement	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Explain the concept of cytogenetics, phylogeny and evolution including the different analysis of banding and molecular cytogenetics such as FISH and CGH • Elucidate the ploidy groups, taxonomic status, phylogeny of polyploid wheats and the evolutionary aspects of diploid, tetraploid and hexaploid wheat and *Aegilops* species • Explain the species groups of *Oryza* and their relationship including haploid, polyploid and aneuploid, their aberrant meiotic behavior and chromosome aberrations • Narrate and validate the genus *Brassica* of diploid and amphidiploid species, their evolution and *Brassica-Arabidopsis* comparative genomics	Evolution of major crops like wheat, rice, brassica, maize, cotton and sugarcane	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report

• Illuminate the evolutionary history of maize, its varieties, transposon, variegation, *Ac/Ds*, *En/Spm* and *Mu/MuDR* (mutator) elements in maize • Explicate the classification of cotton based on ploidy level, characteristics of African-Asian diploids and new-world tetraploids, rapid diversification and speciation, A-genome perspectives and allopolyploidization of cotton • Narrate the high ploidy level and aneuploidy in sugarcane, different species, mobilization and interspecific intrachromosomal recombination in modern sugarcane cultivars			
• Express the importance of alien gene transfer through wide hybridization and chromosome manipulation • Illustrate with examples about the methods of alien gene transfer • Represent the use of alien chromatin in hybrid • Explain how to characterize and monitor the alien chromatin by biochemical and molecular markers	Alien gene transfer through chromosome manipulation	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Classify the aneuploid, Aneuploids in diploids and polyploids, trisomics and tetrasomics in polyploidy crops • Explain the monosomics and nullisomics in polyploids as well as in diploids	Cytogenetic behaviour and use of aneuploids in crop improvement	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Deliver idea about the meiotic behavior of economically important plant species and the relationship with male sterility • Express the views of classical and molecular diversity of SI system, cytogenetic behavior of the S locus as a complex	Cytogenetical basis of self-incompatibility and male sterility with their application in plant breeding	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report

multigenic locus and use in plant breeding			
• Explain the latest research findings and information of advanced cytogenetics	Latest research findings and information regarding advanced cytogenetics	Assignment Group work Presentation Research organizations visit	Report

Reference Books

1. Verma, P.S. and Agarwal, V.K. 2005. Cytology. S. Chand & Company ltd., New Delhi.
2. Wilson, G.B. and Morrison, J.H. 1961. Cytology. Reinhold Publishing Corporation, NewYork.
3. Gupta, P.K. 2007. Cytogenetics. 2nd Edn. Rastogi Publications, *New Delhi.*
4. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Lesick, R. 2004. *Molecular Biology of the Gene. 5th Edn.* Benjamin Cummings, San Francisco.
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10. Sinha, U. 1998. Cytogenetics, Plant Breeding and Evolution. Vikas Pub. Ho. Pvt. Ltd., New Delhi.
11. Bahl, P.N. and Saimath. 1996. Genetics, Cytogenetics and Breeding of Crop Plants: Pulses and Oilseeds. Science Pub. Inc., USA.
12. Moore, D.M. 1976. Plant Cytogenetics. Chapman and Hall. London.
13. Akhtaruzzaman, M. 1997. Koshbidhya. 3rd Edn. Hassan Book House, Dhaka.
14. Sharma, A. 1976. The Chromosomes. Oxford & IBH Pub. Co., New Delhi.
15. Pagliarini, M.S. 2000. Meiotic behavior of economically important plant species: the relationship between fertility and male sterility. Genetics and Molecular Biology. 23(4): 997-1002.
16. Dixit, R. and Nasrallah, J.B. 2001. Recognizing self in the self-incompatibitlity response. Plant Physiology. 125:105-108.

Course Code: GEPB 505 Course Title: Molecular Genetics (Compulsory)	Credit Hour: 03	Semester: July – December

Rationale: This course is designed to provide fundamental and applied knowledge on principles and applications of molecular genetics in relation to improvement of the crop plants.

Course Outcomes:

- Describe the scope and aims of molecular genetics in relation to crop improvement.
- Narrate structure, function and behavior of gene and gene expression and regulation in eukaryotic and prokaryotic cells.
- Implement and use tools and techniques of molecular biology and know the working principles and applications in relation to crop improvement.
- Describe gene cloning, expression vectors, cloning steps, selection and transformation systems.
- Apply the knowledge of MAS and QTL analysis in relation to crop improvement.
- Interpret gene sequencing and next generation sequencing (NGS) principles and analysis the sequencing data.
- Narrate the genetic interactions between nucleus, chloroplast, mitochondria and transposons elements.

Intended Learning Outcomes (ILOs) The students will be able to-	Course Content	Teaching-Learning Strategies	Assessment Strategies
• Stretch the history of molecular genetics • Describe the contributions of different molecular biologists • Interrelate among molecular iology, genetics, cytogenetics, molecular breeding etc.	Introduction to molecular genetics	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Enumerate the different parts of a gene with their roles and regulation in gene expression • Describe the gene expression in relation to up or down regulated genes	Fine structure of gene	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Explain steps of protein synthesis, phases of transcription, post transcriptional modification and translation, post translational modification in eukaryotic and prokaryotic cells • Narrate the different modifications of post-transcription and post-translations with their	Gene function-transcription and post transcriptional modification, translation and post translational modification	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer

functions in gene expression and regulation • Decipher the roles of different transcriptional factors and its roles in plant growth and development and tolerance and resistance to biotic and abiotic stresses			
• Describe the different types of restriction endonuclease (RE) and their roles in genetic engineering • Illustrate the molecular mechanisms of different types of REs with suitable examples • Differentiate between RE and me methlylase enzymes • Construct genetic maps with the reference genes • Describe the applications of gene mapping in identifying genes	Restriction endonuclease, restriction mapping	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Describe the different types of molecular markers and their characteristics • Design the primers of different molecular markers to use in specific markers • Narrate the uses and roles of specific molecular markers in identifying plant species, early expressing genes in breeding methods • Elucidate the uses of molecular markers in MAS in breeding program	Molecular markers and their application in crop improvement	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Describe the principles of Southern, Northern and Western bolt analyses • Differentiate the working procedures and evaluate of these methods of genetic analysis • Narrate the principles of constructing of cDNA and genomic libraries with reference crop plants species	DNA probe, Southern and Northern blot, cDNA and genomic library. Method of genetic analysis	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer

• Evaluate of these genetic analysis procedure to use in reference genes and in specific crop plants			
• State the principles of genes isolating, identification, amplification and cloning of reference gene(s) of crop plants • Describe the procedure of gene cloning, confirmation and selection of the clones into the vectors • Evaluate in selecting of different cloning vectors, expressing vectors and plant expression vectors • Design an experiment starting from isolation, cloning to expression of gene(s) of interest	Gene cloning-conventional and modern method of gene identification and isolation, different types of vectors gene insertion into vectors, selection of transformants use of markers in the transformant selection	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Describe the different methods of DNA sequencing with their advantages, disadvantages and applications • Narrate the basic mechanisms of Sanger's and Maxam and Gilbert sequencing methods • Describe and evaluate different high-throughput sequencing methods and their usages in molecular biology and plant breeding • Analysis DNA and RNA sequencing data • Principles of oligos (primers) and gene synthesis	DNA sequencing and gene synthesis	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Describe the interactions among nucleus, chloroplast and mitochondria • Illustrate the mechanism how the genetic material transfer and shuttle among the nucleus, chloroplast and mitochondria organelles • Explain how nucleus communicates with	Genetic interactions between nucleus, chloroplast and mitochondria; Transport of unclearly encoded products into organelles	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer

chloroplast thorough signaling • Narrate the roles and mechanisms of these types of interactions in male sterility, resistance and tolerance of biotic and abiotic stresses			
• Describe the different transposable elements in reference to crop plants (e.g. maize) • Illustrate the working mechanism of transposable elements in Maize plants • Explain how the transposable elements cause mutations and effect on other genes expressing • Describe the retrotransposon element and describe their influences on crop plants	Transposable elements their characteristics and use	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Explain gene silencing and types and applications of gene silencing • Describe the mechanisms of siRNA and miRNA mediated gene silencing and gene regulation plants • Conceptualize the genome editing in reference of plants • Categorize different kinds of genome editing methods with the basic mechanisms • Describe the CRISPR/CAS9 mediated genome editing methods with reference to corps plants	Gene silencing and genome editing	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Explain the latest research findings and information of Molecular Genetics	Latest research findings and information regarding genetics and embryology	Assignment Group work Research organizations visit	Report, presentation

Reference Books

1. Krebs, J.E., Lewin, B., Goldstein, E.S. Kilpatrick, S.T. 2015. Lewin's Genes XI. Jones & Bartlett Publishers.
2. Clark, D and Pazdernik, N. 2013. Molecular Biology. 2nd Edition. Elsevier.
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9. Buchanan B.B., Gruissem W., Jones R.L. 2015. Biochemistry and Molecular Biology of Plants. 2nd Edition. Wiley.
10. R. L. Jones, H. Ougham, H Thomas, S Waaland. 2012. The Molecular Life of Plants 1st Edition. Wiley-Blackwell.

Course Code: GEPB 506 **Course Title: Breeding for Field Crops (Compulsory)**	**Credit Hour: 03**	**Semester: January- June**

Rationale: This course is designed to provide fundamental and applied in-depth knowledge on breeding of different field crops in relation to improvement of the crops.

Course Outcomes:

- Explain genetic makeup, behavior and consequence of self- and cross-pollinated crops.
- Describe history, evolutionary aspects and present and future aspects of varietal improvement of different field crops.
- Narrate breeding principles, techniques, conventional and advanced methods of improving desire traits of different filed crops.
- Conceptualize and explain the uses of modern breeding techniques in improving of special traits of field crops.

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Interpret the scope and area of plant breeding • Judge the plant breeding as an art and/or science • Narrate the strategy and goal of plant breeding	Introduction of field crops breeding	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Interpret the importance of crop breeding • Evaluate the role of breeding for changing world	Importance of field crops breeding	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Explain the genetic makeup, consequence of SP and CP corps • Justify and evaluate the role pollination behavior in developing crops varietal types	Genetic makeup, behavior and consequence and mode of reproduction of self (SP) and cross (CP) pollinated crops	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Illustrate the history of breeding for different field crops • Demonstrate the evolutionary aspect of modern cultivar of different field crops	History and evolutionary aspects of field crop breeding	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Illustrate, categorize and explain different breeding methods for field crop • Argue and support a particular breeding method to be chosen for a crop	Breeding methods for self and cross pollinated crops	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer

improvement program • Propose and plan suitable breeding method(s) for a particular crop improvement program			
• Explain and narrate the history and evolutionary aspect of origin, species and modern varieties of the crops • Dissect the cytogenetic and genetic aspects of modern varieties of the crops • Explain and judge the adopting breeding method for improvement of different varieties of the crops • Design and plan a breeding program for developing pure line, open-pollinated and hybrid varieties of the crops • Narrate and justify the application the modern techniques in improvement of the crops • Describe the conventional and modern breeding strategies in developing biotic and abiotic resistance / tolerance varieties of the crops	Breeding of : rice, wheat, maize, jute, sugarcane, potato, oil crops and pulse crops	Lecture Visual presentation Discussion, Visiting of field & research stations, Demonstration of hybridization and selection procedure at field/lab and data collection procedure	Quiz/MCQ Short answer Essay type answer
• Narrate the national priorities in breeding the field crops • Justify the problems and breeding goals of the crops in relation to Bangladesh aspect • Prepare the lists of different field crops varieties released from different institutes	Present status of varietal improvement of field crops in Bangladesh	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Explain the latest research findings and information of breeding for field crops	Latest research findings and information regarding genetics and embryology	Assignment Group work Research organizations	Report, Presentation Performance

		visit	

Reference Books

1. Poehlman, J.M. and Sleper, D.A. 2006. Breeding Field Crops. 5th Edn. Iowa State University Press /Ames. USA.
2. ICAR, 2016. Breeding of Field & Horticultural Crops. India.
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Course: GEPB 507 Course Title: Advanced Heterosis Breeding (Elective)	Credit Hour: 03	Semester: January-June

Rationale: This course is designed to develop hybrid varieties of different crop plants by utilizing heterosis and hybrid vigor.

Course Outcomes:

- Explain types, application, recent advances in understanding plant heterosis
- Conceptualize basis of heterosis and mechanism of heterosis.
- Utilize emerging idea about inbreeding depression and hybrid vigor.
- Describe the mechanism of pollination control and reproduction system of crop plants.
- Narrate the procedure of development of parental lines.
- Evaluate of combining ability
- Develop hybrid varieties in different crop plants

Intended Learning Outcomes (ILOs) The student will able to-	Course Content	Teaching – Learning Strategies	Assessment Strategies
• Discuss about the history and evolutionary concept of heterosis • Outline the types and measurement of heterosis	**Introduction:** History of heterosis, evolutionary concept, types and measurement of heterosis	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Explain pollination control mechanism in crops • Describe self incompatibility, types and its significance • Illustrate male sterility, types and utilization in Plant Breeding • Describe schematic diagram of CGMS system • Explain two lines male sterility system • Show major advantages of two line system for hybrid seed production over three line system.	**Pollination control and reproduction system:** Pollination control mechanisms in crops, reproduction systems and hybrid seed production	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Explore inbreeding, inbreeding depression and hybrid vigor	**Inbreeding:** Inbreeding, inbreeding depression and hybrid vigor	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer

• Explain genetic hypothesis of heterosis, its assumption and clarification • Describe biochemical, physiological, plasmatic, molecular and biometrical aspects of heterosis	**Basis of heterosis**: Genetic, biochemical, physiological, plasmatic or organelle, molecular andbiometrical aspects of heterosis	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Discuss about the development, evaluation and maintenance of parental lines	**Development of parental lines:** Development, evaluation and maintenance of parental lines	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Describe the combining ability to identify suitable parents for hybrid seed production	**Combining ability**: Combining ability and identification of superior parent and hybrids	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Develop of hybrid varieties in Rice, Barley, Maize, Cotton and Mustard	**Development of hybrid varieties (field crops):** Development of hybrid varieties in Rice, Barley, Maize, Cotton and Mustard	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Develop of hybrid varieties in Tomato, Onion and Cucurbits	**Development of hybrid varieties (horticultural crops):** Development of hybrid varieties in Tomato, Onion and Cucurbits	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Describe genetic improvement of hybrid • Explain fixation of heterosis	**Genetic improvement:** Genetic improvement of hybrid, fixation of heterosis	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Show development technique of composite variety • Show development procedure of synthetic variety	**Composite and synthetic variety:** Development of composite and synthetic variety	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Illustrate modern techniques in hybrid seed production	**Hybrid seed production techniques:** Use of modern techniques in hybrid seed production	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Explain the latest research findings and information of heterosis and exploitation in developing hybrid varieties.	Latest research findings and information regarding heterosis and exploitation in developing hybrid varieties	Assignment Group work Research organizations visit	Report Presentation Performance

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Course: GEPB 508 **Course Title:** **Experimentation and Data Analysis (Elective)**	**Credit Hour: 03**	**Semester: July-December**

Rationale: The course is designed to provide knowledge on different experimental designs, analysis, testing appropriate hypothesis and meaningful interpretation of data in relation to crop improvement.

Course Outcomes:

- Describe the principles of different field plot techniques for genetic and plant breeding experiment.
- Judge the experimental design appropriate for experimentation.
- Illustrate different experimental design and their analysis.
- Utilize the techniques for mean comparisons and superior genotypes selections.
- Narrate the plant character association, Chi-square test and path co-efficient analysis.

Intended Learning Outcomes (ILOs) The student will able to-	**Course Content**	**Teaching – Learning Strategies**	**Assessment Strategies**
• Determine the sources of variation • Measure of control of error variation, accuracy and precision • Describe the procedure of sampling and data collection	**Field plot techniques for genetic and plant breeding experiment**: Sources of variation control of error variation, accuracy and precision, sampling and data collection	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Select the different design • Demonstrate the layout and randomizations • Discuss different procedure of data collection and its analysis	**Variety testing and single factor experiments**: Choice of design, layout, randomization and data collection and data analysis	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Describe completely randomized design and its layout, randomization, data collection and analysis • Compute randomized complete block design and draw the layout, randomization, data collection and analysis • Explain Latin square design and its layout, randomization, data collection and analysis • Narrate augmented design and lattice design and its layout, randomization, data collection and analysis	**Experimental designs**: Choice of design, layout, randomization, data collection and data analysis of completely randomized design, randomized complete block design, Latin square design, augmented design and lattice design	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer

• Describe Factorial experiments and its layout, randomization, data collection and analysis	**Factorial experiments**: Choice of design, layout, randomization, data collection and data analysis of factorial experiment	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Explain Split plot Design and its layout, randomization, data collection and analysis • Compute Split-split plot experiment and its layout, randomization, data collection and analysis • Describe Strip plot design and its layout, randomization, data collection and analysis	**Split and strip plot experiment**: Layout, randomization, data collection and data analysis of split plot experiment, split-split plot experiment and strip plot experiment	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Compare between test entries and treatments • Describe the different testing methods: Least significant difference, Duncun multiple range test, Tukey's W test and Student-Newman-Keul's test	**Group comparisons**: Comparison between test entries and treatments of Least significant difference, Duncun multiple range test, Tukey's W test and Student-Newman-Keul's test	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Explain Chi-square test and its applications	**Chi-square test:** Chi-square test and its uses	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Describe Simple and multiple correlation • Estimate regression co-efficient	**Plant character association**: Simple and multiple correlation and regression analysis	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Measure direct and indirect effect of different characters	**Path coefficient analysis**	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Calculate missing data of different experimental design • Describe transformation of data	**Analysis of problem data**: Estimation of missing data and transformation of data	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Explain the latest research findings and information of Experimentation and Data Analysis	Latest research findings and information regarding Experimentation and Data Analysis	Assignment Group work Research organizations visit	Report Presentation performance

Reference Books

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Course Code: GEPB 509 Course Title: Developmental and Physiological Genetics (Elective)	Credit Hour: 03	Semester: January – June

Rationale: This course is designed to provide fundamental in-depth knowledge on morphogenetic and physiological role in development in relation to genetic output.

Course Outcomes:

- Explain the role of cytoplasm and nucleus in development process.
- Describe nuclear and chromosomal differentiation and gene acceleration in developmental process
- Justify the role of hormone in plant development.
- Narrate the totipotency and abnormal growth of cell.
- Describe the role of cytoplasmic heredity in development.
- Explain the pigments, proteins and synthetic antigens.

Intended Learning Outcomes (ILOs) The students will be able to-	Course Content	Teaching-Learning Strategies	Assessment Strategies
• Interpret the scope and area of developmental and physiological genetics Narrate the strategy and goal of developmental and physiological genetics	Concept, scope and application	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Illustrate the idea of Mosaic theory and Driesch experiments • Compare and contrast the Mosaic theory and Driesch experiments	Theories of development; mosaic theory, Driesch experiments	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Summarize the importance of nucleus and cytoplasm in development • Conclude the nucleus-cytoplasm interaction mediated nuclear transplantation process	Role of nucleus and cytoplasm in development, nucleus-cytoplasm interaction, nuclear, transplantation	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• State the role of nuclear and chromosomal differentiation in development • Justify and evaluate how genes control the processes of development so that specific characters are produced	Differentiation and development: Nuclear differentiation, chromosomal differentiation and genic control of development	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer

• Illustrate the growth and developmental process of plants in coordination of gene and hormone	Genic control of morphogenetic process: Genic control of hormonal coordination and growth	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Explain and narrate the role of totipotency in organogenesis in tissue culture	Totipotency-switch on and switch off mechanism of differentiation and its use in tissue culture	Lecture Visual presentation Discussion Visiting of laboratory	Quiz/MCQ Short answer Essay type answer
• Describe the role of abnormal growth in cancer development	Genetics of abnormal growth and cancer development	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Generalize the role of cytoplasm in heredity and development • Illustrate the role of genes on character development	Concept and scope of physiological genetics: Cytoplasm in heredity and development, effects of genes on characters at different levels	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Interpret the role of genetic material for pigmentation, protein workflow and synthetic antigen	Genic control of pigments, proteins and antigens	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Explain the latest research findings and information of Developmental and Physiological Genetics	Latest research findings and information on developmental and physiological genetics	Assignment Group work Research organizations visit	Report Presentation

Reference Books

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2. Mather K. 1965. Genes and cytoplasm in development. In: Lang A. (eds) Differenzierung und Entwicklung/Differentiation and Development. Handbuch der Pflanzenphysiologie/ Encyclopedia of Plant Physiology, vol 15. Springer, Berlin, Heidelberg
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Course Code: GEPB 512 **Course Title: Breeding for Horticultural Crops (Elective)**	**Credit Hour: 03**	**Semester: January-June**

Rationale: This course is designed to provide fundamental and applied in-depth knowledge on breeding of different horticultural crops in relation to improvement of the crops.

Course Outcomes:

- Explain the history, evolutionary aspects and present and future aspects of varietal improvement of different horticultural crops.
- Narrate the genetic makeup, behavior and consequence of self- and cross-pollinated as well as asexually propagated horticultural crops.
- Express the breeding principles, techniques, conventional and advanced methods of improving desire traits of different horticultural crops.
- Explain the uses of modern breeding techniques in improving of special traits of horticultural crops.

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Interpret the scope and area of plant breeding related to horticultural crops • Narrate the strategy and goal of plant breeding of horticultural crops	Introduction of horticultural crops breeding	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Describe the importance of horticultural crop breeding • Evaluate the role of breeding of horticultural crops for changing world	Importance of horticultural crops breeding	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Explain the genetic makeup, consequence of self-pollinated and cross-pollinated horticultural corps • Justify and evaluate the role of pollination behavior in developing crops	Genetic makeup, behavior and consequence and mode of reproduction of self-and cross-pollinated crops	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Illustrate the history of breeding for different horticultural crops • Demonstrate the evolutionary aspect of modern cultivar of different horticultural crops	History and evolutionary aspects of horticultural crops breeding	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Illustrate, categorize and explain different breeding methods for horticultural crop	Breeding methods for Self- and cross-pollinated and asexually propagated crops	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer

• Argue and support a particular breeding method to be chosen for horticultural crop improvement program • Propose and plan suitable breeding method(s) for a particular horticultural crop improvement program			
• Explain and narrate the history and evolutionary aspect of origin, species and modern varieties of the horticultural crops • Dissect the cytogenetic and genetic aspects of modern varieties of the horticultural crops • Explain and judge the adopting breeding method for improvement of different varieties of the vegetable, fruit, spices, flower and ornamental crops • Design and plan a breeding program for developing pure line, open-pollinated and hybrid varieties of the horticultural crops • Explain and justify the applications of the modern techniques in improvement of the horticultural crops • Narrate the conventional and modern breeding strategies in developing biotic and abiotic resistance / tolerance varieties of the horticultural crops	Vegetables crops: Tomato, eggplant, tomatillo, country bean, pea, cabbage, cauliflower, cucurbits, sweet potato, ladies finger, spinach. Fruit crops: banana, papaya, pineapple, melons, mango, jackfruit, litchi Spices and condiments: onion, garlic, chili and turmeric Flowers and ornamental plants	Lecture Visual presentation Discussion Visiting of Field & research stations Demonstration of hybridization and selection procedure at field/lab	Quiz/MCQ Short answer Essay type answer
• Describe the national priorities in breeding the horticultural crops • Justify the problems and breeding goals of the horticultural crops in relation to Bangladesh aspect • Prepare the lists of different horticultural crops varieties released from different	Present status of varietal improvement of horticultural crops in Bangladesh	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer

institutes with their specificities			
• Explain the latest research findings and information of breeding for Horticultural crops	Latest research findings and information regarding breeding for Horticultural crops	Assignment Group work Presentation Research organizatios visit	Report

Reference Books

1. B.D. Singh. Plant Breeding-Principles and Methods. 7th Edn. Kalyani Publishers., New Delhi
2. J. M. Poehlman and D. A. Sleper. Breeding Field Crops. 5th Edn. Iowa State University Press /Ames. USA
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9. Allard RW. 1981. Principles of Plant Breeding. John Wiley & Sons.
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Course Code: GEPB 514 **Course Title: Chromosome Engineering and Molecular Plant Breeding (Elective)**	**Credit Hour: 03**	**Semester: January - June**

Rationale: This course is designed to provide basic and applied knowledge on chromosome engineering and molecular plant breeding techniques in relation to improvement of different crops.

Course Outcomes:

- Explain the concept of chromosome, its different modification.
- Describe the process of production of alien addition, substitution and translocation lines and uses theses in plant transformation.
- Narrate the chromosome pairing mutant in alien gene transfer in allopolyploid species and different methods for processing of sorting alien DNA segments.
- Describe the marker assisted introgression on commercially cultivated allopolyploid crop plants.
- Conceptualize the quantitative traits: Multi factorial inheritance and heritable disease, quantitative traits locus: Genetic marker, molecular maps, and QTL mapping, marker assisted selection and 0067enomic selection for crop improvement.
- Apply the techniques of gene transfer and genetically modified plants

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching - Learning Strategies**	**Assessment Strategies**
• Explain chromosome and its different modification • Apply their understanding of chromosome to manipulate specific genes and to address current problems facing humanity	Concepts, scope and importance of chromosome Chromosomal deletion, inversion or translocation	Lecture Visual presentation Discussion Assignment Demonstration	Quiz/MCQ Short answer Essay type answer Report
• Explain alien addition, substitution and translocation lines • Describe how to produce alien addition, substitution and translocation lines • Explain the behavior of alien addition, substitution and translocation lines • Explain and utilization of different techniques to produce alien addition, substitution and translocation lines	Production of alien addition, substitution and translocation lines, and their behavior and uses in plant transformation	Lecture Visual presentation Discussion Demonstration Group work	Quiz/MCQ Short answer Essay type answer
• Explain chromosome pairing mutants • Describe the alien gene transfer through convention	Use of chromosome pairing mutants in alien gene transfer in allopolyploid species	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer

breeding and genetic engineering techniques • Develop efficient methods to use chromosome pairing mutants in allopolyploid species		Demonstration Group work	
• Explain the different methods of alien DNA sorting • Describe the applications of different methods of alien DNA sorting in crop improvement program	Process of sorting alien DNA segments by various methods	Lecture Visual presentation Discussion Demonstration Group work	Quiz/MCQ Short answer Essay type answer Presentation performance
• Explain the procedures of Marker-assisted introgression of alien genetic materials in recipient species • Describe the applications of marker-assisted introgression of alien genetic materials in commercially cultivated allopolyploid crops	Marker-assisted introgression of alien genetic materials in recipient species with special emphasis on commercially cultivated allopolyploid crops	Lecture Visual presentation Discussion Demonstration Group work	Quiz/MCQ Short answer Essay type answer
• Explain the QTLs serve as the basis for selection for a complex traits inheritance with reference to disease and other multifactorial inheritable traits • Describe the markers used in selection of complex traits • Identify the major QTLs used in resistance and tolerance breeding programs	Quantitative traits: Multifactorial traits in general, heritable disease and multifactorial inheritance with some example	Lecture Visual presentation Discussion Demonstration Group work	Quiz/MCQ Short answer Essay type answer
• Explain the applications of molecular markers in plant breeding programs • Describe current methods for mapping quantitative trait loci (QTL), genome-wide association studies (GWAS), marker-assisted selection (MAS), and genomic selection (GS)	Quantitative trait locus, genetic markers and molecular maps: QTL mapping Marker assisted selection and genomic selection	Lecture Visual presentation Discussion Demonstration Group work Partial Projects	Quiz/MCQ Short answer Essay type answer
• Explain the GMOs and GM crops • Narrate the historical context of GMOs • Describe the different stages and statistic of development	Gene transfer and genetically modified plants	Lecture Visual presentation Discussion Demonstration Group work	Quiz/MCQ Short answer Essay type answer

of GMOs with the latest status of GMO crops • Explain the potential risks and benefits of GMOs on the environment and human health • Argue for benefits and risks of GMO debate			
• Explain the latest research findings and information regarding chromosome engineering and molecular plant breeding	Latest research findings and information regarding chromosome engineering and molecular plant breeding	Assignment Group work Presentation Research organization visit	Report Presentation performance

Reference Books

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12. Walbot,q Kan Wang,r Zhanyuan J. Zhang,s and C. Neal Stewart Jr. 2016. "Advancing Crop Transformation in the Era of Genome Editing". The Plant Cell 28:1510–1520.

Course: GEPB 515 **Course Title: Plant Tissue Culture (Elective)**	**Credit Hour: 03**	**Semester: July-December**

Rationale: This course is planned to provide knowledge on plant tissue and organ culture in vitro which can be grown to mature plant.

Course Outcomes:

- Describe the concept, scope and importance of tissue culture
- Illustrate different tissue culture requirements and culture media
- Explain the protocols of different plants tissue culture techniques used crop improvements
- Judge the of different plants tissue culture techniques appropriate of a specific crop.
- Describe the conservations method of tissues, cells and organs

Intended Learning Outcomes (ILO) The student will able to-	**Course Content**	**Teaching – Learning Strategies**	**Assessment Strategies**
• Define tissue culture • Describe concept, history and scope of tissue culture • Explain importance of tissue culture in crop improvement	**Tissue culture**: Concept, scope and importance of tissue culture	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Enumerate organogenesis, embryogenesis and plant regeneration	Organogenesis, embryogenesis and plant regeneration	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Explain different principles and basic protocols of tissue culture • Describe totipotancy	Principles and basic protocols and totipotancy	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Explain different requirements of tissue culture	Tissue culture requirements	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Describe the composition of different tissue culture nutrient media • Outline the sterilization techniques of tissue culture	**Tissue culture media and sterilization:** Media composition, inorganic nutrients, carbon and energy source, growth regulators, organic supplements, gelling agents, pH, methods of sterilization and maintenance of aseptic condition	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Sketch the procedure and significance of callus culture	**Callus culture**	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer

• Explain the factors affecting growth and morphogenesis of plant tissue culture	**Growth and morphogenesis in culture**	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Describe the techniques, factors, application, advantage and disadvantages of micro propagation • Explain the development methods of virus free plant propagation • Outline the embryo culture and embryo rescue and its application • Discuss about the factors, methods and significance of anther and pollen culture • Describe the methods and application of ovary and ovule culture	**Application of tissue culture for plant improvement**: Micro propagation, virus free plant propagation, embryo rescue, anther and pollen culture, ovary and ovule culture	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Explain somaclonal variation, causes of somaclonal variation and its application for crop improvement	**Somaclonal variation**	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Illustrate the types and techniques of cellular mutagenesis	**Cellular mutagenesis**	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Discuss about the methods and application of protoplast culture	**Protoplast culture**	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Explain techniques of somatic hybridization • Describe applications of somatic hybridization	**Somatic hybridization:** Definition, protoplast isolation, fusion, selection of hybrid cells, regeneration of hybrid plants and application of somatic hybridization	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Sketch the methods of *alien gene transfer* in crop plants	**Alien gene transfer**	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Define Cryopreservation and cryoprotectants • Explain the methods and applications of Cryopreservation in crop improvement	**Cryopreservation:** Definition, addition of cryoprotectants, freezing, storage, thawing, determination of viability, plant growth and regeneration, application	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer

• Predict the achievement of plant tissue culture	**Achievement of plant tissue culture**	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Show the types and uses of different secondary metabolites	**Secondary metabolites** Secondary metabolites and their use	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Describe washing facilities of explants, general laboratory and media preparation area, transfer area, culturing facilities and lighting requirements of tissue culture lab. • Measure of laboratory and personal safety	**Laboratory organization and safety measurement:** Washing facility, general laboratory and media preparation area, transfer area, culturing facilities, light units, greenhouses, laboratory and personal safety	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Explain the latest research findings and information of plant tissue culture	Latest research findings and information regarding plant tissue culture	Assignment Group work Presentation Research organizations visit	Report, Presentation performance

Reference Books

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2. Mantel SH & Smith H. 1983. Plant Biotechnology. Cambridge University Press.
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14. Hammoond, J., McGarvey, P. and Yusibov, V. 2000. Plant Biotechnology. Springer Verlag, New York.
15. Arditti, J. and R. Ernst. 1992. Micropropagation of orchids. Wiley, New York, USA.
16. Bhojwani, S. S. and M. K. Razdan. 1996. Plant tissue culture: theory and practice, a revised edition. Elsevier Science, Netherlands.

17. Debergh, P. C. and R. H. Zimmerman. 1990. Micropropagation: technology and application. Kluwer Academic, Netherlands.
18. Dodds, J. H. and L. W. Roberts. 1985. Experiments in plant tissue culture. 2nd ed. Cambridge University, New York, USA.
19. Hartman, H. T., D. E. Kester, F. T. Davies, Jr., and R. L. Geneve. 2002. Plant propagation principles and practices. 7th ed. Prentice Hall, Englewood Cliffs, USA.
20. Mantell, S. H., J. A. Matthews, and R. A. Mckee. 1985. Principles of plant biotechnology: introduction to genetic engineering in plants. 1st Alden, Osney Mead, Oxford.
21. Thorpe, T. A. 1981. Plant tissue culture: methods and applications in agriculture. Academic Press, New York, USA.

Course Code: GEPB 517 **Course Title: Molecular Ecology (Elective)**	**Credit Hour: 03**	**Semester: January - June**

Rationale: This course designed to provide the knowledge for understanding of ecological and evolutionary processes in natural populations such as genetic diversity, gene flow and phylogeography, behavioral mechanism, adaptation and interactions. This course also covers application of molecular principles to ecological conservation and utilization molecular genetic data.

Course Outcomes:

- Identify the common molecular genetic tools and techniques used by molecular ecologists.
- Conceptualize the importance of genetic diversity, gene flow, adaptation and phylogeography in different species in natural populations.
- Explain how different ecological and evolutionary processes shape genetic variation and adaptation.
- Describe the different interactions of biotic and abiotic factors with plants occur in native population.
- Narrate the applications of molecular principles for ecological conservation.
- Be familiar with the literature in the fields of molecular ecology and population genetics.

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Describe the scope and area of molecular ecology field • Explain the contributions of different Ecologist in this field • Narrate the evolution of molecular ecology till genomic ear	Introduction to molecular ecology: History and evolution	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Narrate the applications of molecular marker to study the variation and evolution of different species • Explain the how NGS, genomics and micrroarry data could apply to study the ecology • Analyze the barcoding and genome based method for the identification of species and taxonomy	Molecular methods in ecology: Molecular markers, genomics and next-generation sequencing (NGS), species trees, Phylogenetic analysis and barcoding and genome-based methods to analyze genetic variation, sequencing and DNA microarrays	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer
• Describe the role of mutation is speciation and variation in population • Analyze the role of other factor for ecological	**Mutations:** the role of standing genetic variation in evolution, Other means of genetic evolution and variation **Mutation models:** molecular	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report

variation and speciation • Illustrate the mutation models • Narrate the Molecular Clocks • and divergent Time in point of ecological view	clocks & divergence time estimation		
• Illustrate the idea of conservation genetics and genome scans • Analyze the role of genome environment correlation for the trait • Describe the role of molecular and adaptive variation	Conservation genetics and genome scans and gene- environment correlations molecular and adaptive variation	Lecture Visual presentation Discussion, Assignment	Quiz/MCQ Short answer Essay type answer Report
• Explain the principles and solve the biological problems in relation to population genetics • Measure the cluster analysis and principle component analysis • Illustrate the outcome of gene flow • Describe the role of recombination and linkage disequilibrium • Illustrate the idea of natural selection and its role in adaptation • Explain the role of landscape genetics in genetic variation	Population genetics: Structure, cluster analysis, principle component analysis, gene flow estimation, recombination and linkage disequilibrium natural selection landscape genetics	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Describe the different modes of evolution at gene and protein levels • Narrate the factors affect in such variation with its ecological relevance	Models of evolution at gene and protein level and ecological relevance	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Describe different interactions occurred in plant and environment, microbes and insects in molecular level Explain how the components o gets benefit from such interactions	Molecular interaction of biotic and abiotic- plant: types, mechanisms, ecological importance	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer Report

• Explain how such interactions maintain equilibrium in ecology • Analysis the ecological importance of such interactions			
• Illustrate the idea of quantitative genetics • Describe the method of QTL mapping and genome wide association studies • Explain the role of gene expression in character association • Illustrate the idea of gene networks in relation with non-coding RNA	Quantitative genetics QTL mapping, genome-wide association studies gene expression and gene networks	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• State the role of gene families and genome evolution • Explain the role of molecular evolution and molecular ecology in modern plant breeding	Gene families and genome evolution, future of molecular evolution and molecular ecology	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer
• Explain the latest research findings and information of molecular ecology	Latest research findings and information regarding molecular ecology	Assignment Group work Presentation Research organizations visit	Report Presentation performance

Reference Books

1. Freeland, J.R., Petersen, S.D., and Kirk, H. 2011. *Molecular Ecology*, 2nd Edition, Wiley
2. Graham Rowe, Michael Sweet, Trevor Beebee. 2017. An Introduction to Molecular Ecology 3rd Edition
3. Daniel L. Hartl, Andrew G. Clark. Principles of Population Genetics 4th Edition
4. Douglas S. Falconer and Trudy F.C. Mackay. Introduction to Quantitative Genetics 4th Edition
5. James F. Crow and Motoo Kimura.1970. An Introduction to Population Genetics Theory.
6. James G. Crow. 1986. Basic Concepts in Population, Quantitative, and Evolutionary Genetics.

Course Code: GEPB 518 **Course Title: Genomics and Bioinformatics (Elective)**	**Credit Hour: 03**	**Semester: July - December**
Rationale: This course is designed to provide basic and applied in-depth knowledge on genomics and bioinformatics in relation to improvement of the crops.		
Course Outcomes: • Describe different data base and can use these data base. • Explain the sequencing methods and analyze the large number sequencing of data. • Analyze large-scale sequence data with respect to, for example, homology, similarity, phylogeny, gene expression, genome function, genome evolution, and variations within populations. • Assemble the raw sequence data into genome assemblies and/or to existing reference genome sequences. • Identify and annotate genes and other coding information in genome sequences. • Select sequence technology and apply existing software on given biological problems in the subject. • Analyze, evaluate and assemble obtained results from large-scale sequence analyses.		

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching - Learning Strategies**	**Assessment Strategies**
• Interpret the evolution, scope and area of genomics and bioinformatics • Describe the classification of genomics and their scope and application • Justify the importance of genomics in crop improvement, and its limitation and future trust • Narrate the strategies of plant genomics and bioinformatics • Describe the applications of bioinformatics in crop breeding and improvement	Concepts, history of genomics and bioinformatics	Lecture Visual presentation Discussion Assignment Demonstration	Quiz/MCQ Short answer Essay type answer Report
• Explain the different methods of DNA sequencing with their advantages, disadvantages and applications • Narrate the basic mechanisms of Sanger's and Maxam Gilbert sequencing methods • Evaluate different high-throughput sequencing methods and their usages in molecular biology and plant breeding • Analyze DNA and RNA	Concept of gene sequencing and methods, codon biasness, redundancy, and optimization	Lecture Visual presentation Discussion Demonstration Group work	Quiz/MCQ Short answer Essay type answer

sequencing data • State the principles of oligo (primers) and gene synthesis • Describe the codon biasness, codon redundancy and optimization of gene during synthesis of genes			
• Describe the approaches of whole genome sequencing with reference to crop plant species • Annotate the genes taking examples from publicly available data base • Describe the methods of estimation single nucleotide polymorphisms (SNPs) from the whole genome sequencing data	Whole genomes analysis, gene annotation, genome similarities and SNPs	Lecture Visual presentation Discussion Demonstration Group work	Quiz/MCQ Short answer Essay type answer
• Categorize different data bases based on applications and usages • Use different data base for mining the data • Describe the applications of the data base with advantages and disadvantages • Use the data base with reference genes or proteins of interest • Deploy the database for research purpose with suitable examples	Database, classifications and background of database: NCBI, PDB, Uniport, ExPASy, DDBJ, MPSS, miRBase, TAIR, EMBL-EBI, DEG, KEGG, DDBJ, RGP, NIAS DNA Bank, Gene bank and Pubmed etc	Lecture Visual presentation Discussion Demonstration Group work	Quiz/MCQ Short answer Essay type answer
• List down different Bioinformatic tools of with their applications and usages • Work out with different Bioinformatic tools and use these tools with reference genes or protein sequences • Demonstrate the procedure of using the tools with particular references of genes and amino acid sequences	**Bioinformatic tools**: Analysis and applications, bioinformatic tools	Lecture Visual presentation Discussion Demonstration Group work	Quiz/MCQ Short answer Essay type answer
• Describe different types sequences used in bioinformatic analysis • Enumerate the FASTA format and usages of FASTA format	Sequence analysis, FASTA format, IUPAC symbols, nomenclature of DNA sequences, directionality of sequence and types of sequences used in	Lecture Visual presentation Discussion Demonstration	Quiz/MCQ Short answer Essay type answer

of sequences in bioinformatic analysis • Describe the IUPAC symbols and nomenclature of genes • Differentiate between directionality of sequence and non-directional sequence • Identify the direction of genes	bioinformatics	Group work	
• Describe the principle of homology and phylogeny analyses • Describe the different homology tools available with their advantages and disadvantage • Explain procedure of running different homology and phylogenetic softwares • Demonstrate the running of homology and phylogeny tools programs with reference genes and proteins • Analysis the results of homology and phylogenetic analysis of reference genes and proteins	Homology search, Blast : nBlast, pBlast, tBlast, bBlast, tbBlastn, tbBlastx. and phylogenetic analysis	Lecture Visual presentation Discussion Demonstration Group work	Quiz/MCQ Short answer Essay type answer
• State of features of ORF and Origin of replication • Describe the procedure of running the ORF finder program and analysis the data and protein sequence • Explain the rational and opportunities for identification of their oriCs *in silico*, as well as *in vivo* • Demonstrate the procedure of running DoriC program	ORF finder, DoriC (Origin of DNA replication)	Lecture Visual presentation Discussion Demonstration Group work	Quiz/MCQ Short answer Essay type answer
• Describe the principles of multiple sequence alignment tools • Illustrate the different multiples sequence alignment tools for genes and proteins available with their advantages and disadvantage • Explain the procedure of running different multiples	Multiple sequences alignment of gene and protein families	Lecture Visual presentation Discussion Demonstration Group work	Quiz/MCQ Short answer Essay type answer

sequence alignment tools • Demonstrate the running of multiples sequence alignment tools with reference genes and proteins • Analysis the results multiples sequence alignment tools in reference genes and proteins			
• Describe the principles of microarray and RNAseq data analysis • Narrate the preparation of the plants samples for microarray and RNA-seq data analysis • Analyze and interpret of microarray and RNA-seq data	Mricroarray and RNA-seq data anaslysis: methods, tools and resources in public repositories	Lecture Visual presentation Discussion Demonstration Group work	Quiz/MCQ Short answer Essay type answer
• Explain the latest research finding and information regarding genomics and bioinformatics	Latest research finding and information regarding genomics and bioinformatics	Visual presentation Assignment Demonstration Group work Research organizations visit	Presentation performance Report Presentation performance

Reference Books

1. Moun, D. 2013. Bioinformatics: Sequence and Genome Analysis, 2nd Edition, Cold Spring Harbor Laboratory.
2. Pevsner, J. 2015. Bioinformatics and Functional Genomics 3rd Edition. Wiley-Blackwell.
3. Campos-de Q. H. 2002. Plant genomics: an overview. Biol Res. 35(3-4):385-99.
4. Busch**,** W. (Ed.). 2017. Plant Genomics Methods and Protocols. Springer.
5. Somerville C., and Somerville S. 1999. Plant Functional Genomics. Science.
6. Kole C and. Abbott, A. G. 2017. Principles and Practices of Plant Genomics, Volume 3: Advanced Genomics. CRC Press.
7. Can T. 2014. Introduction to bioinformatics. Methods Mol Biol. Springer.
8. Edwards D. 2207. Plant Bioinformatics: Methods and Protocols. Humana Press.
9. Singh S. 2013. Plant Bioinformatics. Black Prints

Department of Horticulture

Course Layout

Sl. No.	Course Code and Title	Cr. Hrs.
A. Compulsory Courses		
1	HORT 501: Advanced fruit Production	3
2	HORT 502: Advanced Vegetable Production	3
3	HORT 503: Floriculture & Landscaping	3
4	HORT 504: Spices and Plantation Crops	3
5	HORT 505: Seed Technology of Horticultural Crops	3
6	HORT 506: Research Methodology	3
	Total	**18**
B. Elective Courses		
7	HORT 507: Nursery Management of Horticultural Crops	3
8	HORT 508: Biotechnology in Horticulture	3
9	HORT 509: Medicinal Plants	3
10	HORT 510: Homestead Gardening	3
11	HORT 511: Physiology of Horticultural Crops	3
12	HORT 512: Postharvest Technology of Horticultural Crops	3
13	HORT 513: Growth Regulator in Horticulture	3
14	HORT 514: Hydroponics & Organic Farming	3
15	HORT 515: Minor and Exotic Fruits of Bangladesh	3
	Minimum	**12**
C. Seminar		
16	HORT 598	1
D. Thesis Research		
17	HORT 599	16

Compulsory Courses	**18**
Elective Courses	**12**
Seminar	**1**
Thesis Research	**16**
Total	**47**

Curriculum Alignment / Skill Mapping

Curriculum must be aligned with program objectives, program learning outcome and intended learning outcomes through proper skill mapping.

Department of Horticulture

Courses	Program Learning Outcome							
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
HORT 501	x	x	x	x				x
HORT 502	x	x	x	x				x
HORT 503	x	x	x	x				x
HORT 504	x	x	x	x				x
HORT 505	x	x	x	x				x
HORT 506	x	x	x	x				x
HORT 507	x	x	x	x				x
HORT 508	x	x	x	x				x
HORT 509	x	x	x	x				x
HORT 510	x	x	x	x				x
HORT 511	x	x	x	x				x
HORT 512	x	x	x	x				x
HORT 513	x	x	x	x				x
HORT 514	x	x	x	x				x
HORT 515	x	x	x	x	x			x
HORT 598						x	x	x
HORT 599					x	x	x	x

Course code: HORT 501 **Course Title: Advanced Fruit Production (Compulsory)**	**Credit Hours: 03**	**Semester: July-December**	
Rationale: This course is designed to provide applied knowledge about fruit production in advanced level.			
Course Outcomes: • Acquire knowledge on advanced propagation techniques for improvement of fruit plants. • Establish and manage orchard properly by considering environmental factor and ecophysiology of fruit crops • Describe methods of fruit production and their postharvest management • Explain and apply different breeding methods for fruit crops improvement			
Intended Learning Outcomes (ILOs) The students will be able to -	**Course Content**	**Teaching-learning Strategies**	**Assessment Strategies**
• Describe present situation of fruit production and possibilities for increasing fruit production in Bangladesh • Compare nutritive values of fruits	**Introduction to fruit production:** Importance and scope of fruit production in Bangladesh, Present situation and future possibilities for increased fruit production. Nutritive value of fruits	Lecture Discussion	Quiz/MCQ Short answer Essay type answer
• Explain fruit distribution over the world, best fruit growing region and environmental factors of fruit production • Analyze the ecophysiology related productivity of common fruits of Bangladesh • Describe winter injury in related to fruit crops	**Environmental factors & ecophysiology of fruit crops:** Environmental factors affecting distribution of fruit crops. Ecophysiology related to growth, development, flowering, fruiting and productivity of fruit crops. Winter injury in related to specific fruit crops	Lecture Discussion Visual Presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Describe and practices different methods of orchard management	**Orchard management:** Layout, irrigation, Fertilizer application, pruning and training, pest management etc.	Lecture Discussion Visual presentation Group work	Quiz/MCQ Short answer Essay type answer Presentation
• Illustrate anatomical and physiological aspects of propagation • Apply and explain the principles and techniques of micro-propagation of fruit plants.	**Advanced studies on propagation:** Anatomical and physiological aspects of propagation. Importance, principles and techniques of micro propagation of fruit crops	Lecture Discussion Visual presentation	Quiz/MCQ Short answer Essay type answer
• Describe the cultural practices for better fruiting • Practice training and pruning for increasing fruit bearing and development of fruit	**Bearing habit of fruit trees:** Bearing habit of major fruit plant, principles and practices of training and pruning relation to bearing habits.	Lecture Discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report

plant			
• Explain advance breeding methods for fruit crops improvement • Use different breeding methods in the field for improving fruit plant	**Improvement of fruit crops:** Importance and methods of breeding, utilization of male sterility, heterosis, somaclonal variation and somatic hybridization in fruit breeding, molecular aspect of fruit breeding	Lecture discussion, Visual presentation Assignment	MCQ Short answer Essay type answer Report
• Illustrate modern production technology of fruit plants of Bangladesh	**Fruit setting and unfruitfulness:** Physiology of flowering and floral bud differentiation. Endogenous and exogenous factors responsible for flowering in fruit crops, Factors concerned with setting, development and quality of fruits, Causes, occurrence and remedial measures for unfruitfulness.	Lecture Discussion Visual Presentation Assignment Field visit	Quiz/MCQ Short answer Essay type answer Report
• Explain the latest research findings and information of advanced fruit production	Latest research findings and information regarding Advanced fruit production.	Assignment	Report

Reference Books

1. B. Pike. 2011. The Fruit Tree Handbook.
2. H. T. Hartmann, D.E. Kester and F.T. Davis Jr. 1990. Plant propagation principle and practices. Prentice –Hall, International Editions.
3. K. K. De. 1992. An Introduction to plant Tissue Culture. New Central Book Agency, Calcutta.
4. L. Hill and L. Perry. 2011. The Fruit Gardener's Bible: A complete Guide to Growing Fruits and Nuts in the Home Garden.
5. R. S. Martin and C. Schultz. 2013. How to Prune Fruit Trees, Twentieth Edition.
6. T. K. Bose and S. K. Mitra, 1995. Fruits: Tropical and Subtropical. Naya prokash, Calcutta- India.
7. T. K. Bose, S. K. Mitra and M. K. Sadu, 1990. Propagation of Tropical and Subtropical. Horticultural Crops. Naya Prokash, Calcutta- India.

Course code: HORT 502 **Course Title: Advanced vegetable production (Compulsory)**	**Credit Hour: 03**	**Semester:July-December**	
Rationale: This course is designed to provide applied knowledge about vegetable production and management in advanced level.			
Course Outcomes: • Acquire knowledge on traditional and non-traditional vegetable corps production techniques. • Analyze the different environmental factors affecting vegetable production. • Acquire knowledge about different propagation techniques for multiplication and improvement of vegetable crops production.			
Intended Learning Outcomes (ILOs) The students will be able to	**Course Content**	**Teaching Learning Strategies**	**Assessment Strategies**
• Describe the present status, problems and future prospects of vegetable production in Bangladesh	**Introduction:** Present status, problem and prospect of vegetable production	Lecture Discussion Multimedia presentation Assessment	Quiz/MCQ Short answer Essay type answer Report
• Illustrate and use advanced propagation techniques for vegetable crops	**Propagation:** Advanced propagation techniques of vegetable crops: Sexual, asexual and micro propagation	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer Report
• Explain environmental factors for different vegetable crops production	**Environmental factors affecting vegetable production**: Light, temperature, air, rainfall, snowfall, dew, RH.	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Describe the production and management techniques vegetable crops • Apply advanced production techniques for vegetable production	**Production and management on vegetable crops**: Tomato, potato, brinjal, Cole crops, sweet potato, radish, cucurbits, aroids, legumes, okra, amaranth	Lecture Discussion Multimedia presentation Assessment	Quiz/MCQ Short answer Essay type answer Report
• Use and explain about the improvement techniques of different vegetable crops	**Improvement of vegetable crops**: Solanaceous, cruciferous and cucurbitaceous crops	Lecture Discussion Multimedia presentation Assignment	Quiz/MCQ Short answer Essay type answer Assignment Report
• Explain and use the techniques of non-traditional vegetable crops production	**Production of nontraditional vegetable crops**: Dioscorea, Moringa, peas, mushroom, sweet corn, parsley, water lily, chow-chow, bamboo shoot, gaint grandilla,	Lecture Discussion Multimedia Presentation Assignment	Quiz/MCQ Short answer Essay type answer Report

	bathua, lima bean, french bean		
• Explain the latest research findings and information of Advanced vegetable production	Latest research findings and information regarding Advanced vegetable production	Assignment	Report

Reference Books

1. S. L. katyal and K. L. Chadha. 1996. Vegetable growing in India. Oxford and IBH Pub.Com. Pvt. Ltd, New Delhi.
2. J. W. E. Purseglove, G. Brown, C. L. Green and S.R.J. Robbins. 1981. Spices, Boll & Longman Group Uk Ltd. London.
3. T. K. Bose and M. G. Som. 1990. Vegetable crops in India. Naya Prokash, Calcutta
4. T. K. Bose, S. K. Mitra and M. K. Sadhu, 1996. Propagation of tropical and sub-tropical horticultural crops. Naya Prokash, Calcutta.

Course Code: HORT 503 Course Title: Floriculture & Landscaping (Compulsory)	Credit Hours: 03	Semester: July-December

Rationale: This course is designed to provide clear concepts of Floriculture & Landscaping.

Course Outcomes:

- Conceptualize Floriculture & Landscaping
- Acquire knowledge on production of flower and ornamental plants
- Enlighten about special practices on gardening.
- Acquaint with cut flower and pot plants.
- Comprehend about landscape horticulture.

Intended Learning Outcomes (ILOs) The students will be able to	Course Content	Teaching Learning Strategies	Assessment Strategies
• Describe present status of Floriculture and Landscaping in Bangladesh.	**ntroduction to Floriculture & Landscaping:** Concept, importance and present status in Bangladesh	Lecture Discussion	Quiz/MCQ Short answer Essay type answer
• Mention about production technique of Flower & ornamental plants	**Production of flowers & ornamental plants:** Ecophysiology & commercial production of Chrysanthemum, Dahlia, Gladiolus, Marigold, Rose, Tuberose, Orchid and Cacti	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Exhibit the special practices of gardening.	**Special practices in gardening:** Water garden, rock garden, bonsai and topiary	Lecture Discussion	Quiz/MCQ Short answer Essay type answer
• Explain the management of cut flower, pot plants and flower designing	**Management of cut flowers and pot plants:** Harvesting and selecting of cut flowers. Postharvest changes in cut flower, their handling and marketing Flower design and flower show. Culture and management of pot plants	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer & Report
• Enumerate about planning, designing of landscape	**Landscape horticulture:** Definition, objective and classification of landscape. Principles, planning and designing of landscape Development and maintenance of lawn, turf and hedge	Lecture Discussion Multimedia presentation Assignment	Quiz/MCQ Short answer Essay type answer

• Describe and manage of landscape, arboriculture, nature conservation	**Landscape management:** Ecological principles applied to the design and management of landscape. Landscape management in relation recreation, arboriculture Social forestry and nature conservation	Lecture Discussion Multimedia presentation Assignment	Quiz/MCQ Short answer Essay type Report
• Explain the latest research findings and information of Floriculture & Landscaping	Latest research findings and information on Floriculture & Landscaping	Assignment	Report

Reference Books

1. Chadha, K. L. 2001, Handbook of Horticulture, ICAR, New Delhi.
2. Prashad, S and Kumas, U, Principles of Horticulture, Agro-Botanica, New Delhi.
3. Bose T. K. and B. Choudhury, 1991, Tropical garden plants in colour, Horticulture & Allied Publishers, Calcutta.
4. Bose, T. K., R. S. Maiti, R. S. Dhua and P. Das, 1999, Floriculture & Landscaping. Naya Prokash, Calcutta.
5. Bhattachajees S. K. 2012. Advances in Ornamental Horticulture. Pointer Publishers, Jaipur,India.
6. Bhattacharjee, S. K. and L. C. De 2005. Postharvest Technology of Flouess and Ornamental Plants. Pointer Publishers, Joipur, India.

Course Code: HORT 504 Course title: Spices and Plantation Crops (Compulsory)	**Credit Hours: 03**	**Semester: January-June**	
Rationale: This course is planned to provide concepts on spices plantation crops, production practices and improvement of major spices crops in Bangladesh			
Course Outcomes: • Conceptualize on spices and plantation crops. • Acquire knowledge on production of spices and plantation crops in advance. • Elucidate special practices postharvest handling, processing and marketing of spices and plantation crops. • Apply techniques for improvement of spices crop production			
Intended Learning Outcomes (ILOs) The students will be able to	**Course Content**	**Teaching Learning Strategies**	**Assessment strategies**
• Describe present status of spices and Plantation crops in Bangladesh. • Illustrate ecophysiology and morphology of important spices and plantation crops	**Spices and plantation Crops in Bangladesh:** Concept, present situation, Economics, prospects of production. Ecophysiology and morphology of important spices and plantation crops.	Lecture Discussion Multimedia Presentation	Quiz/MCQ Short answer Essay type answer
• Illustrate production and process of spices and plantation crops in advance level • Apply advanced production practices of spices and plantation crops	**Production practices of spices and plantation crops:** a**) Spices**: Onion, Garlic, Chilli, Black paper, Coriander, Ginger Cumin, Cinnamon, Turmeric, Cardamom and Bay leaf b) **Plantation crops**: Tea, Rubber, Coffee, oil palm, Cocoa, Betel leaf, betel nut and Bamboo	Lecture Discussion Multimedia presentation Assessment Group work	Quiz/MCQ Short answer Essay type answer Report
• Indicate the special practices for postharvest handling and storing of spices and plantation crops • Use advanced harvesting and processing, storing of spices and plantation crops	**Post-harvest handling and marketing of the products:** Harvesting, Handling Processing, Storing and Marketing of Spices: Black pepper, Turmeric, Ginger, Cardamom and Cumin Plantation crops: Rubber, Tea, Coffee, oil palm, Cacao, Betel leaf Betel nut and bamboo	Lecture Discussion Multimedia presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Elucidate or illustrate the different improvement techniques of major spices and plantation crops. • Utilize different techniques in the field for improving major spices and plantation	**Improvement of major spices and plantation corps:** Different techniques and achievements	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer

crops			
• Describe the importance and prospect of minor spices crops in Bangladesh • Produce minor and prospective spices crops	**Production of minor and prospective spice crops in Bangladesh:** Clove, Fenugreek, Aniseed, Spear mint, Fennel, Black Cumin, Nutmeg, saffron	Lecture Discussion Multimedia presentation Assignment	Quiz/MCQ Short answer Essay type Report
• Explain the latest research findings and information of Spices and Plantation Crops	Latest research findings and information regarding Spices and Plantation Crops	Assignment	Report

Reference Books

1. L. Herman. 2015. Herb and Spice Companion: The Complete to over 100 Herbs and spices. Guarto publishing group, USA Ihc.
2. J. W. E. Purseglove, G. Brown, C. L. Green and S. R. J. Robbins. 1981. Spices, Boll and Longman Group UK Ltd, London.
3. A. Farooqi, B. S. Sreeramu and K. N. Sririvasappa. 2005. Cultivation of spices crops. University Press.

Course Code: HORT 505 **Course Title: Seed Technology of Horticultural Crops (Compulsory)**	**Credit Hours: 03**	**Semester: January-June**

Rationale: This course is designed to provide applied knowledge about horticultural seed technology in advanced level.

Course Outcomes:

- Acquire knowledge on seed morphology and their development Practices
- Acquaint with seed and their business strategies, certification/registration
- Understand about advanced propagation techniques for healthy and quality seed production

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching Learning Strategies**	**Assessment Strategies**
• Discuss about seeds, its importance and production status • Describe the problems of vegetable and flower seed production in Bangladesh	**Introduction:** Background of seed technology, present status, problems and scope of vegetable and flowers seed production in Bangladesh	Lecture Discussion Multimedia presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Elucidate about quality seed, its morphology and their physiological functions • Illustrate seed, embryo, endosperm and seed coat development process	**Morphology and development of seed:** Seed structure, seed quality, characteristics of good seed, seed formation, embryo development, endosperm development, seed coat development	Lecture Discussion Multimedia presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Explain/Criticize the present scenario of seed business in Bangladesh • Explain the prospect of seed industry development in Bangladesh	**Vegetable and flower seed growing Business and Industry:** Present status, scope and opportunities for development of seed industry in Bangladesh. Scope of vegetable seed agribusiness	Lecture Discussion Visual presentation Group work	Quiz/MCQ Short answer Essay type answer Presentation performance
• Differentiate different types of seeds and their certification policies • Discuss national seed policy and seed rule	**Seed Classes and Seed rules:** Breeder's seed, foundation seed, registered seed, certified seed, truthfully labeled seed, farmer's seed. Seed certification, seed certification standards of vegetable seed. National seed policy and seed rule	Lecture Discussion Multimedia presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Describe & implement the postharvest Processing and handling of seeds and their marketing system • Analyze factors affecting seed marketing and seed demand.	**Postharvest Biotechnology:** Harvesting, drying, processing and storage of seed, use of instrument for threshing, cleaning, drying, grading and packaging. Seed marketing. Demand forecast, marketing structure, factors affect seed marketing	Lecture Discussion Multimedia presentation Assignment	Quiz/MCQ Short answer Essay type & Report

• Demonstrate/Operate the advance seed production techniques for crop improvement • Apply advanced vegetable seed production technology for vegetable seed production	**Seed production of Horticultural Crops:** Seed production technology of tomato, brinjal, cauliflower, cabbage, okra, chilli, onion, potato, TPS, use of TPS for potato production	Lecture Discussion Multimedia presentation Assignment	Quiz/MCQ Short answer Essay type answer Report

Reference Books

1. Amarjit Basra, 2006. Handbook of Seed Science and Technology (Seed Biology, Production, and Technology) 1st Edition
2. Copeland, 2010. Principles of Seed Science and Technology
3. Keith Aoki, 2008. Seed Wars: Cases and Materials on Intellectual Property and Plant Genetic Resources
4. Thomas Merton, 2002. Seeds. Shambhala; 1 edition 192 pages
5. Erik Guzman, 2016. The Seed: A True Myth. New Growth Press; First edition, 240 pages
6. Ratan Lal Agrawal, 2018. Seed Technology

Course code: HORT 506 Title: Research Methodology (Compulsory)	**Credit Hour: 03**	**Semester: January-June**	
Rationale: This course is designed to provide knowledge to conduct research experiment, introduce different statistical design, analyze data, write research report and interpreted research findings.			
Course Outcomes: • Acquire knowledge for the basic frame work of research process. • Enhance the ability to design the research experiment and conduct statistical analysis by themselves • Develop students' ability to prepare and interpretate the results accurately and efficiently.			
Intended Learning Outcomes (ILOs) The students will be able to	**Course Content**	**Teaching Learning Strategies**	**Assessment Strategies**
• Explain major aspects of research methodology, prioritize research problem and develop research project for probable solution.	**Identification and Prioritization of Researchable Problem:** Guidelines, planning and development of research projects and their evaluation	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Compute/Operate different statistical design of experiment and data analysis. • Develop/Design a research project.	**Statistical procedure:** a) Field plot techniques b) Design of experiments and analysis of data a) Comparison among means b) Correlation and regression analyses	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Prepare report and present the research data effectively.	**Presentation and Interpretation of Experimental Results:** Scientific report writing a) Types of scientific reports b) Contents of scientific reports c) Techniques of data presentation	Lecture Discussion Presentation	Quiz/MCQ Short answer Essay type answer
• Compare/Evaluate different research organization in Banglades	**Research System in Bangladesh:** Research and development systems in different organization of Bangladesh, including visit of activities of the organization.	Field visit and discussion	Report
• Compare data management and deduce statistical analysis.	**Practical:** Data entry and analysis	Lecture Discussion Multimedia Presentation	Quiz/MCQ Short answer Essay type & Assignment

Reference Books

1. Research Methodology: A Guide for research in agricultural science, soil science and other related fields. Pradip Kumar Sahu. 2013, Publisher Spring India.
2. Statistical Procedures for agricultural research second edition Kwanchai. A. Gomez, Head, Department of Statistics, The international Rice research intuition Los banos, Leguna, Philippines Arturo.A. Gomez Professor of Agronomy University of the Philippines at Baflos Collge, Lagua, Philippines.
3. Research Design: Qualitative, Quantitative and Mixed Methods Approacher, 4th Edition by John W. Creswell
4. Introducing Research Methodology: A beginner Guide to doing a research project, 2nd Edition, by Uwe Flick.

Course code: HORT 507 Title: Nursery Management of Horticultural Crops (Elective)	Credit Hours: 03	Semester: January - June

Rationale: This course is designed to provide clear concepts on nursery management of horticultural crops.

Course Outcomes:

- Enrich knowledge on modern nursery structure & controlled environment in nursery.
- Acquire knowledge on controlled environment
- Conceptualize different growing media, nursery bed, container & special nursery practices Especial nursery practices
- Conceptualize on collection and maintenance of new stalk plants
- Acquire knowledge on growth regulators

Intended Learning Outcomes (ILOs) The students will be able to	Course Content	Teaching Learning Strategies	Assessment Strategies
• Recognize about nursery structures and different types of nursery	**Nursery structures:** Establishment & management of modern nursery structures green house, lath house, net house, moist house, orchid house	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Explain about controlled environment in nursery	**Controlled Environment in Nursery:** Soil, light, water, temperature, humidity, gases, mineral nutrients, hydroponics and close case propagation systems.	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Demonstrate about growing media and nursery bed	**Growing media & nursery bed:** Preparation of growing media, nursery bed and container for nursery plant and their management.	Lecture Discussion	Quiz/MCQ Short answer Essay type
• Exhibit the special practices of nursery	**Nursery practices:** Propagation practices, nursing of seed grafting, nursing of root grafting. Post propagation cares of different nursery plants.	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer Report
• Operate/Implement the collection and maintenance of new stalk plants	**Collection and maintenance of new stalk plants:** Collection and maintenance of new clones and disease-free clones.	Lecture Discussion Multimedia presentation Assignment	Quiz/MCQ Short answer Essay type answer

• Identify & apply/use plant growth regulators	**Use of growth regulators:** List & classification of growth regulators Use of growth regulators in plant Propagation practices.	Lecture Discussion Multimedia presentation Assignment	Quiz/MCQ Short answer Essay type Report

Reference Books

1. Modern Nursing Management by R. L. Bhardwaj and D. A. Sarolia. 2009
2. Nursery Management by Jhon Mason, 2004, Landinks press, Vedasing e Books Ltd, New Delhi, India, 2009.
3. Plant Nursery Management: Principles and Practices. By P Ratha Krishanan, Rajwant K. Kalia, JC Tewari and M. M. Roy, Central, JC Tewari and M. M. Roy, Central Arid Zone Research Institute, ISO:90001, Published 2014
4. Plant Propagation and Nursery Management Agrotech Published Academy, 1st edn, by BS Chundrwat, 2017.
5. Essential Nursery Management by susar Hay, 1st edn. 17 September 2017.

Course code: HORT 508 Course Title: Biotechnology in Horticulture (Elective)	Credit Hours: 03	Semester: July-December	
Rationale: This course is designed to provide advanced knowledge on Biotechnology and application of different techniques of biotechnology for the improvement of horticultural crops.			
Course Outcomes: • Enrich knowledge on Biotechnology and laboratory design to conduct quality research • Experiment on different techniques of plant tissue culture or *in vitro* culture • Develop skills on modern biotechnological techniques and its application to horticultural crops • Utilize the knowledge of biotechnology for the improvement of crops			
Intended Learning Outcomes (ILOs) The students will be able to -	**Course Content**	**Teaching Learning Strategies**	**Assessment Strategies**
• Describe biotechnology and its status	**Introduction to biotechnology:** Concept, role in horticulture, present situation, achievement, prospects and limitations	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Skatch a modern laboratory of Biotechnology & compute its requirement	**Laboratory requirements:** Laboratory equipments, required environmental facilities, different culture media and necessary chemicals	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Apply different techniques of micro propagation and its application • Demonstrate to regenerate potato, papaya, banana, jackfruit, orchid, onion, garlic, mushroom, thuja and other horticultural crops	**Micropropagation and plant regeneration: C**oncept, technique of micro propagation and its application, differentiation of cell and tissue, cytodifferentiation, organogenesis, somatic embryogenesis, protoplast fusion, somatic hybridization. Regeneration of potato, papaya, banana, jackfruit, orchid, onion, garlic, mushroom, thuja and other horticultural crops	Lecture Discussion	Quiz/MCQ Short answer Essay type answer
• Compare and apply the knowledge of different *in vitro* culture techniques like meristem, anther, pollen and ovary culture. • Operate the *in vitro* culture techniques to produce haploid or to preserve samples or to rescue embryo, etc.	**In vitro techniques for horticultural crops:** Meristem, anther, pollen and ovary for horticulture, production of haploids in vegetable crops, cryopreservation, embryo rescue	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer Report
• Prepare/Demonstrate vegetative propagating materials of potato, sweet potato, yam, ginger, turmeric, etc.	**Production of vegetative propagating material through tissue culture:** Virus elimination and clean seed production of	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer

	potato, sweet potato, yam, ginger, turmeric, etc.	Assignment	Report
• Explain & use the modern biotechnological tools or advanced techniques related to genetic engineering in horticulture. • Illustrate the technique of gene or protein expression, generation of GMO and molecular aspect of stress tolerance improvement of plant	**Genetic engineering in horticulture:** Gene cloning, cloning vehicles and strategies, restriction, digestion, ligation, genomic and cDNA isolation. cDNA library screening, isolation of genomic DNA and RNA from papaya potato. plasmid DNA isolation, DNA sequencing. Use of DNA markers vegetables and fruits for genomic analysis, Gene transfer Gene or protein expression, GMO, molecular aspect of abiotic and biotic stress tolerance improvement of horticultural crops, protein purification	Lecture Discussion Multimedia presentation Assignment	Quiz/MCQ Short answer Essay type answer Report

Reference Books

1. Malik, C.P. 2010 Genetic Engineering: A new hope for crop production & improvement. Aviskar Publishers, Jaipur, India
2. Chawla, H.S. 2008 Introduction to Plant Biotechnology. Second edition. Oxford Publishing Co. Pvt. Ltd., New Delhi
3. Rezdea, M. K. 2004. Introduction to plant tissue culture. 2nd edition. Oxford and IBH publishing co. Ltd., New Delhi, India.
4. Sing, B. D. 2014. Biotechnology: Expanding Horizon, 4th Edn. Kalyanix Publishrs, India.

Course Code: HORT 509 **Course Title: Medicinal Plants (Elective)**	**Credit Hour: 03**	**Semester: July-December**

Rational: The course is designed to provide advanced knowledge for the investigators, bases on different approaches of bioassay guided study, which will scientifically validate the traditional claim of the selected medicinal plants in an empirical way.

Course Outcomes:

- Enrich knowledge in developing sustainable cultivation techniques (agro-techniques) including quality plant materials, irrigation, fertilizer, plant protection, post-harvest collection and Processing.
- Strengthen skills on promoting of cultivation and conservation of Medicinal Plants.
- Identify the plants to be conserved/cultivated at the different agro-climatic regions and those to be cultivated /conserved in the fields.
- Create optimum awareness and interest amongst the common people about Medicinal Plants
- Evaluate and apply the knowledge of medicinal plants for herbal and unani medications as horticultural commodity.

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching Learning Strategies**	**Assessment strategies**
• Strengthen knowledge on medicinal plant cultivation and its prospects • Illustrate the cultivation of more and more exotic medicinal plants to minimize the import expenditure. • Create optimum interest and awareness amongst cultivators/ farmers for the cultivation of medicinal plants	**Introduction:** Nomenclature & classification on medicinal plants	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Detect medicinal plants at the first instance for ensuring its overall development in a particular region • Cultivate medicinal plants which fare well in the field as horticultural crop • Employ latest techniques to improve the production system so that the medicinal plants produced; can compete in the international market. • Develop a data bank of naturally grown medicinal plants in Bangladesh and their dealers and users	**Morphology, cultivation of important medicinal plants in Bangladesh:** Aonla, Apang, Agar Antigonon, Aloe, Arjun, Asparagus, Ajowan, Bitter gourd, Belledona, Bohera, Bael, Colchicin, Cinnamon, Clove, Chirata, Cardamon, Ciruander, Cissus, Cassia, Clitonia, Camphor, Datura, Fig, Garlic, Ginger, Gloriosa, Horitoki, Ixora, Kalanchoe Mimosa, Moringa, Neem, Nishinda, podophyllum, Sweet potato, Saffron, Tamarind, Vinca, Vitex, Veronia, etc	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer

• Describe and apply cultivation and processing of medicinal plants.	**Plant parts use as medicine:** Fresh Fresh and dry plant parts use for treating common diseases	Lecture Discussion	Quiz/MCQ Short answer Essay type answer
• Describe separating and extracting compounds from the medicinal plants for medical use. • Interpret and operate the equipment that are needed for extracting effective compounds from the MP	**Collection Technique of Extracts from medicinal plants:** Different medicinal extracts-alkaloid, essential oil, glycosides, active constituents, latex, organic acid pigment, resins, tannins, vitamin and enzymes, waxes –their properties, preparation and preservation	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer Report
• Identify (a) high (b) medium & (c) low consuming medicinal plants and herbal drugs.	**Products from medicinal plants and their use:** Syrup, ointment, extract, tablet, juice, tincture, aromatic water, lotion, spirit, vinegar, plaster etc. use of products for control of diseases	Lecture Discussion Multimedia presentation Assignment	Quiz/MCQ Short answer Essay type answer

Reference Books

1. Md. Kamal Hossain, Istick Sobhan, K Alam, N Khan, Selected medicinal plants of Chittagong Hill Tracts, IUCN 2011.
2. Commonly used medicinal herbs & shrabs by traditional herbal practitioners, by M. A Motaleb, M. K Hossain, M. K Alam, M. M. Al Mamun, M. Sultana, IUCN 2013.
3. Healthe wealth from medicinal aromatic plants, Elaire marshall, FAO, Booklet Number 77, 2012
4. Jitendra Kumar, BB Basak, RS Jat and N. Reddy. 2016, Medicinal and aromatic plants making healthy and wealthy. Indian making healthy and wealthy. Indian hort. www.icar.org.in.
5. A guide to medicinal plants: An Illustrated scientific, and approach koh. H ling, C. T. Kian, TC Hoor2009, World scientific publication.
6. WHO monographs of medicinal plannts Vol-4, 2009, WHO.
7. Training manual on propagation technique of commercially important medicinal plants. B. S. Somashekhar, Manju shaha, Foundation for revitatislm of local health trachition , Bangladesh. 2012
8. Guide on medicinal and Aromatic plants of SAARC countries, SAIC, BARC, 2006, Dhaka.

Course Code: HORT 510 Course Title: Homestead gardening (Elective)	Credit Hours: 03	Semester: July-December

Rational: In the context of urban farming strategies, the course is designed to provide advanced knowledge and scope for homestead farming.

Course Outcomes:

- Enrich knowledge in developing sustainable cultivation techniques in homestead areas.
- Strengthen skills on promoting of cultivation and conservation of horticultural crops in urban farming.
- Identify the plants to be conserved/cultivated at the homestead areas
- Create optimum awareness and interest amongst the common people about homestead farming

Intended Learning Outcomes (ILOs) The students will be able to	Course Content	Teaching Learning Strategies	Assessment Strategies
• Conclude importance on homestead farming and its prospects • Introduce the cultivation procedure of more and more exotic plants in homestead and urban areas. • Create optimum interest and awareness amongst cultivators/farmers	**Introduction:** Concept of homestead gardening, importance and scope of homestead grading. Status of homestead in Bangladesh. Area and utilization of homestead area	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Compare economic importance and cost analysis of crop production in urban and homestead areas	**Economic and nutritional aspect:** Economic return from homestead, Labour utilization in homestead gardening	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Constract models of different homestead & urban gardening	**Principles of homestead gardening:** Basic principles for homestead gardening. Models of homestead gardening; kalikapur model, Labukhali model. kalapara models and sorzan model for homestead area	Lecture Discussion	Quiz/MCQ Short answer Essay type answer
• Illustrate principles, management practice and crop calendar of vegetable crops in	**Vegetable crops production in homestead area:** Principles of vegetable production in homestead	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer

respect of urban and homestead farmers	area. Management practices for homestead vegetables. Crop calendar for vegetable production in homestead area		Report
• Select sustainable farming Teaching Learning Strategies for fruit production in homestead and urban • Select production technology of the fruit plants for urban and homestead farming	**Fruits production in homestead area:** Principles of fruits production in homestead area, Management practices for homestead fruits. Minor fruits production technology as homestead component	Lecture Discussion Multimedia presentation Assignment	Quiz/MCQ Short answer Essay type answer
• Decide sustainable farming Teaching Learning Strategies for spices production in homestead and urban	**Spices production in homestead area:** Spices production technology in shady area in homestead	Lecture Discussion Multimedia presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Illustrate spearing for pot culture, care and management procedure of pot culture	**Pot planting:** Spearing for pot culture. Care and management for pot culture	Lecture Discussion Multimedia presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Enrich knowledge on urban gardening, vertical farming including modern farming Teaching Learning Strategies	**Roof gardening:** Importance, economic aspect, specs for roof gardening and cultural management for roof garden	Lecture Discussion Multimedia presentation Assignment	Quiz/MCQ Short answer Essay type answer Report

Reference Books

1. T. K. Bose, S. K. Mitra and M. K. Sadu, 1990. Propagation of Tropical and Subtropical. Horticultural Crops. Naya Prokash, Calcutta- India.
2. C.C. Webster and W.J. Baulkwill. 1989. Rybber. Longman Scientific and Technical, NY, USA.
3. M. F. Mondal. 2000. Nursery and plant propagation (in Bangla). Afia Mondal, BAU Campus, Mymensingh
4. L. Hill and L. Perry. 2011. The Fruit Gardener's Bible: A complete Guide to Growing Fruits and Nuts in the Home Garden.

Course code: HORT 511 **Course title: Physiology of Horticultural Crops (Elective)**	**Credit Hours: 03**	**Semester: January - June**

Rationale: This course is designed to provide applied knowledge about horticultural plant physiology in advanced level.

Course Outcomes:

- Acquire knowledge on morpho-physiology of horticultural crops
- Acquaint about photoperiodic schemes for improvement of horticultural crops
- Understand about advanced stress management techniques for horticultural crops

Intended Learning Outcomes (ILOs) The students will be able to	**Course Content**	**Teaching Learning Strategies**	**Assessment Strategies**
• Differentiate about plant growth and its development methods	**Plant growth and development:** Initiation and regulation of development pathways. Analysis of plant growth and Senescence	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Elucidate about water management system for improving horticultural plants	**Water balance in plant:** Water absorption by root and water translocation through xylem	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Explain the different plant solvent transportation process and their Teaching Learning Strategies	**Solute transport process:** Active and passive transport, Membrane transport process and Ion transport in roots	Lecture Discussion	Quiz/MCQ Short answer Essay type answer
• Describe the photosynthesis and their mechanism pathway	**Photosynthesis:** The Light responses/reactions, Carbon reaction and translocation in the phloem (Source to sink)	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer Report
• Illustrate the respiration system and their mechanism	**Respiration:** Overview of plant respiration definition, characterization, and measurement and Respiration in Intact plants and tissues	Lecture Discussion Multimedia presentation Assignment	Quiz/MCQ Short answer Essay type answer
• Recognize the transpiration methods and their related factors	**Transpiration:** Characterization, significance, inherent and environmental factors	Lecture Discussion Multimedia presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Realize the development process of plant depends on light	**Light control of plant development**: Flowering physiology. Stomatal movement	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer

		Assignment	Report
• Designate different stress physiology and their management practices	**H. Stress Physiology:** Heat stress and heat shock, chilling and freezing, and salinity stress and Importance of the stress tolerance and avoidance.	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer Assignment Report
• Identify the different physiological disorder and their control measures	**Physiological disorders:** Symptoms and causes	Lecture Discussion Multimedia presentation Assignment	Quiz/MCQ Short answer Essay type answer Report

Reference Books

1. Edward F. Durner, 2013. Principles of Horticultural Physiology
2. P. Stewart and S. Globig, 2011. Plant Physiology, Apple Academic Press, pages 298
3. Chris Bird, 2014. The Fundamentals of Horticulture: Theory and Practice, Cambridge University Press
4. Charles B. Beck, 2010. An Introduction to Plant Structure and Development: Plant Anatomy for the Twenty-First Century. Cambridge University Press
5. L. Taiz, I. Moller, E. Zeiger and A. Murphy, 2015. Plant Physiology & Development, Sinauer Associates Inc.,U.S.

Course code: HORT 512 Course Title: Postharvest Technology of Horticultural Crops (Optional)	Credit Hours: 03	Semester: January-June

Rationale: This course is designed for proper concept on postharvest management of horticultural crops

Course Outcomes:

- Hypothesize on postharvest status in Bangladesh.
- Conceptualize different postharvest handling techniques.
- Provide knowledge on postharvest physiology of horticultural crops.
- Acquaint with storage system of horticultural crops.
- Acquire knowledge on processing of horticultural crops.

Intended Learning Outcomes (ILOs) The students will be able to	Course Content	Teaching Learning Strategies	Assessment Strategies
• Narrate about the concept of Postharvest status.	**Introduction:** Concept of Postharvest management of Horticultural Crops. Quality, present status and improvement of postharvest situation of horticultural crops, Detail studies of factors affecting postharvest of horticultural products	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Describe the postharvest handling techniques of Horticultural Crops	**Postharvest handling of horticultural crops:** Harvesting, cooling, cleaning, sorting, grading, packaging and transportation of horticultural crops. Export of horticultural commodities	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Express the postharvest physiology of Horticultural crops.	**Postharvest physiology:** Physiological and biochemical changes after harvest, factor causing physicochemical changes	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer
• Explain storage technology of • Horticultural crops.	**Technology of storage:** Principles, methods of storage and maintenance of conditions in store houses, Environmental requirements for storage of different fruits, vegetable and flowers.	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Narrate about postharvest spoilage of Horticultural crops.	**Postharvest spoilage:** Causes of spoilage and their remedies, Postharvest disorders, disease, pests and their minimization techniques	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Enumerate the techniques of processing, packaging and preservation.	**Processing and preservation:** Importance, principles and techniques of processing, packaging and preservation of fruits and vegetable;	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer

	Quality control of processed fruits and vegetables and value-added products, food safety issues.		

Reference Books

1. M.R. Amin. 1999. Names of Garden plants. B. Akter, 154, Aga-Sadek Road, Dhaka-2.
2. R. A. Larson. 2004. Introduction to Floriculture, 2nd edition, North Carolina State University, North Carolina.
3. T. K. Bose, R. Maiti, S. Dhua and P. Das. 1999. Floriculture & Landscaping. Naya prokash, Calcutta.
4. C. Hefferman. 2005. Flowers A to Z: Buying, Growing, Cutting, Arranging- A Beautiful Reference Guide to Selecting and Caring for the Best from Florist and Garden (Paperback).
5. M.F. Mondal. 2000. Nursery and plant propagation (in Bangla) Mrs. Afia Mondal, BAU campus, Mymensingh.
6. T. K. Bose and B. Chowdhury. 1991. Tropical Garden plants in Color. Horticulture & Allied publishers, Calcutta,India.
7. C.C. Webster and W.J. Baulkwill. 1989. Rybber. Longman Scientific and Technical, NY, USA.

Course code: HORT 513 Course Title: Growth Regulator in Horticulture (Elective)	Credit Hours: 03	Semester: July-December

Rationale: This course is designed to provide knowledge on plant growth regulator in horticultural crops

Course Outcomes:

- Conceptualize different plant growth regulators and their uses.
- Provide knowledge on application of PGRs in horticultural crops.
- Acquire knowledge on beneficial and harmful effect of PGRs in horticultural crops.
- Aware about food safety issues and PGRs

Intended Learning Outcomes (ILOs) The students will be able to	Course Content	Teaching Learning Strategies	Assessment Strategies
• State and describe the classification of plant growth regulators and their effects on horticultural crops.	**Introduction:** Classification and overview of PGRs Beneficial and detrimental effect of PGRs	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Mention about the plant physiology and PGRs	**PGRs and Plant physiology** Mechanism of action of plant hormones Naturally occurring plant hormones, their major physiological effect on plant growth and development	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Explain the plant growth and PGRs	**PGRs on plant growth** Structure, physiological effect, biosynthesis, metabolism and transport of Auxin. Gibberellins, Cytokinin Ethylene, Abscisic acid and others	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Describe of synthetic PGRs and their application.	**Synthetic PGRs and their application** Different synthetically produced plant growth regulators Methods of applying plant growth regulators and their advantage and disadvantage.	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Enumerate the uses of PGRs in Agriculture. • Exercise/operate the use of PGRs in agriculture.	**Uses of PGRs** Uses of growth regulators in fruit, vegetable, ornamental and cut flowers Practical uses of PGRs	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer

	in agriculture		

Reference Books

1. Louis G. Nickell. 1982 Plant Growth Regulators: Agricultural uses. springer verlag, PP173.
2. Brooklyn Botanical Garden. 1961. Boyce Thompson Institutes, New York, US.
3. Lalit Mohan Srivastava. 2002. Plant Growth Development: Hermones and Environment. Academic Press, Elsevier Science, USA.
4. Peter. J. Davies. 1995. Plant Hormones: Physiology, Biochemistry and Molecular Biology. Springer Science, USA.

Course code: HORT 514 Course Title: Hydroponics and Organic Farming (Elective)	Credit Hours: 03	Semester: January-June

Rationale: This course is designed to provide knowledge on protected culture, hydroponics and organic farming system.

Course Outcomes:

- Hypothesize hydroponics and organic farming.
- Conceptualize controlled environment agriculture.
- Provide knowledge on hydroponic crop production.
- Acquaint with greenhouse for the tropics.
- Provide knowledge on organic crop production.
- Aware about food safety and security.

Intended Learning Outcomes (ILOs) The students will be able to	Course Content	Teaching Learning Strategies	Assessment Strategies
• Narrate importance, advantage and present status of hydroponics in the world.	**Introduction to hydroponics:** Concept of controlled environment agriculture. Objectives, importance, advantages and disadvantages of hydroponics. Hydroponic basic. Research activities of soilless culture in the world. Present status and future prospect of hydroponics in Bangladesh	Lecture Discussion Video	Quiz/MCQ Short answer Essay type answer
• Explain about different hydroponic system.	**Classification of hydroponic system:** Classification of hydroponic growing system. Circulating and non-circulating systems, NFT, DFT and other system. Water quality and oxygen problem in hydroponic system. Infrastructure preparation of different systems. Aeration methods in hydroponics	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Demonstrate about low-cost hydroponic system for Bangladesh.	**Hydroponic system for the tropics**: Low-cost and simple (LCS) hydroponic system for Bangladesh. Tips on carrying out an installation. Protected vegetable cultivation system in urban and peri-urban areas in Bangladesh	Lecture Discussion Multimedia presentation Video	Quiz/MCQ Short answer Essay type answer

• Illustrate about setting and maintenance system of substrates.	**Substrate culture:** Classification and properties of substrates, system settings and maintenance	Lecture Discussion Multimedia presentation Video	Quiz/MCQ Short answer Essay type answer
• Exhibit the installation and working system of hydroponic growing unit.	**Growing unit for hydroponics**: Different units in the world and Bangladesh. Consideration of selecting equipment and units, equipment and their installation. Supplementary needs. Hydroponic seeding methods, containers, and growing media	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Describe on preparation, application of nutrient solution.	**Nutrient solution:** Nutrient formulae-Hoagland and Arnon (1938), Rahman and Inden (2012), etc. Preparation of nutrient solution, rate of application. Solution pH and EC and, temperature. Nutrient solution application equipment, automatic dosing equipment	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Describe/state the management of green house.	**Environmental control and Greenhouse design:** Temperature, RH, cooling and heating, lighting management system. CEA, greenhouse design and materials. Greenhouse for the tropics and automated system	Lecture Discussion Multimedia presentation Video	Quiz/MCQ Short answer Essay type answer
• Describe scope and importance of organic farming in Bangladesh.	**Introduction to organic farming:** Concept, scope and importance in Bangladesh	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Explain about adverse effect of present agricultural practices in Bangladesh.	**Sustainable agriculture and cycle for survival**: Adverse effects of agricultural practices on farm. Towards organic farming: Management of autonomous ecosystem, general principles of organic agriculture.	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Mention about compost, bio-fertilizer and microbial inoculates for nutrient management.	**Bio-intensive nutrient management:** Soil populations and process, use of bio-fertilizes, enrichment of compost with microbial inoculates.	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Describe about biological and ecological pest management.	**Biological pest management:** Ecological pest management, Neem etc.	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer

• Narrate about present status of food safety in Bangladesh.	**Food safety and security:** Concept, present status in Bangladesh. Toxins in conventional system of crop production, Probable remedies.	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Exhibit about global scenario of organic movement.	**IFOAM:** Global scenario of organic movement.	Lecture Discussion Multimedia presentation	Quiz/MCQ Short answer Essay type answer

Reference Books

1. "Trickle Irrigation for crop Production "Vol-9, 1st Edn-April 1986, Editors FS Nakeyame, DA Books © Elsevier Science 1986
2. Hydroponic food production: A Home gardening and the commercial hydroponic grower; 7th edn. By Howard M. Resh, CRC Press, Tailor & Framcis group, 2012.
3. "Practical Guide for simple Soilless Culture Technology", 1992, F. Benoit. European Vegetable R& D Centre, Belgium.

Course code: HORT 515 Course Title: Minor and Exotic fruits of Bangladesh (Elective)	Credit Hours: 03	Semester: July-December

Rationale: This course is designed to provide applied knowledge about minor and exotic fruits of Bangladesh.

Course Outcomes:

- Provide knowledge about minor and exotic fruits.
- Acquaint the establishment and proper management of orchard.

Intended Learning Outcomes (ILOs) The students will be able to	Course Content	Teaching Learning Strategies	Assessment Strategies
• Discriminate about minor and exotic fruits its scope importance and production status.	**Introduction:** Concept, Classification, scope and importance	Lecture Discussion Multimedia Presentation	Quiz/MCQ Short answer Essay type answer
• Describe about minor fruit.	**Minor fruit:** Importance, morphology, ecophysiology, culture and management of the minor fruits of Bangladesh	Lecture Discussion Multimedia Presentation	Quiz/MCQ Short answer Essay type answer
• Mention about improvement techniques of minor fruits.	**Improvement of minor fruits:** Different techniques and achievements	Lecture Discussion	Quiz/MCQ Short answer Essay type answer
• Describe the cultural practices of exotic fruits.	**Exotic Fruits:** Importance, morphology, ecophysiology, culture and management of the following fruits: An avocado cashew nut, grapes strawberry, macadamia nut, mangosteen, ambulant, apple and pear	Lecture Discussion Multimedia Presentation	Quiz MCQ Short answer Essay type answer Report

Reference Books

1. L. Hill and L. Perry. 2011. The fruit Gardeners Bible: A Complete Guide to Growing Fruits and Nuts in the Home Garden
2. T.K. Bose and S. K. Mitra 1995. Fruits: Tropical and Sub-tropical. Naya Prokash, Calcutta, India

Department of Plant Pathology

Course Layout

Sl. No.	Course Code and Title	Cr. Hrs
A. Compulsory Courses		
1	PLPA 501: Mycology	3
2	PLPA 502: Phytopathological Research Methodology	3
3	PLPA 503: Epidemiology and Disease Dynamics	3
4	PLPA 504: Plant Disease Management	3
5	PLPA 505: Clinical Plant Pathology	3
6	PLPA 506: Molecular Biology of Host-Pathogen Interaction	3
	Total	18
B. Elective Courses		
7	PLPA 507: Field Plant Pathology	3
8	PLPA 508: Plant Nematology	3
9	PLPA 509: Phytobacteriology	3
10	PLPA 510: Methods in Plant Plathology	3
11	PLPA 511: Plant Virology	3
12	PLPA 512: Soil-borne Disease	3
13	PLPA 513: Post Harvest Pathology	3
14	PLPA 514: Disease Resistance in Plants	3
15	PLPA 515: Microbial Genetics	3
16	PLPA 516: Seed Pathology	3
17	PLPA 517:Industrial Microbiology	3
	Minimum	**12**
C. Seminar Course		
16	PLPA 598: Seminar	01
D. Thesis Research		
	PLPA-599 Research work for thesis	16
	Compulsory Courses	**18**
	Elective Courses	**12**
	Seminar Course	**01**
	Thesis Research	**16**
	Total	**47**

Curriculum Alignment / Skill Mapping

Curriculum must be aligned with program objectives, program learning outcome and intended learning outcomes through proper skill mapping.

Department of Plant Pathology

Courses	Program Learning Outcome							
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
PLPA 501	x	x	x	x				x
PLPA 502	x	x	x		x			x
PLPA 503	x	x	x	x				x
PLPA 504	x	x	x	x				x
PLPA 505	x	x	x	x				x
PLPA 506	x	x	x	x				x
PLPA 507	x	x	x	x				x
PLPA 508	x	x	x	x				x
PLPA 509	x	x	x	x				x
PLPA 510	x	x	x	x				x
PLPA 511	x	x	x	x				x
PLPA 512	x	x	x	x				x
PLPA 513	x	x	x	x				x
PLPA 514	x	x	x	x				x
PLPA 515	x	x	x	x				x
PLPA 516	x	x	x	x				x
PLPA 598						x	x	
PLPA 599					x	x	x	x

Code: PLPA 501 Course Title: Mycology (Compulsory)	Credit Hour: 03	Semester: January-June

Rationale: This course is designed to provide basic understanding of the biology, taxonomy and phylogeny of fungi with emphasis on particular principles and facts regarding detection and identification of fungi.

Course Outcomes:

- Identify major group of fungi based on morphology (both in lab and field)
- Locate and use fungal biology resources to interpret fungal nomenclature and systematic position
- Conceptualize and explain the ecological roles of major fungal groups
- Gather knowledge on molecular identification of fungi and interpret a phylogenic tree
- Acquire knowledge about economic and environmental mycology

Intended Learning Outcomes (ILOs) The student will be able to-	Course Content	Teaching - Learning Strategies	Assessment Strategies
• Define fungi, mycology. • Describe the characteristics of fungi.	General overview of fungi	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Discuss different forms of fungi.	Introduction to fungal form	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Depict fungal cell • Describe the functions of cell organelles	Fungal cell structure	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Categorize the structure of cell wall and septa	Fungal cell wall architecture and hyphal growth	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Explain the origin and evolution of fungi • Criticize the theories on evolution of fungi	Phylogeny of fungi	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Define Taxonomy • Illustrate the classification of fungi and fungus like organisms	Taxonomy of fungi	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Analyze the biochemical aspects of growth, respiration and metabolism	Physiology of Fungi	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer

• Distinguish among spore, conidia and inocula • Sketch the sexual and asexual devices of inocula production of fungi • Describe the ways and means of liberation and dissemination of inocula	Inocula production of fungi, its liberation and dissemination	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Able to prepare semi permanent and permanent slide for compound microscopy	Description for slide preparation for identification of fungi by microscopic study	Lecture Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer
• Able to explain the characteristics, reproduction and classification of zoosporic fungi	Zoosporic fungi: Chytrids, Oomycetes and others	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Able to discuss the characteristics, zygospore fromation and classification of zygosporic fungi • Describe the life cycle of saprophytic (Rhizopus) fungi	Phylum Zygomycota (General overview)	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Enrich understanding on the characteristics, Ascus formation, reproduction, different types of ascocarp and classification of sac fungi	Phylum Ascomycota (General overview): Apothecial, Perithecial, Cleistothecial and unicellular Ascomycota	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Discuss the characteristics, • Classify the fungi under Basidiomycetes • Illustrate the life cycle of fungi under Basidiomycetes	Phylum Basidiomycota (General overview)	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Know the characteristics and classification of imperfect fungi	Phylum Deuteromycota -The Imperfect Fungi	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Explain the characteristics of different types of genetic materials and para-sexuality of fungi	Fungal genetics	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Describe the structure of macro-fungi • Illustrate the features of different mushrooms • Describe / overview the production technology of different edible mushroom	Cultivation of mushrooms and other fungi	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer

• Explain the lifecycle, history and evolution of *Claviceps* • Effects of ergot in human livestock and environment	Ergot and Ergotism	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Discuss the different environmental factors on fungal life cycle	Environmental mycology	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Categorize the different forms of relationship between organisms	Symbiotic and parasitic relationship	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Discuss commensalism relationship between fungi and algae	Lichens	Lecture Visual presentation Interactive discussion	Quiz/MCQ Short answer Essay type answer
• Describe the mutual relationship between plants and fungi	Mycorrhizae	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Describe basic and fundamentals of molecular identification of fungi	Molecular identification of fungi	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Illustrate the protocol of isolation of genomic DNA from fungi	Isolation and purification of genomic DNA from	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Explain different steps of PCR protocol • Discuss the mechanism of gel electrophoresis	PCR and gel electrophoresis for amplification and confirmation of fungal DNA	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Describe the procedure of gel purification of PCR product	Gel purification of PCR product	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Analyze sequences using BioEdit and Mega 4.0 software	Quality analysis of sequence	Lecture Visual presentation	Quiz/MCQ Short answer Essay type
• Show the procedure of BLAST search for identification of fungi. • Interpret a phylogenetic tree	BLAST search and phylogenetic tree for identification of fungi	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer

• Prepare an assignment on common fungal species of Bangladesh • Prepare 10 permanent slides of common fungi	Lab report work/ Assignment presentation	Laboratory work Multimedia presentation	Quiz/MCQ Short answer Essay type answer

References Books

1. Introductory Mycology- C.J. Alexopoulos; C.W. Mims and M. Balackwell- Forth Edition, Jhon Wiley & Sons Publication.
2. Text book of Fungi- O.P. Sharma- 11th Edition, McGraw –Hill Publishing Company Limited.
3. Plant Pathology- George N. Agrios – Fifth Edition- Elsevier Academic Press.
4. An Introduction to Fungi- H. C. Dube. Vikas Publishing House Pvt. Ltd.
5. Dictionary of the Fungi- Kirk, Cannon, Minter- 10th edition- CAB International
6. Infections Fungi- K. M. Chandniwala, 1st edition- Anmol Publication Pvt. Ltd.
7. Beneficial fungi and their Utilization – M. C. Nair, S. Balakrishnan – Scientific Publisher Ltd.
8. Introduction to fungi- John Webster- 1st edition.
9. Fungi and disease in Plant- F. J. Butler
10. Fungi and Biocontrol Agent Progress, Problem and Potential- T. M Bult, C. W. Jackson, N. Magan- CABI Publishing.
11. Physiology of Fungi- Vincent W. Cochrane - Wiley International Edition.
12. Microfungi on Lands Plants and Identification Hand book –B. Ellis, J Pamela Ellis – 2001. CroomttelmAugtraliapty Ltd.
13. A hand Book of Edible Mushroom – S. Kannaiyan, K. Ramasamy- Today & tomorrows Pvt. Ltd.
14. Mushroom Production and Processing Technology – PathakYadavGour, Agrobios publisher.
15. Introduction To Mushroom Science – T. N. Kaul – Oxford & IBH publishing Co. Ltd.

Course Code: PLPA 502 Course Title: Phytopathological Research Methodology (Compulsory)	Credit Hour: 03	Semester: January-June

Rationale: This course is designed to provide advanced concept on phytopathological research methodology and the basic Teaching Learning Strategies to design the phytopathological research methodology to perform basic and applied research.

Course Outcomes:

- Acquire basic knowledge on phytopathological research methodology
- Acquaint with knowledge about experimental design and methodology of phytopathological research
- Gather advanced knowledge on data collection, compilation and data analysis with updated package program
- Equipped with updated knowledge to write scientific article, report and organize / prepare MS /Ph.D Thesis / dissertation

Intended Learning Outcomes (ILOs) The student will be able to-	Course Content	Teaching Learning Strategies	Assessment Strategies
• Describe the concept of phytopathological research methodology • Explain the components of phytopathological research methodology	Concept and components of phytopathological research methodology	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Exercise the selection process of research title • State the significance of reviewing existing literature in research title selection process	Selection of research title	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer Book/journal review Essay type answer
• Illustrate the methodology for designing and conducting the phytopathological research • Disclose the methodology for achieving the objectives of research	Research Methodology, achieving the objectives of Phytopathological research	Lecture Multimedia presentation Field demonstration	Quiz/MCQ Short answer Essay type answer Case analysis
• Analyse the situation of study area. • Identify and prioritize the problems • Develop the hypothesis of the study	Analysis of facts / situation, identification and prioritization of problems and developing the hypothesis	Lecture Multimedia presentation Field visit	Quiz/MCQ Short answer Essay type answer Report writing

• Describe the methods of sampling, data collection and its compilation, analysis, interpretation and presentation	Collection data/facts, compilation, analysis, presentation, interpretation and summarization	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer Writing a script/research proposal
• State the components of writing thesis and scientific article • Exercise the writing process of thesis, scientific articles and reports • valuate thesis and scientific articles	Components / contents of Thesis / Dissertation, scientific articles and reports; their writing articulation and evaluation	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer Self-study
• State the basic designs and basic consideration in designing Phytopathological experiments • State the significance of different experimental designs	Basic designs and basic considerations for Phytopathological research experiments	Lecture Multimedia presentation Interactive discussion	Quiz/MCQ Short answer Essay type answer Report submission
• Describe the process of treatments determination and variables selection • State the parameters of data collection	Determining treatments, variables, parameters of data collection	Lecture Multimedia presentation Interactive discussion	Quiz/MCQ Short answer Essay type answer Case analysis
• Describe the process of experimental unit selection and fixation of unit size • Explain the design of simple and factorial experiments	Size of experimental unit and fixing replication for simple and factorial experiments in different types of Phytopathological research	Lecture Multimedia presentation Interactive discussion	Quiz/MCQ Short answer Essay type answer Case analysis
• Define correlation and regression, correlation coefficient and regression coefficient • Construct regression equation in phytopathological research	Correlation and regression in phytopathological research	Lecture Multimedia Visual presentation presentation	Quiz/MCQ Short answer Essay type answer Data based analysis
• State the model experimental design of phytopathological research. • Explain the process for estimation of percent disease incidence and severity. • Describe the management Teaching Learning Strategies of plant diseases.	Model experimental design on: disease incidence and severity, disease management, integrated disease management	Lecture Multimedia presentation. Group discussion	Quiz/MCQ Short answer Essay type answer Assignment

• Explain the experimental design for vector borne, seed borne and soil borne diseases.	Model experimental design on: vector borne, seed borne and soil borne diseases	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Explain the experimental design for fungicidal evaluation. • Analysis the fungicidal effect/residues. • Explain the yield loss estimation procedure.	Model experimental design on: fungicide evaluation, fungicide residues, disease resistance, detection of pathogens, yield loss estimation	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• State the computer based techniques for phytopathological data analysis.	Analysis of Phytopathological data	Lecture Multimedia presentation Self study	Quiz/MCQ Short answer Essay type answer Case analysis
• State the MSTAT-C software for phytopathological data analysis.	Analysis of data by using - MSTAT-C	Lecture Multimedia presentation Self study	Quiz/MCQ Short answer Essay type answer Case analysis
• Describe the techniques for phytopathological data analysis by using 10-STAT software.	Analysis of data by using- 10 STAT software	Lecture Multimedia presentation Self study	Quiz/MCQ Short answer Essay type answer Case analysis
• Describe the techniques for phytopathological data analysis by using SPSS software.	Analysis of data by using SPSS	Lecture Multimedia presentation Self study	Quiz/MCQ Short answer Essay type answer Case analysis
• Explain the genetic engineering process. • Apply the genetic engineering for developing resistant / tolerance variety / cultivar.		Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer Case analysis

Reference Books

1. Adams G. R. and Schvaneveldt, J. D. Understanding Research Methods, New York, Longman inc. 1985.
2. Begum, N. N. 1988. SamajikGabeshanaParichiti. Knowledge View, Dhaka.
3. Bovaird, James A. and Kevin A. Kupzyk, 2010."Sequential Design" In Encyclopedia of Research Design. Neil J. Salkind, Academic Press, New York.
4. Consuelo G. Sevilla, Jesus A. Ochave, Twila G. Punsalan and Bella P. Regala, Gabriel G. Uriarte. 1984.An Introduction to Research Methods. Manila: Rex Book Store.
5. Ghosh, B.N. (1993). Scientific Method and Social Research. Sterting Publishers Private Limited. New Delhi Page-6.
6. Hall, R. O. 1943. Handbook of Tabular Presentation. The Ronald Press Company, New York.
7. International Encyclopaedia of the Social Sciences. 1968. The Macmillan Company and the Free

Press, USA. 14 (1968):85-90.
8. Islam, M. N. 2013. Social Research., Tasmia Publications, Dhaka
9. Janicki R., Parnas, D. L., and Zucker, J. 1997."Tabular representations in relational documents". In Brink, C.; Kahl, W and Schmidt, G. Relational Methods in Computer Science. Springer Verlag. ISBN 3-211-82971-7
10. Kothari, C.R. 1990. Research Methodology: Methods and Techniques, New Age International (P) Ltd. Publishers, New Delhi, India.
11. Maykut, Pamela S. 2013. Beginning Qualitative Research: A Philosophic and Practical Guide. Washington, D.C.
12. Nataliya V. Ivankova. 2006. "Using Mixed-Methods Sequential Explanatory Design: From Theory to Practice."Field Methods 18 (2013): 3-20.
13. Rummel, J. Francis. 1964. An Introduction to research procedures in education, 2nd ed. New York: Harper & Row, Publisher.
14. Taher, M. A. 2007. SamajikGabeshanaParichiti. Dhaka. Anuprokashoni.
15. Trochim, William M. K. and Cuthill, Michael. 2002. "Exploratory Research: Citizen Participation, Local Government, and Sustainable Development in Australia." Sustainable Development 10 (2002): 79-89.
16. Webb, E. J., Campbell, D. T., Schwartz, R. D. And Sechrest, L. (2000). *Unobtrusive Measures*; revised edition. Thousand Oaks: Sage Publications Inc. ISBN 0-7619-2011-0
17. Plant Diseases Phytopathological and Botanical Research MethodsHardcover– 2007 byT Elsworth Rawlins.

Course Code: PLPA 503 **Course Title: Epidemiology and Disease Dynamics (Compulsory)**	**Credit Hour: 03**	**Semester: January - June**

Rationale: This course is designed to provide basic and applied knowledge on important aspects of plant disease epidemics, modeling and forecasting.

Course Outcomes:

- Explain how plant disease epidemics occur in nature, illustrate meteorological factors influencing epidemics and how they can be monitored and analyzed.
- Predict plant disease progression, measure and compare epidemics, analyze temporal and spatial aspects of epidemics,
- Compute and interpret plant disease model and plant disease forecasting systems

Intended Learning Outcomes (ILOs) The student will be able to-	**Course Content**	**Teaching Learning Strategies**	**Assessment Strategies**
• Describe concept of epidemiology and its impact on disease occurrence • Identify major environmental factors affecting plant disease epidemics; • Illustrate schematic diagrams of the interactions of factors in plant disease development • Describe the inocula production and liberation devices of plant pathogens	**Concepts of epidemiology** Introduction to botanical epidemiology, history of plant disease epidemiology, and definition of key terms. Disease triangle and disease tetrahedron, (managed patho-system) factors associated with development of epidemics Production and liberation of inocula; Dissemination of plant pathogens; Principals of population dynamics as affected by environment and host-pathogen interactions	Lectures Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer
• Measure plant disease and quantify disease using statistical procedures • Use statistical procedures for quantifying and comparing epidemics.	**Quantification of disease** Measuring plant disease and plant host, and monitoring epidemics; Disease incidence and severity; measuring disease incidence and severity. statistical distributions of disease incidence; sampling for incidence Regression analysis	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Explain temporal and spatial pattern of disease progress • Compare different pattern of epidemics • Develop and design innovative epidemiologic	**Disease progress and disease modeling** Disease Progress over time and space; concepts of monocyclic and polycyclic epidemics; models for disease progress over time; analysis of disease progress curves;	Lectures Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report

models	Spatial patterns of epidemics: concepts of dispersion and aggregation, and scale of aggregation; statistical distributions of disease incidence; analysis of spatial patterns and interpretation of results; sampling for incidence		
• Explain how epidemiology is used to set the strategy of plant disease control	**Disease management** Principal of plant disease management & how epidemiology set the strategy of disease management	Lectures Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Describe how to predict crop loss. • Perform a critical analysis of forecasting systems; Develop and design innovative epidemiologic models and forecasting systems.	**Crop loss assessment** Plant disease epidemics resulting crop losses; models for crop losses; linkages between epidemiology and crop physiology; prediction of losses	Lectures Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report

Reference Books

1. The Study of Plant Disease Epidemics. By Laurence V. Madden, Gareth Hughes and Frank van den Bosch. APS Press, 3340 Pilot Knob Road, St. Paul, MN 55121-2097. (ISBN: 978-089054-354-2).
2. B.M. Cooke, D. Gareth Jones And B. Kaye. 2006. The Epidemiology Of Plant Diseases. Second Edition. Springer, Dordrecht, The Netherlands.
3. Chiarappa, L., ed. 1971. Crop loss assessment methods: FAO manual on the evaluation and prevention of losses by pests, disease and weeds. [Farmham Royal]: Commonwealth Agricultural Bureaux FAO United Nations

Course Code: PLPA 504 Course Title: Plant Disease Management (Compulsory)	Credit Hour: 03	Semester: July -December

Rationale: The couse is designed to provide knowledge on components, principles and methods of plant disease management emphasis on integrated approaches with ecofrendly bio-control agents and its cost effectivity.

Course Outcomes:

- Conceptualize plant disease management rather than control
- Exercise principles and methods of plant disease management
- Acquire knowledge on modern integrated approach for plant disease management and study of its costing
- Optimize crop production by utilizing knowledge, skills, expertise regarding plant disease management

Intended Learning Outcomes (ILOs) The student will be able to-	Course Content	Teaching - Learning Strategies	Assessment Strategies
• Disclose the basic concept on plnat disease management rather than control • State the management tools / components of plant disease management. • Describe the ETH and EIL of pathogen population in field condition.	Concept of plant disease management and its components.	Lecture Multimedia presentation Interactive discussion	Quiz/MCQ Short answer Essay type answer
• State and explain the priciples of plant disease management. • Describe the methods of plant disease management (cultural, physical, chemical and biological).	Principles and methods of plant disease management: Physical, cultural, chemical, biological, legislative and host resistance.	Lecture Multimedia presentation Interactive discussion	Quiz/MCQ Short answer Essay type answer
• Explain the principles / strategies for biological control. • State the modern tools / options of biological control. • Describe the modern approaches of biological control.	Modern approach of biological control: Black box approach and Silver bullet approach.	Lecture Multimedia presentation Interactive discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Acquaint with formulated products of bio-pesticides in the world. • Describe the techniques of formulating bio-pesticides using bio-agents.	Formulation of biopesticides using biocontrol agents. Assaying of bioagents / biopesticides angainst plant pathogen	Lecture Multimedia presentation Interactive discussion	Quiz/MCQ Short answer Essay type answer

• Practise the assaying of biopesticides against plant pathogens.			
• Define plant quarantine. • State and explain the Teaching Learning Strategies / rules of plant quarantine. • Exercise the rules of plant quarantine in Bangladesh.	Principles and practices of plant quarantine.	Lecture Multimedia presentation Interactive discussion	Quiz/MCQ Short answer Essay type answer
• Classify chemical fungicides. • Explain the mode of action of chemical fungicides. • Exercise the judicious application of chemical fungicides. • Mention the active ingredients and systemic nature of fungicides	The groups and mode of action of chemical fungicides. Active ingredients, adjuvants and systemic nature of fungicides.	Lecture Multimedia presentation Interactive discussion	Quiz/MCQ Short answer Essay type answer
• Acquaint with the hazardous affect of fungicides on environment and food chain as residual effect. • Address the problems regarding fungicides resistance.	Bio-assay of chemical fungicides against plant pathogens. Application and management of fungicide resistance.	Lecture Multimedia presentation Interactive discussion	Quiz/MCQ Short answer Essay type answer
• Familiar with pathogen elicitors and it's response by host plants. • Define and explain the structural, physiological and chemical defence mechanism of plants.	Plant defense Teaching Learning Strategies and mechanisms.	Lecture Multimedia presentation Interactive discussion	Quiz/MCQ Short answer Essay type answer
• Define host resistance, immunity and tolarance. • Differentiate vertical resistance (VR) and horizontal resistance (HR). • Develop disease resistant variety through conventional breeding. • Address the detarioration of a disease resistant variety.	Development of host resistance through conventional breeding.	Lecture Multimedia presentation Interactive discussion	Quiz/MCQ Short answer Essay type answer
• Define transgenic variety for disease resistance. • Acquaint with ways and means of gene transfer. • Acquire knowledge on gene	Development of host resistance making transgenic crop through genetic engineering.	Lecture Multimedia presentation Interactive discussion	Quiz/MCQ Short answer Essay type answer

multiplication. • Develop disease resistant transgenic variety by Agrobacterium mediated gene transfar.			
• Defien IPM/ IDM and it's tools for disease management. • State the eco-friendly components of IPM / IDM. • Aquire knowledge on formulation of botanical pesticides.	Integrated approaches for plant disease management, Eco-friendly components of IPM/IDM, Biopesticides, Botanical pesticides.	Lecture Multimedia presentation Demonstration Field visit	Quiz/MCQ Short answer Essay type answer Report writing
• Define cost (BCR) analysis. • Calculate cost of goods and • Aanalyze the BCR for IPM / IDM approaches. • Utulize and evaluate the cost effectivity in decision making process for integrated apporaches.	Cost analysis (BCR) and decision making for integrated disease management.	Lecture Multimedia presentation Interactive discussion Assignment	Quiz/MCQ Short answer Essay type Report

Reference Books

1. Principles of Plant Disease Management - William Fry, 1st Edition, Academic Press, 2012.
2. Plant Pathology- George N. Agrios – Fifth Edition- Elsevier Academic Press, 2006.
3. General Concepts in Integrated Pest and Disease Management-A. Ciancio and K. G. Mukerji, Springer, 2007.
4. Disease Control in Crops: Biological and Environmentally-Friendly Approaches, Dale Walters (Editor), Wiley-Blackwell Publishing, 2009.
5. Disease Control in Crops: Biological and Environmentally Friendly Approaches, Edited by Dale Walters, APSnet, 2013.
6. Disease Control in Crops: Biological and Environmentally-Friendly Approaches-Dale Walters, John Wiley & Sons, 2009.
7. Advances in Plant Disease Management - Hung-Chang Huang and Surya N. Acharya (Editors), Research Signpost, Trivandrum, Kerala, India, 2003.
8. Fungicides in Plant Disease Control- Y.L. Nene and P. N. Thapliyal, Third Edition, Oxford and IBH Publishing Co. PVT. LTD. 2002.
9. Plant Disease- R.S. Singh, Eight Edition, Oxford and IBH Publishing Co. PVT. LTD. 2005.
10. Diseases of Crop Plants in India- G. Rangaswami and A. Mahadevan, Fourth Edition, Prentice –Hall India Pvt. Ltd. 2004.
11. Plant Protection- A Biocontrol Approach- Pravin Chandra Trivedi, Aavishkar Publishers, 2003.
12. Ecofriendly Management of Plant Disease- Shahid Ahmed and Udit Narain, Daya Publishing House, 2007.
13. Disease Problems in Vegetable Production- S.K. Gupta and T.S. Thind, Scientific Publishers, 2006.

Course Code: PLPA 505 Course Title: Clinical Plant Pathology (Compulsory)	Credit Hour: 03	Semester: January-June

Rationale: This course is designed to provide knowledge on proper diagnosis and prescription for the management of plant diseases. The student will equipped with knowledge on organizational set up a Plant Clinic, its operation and maintenance.

Course Outcomes:

- Acquire knowledge on organizational set up a Plant Clinic and its operation and maintenance
- Diagnose the major crop diseases and identify their causal microorganisms / agents
- Gather knowledge on anti-pathogenic chemicals / materials available in Bangladesh and world market
- Prescribe the control measures for major crop diseases

Intended Learning Outcomes (ILOs) The student will be able to-	Course Content	Teaching Learning Strategies	Assessment Strategies
• Define a Plant Clinic. • Describe the necessity of Plant Clinic • Outline the infrastructure of a plant clinic	Requirements of Plant Pathology Clinic.	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Create facilities of a plant clinic • Organize layout set up of a Plant Clinic • Operate and maintain a Plant Clinic	Technical procedures, material requirements and organizational set up for the effective operation of a Plant Clinic.	Lecture Multimedia presentation Interactive discussion	Quiz/MCQ Short answer Essay type answer
• Collect and keeping records of diseases samples • Identify causal organism of the diseases using proper diagnostic techniques	Fiagnostic process: Field observation, collection diseased samples, methods of culture, microscopy, keeping records and reference material.	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Perform laboratory practices effectively • Operate and maintain laboratory equipments properly	General laboratory practices and equipment maintenance.	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Preserve diseased specimens for future demonstration • Prepare diseased specimens for clinical study	Collection, preservation and preparation of plant disease specimen for clinical studies.	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Make pure culture of plant pathogens and bioagents • Evaluate anti-pathogenic chemicals / materials through food poisoning techniques	Maintenance of pure cultures of plant pathogens and bioagents.	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer

• Explain typical sign and symptoms of plant diseases	Field trips / visit to experimental stations and farmer's field. Symptomology of plant diseases	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Identify the destructive diseases of vegetables crops, field crops and fruits crops • Prescribe control measures of plant diseases	Overview of plant diseases of vegetable crops, field crops and fruits crops. Prescription of control measures	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Describe the sample size, and sampling for survey of plant diseases • Calculate disease incidence and severity of crop diseases	Plant disease survey, detection and evaluation methods	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Explain the latest research findings and information of Clinical Plant Pathology	Latest research findings and information regarding Clinical Plant Pathology	Assignment Group work	Report Presentation

References Books

1. Detection and Diagnostics of Plant Pathogens- Editors: **Gullino**, Maria Lodovica, **Bonants**, Peter J. M. (Eds.)
2. Clinical Plant Pathology- George N. Agrios – Fifth Edition- Elsevier Academic Press
3. Fungi and disease in Plant- F. J. Butler
4. Plant Clinic- M.I.Mian

Course Code: PLPA 506 Course Title: Molecular Biology of Host-Pathogen Interaction (Compulsory)	**Credit Hour: 03**	**Semester: July-December**

Rationale: This course is designed to provide basic understanding of the molecular biology and molecular plant microbe interaction.

Course Outcomes:

- Understand basic molecular tools, chemicals and their uses
- Identify microorganisms causing major field crop diseases based on molecular tools and techniques.
- Acquire knowledge about molecular plant microbe interaction.
- Improve disease diagnosis and control Teaching Learning Strategies using molecular techniques.

Intended Learning Outcomes (ILOs) The student will be able to-	**Course Content**	**Teaching Learning Strategies**	**Assessment Strategies**
• Define host pathogen interaction. • Explain history and scope of molecular host pathogen interaction	Concept of molecular biology of host pathogen interaction, Importance	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Explain molecular biology • Perform molecular tools handling chemical using • Perform PCR and gel electrophoresis	Basics molecular biology, molecular tools, chemicals, PCR, primer, gel electrophoresis.	Lecture Multimedia presentation Interactive discussion	Quiz/MCQ Short answer Essay type answer
• Explain molecular and biochemical basis of plant defence mechanisms • Analyze disease resistance in plants • Describe secondary metabolites and antimicrobial proteins	Molecular and biochemical basis of plant defence mechanisms, disease resistance including secondary metabolites and antimicrobial proteins.	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Explain biotrophic, necrotrophic and symbiotic molecular interaction mechanisms • Differentiate among biotrophic, necrotrophic and symbiotic interaction • Explain plant virus interaction	Microbial trophic Teaching Learning Strategies e.g. biotrophy, necrotrophy, symbiotic and virus interactions with plants.	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Explain mechanisms and Teaching Learning Strategies of pathogen invading plants • Discuss host defence mechanisms against pathogenic infection	Mechanisms and Teaching Learning Strategies by which pathogens invade plants, overcome host defense responses and	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer

	reproduce in or on the host tissues.		
• Describe fundamental molecular knowledge application on biological process of plants • Compare novel non-toxic chemicals, chemical pesticides and genetic manipulation in improving control Teaching Learning Strategies	Importance of fundamental molecular knowledge on these biological processes in improving control measures, by novel non-toxic chemicals or genetic modification.	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Explain the latest research findings and information of Molecular Biology of Host Pathogen Interaction	Latest research findings and information regarding Molecular Biology of Host Pathogen Interaction	Assignment Group work	Report Presentation

References Books

1. Dickinson, M. 2005. Molecular Plant Pathology. BIOS Scientific Publishers in a member of Taylor and Francis groups
2. Ronald, P. C. 2007. Plant-Pathogens Interaction Methods and Protocols. Springer.
3. Bouarab, K., Brisson, N. and Daayf, F. 2009. Molecular Plant Microbe Interactions. CABI.
4. Cox, M. M., Doudna, J. A.andO'Donnell, M. 2015. Molecular Biology: **Principles and Practice.** Macmillan Learning

Course Code: PLPA 507 Course Title: Field Plant Pathology (Elective)	Credit Hour: 03	Semester: January-June

Rationale: This course is designed to provide basic understanding of the diagnosis, assessment and management of field crop diseases.

Course Outcomes:

- Assessment of plant diseases in the field.
- Identify microorganisms causing major field crop diseases.
- Plant diseases management in commercial production.

Intended Learning Outcomes (ILOs) The student will be able to-	Course Content	Teaching Learning Strategies	Assessment Strategies
• Identify plant diseases. • Estimate plant diseases incidence and severity.	Plant disease assessment methods	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Identify causal organism of the diseases • Formulate effective control measures	Diagnosis of plant disease and the integration of disease management into commercial crop production practices.	Lecture Multimedia presentation Interactive discussion	Quiz/MCQ Short answer Essay type answer
• Identify causal organism of the diseases • Compare different disease diagnostic and management methods.	Common disease diagnosis and disease management methods	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Explain present status of field diseases • Identify destructive diseases of ornamental plants.	Field trips include commercial operations, agricultural research facilities and ornamental planting	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Explain the latest research findings and information of clinical Plant Pathology	Latest research findings and information regarding Field Plant Pathology	Assignment Group work	Report Presentation

References Books

1. Detection and Diagnostics of Plant Pathogens- Editors: **Gullino**, Maria Lodovica, **Bonants**, Peter J. M. (Eds.)
2. Clinical Plant Pathology- George N. Agrios – Fifth Edition- Elsevier Academic Press
3. Fungi and disease in Plant- F. J. Butler
4. Plant Clinic- M.I.Mian

Course Code: PLPA 508 Course Title: Plant Nematology (Elective)	Credit Hour: 03	Semester: January-June

Rationale: This course is designed to provide basic understanding of the biology, taxonomy and phylogeny of plant parasitic nematode with emphasis on particular principles and facts regarding detection and identification of nematode.

Course Outcomes:

- Identify major nematode based on morphology (both in lab and field).
- Understand and explain the ecological roles of major nematode groups.
- Understand and identification of nematode based on different morphological and anatomical characters.
- Acquire knowledge about economic importance and management of nemic diseases.

Intended Learning Outcomes (ILOs) The student will be able to-	Course Content	Teaching Learning Strategies	Assessment Strategies
• Define nematode, nematology. • Describe the historical back ground of nematology	Plant nematology and historical development	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Describe different morphological and anatomical features of plant parasitic nematodes. • Differentiate different genera and species of plant parasitic nematodes	Morphology and Anatomy of plant parasitic nematodes	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Classify different genera of plant parasitic nematodes according to rules	Classification of plant parasitic nematodes	Lecture Multimedia presentation Interactive discussion	Quiz/MCQ Short answer Essay type answer
• Prepare slide for microscopic observation • Detect and identify plant parasitic nematodes	Slide preparation and identification of plant parasitic nematodes	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Know the different parts of reproductive system and their function of PPN	Reproduction and reproductive systems of plant parasitic nematodes	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Formulate the effective control measures of plant parasitic nematodes	Feeding habit, feeding sequences and feeding group of plant parasitic nematodes	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer

• Identify diseases caused by plant parasitic nematodes	Symptoms caused by plant parasitic nematodes	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Formulate effective control Teaching Learning Strategies of root-knot nematodes	Biology, ecology and epidemiology of root-knot nematodes	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Compare different stages of development of root-knot and cyst nematode • Know the infective stage of plant parasitic nematodes	Life cycle of root-knot and cyst nematodes	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Analyze soil and root sample for presence of plant parasitic nematodes • Design effective control Teaching Learning Strategies for plant parasitic nematodes	Sampling of nematodes	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Detect plant parasitic nematodes	Extraction of nematodes	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Measure damage caused by plant parasitic nematodes	Important nemic diseases of rice, wheat and maize	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Evaluate cultivars for resistance to plant parasitic nematodes	Culturing nematodes	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Develop disease resistant varieties to plant parasitic nematodes	Screening germplasms for resistance to nematode	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Design IPM approach for management of plant parasitic nematodes	General control measures of plant parasitic nematodes	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Formulate management Teaching Learning Strategies to plant parasitic nematodes	Nematicides available in Bangladesh and world market	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Explain the latest research findings and information of Plant Nematology	Latest research findings and information regarding Plant Nematology	Assignment Group work	Report Presentation

Reference Books

1. Text Book of Introductory Plant Nematology-by R. K. Walia and H. K. Bajaj
2. Plant Nematodes of Agricultural Importance; A color hand book by J. Bridge and J. L. Starr
3. Plant Pathology- George N. Agrios – Fifth Edition- Elsevier Academic Press
4. Plant Nematology- M.I.Mian

Course Code: PLPA 509 Course Title: Phytobacteriology (Elective)	Credit Hour: 03	Semester: January-June

Rationale: This course is intended to introduce the student to plant pathogenic bacteria and their role that they play in their interactions with plants and their direct and indirect impact upon humans. The biological properties of phytopathogenic bacteria, contemporary method used to characterize them and the diseases they cause, strategis, and tools for their management.

Course Outcomes:

- Outline the history and current focus of the field of phytobacteriology
- Describe the diversity and ecology of plant-associated bacteria that affect plant health
- Comprehend diagnostic characteristics used in their identification/ diagnosis and isolation procedure.
- Describe the interactions between bacteria and plants and their effect on plant health.
- Name the major groups of phytobacterial pathogens and the diseases they cause
- Describe how people prevent and manage plant diseases caused by bacteria
- Name the major groups of plant-beneficial bacteria and their activities
- Describe some of the disease causing mechanisms expressed by phytobacteria
- Utilize different approaches used to study and classify bacteria
- Successfully isolate and identify bacterial pathogens of plants
- Test bacteria for their ability to infect plants and measure their ability to cause disease

Intended Learning Outcomes (ILOs) The student will be able to-	Course Content	Teaching Learning Strategies	Assessment Strategies
• Define bacteria and Phytobacteriology • Memorize the historical background of Phytobacteriology	Introduction to phytobacteriology and bacteria	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Describe the characteristics of bacteria • Describe the morphology, growth and functions of different organales of bacterial cell • Summerize the diversity and ecology of plant-associated bacteria that affect plant health	Morphology, physiology, ecology and growth of bacteria	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Explain the mechanism of genetic exhange in baceria	Reproduction and genetics of bacteria	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer

• Categorize bacteria into different groups	Taxonomy of bacteria	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Comprehend diagnostic characteristics used in identification/ diagnosis and isolation procedure.	Diagnosis of bacerial diseases of plants, isolation and pure culture of bacteria	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Apply conventional and advanced method of detection and identification of bacteria	Conventional and advanced method of detection and identification of bacteria	Lecture Multimedia presentation Interactive discussion	Quiz/MCQ Short answer Essay type answer
• Practice inoculation, reisolation and reidentification of plant bacteria	Pathogenicity test, reisolation, reidentification and diagnosis	Lecture Visual presentation	Quiz/MCQ Short answer Essay typoe answer
• Categorize symptoms caused by bacteria	Disease symptoms caused by plant pathogenic bacteria	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Describe how do bacteria cause diseases in plants • Demonstrate pathogenicity	Molecular basis of interaction between pathogenic bacteria and host; pathogenicity, virulence, HR reaction and resistance.	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type ansawer
• Express chain of events in pathogenesis • Describe symptoms caused by bacterial infection	Phases in pathogenesis and symptoms	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Analyse the effect of environmental factors on bacteria and disease development	Epidemiology (environmental effects and disease development and survival.	Multimedia presentation, Visual presentation	Quiz/MCQ Short answer Essay type answer
• Describe the mechanisms involved in the different steps of bacterial disease epidemiology	Dissemination and transmission of phytopatogenic bacteria and geographical distribution of some plant pathogenic bacteria	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Estimate damage and losses caused by plant pathogenic bacteria	Damage and losses caused by plant pathogenic bacteria	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Demonstrate preventive measure to control bacterial plant diseases • Integrate all methods to	Prevention and control of bacterial pathogens and disease- Principles of control of plant pathogenic bacteria and or the disease they cause	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer

control plant pathogenic bacteria and or the disease they cause			
• Evaluate biological efficacy of bacteria	Major groups of plant-beneficial bacteria and their activities	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer

Reference Books

1. Bergey, D. H. and Holt, J. G. (1994). *In:* Bergey's Manual of Determinative Bacteriology. 9th ed. Williams & Wilkins Publishers, Baltimore.
2. Clarence, I. Kado. (2010). Plant bacteriology. APS Press.
3. Goszczynska, T., Serfontein, J. J and Serfontein. S.(2000). Introduction to practical Phytobacteriology
4. Jackson R.W. (2009). Plant pathogenic bacteria. Caister Academic Press.
5. Janse, J.D. (2009). Phytobacteriology: Principles and Practices. CABI Press.
6. Schaad, Jones, and Chun. (2001). Laboratory guide for the identification of bacterial plant pathogens. APS Press.

Course Code: PLPA 510 Course Title: Methods in Plant Pathology (Elective)	Credit Hour: 03	Semester: January-June

Rationale: This course is designed to provide basic understanding of the collection and preservationof plant disease specimen. Isolation and demonstration of Koch's postulates (pathogenicity), spore size determination of fungal pathogen, preservation methods of microorganisms culture, evaluation of antimicrobial chemicals, botanicals and bioagents, residual toxicity analysis and plant disease survey and monitoring.

Course Outcomes:

- Collect and preservemajor field crop diseases for clinical study and future demonstration.
- Acquire knowledge about pesticides available in Bangladesh and world market.
- Prescribe the control measures against field crop diseases.

Intended Learning Outcomes (ILOs) The student will be able to-	Course Content	Teaching Learning Strategies	Assessment Strategies
• Demonstrate plant disease symptom. • Diagnosis of plant diseases.	Procedure of collection, preservation and preparation of plant disease specimen for clinical studies.	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Identify causal organism of the diseases • Formulate effective control measures	Methods of isolation of plant pathogenic fungi, bacteria, viruses and nematodes.	Lecture Multimedia presentation Interactive discussion	Quiz/MCQ Short answer Essay type answer
• Demonstrate koch's postulates or pathogenicity.	Techniques of inoculation of plant pathogenic fungi, bacteria, and nematodes and demonstration of pathogenicity.	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Identify pathogenic microorganisms. • Identify virulent microorganisms.	Calibration of microscope and determination the size of pathogenic unit. Spore counting by hemacytometer.	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Discover new race/type of strain. • Evaluate germplasms for resistance.	Determination of race, cultural race/group, physiologic race and pathotypes.	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Utilize plant pathogens and bioagents in future	Maintenance of pure cultures of plant pathogens.	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Apply effective chemicals in controlling of plant diseases	Evaluation of antipathogenic chemicals, efficiency assessment, residue analysis (Laboratory bioassay and field application).	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer

• Explain present status of field diseases	Methods of survey and monitoring of plant diseases.	Lecture Visual presentation Survey	Quiz/MCQ Short answer Essay type answer
• Explain the latest research findings and information onMethods in Plant Pathology	Latest research findings and information regarding Methods in Plant Pathology	Assignment Group work	Report Presentation

Reference Books

1. Basic Plant Pathology MethodsBy James B. Sinclair, Onkar Dev Dhingra
2. Methods in Plant Pathology by Ismail Hossain Mian

Course Code: PLPA 511 **Course Title: Plant Virology (Elective)**	**Credit Hour: 03**	**Semester: July-December**

Rationale: This course is designed to provide fundamental concept on Plant Virology and which covers the basic knowledge about plant viruses those cause diseases in plant and their management.

Course Outcomes:

- Identify different viral diseases of crop plants.
- Gather basic knowledge on viral disease symptoms and their mode of transmission.
- Acquire knowledge on viral genomes, gene expression & replication in plant cell.
- Apply the basic knowledge to manage the viral diseases

Intended Learning Outcomes (ILOs) The student will be able to-	**Course Content**	**Teaching Learning Strategies**	**Assessment Strategies**
• Define plant virus & plant virology. Disesases cused by plant viruses.	Introduction to plant virology	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• State the significance of plant viral diseases and economics losses due these diseases.	Important of Plant Virology/Economics	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Describe the historical background of Plant Virology	History of Plant Virology	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Describe the classification, nomenclature, orthography and taxonomy of plant virus according to international committee of viruses. • Classify the plant viruses based on their nucleic acid contain.	Classification of plant viruses	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Define and describe sign and symptoms of plant viral diseases. • Identify the plant viral diseases based on morphological and physiological changes.	Symptoms of plant viral diseases	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Describe the structure of plant viruses and mention their functions • in infection and replication.	Structure of plant viruses and their function	Lecture Multimedia presentation Interactive discussion	Quiz/MCQ Short answer Essay type answer

• Describe and characterize the biochemical-biophysical properties of plant viruses.	Biochemical-Biophysical properties of plant viruses.	Lecture Multimedia presentation Interactive discussion	Quiz/MCQ Short answer Essay type answer
• Describe the transmission mediators and mechanisms of different plant viruses.	Transmission of plant viruses (RNA/DNA viruses).	Lecture Multimedia/ Visual presentation Interactive discussion	Quiz/MCQ Short answer Essay type answer
• Explain the viral infection, gene expression & replication and translocation of plant virus into host cell.	Viral Infection, Gene Expression & Replication and translocation of plant virus	Lecture Multimedia/ Visualpresentation	Quiz/MCQ Short answer Essay type answer
• Describe the virus identification & purification methods.	Virus identification& purification methods,	Lecture Multimedia Visual presentation presentation	Quiz/MCQ Short answer Essay type answer
• Detect the plant viruses on the basis of coat protein and nucleic acid.	Viral Antigen Detection (ELISA), Serology (Antibodies detection) &Modern Molecular Techniques (PCR,PAGE, Western blotting, and Northern blotting etc.),	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Illustrate the virus genomes & genetics	Virus Genomes & Genetics	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Explain different procedure/ protocol to isolate of replicative genomic forms. • Characterize the isolated replicative genomic forms of specific virus.	Isolation and characterization of replicative genomic forms.	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Describe the viral transformation process.	nation a. RNA n Viruses b. DNA Transformation Viruses	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• State the Teaching Learning Strategies of plant viral disease management	Emphasis on epidemiology and control/management of plant viral diseases.	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer

• Explain the epidemiology of plant viral diseases. • Exercise the integrated aprochess for controlling / management of plant viral diseases.			

Reference Books

1. Agrios, G.N. 1998. Plant Pathology, Fifth edition. Academic press, New York.
2. Schumann, G. L and Cleora J. D'Arcy. 2012. Essential Plant Pathology. 2nd Edition.
3. Introduction to Plant Virology-L. Boss
4. Applied Virology-D. G. A walky
5. The Biochemistry and Physiology of Infectious Plant Diseases: Goodman *et al.,* Van Nostrand, Princeton, 1967.
6. Plant Virology: Corbett and Sisler, eds. University of Florida Press, Gainesville, 1964.
7. Plant Virology: Matthews. Academic Press, New York, 1970.
8. Plant Viruses and Virus Diseases (4th ed.); Bawden. Ronald Press, New York,1964.
9. PrinCiples and Techniques in Plant Virology: Kado and Agrawal, eds. Van Nostrand Reinhold, New York, 1972.
10. Symptoms of Virus Diseases in Plants: Bos, Vada, Wageningen, The Netherlands, 1963.
11. A Textbook of Plant Virus Diseases (3rd ed.); Smith. Academic Press, New York, 1973.
12. Viruses in Plant Hosts: Form, Distribution, and Pathologic Effects: Esau. University of Wisconsin Press, Madison, 1968.
13. Viruses, Vectors, and Vegetation: Maramorosch, ed. Wiley, New York, 1969. 14. Plant Virology-Elsevier-5th Edition-byRoger Hull

Course Code: PLPA 512 Course Title: Soil Borne Diseases (Elective)	Credit Hour: 03	Semester: January-June

Rationale: This course is designed to provide basic understanding of the biology, ecology and epidemiology of soil borne pathogens giving emphasis on detection and identification of soil borne diseases and their management.

Course Outcomes:

- Describe biology, ecology and epidemiology of soil borne pathogens.
- Identify major soil borne diseases.
- Apply biological control agents in controlling soil borne diseases.
- Acquire knowledge about economic importance and management of soil borne diseases.

Intended Learning Outcomes (ILOs) The student will be able to-	**Course Content**	**Teaching Learning Strategies**	**Assessment Strategies**
• Define soil borne pathogen and soil borne diseases • List of soil borne pathogens and diseases • Assess yield loss caused by soil borne diseases	Concept of Soil borne diseases and pathogens, their recognition and importance.	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Locate soil borne pathogens in soil • Choose effective control measures of soil borne diseases	Soil survival and survival structure, modes of survival, survival duration, survival and variation mechanisms.	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Detect soil borne pathogens • Describe conditions for developing soil borne disease epidemics • Design effective control measures for soil borne diseases	Isolation, Identification, Biology, Ecology and Epidemiology of soil borne plant pathogens.	Lecture Multimedia presentation Interactive discussion	Quiz/MCQ Short answer Essay type answer
• Evaluate soil borne BCAs • Select soil borne BCAs for future uses	Effect of Agro-chemicals on soil borne BCAs:*Trichoderma, Gliocladium, Purpureocillium, Pochonia, Bacillus*,	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Formulate effective control measures to control soil borne diseases	Suppressive soil effects and novel Teaching Learning Strategies for soil-borne disease management.	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Differentiate types of mycorrhizae • Evaluate mycorrhiza for plant disease management	Mycorrhiza; types of association, researches and importance in agriculture.	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer

• Explain the latest research findings and information of Soil Borne Diseases	Latest research findings and information regarding Soil Borne Diseases	Assignment Group work	Report Presentation

References Books

1. Soil Borne Diseases of tropical crops by R. J. Hillocks and J. M. Waller
2. Soilborne diseases and their control by J. M. Kraft, M. P.Haware, H. Halila, M. Sweetingham and B. Bayaa
3. The ecology of soil fungi edited by D. Parkinson and J. S. Waid
4. Ecology of soil-borne plant pathogens Prelude to biological control edited by K. F. Baker and W. C. Snyder
5. Plant Pathology- George N. Agrios – Fifth Edition- Elsevier Academic Press 6. Fungi and disease in Plant- F. J. Butler

Course Code: PLPA 513 **Course Title: Post Harvest Pathology (Elective)**	**Credit Hour: 03**	**Semester: July- December**

Rationale: This course is intended to introduce the student to post harvest diseases of plant produces and their impact upon humans.

Course Outcomes:

- Define post harvest pathology
- Determine the importance and objectives of post harvest pathology
- Explain the causes of post harvest food losses and how to prevent post harvest diseases
- Determine the pre-harvest factors affecting post harvest losses
- Analyse post harvest food loss assessment
- Estimate chemical residue in treated perishable agricultural produce

Intended Learning Outcomes (ILOs) The student will be able to-	**Course Content**	**Teaching Learning Strategies**	**Assessment Strategies**
• Define post harvest pathology • Determine the importance and objectives of post harvest pathology	Scope and importance of post harvest pathology	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Describe the characteristics of perishable plant produce • Explain the causes of post-harvest diseases	Nature and causes of post harvest diseases	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Categorize diseases caused by bioic causes and abiotic causes • Evaluate importance of physiogenic diseases of plant produce upon humans	Physiogenic diseases	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Determine pre harvest and post harvest factors influencing post harvest diseases	Factors influencing post harvest diseases	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Use chemicals to control post harvest infection	Control of post harvest infection	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Use key processes during post harvest life • Design an ideal storage practices to avoid post harvest losses	Harvesting, handling and packaging conditions during transit and storage	Lecture Multimedia presentation Interactive discussion	Quiz/MCQ Short answer Essay type answer
• Apply preharvest treatment and • Post harvest treatments	Control of post harvest diseases preharvest protectant treatments and post harvest treatment	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer

• Practice hygine during harvest and transit	General precaution during harvest and transit	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Use good management practices in storage	General precaution during marketing and storage	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Differentiate between Controlled atmosphere and modified atmosphere • Evaluate effect of CA and MA storage on perishable produce	Controlled atmosphere, modified atmosphere and controlled atmosphere packaging as post harvest management	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Estimate losses caused by post harvest diseases of fruits and vegetables	Disease loss assessment of fruits and vegetables	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer Calculation
• Demonstrate post harvest management practices • Evaluate efficacy of different management practices	Demonstration of post harvest disease management	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Measure chemical residue in treated fruits and vegetables	Estimation of chemical residue in treated perishable agricultural produce	Lecture Multimedia presentation Lab work	Quiz/MCQ Short answer Essay type answer Calculation
• Interpret current research trends in post harvest pathology	Discussion on current research trends in post harvest pathology research	Discussion on review	Quiz/MCQ Short answer Essay type answer

Reference Books

1. Rivka Barkai-Golan (2001). Postharvest Diseases of Fruits and Vegetables. Development and Control. Department of Postharvest Science of Fresh Produce, Institute of Technology and Storage of Agricultural Products, The Volcani Center, Bet-Dagans, Israel.
2. Prusky, Dov, Gullino and Maria Lodovica (2010). Post Harvest Pathology. Springer.
3. Narayansamy, P. (2005). Post harvest Pathogens and Disease Management. John Wiley & Sons, Inc.
4. Jerry A. Bartz, Jeffrey K and Brecht (2002). Postharvest Physiology and Pathology of Vegetables.
5. CRC Press,

Course Code: PLPA 514 Course Title: Disease Resistance in Plants (Elective)	**Credit Hour: 03**	**Semester: July-December**

Rationale: This course is designed to provide advanced concept on disease resistance in plants and which covers the basic technologies for development of resistant plant cultivars.

Course Outcomes:

- Now the basic knowledge of Genomes & Genetics of plants and pathogens.
- Acquire knowledge about gene expression in plant cell to be diseases resistant.
- Now and apply the advanced knowledge about genetic engineering for developing resistant plant cultivars.

Intended Learning Outcomes (ILOs) The student will be able to-	**Course Content**	**Teaching Learning Strategies**	**Assessment Strategies**
• Define plant disease resistance / tolerance to pathogenic infection and establishment.	Introduction to disease resistance in plants	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Describe the economics losses due plant diseases. • State the significance of diseases resistance in plants	Importance of disease resistance	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Illustrate the genetics& genomes in host plants and plant pathogen.	Genetics of host plants& plant pathogen	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Describe the interaction between plant and pathogen.	Interaction between plant & pathogen	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Illustrate the Flor's gene –gene- for –gene hypothesis • Apply the gene for gene concept in breeding for disease resistance.	Flor's gene –gene- for –gene hypothesis and its implications in breeding for disease resistance.	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Describe the different mechanisms of resistance to plant disease.	Mechanisms of resistance to disease; structural, bio- chemicals and molecular Teaching Learning Strategies.	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Describe the kinds of resistance. • State the significance of different resistance in plants	Kinds of resistance: horizontal and vertical resistance, oligogenic and polygenic resistance.	Lecture Multimedia presentation Interactive discussion	Quiz/MCQ Short answer Essay type answer

• Describe the other types of resistance. • State the significance of different resistance in plants	Major and minor gene resistance, race specific and race non specific resistance,	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Describe the other types of resistance. • State the significance of different resistance in plants	Seedling resistance, intermediate resistance, partial resistance, adult plant resistance, generalized resistance and cytoplasmic resistance.	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Illustrate the Components of host resistance • Describe the mechanisms of Components in host resistance.	Components of host resistance: latent period, receptivity, infection rate, infection frequency	Lecture Multimedia presentation Visual presentation	Quiz/MCQ Short answer Essay type answer
• Illustrate the Components of host resistance • Describe the mechanisms of Components in host resistance.	Components of host resistance: infection efficiency, sporulation capacity, fructification period etc.	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• State the roles of environment on host and pathogen in disease resistance.	Role of environment on host and pathogen in disease resistance.	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Describe the breeding for disease resistance.	Breeding for disease resistance.	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Describe the conventional, mutation and varietal mixture breeding for disease resistance	Conventional, mutation, varietal mixture,	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• State the multiline theories in breeding for disease resistance.	Multiline theories	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Describe the techniques of tissue culture and induced resistance.	Tissue culture and induced resistance.	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• State the Systemic Activated Resistance (SAR).	Systemic Activated Resistance (SAR).	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Identify the problems in breeding for disease resistance.	Problems in breeding for disease resistance.	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer

• Explain the genetic engineering process. • Apply the genetic engineering for developing resistant / tolerance variety / cultivar.	Genetic engineering for developing resistant variety.	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer

Reference Books

1. Agrios, G.N. 1998. Plant Pathology, Fifth edition. Academic press, New York.
2. Schumann, G. L and Cleora J. D'Arcy. 2012. Essential Plant Pathology. 2nd Edition.
3. Bruce Alberts, 2013, Molecular Biology of the Cell. 15th Edition.
4. Plant Breeding for Pest and Disease Resistance-Elsevier- 1st Edition Authors: G.E. Russell, eBook ISBN: 9781483192369.
5. Plant Pathogen Resistance Biotechnology-David B. Collinge

Course Code: PLPA 515 **Course Title: Microbial genetics (Elective)**	**Credit Hour: 03**	**Semester: January-June**

Rationale: This course examines the transmission of heritable traits by microbes and the methods and principles used to study inheritance. The role of genetic variation in driving microbial evolution. (will be an underlying theme.) Also to explore how knowledge of natural genetic processes in bacteria have been utilized under controlled conditions to produce desirable/valuable traits.

Course Outcomes:

- Understand the core principles, paradigms and unique aspects of microbial genetics
- Familiar with historically important, contemporary, and state-of-the-art research techniques used in microbial genetics
- Develop skills in critical thinking, integration/synthesis of concepts and ideas and scientific problem-solving

Intended Learning Outcomes (ILOs) The student will be able to-	**Course Content**	**Teaching - Learning Strategies**	**Assessment Strategies**
• Summarize Prokaryotes vs Eukaryotes, Genome size and Chromosome organization • Review of DNA -RNA - Protein	Chromosomes, genes, and proteins	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Recognize mutants & mutations DNA damage & repair mutaror genes • Describetypes, effects, rates & probability of mutations	Metagenomics: Bacteria cell biology, Plasmids and Bacteriophages	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Implement the gene transfer technology efficiently between unicellular/multicellul ar organisms through HGT or LGT • Differentiate among vector mediated gene transfer & direct DNA transfer • Genome mapping – DNA & RNA sequencing	Methods of Gene transfer and mapping	Lecture Demonstration on computer analysis Multimedia presentation	Quiz/MCQ Short answer Problem solving/ Essay type answer
• Acquire knowledge on regulation of gene expression • Familiar with reporter gene, uses of fusions, DNA-Protein interactions	Genetic regulation	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer

• Genome sequencing & analysis, Proteomics	Genomics	Lecture Demonstration on computer analysis Multimedia presentation	Quiz/MCQ Short answer Problem solving/ Essay type answer
• Describe cloning and expression vectors • Illustrated DNA seq analysis-PCR and RT-PCR	In vitro genetics: DNA sequences, computer analysis, gene cloning	Lecture Demonstration on computer analysis	Quiz/MCQ Short answer Problem solving/ Essay type answer
• Familiar with the bacterial plasmids, plasmid replication, conjugation	Biology of Plasmids	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Describe the general properties of phages, Lysogenic phages, transduction	Phage	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer

References Books

1. Keya, C.(2012)Text book of Microbial Genetics,Teri press.
2. FAO/IAEA (Food and Agriculture Organization of the United Nations/ International Atomic Energy Agency). (2001). FAO/IAEA Mutant Varieties Database. Online: from January 2003 http://www-infocris.iaea.org/MDV/ .
3. Gupta, P.K. and Tsuchiya, T.(1991).*Chromosome Engineering in Plants: Genetics, Breeding Evolution*. Amsterdam: Elsevier.
4. Uldis, N. S. and Ronald, E. Y.(2002). Modern Microbial Genetics. 2nd edition. Wiley-liss Inc.ISBNs: 0-471-38665-0. pp. 655.
5. Lewin, B. (1985),*Genes*. 2nd edition. John Wiley and Sons. New York.
6. Kreuzer,H. and Adrianne, M. (2008). Molecular Biology and Biotechnology: A Guide for Students. Third Edition. e-ISBN :9781555817480. DOI: 10.1128/9781555817480.
7. International publications, E-book and online publication.

Course Code: PLPA 516 Course Title: Seed Pathology (Elective)	Credit Hour: 03	Semester: January - June

Rationale: This course is designed to acquaint students with basic and applied knowledge on important aspects of seed and seed borne diseases, detection and identification of seed borne pathogens, laws relating to seed business and management of seed borne diseases.

Course Outcomes:

- Explain importance of seed borne pathogens and seed disease of important crops,
- Illustrate factors influencing seed borne disease, seed transmission and how seed borne pathogen can be identified and examined,
- Evaluate seed lot and take decision on seed lot planting value and trade value,
- Design innovative and safe plan for national and international trade of seed and plant material,
- Develop and design Teaching Learning Strategies for seed crop cultivation and utilize management aspects to combat seed borne diseases.

Intended Learning Outcomes (ILOs) The student will be able to-	Course Content	Teaching Learning Strategies	Assessment Strategies
• Describe concept of Seed Pathology and its impact on crop production • Identify major seed borne diseases and pathogens affecting crop seeds • Outline and describe the transmission mechanisms of pathogen from seed to plant to seed	**Concepts of Seed Pathology** History and concept of seed pathology Importance of seed health and its impact on food security Significance of seed borne disease and effect of seed diseases on crop production Mechanism of seed transmission of pathogens	Lectures Visual presentation Discussion Assignment	Quiz/MCQ Short questions Essay type answer
• Evaluate seed lot and take decision on seed lot planting value and trade value • Examine seed health of different crops	**Seed sampling and seed health testing methods** Seed sampling and related issues Laboratory seed health testing methods Detection and identification of seed borne pathogen(s) (Fungi, bacteria, virus and nematodes)	Lecture Visual presentation Laboratory exercise and Assignment	Quiz/MCQ Short answer Essay type answer
• Explain national and international rules practice in seed trade • Describe quarantine rules and related regulations • Design innovative and safe plan for national and international trade seed	**Rules regulating national and international seed transaction** Seed supply chain management in Bangladesh National laws related to seed and seed certification	Lectures Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer

and plant material.	NPPO and quarantine regulation International rules related to seed business ISTA and IPPC in seed transaction and trade		
• Employ effective strategy to combat seed borne pathogens judiciously • Practice seed crop manage and post harvest management for healthy seeds • Exercise storage management for quality control of seeds • Exercise seed treatment for controlling seed borne pathogens	**Management of seed borne pathogens** Control of seed borne pathogens: Seed crop management and post harvest management for healthy seed production. Storage management: principles and practices. Antipathogenic chemicals and eco-friendly agents for seed treatment	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer
• Perform a critical analysis of pathogen situation in a area or in the country • Develop and design Teaching Learning Strategies for seed crop cultivation	**Pest risk analysis** Pest risk analysis: seed perspective Pest risk analysis : Bangladesh perspective	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer

Reference Books

1. Seed Pathology (Volume 1-2), Paul Neergaard, ISBN 10: 8172337485 / ISBN 13: 9788172337483, Published by Scientific Publishers, 2011
2. Common laboratory seed health testing methods for detecting fungi, S. B. Mathur and Olga Kongsdal
3. Seed technology and seed pathology, Tribhuwan Singh and K. Agarwal

Course code: PLPA 517 Course title: Industrial Microbiology (Elective)	Credit Hour: 03	Semester: January–June

Rationale: The course is designed to highlight the importance of microorganisms in the production of useful human products and to dispel the age long fear that microorganisms can only cause sicknesses and diseases

Course Outcomes:

- Know that microorganisms are important in the production of many useful products
- Explain source for microorganisms of industrial importance from the environment
- Enrich knowledge on physical and chemical conditions that are involved in the production of useful industrial products of microbial origin
- Describe cultural and genetic manipulation of these micro orgasms in order to produce more of these useful products

Intended Learning Outcomes (ILOs)	Course Content	Teaching Learning Strategies	Assessment Strategies
• Undertake an independent investigation to propose microbiological options for developing a new production a large-scale commercial basis • Define the terms with illustrations were applicable; discuss the microbial groups (bacteria, algae, protozoa, cynobacteria, fungi, viruses); • Classify, nomenclature and identification of microbes;	Introduction and background of Industrial Microbiology	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Define and describe the factors related with the industrial microbes	Factors affecting growth of industrial microbes	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Describe the process used to produce primary and secondary metabolites	Primary and secondary metabolites	Lecture Visual presentation	Quiz/MCQ Short answer Essay type answer
• Search for new useful • microorganisms and store them reliably for later use • Preserve and maintain of microbes	Improvement and preservation of microbial strains	Lecture Visual presentation	Quiz Short answer Essay type answer
• Evaluate which molecular techniques are applicable to improve production (including transfer of useful genes to microorganisms that are more amenable to large-scale	Recombinant DNA Technology and production of biomass	Lecture Multimedia presentation Assignments	Quiz Short answer Essay type answer Report

production and the use of molecular techniques to block and enhance specific metabolism)			
• Describe the main steps and processes used to produce biological products in industry	Isolation of yeast and study of its characters	Lecture Multimedia presentation	Quiz Short answer Essay type answer
• Explores the application of these environmental microorganisms, products and processes within the environmental biotechnology sector for the benefit of both human society and the environment • Provide an understanding of the central importance of microbial life to key ecosystem processes and systems and, in turn, how microbiology can be applied to bioremediation and bioenergy production.	Environmental biotechnology, biodegradation of toxic chemical, and hazardous waste	Lecture Multimedia presentation	Quiz Short answer Essay type answer
• Describe the main steps and processes used to produce biological products in industry	Production of citric acid, Lactic acid, bread and Yoghurt, wine from grapes	Lecture Visual presentation Field trip/ Factory visit	Quiz/ /MCQ Comprehension Short answer Essay type answer
• Describe the main steps and processes used to produce biological products in industry	Foodand beverage biotechnology: fermented foods, beverages, beer, wine etc.	Lecture Multimedia Visual presentation presentation	Quiz/MCQ Short answer Essay type answer
• Discuss the main steps and processes used to produce biological products in industry	Vinegar production; Acetic Acetic acid bacteria, Mechanism of acetic acid fermentation; Grading, processing and uses of Vinegar	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Discuss the industrial effluent to use in bioremediationto control environmental pollution	Role of microorganisms in bioleaching and textile industry	Lecture Visual presentation Factory visit	Quiz/MCQ Short answer Essay type answer

• Describe the waste and toxic substances by microbial isolates and Recycling of microbial remediated petroleum industry effluent for agricultural use.	Microbial recovery of petroleum, enhanced recovery of metals and bio-plastics	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer
• Discuss on biodegradation of dairy effluent by using microbial isolates • Explain physico-chemical and biological characteristics of sugar mill effluent and process of waste degradation process of sugar and dairy industry	Characteristics and treatment of wastes of sugar industry and dairy industry	Lecture Multimedia presentation	Quiz/MCQ Short answer Essay type answer

Reference Books

1. Microbial Biotechnology: Fundamentals of Applied Microbiology books.google.com.np/books =0521842107
2. Modern Industrial Microbiology Biotechnology www.cenicana.org/investigacion/seica/imagenes.../modern_indutrial.pdf
3. Journal of Industrial Microbiology and Biotechnology www.scimagojr.com/journalsearch.php?q=16085&tip=sid
4. Microbiology - Wikipedia, the free encyclopedia
5. Microbial Biotechnology - All Issues - Wiley Online Library
6. Pelczar, M.J, Chan, E.C.S. and Krieg, N.R. (2006) Microbiology. 32ndh edition. Tata McGraw-Hill Publishing Company Limited.
7. Nduka Okafor, Industrial Microbiology

Department of Soil Science

Course Layout

Sl. No.	Course Code and Title		Cr. Hr.
A. Compulsory Courses			
1	SOIL 501**:** Soil Physics		03
2	SOIL 502**:** Soil Chemistry		03
3	SOIL 503**:** Soil Microbiology		03
4	SOIL 504: Soil Fertility and Plant Nutrition		03
5	SOIL 505: Pedogenesis, Soil Survey and Classification		03
6	SOIL 506: Soils of Bangladesh		03
		Total	18
B. Elective Courses			
7	SOIL 507: Soil, Plant and Water Analysis		03
8	SOIL 508: Soil Organic Matter		03
9	SOIL 509: Environments and Soil Pollution		03
10	SOIL 510: Soil Clay Mineralogy		03
11	SOIL 511: Biofertilizer Technology		03
12	SOIL 512: Soil and Water Conservation		03
13	Or Related course from other Departments		03
		Minimum	12
C. Seminar Course			
14	SOIL: 598		01
D. Thesis Research			
15	SOIL: 599		16
		Compulsory Courses	**18**
		Elective Courses	**12**
		Seminar Course	**01**
		Thesis Research	**16**
		Total	**47**

Curriculum Alignment / Skill Mapping

Curriculum must be aligned with program objectives, program learning outcome and intended learning outcomes through proper skill mapping.

Department of Soil Science

Courses	Program Learning Outcome							
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
SOIL 501	x	x	x	x			x	x
SOIL 502	x	x	x	x			x	x
SOIL 503	x	x	x	x			x	x
SOIL 504	x	x	x	x			x	x
SOIL 505	x	x	x	x			x	x
SOIL 506	x	x	x	x			x	x
SOIL 507	x	x	x	x			x	x
SOIL 508	x	x	x	x			x	x
SOIL 509	x	x	x	x			x	x
SOIL 510	x	x	x	x			x	x
SOIL 511	x	x	x	x			x	x
SOIL 512	x	x	x	x			x	x
SOIL 598						x	x	
SOIL 599					x	x	x	x

Course Code: SOIL 501 **Course Title: Soil Physics (Compulsory)**	**Credit Hour: 03**	**Semester: July-December**

Rationale: This course is designed to provide applied knowledge on soil physical properties as well as soil water management for successful crop production.

Course Outcomes:

- Acquire knowledge and practical application of different soil physical properties for better crop production.
- Categories the different management practices to improve the different physical properties of soil.
- Evaluate different techniques of measuring soil moisture and evapotranspiration loss.
- Explain and apply irrigation scheduling and importance of drainage for different major crops.

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching Learning Strategies**	**Assessment Strategies**
• Describe solid, liquid and gaseous system of soil • Prove the volume mass mathematical relationship of soil constituents	**Soil physical properties** Soil as a three- phase system, volume-mass relationship of soil constituents.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Describe mechanical composition and particle size analysis of soil • Distinguish between different classes of soil texture regarding fineness, coarseness, water holding capacity, porosity etc. • Evaluate the soil textural classes on suitability of different crop production	**Soil texture** Classification, properties, mechanical composition of soil and particle-size analysis.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Explain the genesis, types, grades and classes of soil structure • Illustrate the significance of soil structure on compaction, crusting, aeration and water holding capacity of soil. • Evaluate soil management practices to improve or to deteriorate soil structure.	**Soil structure** Genesis, classification, characterization and agricultural significance; soil compaction, soil crusting, management of soil structure.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Describe soil consistency, its different types and shear strength. • Describe the causes of pan	**Soil consistency** Plasticity, shear strength, pan formation, soil tilth.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer

formation and ways of getting good soil tilth.			
• Differentiate between soil air and atmospheric air • Interpret the different factors which affect on soil air composition. • Discuss the different management practices which improve soil aeration.	**Soil air** Factors affecting composition of soil air, management of soil air.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Describe soil temperature, thermal properties of soil and heat flow equations • Discuss the different methods of soil management of increasing and decreasing soil temperature. • Illustrate the importance of soil temperature on successful crop production.	**Soil temperature** Factors affecting soil temperature, thermal properties of soil, heat flow equations; methods of measuring soil temperature, management of soil temperature.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Define soil colour with its importance on crop production. • Explain the causes of influencing factors for different soil colour. • Illustrate the method of determining soil colour.	**Soil colour** Factors influencing soil colour, determination of soil colour.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Explain different classes of soil water, soil water constants in respect of its availability, tension and amount of pore spaces occupied by water. • Describe in brief the methods of measuring soil water. • Demonstrate the calculation techniques of the amount of water present in soil, amount to be needed to bring the soil at certain stages. • Show the importance of soil water potential in crop production. • Explain different types of flow of water in soil.	**Soil water** Water flow in soil, Darcy's law; hydraulic conductivity of soils and methods of measurement; soil water potential, soil water retention characteristics, hysteresis, infiltration equations, profile moisture distribution during infiltration; classification of infiltration.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer

• State Darcy's law and derive hydraulic conductivity from the law. • Describe the different methods of measuring hydraulic conductivity. • Explain soil water infiltration regarding its equations, importance and classification. • Explain hysteresis with its effect on moisture distribution curve.			
• Explain evapotranspiration and different factors which affect ET values. • Illustrate the different methods of measuring ET values for different crops. • Evaluate the use of ET values for preparation of irrigation scheduling.	**Evapotranspiration (ET)** Soil water balance; factors affecting ET; control of ET; methods of measuring ET; application of ET values in irrigation scheduling.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Explain and categorize the quality of irrigation water for crop production. • Describe the sources and criteria of evaluating irrigation water. • Illustrate the principles of irrigation scheduling and drainage management. • Describe the different methods of drainage management practices and illustrate different factors which influence soil water.	**Irrigation and drainage** sources and quality of irrigation water; criteria for evaluating irrigation water; moisture management. Drainage- Principles and methods of drainage, factors influencing drainage.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Explain the latest research findings and information of Soil Physics	Latest research findings and information regarding Soil Physics	Assignment	Report

Reference Book

1. ISSS. 2000. Fundamentals of Soil Science. Published by Indian Society of Soil Science.M.A. Sattar and M.M.Rahman.1987. Techniques of Soil Analysis. Mymensingh, Bangladesh
2. N.S. SubbaRao. 1988. Bio-fertilizers in Agriculture. Oxford and IBH Pub., Co., Ltd., New Delhi.
3. R.A. Singh. 1989. Soil Physical Analysis.Kalyani Pub., New Delhi.
4. R. L.Donahue, R. W. Miller and J. C. Shickluna. 1990. Soil: An Introduction to Soils and Plant Growth, 5thEdn. Prentice hall of Ind. Pvt. Ltd. New Delhi.
5. S. P. Majumdar and R.A. Singh.2002.Analysis of Soil Physical Properties. Agrobios, India.

Course Code: SOIL 502 Course Title : Soil Chemistry (Compulsory)	Credit Hour: 3	Semester: January-June
Rationale: This course is designed to provide detailed knowledge on soil chemistry		
Course Outcomes: • Explain electrochemical properties, ion adsorption, desorption theories in soil • Develop knowledge on rocks and minerals and their weathering processes for soil formation • Describe physico-chemical properties of soils and their impacts on soil fertility and productivity		

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching Learning Strategies**	**Assessment Strategies**
• Explain the origin of charges, ion adsorption theories and mechanisms in soil • Analyze the precipitation and chemical equilibria of ions in soils • Evaluate and compare the double layer theories	**Soil colloids:** Electro-kinetic and electrochemical properties, origin of charges in soil colloids, double layer theories. Adsorption and desorption phenomena, adsorption isotherm, precipitation of ions; chemical equilibria of ions in soils.	Lecture Visual presentation Interactive discussion	Quiz/MCQ Short answer Essay type answer
• Analyze the factors affecting ion exchange and ion exchange capacity in soil in relation to nutrient availability • Explain the Donnan membrane equilibrium and its application	**Ion exchange:** Origin of ion exchange properties; factors influencing ion exchange; cation, and anion exchange; ion exchange capacity of soil constituents; ion exchange equation; Donnan membrane equilibrium.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Describe the composition of nutrient in soil solution • Explain the causes of ion movement in soil	**Soil solution:** Factors affecting the composition of soil solution, Q/I relationships, ion movement in soil.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type
• Illustrate the sources of H^+ ions and buffering mechanism in soil • Apply principle of reactions of liming material with soil • Calculate the lime requirement of soil	**Soil pH and liming:** Sources of H^+ ions in soil, buffering capacity, reactions of lime in soil, lime requirement of soil.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Explain the chemical and electro- chemical changes of flooded soil • Evaluate the changes of nutrient availability in	**Waterlogged soils:** Chemical and electro-chemical changes; effects of alternate wetting and drying on soil properties.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer

flooded soil in comparison to upland soil			
• Analyze and explain the causes of salt affected and acid sulphate soil formation in Bangladesh • Apply and explain the methods of remediation of saline and acid sulphate soil	**Soil degradation:** Salt affected soils; acid and acid sulphate soils.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Explain the latest research findings and information of Soil Chemistry	Latest research findings and information regarding Soil Chemistry	Assignment	Report

Reference Books

1. N.C. Brady and R.R. Weily. 2014. The Nature and Properties of Soils. 14thEdn. Macmillan Pub. Co., New York.
2. M. Alexander. 1977. Introduction to Soil Microbiology. John Wiley and Sons, New York.
3. T.D. Biswas and S.K. Mukherjee. 1989. Text Book of Soil Science. Tata McGraw-Hill Pub. Co., New Delhi, India.
4. D.K. Das. 2014. Introductory Soil Science. Kalyani Publishers, India.
5. R.L. Donahue, R.W. Miller and J.C. Shickluna. 1992. Soils : An Introduction to Soils and Plant Growth, 5thEdn. Prentice Hall of India Pvt. Ltd., New Delhi.
6. H.D. Foth. 1984. Fundamentals of Soil Science, 7thEdn., John Wiley and Sons, New York.
7. J.A. Daji. 1992. A Textbook of Soil Science.
8. ISSS. 2000. Fundamentals of Soil Science. Indian Society of Soil Science.

Course Code: SOIL 503 Course Title: Soil Microbiology (Compulsory)	Credit Hour: 03	Semester: January-June

Rationale: This course is designed to provide knowledge on effect of soil microorganisms on soil properties, nutrient transformation, growth and development of plants and microbes, bioremediation of different fertilizers, pesticides, waste products and soil amendments.

Course Outcomes:

- Describe significance and historical development of soil microbiology.
- Explain classification and distribution of soil microorganisms, their significance in soil formation especially in waterlogged and salt affected conditions.
- Describe biological equilibrium in soil, beneficial and harmful interactions between different soil organisms and antibiotic formation by different soil organisms & antibiosis.
- Illustrate environmental factors affecting plant microbe system and rhizospheric plant microbe interaction and biochemical transformation of plant nutrients in soil.
- Explain biological nitrogen fixation, types, biochemistry, environmental conditions of BNF, biological inoculum preparation, biofertilizer production-its measure and use in agriculture.
- Illustrate organic matter decomposition, transformation of plant nutrients to their available forms and humus formation by the activities of soil microorganisms.
- Explain mycorrhizae development in soil and its role in plant nutrition.
- Describe pesticides degradation by soil microorganisms and effect of pesticides on soil microbes.

Intended Learning Outcomes (ILOs) The students will be able to-	Course Content	Teaching Learning Strategies	Assessment Strategies
• Explain significance and role of soil microorganisms on plant nutrition and human welfare. • Describe historical development of soil microbiology.	Soil microbiology-significance and historical development	Lecture Interactive discussion	Quiz/MCQ Short answer Essay type answer
• Classify and describe distribution of soil microorganisms • Discuss significance of microorganisms in soil processes. • Analyze biological activities in waterlogged and salt affected soils.	**Soil microorganisms:** Types and distribution of soil microorganisms and their significance in soil, biology of waterlogged and salt affected soils	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Apply antagonistic and associative relationship among soil microorganisms. • Illustrate antibiotic production by microbes and its role in crop production.	Biological equilibrium in soil	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer

• Describe rhizosphere, rhizospheric effect, plant microbe associations, associative and antagonistic interactions in rhizosphere. • Explain root exudates and their effects in soil • Describe rhizospheric relationships with plant pathogens.	Concept of plant microbe system: Environmental factors affective plant microbe system, rhizosphere	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Illustrate the N, P, S, Fe and Mn transformations by microbiological activities. • Describe N, P, S, Fe and Mn cycles in soil. • Show the processes of N, P, S, Fe and Mn becoming available to plants and microbes.	Biological transformations of N, P, S, Fe and Mn in soils	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Illustrate symbiotic and nonsymbiotic nitrogen fixation. • Explain biochemistry of N fixation. • Analyze the factors of N fixation under different environmental conditions. • Describe the use of different inoculum and preparation of bio fertilizers. • Apply and describe the use of biofertilizers. • Assess and measure the amount of biofertilizers prepared by different inoculum and biofertilizer preparation technology.	Biological nitrogen fixation (BNF): symbiotic and nonsymbiotic nitrogen fixation, biochemistry of nitrogen fixation; nitrogen fixation under different environmental conditions; preparation and use of inoculum; measurement of BNF.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Describe different types of soil organic matter. • Explain the organic matter decomposition process in soil environment. • Illustrate the humus formation process in soil. • Elucidate the characteristics of different humic substances, their formation and measurement of the fractions of humic substances. • Discuss the role of organic	Soil organic matter	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report

matter and humus on soil properties and plant nutrition.			
• Explain different types of mycorrhizae. • Illustrate the relationship of ecto-and endo-mycorrhizae with plant roots and plant nutrition. • Show the processes of plant disease protection by mycorrhizae.	Mycorrhizae: types and significance in plant nutrition	Lecture Visual presentation Discussion Field visit	Quiz/MCQ Short answer Essay type answer Report
• Define and discuss biodegradation of pesticides. • Describe the process of bioremediation of pesticides in soil environment. • Explain the effect of pesticides on soil microbes, soil properties and soil health.	Pesticides: Biodegradation of pesticides, effect of pesticides on soil microbes	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Describe different types of soil enzymes. • Define and discuss the endo- and exo-trophic enzymes. • Explain the role of soil enzymes on breakdown and decomposition of soil organic matter. • Discuss the role of soil enzymes on the transformation and fate of plant nutrients.	Soil enzymes: Types, significance and their role in organic matter breakdown and plant nutrient transformations	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Explain the latest research findings and information of Soil Microbiology	Latest research findings and information regarding Soil Microbiology	Assignment	Report

Reference Books

1. N.C. Brady and R.R. Weily. 2014. The Nature and Properties of Soils. 14thEdn. Macmillan Pub. Co., New York.
2. M. Alexander. 1977. Introduction to Soil Microbiology. John Wiley and Sons, New York.
3. Chemistry of the soil . Second edition by Firman E. Bear
4. Introductory Soil Science. Kalyani Publishers, India. 2014. By D.K. Das.
5. Fundamentals of Agricultural Microbiology by K. C. Mahanta
6. H.D. Foth. 1984. Fundamentals of Soil Science, 7th Edn., John Wiley and Sons, New York.
7. J.A. Daji. 1992. A Textbook of Soil Science.
8. ISSS. 2000. Fundamentals of Soil Science. Indian Society of Soil Science.

Course Code: SOIL 504 Course Title: Soil Fertility and Plant Nutrition (Compulsory)	Credit Hour: 03	Semester: July-December

Rationale: This course is designed to enrich student knowledge on soil fertility and plant nutrition.

Course Outcomes:

- Evaluate the past and present fertility status and problems of Bangladesh soils.
- Explain transformation and factors affecting availability of macro and micro nutrient for plant uptake.
- Apply fertilizer judiciously and implement integrated nutrient management system for improving soil fertility and productivity
- Analyze the different nutrient interactions in soil and nutrient uptake mechanism.
- Evaluate soil fertility for fertilizer recommendation and determine soil fertility problems for remediation.

Intended Learning Outcomes (ILOs) The students will be able to -	Course Content	Teaching Learning Strategies	Assessment Strategies
• Evaluate the past and present fertility status of Bangladesh soils. • Explain the causes of fertility problems of Bangladesh soils • Analyze the relationship between soil fertility and plant growth	**Soil fertility and productivity** Soil fertility- past and present, soil fertility and plant growth, soil fertility problems in Bangladesh, soil fertility based growth equations.	Lecture Discussion Visual presentation	Quiz/MCQ Short answer Essay type answer
• Identify deficiency symptoms of different nutrient in crops. • Explain the transformation and availability of nutrient in soil • Describe the factors affecting nutrient availability in soil	**Essential plant nutrients** Physiological roles of plant nutrient elements. Transformations and availability of N, P, K, S, Mg, Zn and B in soil. Chelates and plant nutrition.	Lecture Discussion Visual presentation	Quiz/MCQ Short answer Essay type answer
• Apply fertilizer properly by using appropriate methods for increasing efficiency and reducing loss of added fertilizer • Describe fate of applied fertilizer in different soils • Recommend balanced use of fertilizers and apply	**Fertilizers and their use efficiency** A brief account of manures and fertilizers; fate of fertilizers in soil; factors affecting fertilizer use efficiency, time and methods of fertilizer application, balanced use of fertilizers, Integrated Nutrient Management System (INMS)-concept and objectives.	Lecture Discussion Visual presentation	Quiz/MCQ Short answer Essay type answer

integrated nutrient management system for crop production			
• Show diagram of root nutrient uptake mechanism from soil. • Describe different theories of nutrient uptake mechanism	**Nutrient uptake** Mechanism of nutrient uptake.	Lecture Discussion Visual presentation	Quiz/MCQ Short answer Essay type answer
• Explain the antagonistic and synergistic interactions of different nutrient in soil • Apply and manage fertilizer by considering antagonistic and synergistic interactions of different nutrient	**Nutrient interactions** Antagonistic, synergistic and additive activities. Management of nutrient interactions.	Lecture Discussion Visual presentation	Quiz/MCQ Short answer Essay type answer
• Explain the importance and use of fertility evaluation • Evaluate soil fertility by using different methods of soil and plant analysis. • Recommend and calculate fertilizer by soil test basis	**Soil fertility evaluation** Principle and importance of soil fertility evaluation; methods of soil fertility evaluation, fertilizer recommendation.	Lecture Discussion Visual presentation	Quiz/MCQ Short answer Essay type answer
• Explain the latest research findings and information of Soil Fertility and Plant Nutrition	Latest research findings and information regarding Soil Fertility and Plant Nutrition	Assignment	Report

Reference Books

1. N. C. Brady and R. R. Weily. 2014. The Nature and Properties of Soils. 14thEdn. Macmillan Pub. Co., New York.
2. J. L. Havlin, J. D. Beaton, S. L. Tisdale and W. L. Nelson. 2006. Soil Fertility and Fertilizers, 6thEdn., Prentice-Hall of India
3. D. K. Das. 2014. Introductory Soil Science. Kalyani Publishers, India
4. E. A. Paul.2007. Soil Microbiology,Ecology and Biochemistry. 3rdEdn., Academic Press of Elsevier. USA
5. K. Mengel, E.A.Kirkby. 1987. Principles of Plant Nutrition. International Potash Institute, Switzerland
6. R. L. Donahue, R. W. Miller and J. C. Shickluna. 1992. Soils: An Introduction to Soils and Plant Growth. Prentice Hall of Ind. Pvt. Ltd., New Delhi.
7. Fertilizer Recommendation Guide, Bangladesh Agricultural Research Council

Course Code: SOIL 505 Course Title: Pedogenesis, Soil Survey and Classification (Compulsory)	Credit Hour: 03	Semester: July-December

Rationale: This course is designed to develop students' knowledge on the soil formation, soil survey and their classification.

Course Outcomes:

- Describe the concept and scope of pedology as well as the historical development of soil genesis.
- Explain different weathering processes of rocks and minerals.
- Acquire knowledge about the factors and processes involved in soil formation.
- Develop knowledge on soil survey and preparation of soil survey reports.
- Classify Bangladesh soil according to USDA soil taxonomy classification.
- Apply and describe GIS (geographical information systems) and RS (remote sensing) in soil resource management in Bangladesh
- Describe land evaluation principles, methods, criteria, and classification.

Intended Learning Outcomes (ILOs) The students will be able to –	**Course Content**	**Teaching Learning Strategies**	**Assessment Strategies**
• Point out the concept and scope of pedology • Discover the historical development of soil genesis • Differentiate the pedological and edaphological approaches in the study of soil	**Introduction to Pedology-**Concept and scope of pedology; Historical development of soil genesis; Pedological and edaphological approaches in the study of soil.	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Classify the weathering processes. • Interpret the weathering agents. • Analyze chemical weathering processes of some silicates. • Compare the weathering sequences.	**Weathering of Rocks and Minerals-**Weathering processes; Chemical weathering of some silicates; weathering sequences.	Lecture Discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Classify soil forming factors. • Describe active soil forming factors. • Explain passive soil forming factors. • Analyze soil forming factors relevant with soil	**Soil forming factors-**Active and passive factors.	Lecture Discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report

properties and profile development.			
• Describe basic processes of soil formation. • Explain fundamental soil forming processes in soil. • Describe specific soil forming processes • Analyze the soil forming processes relevant with the formation of soil and profile development. • Analyze the soil forming processes relevant with the formation of Bangladesh soil	**Pedogenic processes**-Humification; eluviation; Illuviotion; calcification; decalcification; podsolization; laterization; gleization; salinization; solonization or alkalization; solodization or dealkalization; pedoterbation.	Lecture Discussion Visual presentation Assignment Field visit	Quiz/MCQ Short answer Essay type answer Report
• Express concept of soil survey as well as objectives of soil survey. • Describe different kinds of soil survey and different types of base maps are used for soil survey. • Show and describe soil maps and mention different soil mapping units which are used for soil survey. • Prepare soil survey report by using survey data. • Use information obtained through soil survey • Analyze different soil profile in the field.	**Soil survey**- Principles and purposes of soil survey; kinds of soil survey; soil survey work plan; base map-aerial photographs, imagerymosaics; planimetric and topographic maps; examination and descriptation of soil profile; preparation of soil survey reports-soil maps and reports; field trip for insitu soil profile study.	Lecture Discussion Visual presentation Assignment Field visit	Quiz/MCQ Short answer Essay type answer Report
• Describe the concepts of geographical information systems and remote sensing in Bangladesh • Explain the applications of GIS in soil resource management • Explain the applications of RS in soil resource management	GIS (geographical information systems) and RS (remote sensing) in Bangladesh-concept and applications in soil resource management.	Lecture Discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Discuss concept and purposes of soil classification and evolution of soil	**Soil classification**-systems of soil classification; soil taxonomy; nomenclature; categories of the soil orders, suborders and grate groups;	Lecture Discussion Visual presentation	Quiz/MCQ Short answer Essay type

classification systems. • Describe soil Taxonomic classification into different categories on the basis of their diagnostic horizons and other related features like soil moisture and temperature regimes. • Differentiate and characterize different categories in soil taxonomy. • Mention and explain orders and suborders and approximate equivalents of Bangladesh soils according to USDA soil Taxonomy.	interpretation of soil data for clafication; soil temperature and moisture regimes; classification of Bangladesh soils according to USDA soil taxonomy.	Assignment	answer Report
• Discuss the concept and objectives of land evaluation. • Describe the criteria of land evaluation. • Show different methods of land evaluation. • Describe land capability classification according to USDA system. • Explain land capability classification developed by Soil Survey Department of Bangladesh (SRDI).	**Land evaluation-**principles and methods of land evaluation; criteria of land evaluation; land capability classification; land suitability classification; land suitability rating major crops in Bangladesh.	Lecture Discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Explain the latest research findings and information of Pedogenesis, Soil Survey and Classification	Latest research findings and information regarding Pedogenesis, Soil Survey and Classification	Assignment	Report

Reference Books

1. N. C. Brady and R. R. Weil. 2014. The Nature and Properties of Soils. 14thEdn. Macmillan Pub. Co., New York.
2. T.D. Biswas and S.K. Mukherjee. 1989. Text Book of Soil Science. Tata McGraw-Hill Pub. Co., New Delhi, India.
3. J Sehagal.2000. Pedology Concepts and Application. Kalyani Publishers, New Delhi, India.
4. H. Brammer. 1996. The Geography of the Soils of Bangladesh. University Press Ltd. Dhaka.
5. FAO. 1988. Agro ecological Regions of Bangladesh, Report No.2, UNDP-FAO, Rome.
6. M. M. Hassan. 1999. Soils of Bangladesh : Their genesis, classification and use potential.

7. M. S. Hussain. 1992. Soil Classification with special reference to the soils of Bangladesh.
8. M. Idris. 1987. Erosion Hazard Areas in Bangladesh. Report on Soil Conservation, SRDI, Dhaka.
9. Soil Survey Staff. 1951. Soil Survey Manual, USDA No. 18, US Govt. Printing Office, Washington, D.C.
10. Soil Survey Staff. 1978. Soil Taxonomy-A basic System of Soil Classification. Agricultural Handbook No. 456, Soil Conservation Service, USDA.
11. Fertilizer Recommendation Guide, Bangladesh Agricultural Research Council.

Course Code: SOIL 506 **Course Title: Soils of Bangladesh (Compulsory)**	**Credit Hour: 03**	**Semester: January-June**

Rationale: This course is designed to enrich knowledge on soil genesis, soil types and AEZ of Bangladesh soils

Course Outcomes:

- Describe the concept and scope of pedology as well as the historical development of soil genesis.
- Explain different weathering processes of rocks and minerals.
- Analyze the factors and processes involved in soil formation.
- Apply soil survey and prepare soil survey reports.
- Classify Bangladesh soil according to USDA soil taxonomy classification.
- Apply and describe GIS (geographical information systems) and RS (remote sensing) in soil resource management in Bangladesh
- Describe land evaluation principles, methods, criteria, and classification.

Intended Learning Outcomes (ILOs) The students will be able to –	**Course Content**	**Teaching Learning Strategies**	**Assessment Strategies**
• Describe the geology, geomorphology and vegetation of Bangladesh soil • Compare the variability of soil properties and vegetation in Bangladesh in relation to climate • Explain the physical, chemical and mineralogical properties of floodplain, terrace and hill soils	**Genesis of Bangladesh soils** Geology, geomorphology, hydrology, vegetation and climate of Bangladesh. Physical, chemical and mineralogical properties of floodplain, terrace and hill soils.	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Describe the agricultural potentials of different soils of USDA soil taxonomy and FAO-UNESCO classes. • Compare different soil series of Bangladesh soils. • Evaluate the agricultural potentials of different soils of Bangladesh	**General soil types of Bangladesh** Brief description, agricultural potentials, correlations with USDA soil taxonomy and the FAO-UNESCO legend. Soil series of Bangladesh.	Lecture Discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Describe different AEZ of Bangladesh soils with mentioning location, area, soil properties and soil fertility • Explain agricultural	**Agro-ecological Zones of Bangladesh** Concept, brief description of different AEZ, fertility status of different AEZ, utility in agricultural development.	Lecture Discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type Report

potentials of different AEZ of Bangladesh. • Evaluate the soils of different AEZ for agricultural development.			
• Describe crop production in different soils of Bangladesh • Apply and manage different problems during crop production	**Problem soils of Bangladesh** Types, location, extent, constraints to crop production and management.	Lecture Discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Explain the latest research findings and information of Soils of Bangladesh	Latest research findings and information regarding Soils of Bangladesh	Assignment	Report

Reference Books

1. N. C. Brady and R. R. Weil. 2014. The Nature and Properties of Soils. 14thEdn. Macmillan Pub. Co., New York.
2. T.D. Biswas and S.K. Mukherjee. 1989. Text Book of Soil Science. Tata McGraw-Hill Pub. Co., New Delhi, India.
3. J Sehagal.2000. Pedology Concepts and Application. Kalyani Publishers, New Delhi, India.
4. H. Brammer. 1996. The Geography of the Soils of Bangladesh. University Press Ltd. Dhaka.
5. FAO. 1988. Agro ecological Regions of Bangladesh, Report No.2, UNDP-FAO, Rome.
6. M. M. Hassan. 1999. Soils of Bangladesh: Their genesis, classification and use potential.
7. M. S. Hussain. 1992. Soil Classification with special reference to the soils of Bangladesh.
8. M. Idris. 1987. Erosion Hazard Areas in Bangladesh. Report on Soil Conservation, SRDI, Dhaka.
9. Soil Survey Staff. 1951. Soil Survey Manual, USDA No. 18, US Govt. Printing Office, Washington, D.C.
10. Soil Survey Staff. 1978. Soil Taxonomy-A basic System of Soil Classification. Agricultural Handbook No. 456, Soil Conservation Service, USDA.
11. Fertilizer Recommendation Guide, Bangladesh Agricultural Research Council.

Course Code: SOIL 507 Course Title: Soil, Plant and Water Analysis (Elective)	Credit Hour: 03	Semester: January-June/ July-December
Rationale: This course is designed to provide knowledge on Soil, Plant and Water Analysis.		
Course Outcomes: • Apply the knowledge in collection and processing of soil, plant and water samples for analysis. • Determine and explain the methodology of pH, redox potential, CEC, conductivity and other chemical analysis of soil. • Analyze soil, plant and water samples for different elements. • Evaluate the quality of soil, water and plant according to the rating of analytical value.		

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching Learning Strategies**	**Assessment Strategies**
• Demonstrate and describe the procedure of soil, plant and water sample collection and preparation • Apply the roles and errors in collecting and preparation of soil, plant and water samples	Errors of observation and sampling; samplings procedures for soil, plant and water;	Lecture Discussion Demonstration	Quiz/MCQ Short answer Essay type answer Demonstration performance
• Describe the principles of volumetric and gravimetric analysis • Distinguish between volumetric and gravimetric analysis • Measure the pH, redox potential, CEC, conductivity and other chemical properties of soil	Principles of volumetric and gravimetric analysis; pH, redox potential, CEC and conductivity measurements;	Lecture Discussion Demonstration Group work	Quiz/MCQ Short answer Essay type answer Demonstration performance
• Evaluate the quality of irrigation water • Explain the analytical principles and methodologies of different elements in soil, plant and water • Determine macro, micro nutrient and other necessary elements in soil, water and plant	Quality rating of irrigation water, total elemental analysis of soils; ashing, digestion and analysis of plant samples; water analysis.	Lecture Discussion Demonstration	Quiz/MCQ Short answer Essay type answer Demonstration performance

• Explain the latest research findings and information of Soil, Plant and Water Analysis	Latest research findings and information regarding Soil, Plant and Water Analysis	Assignment	Report

Reference Books

1. D.L. Sparks, A.L. Page, P.A. Helmke.1996.Methods of soil analysis, Part 3 Chemical Methods. Soil Science Society of America, Inc. American Society of Agronomy, Inc. Madison, Wisconsin, USA.
2. ISSS. 2000. Fundamentals of Soil Science. Published by Indian Society of Soil Science.M. A. Sattar and M. M. Rahman. 1987. Techniques of Soil Analysis. Mymensingh, Bangladesh
3. N. S. Subba Rao. 1988. Bio-fertilizers in Agriculture. Oxford and IBH Pub., Co., Ltd., New Delhi.
4. R. A. Singh. 1989. Soil Physical Analysis. Kalyani Pub., New Delhi.
5. R. L. Donahue, R. W. Miller and J. C. Shickluna. 1990. Soil: An Introduction to Soils and Plant Growth, 5thEdn. Prentice hall of Ind. Pvt. Ltd. New Delhi.
6. S. P. Majumdar and R. A. Singh. 2002. Analysis of Soil Physical Properties. Agrobios, India.

Course Code: SOIL 508 **Course Title: Soil Organic Matter (Elective)**	**Credit Hour: 03**	**Semester: July-December**

Rationale: This course is designed to develop student knowledge on organic matter (OM) dynamics in soil including input and output of OM and their maintenance for sustainable agriculture as well as environmental aspect.

Course Outcomes:

- Describe the importance of soil organic matter (SOM) with different sources and composition of organic compounds.
- Illustrate decomposition of different types of organic compound in soil and the effects of decomposing products on soil health.
- Evaluate/justify the different types of decomposition occurred in soil.
- Identify the way to improve/maintain organic matter in soil for sustainable crop production.
- Evaluate/criticize the SOM as a source and a sink of atmospheric carbondioxide.
- Create a link between SOM stock and greenhouse gas (GHG) emission mitigation as well as mitigating climate change.

Intended Learning Outcomes (ILOs) The students will be able to –	**Course Content**	**Teaching Learning Strategies**	**Assessment Strategies**
• Define and describe the SOM • Identify the sources of SOM • Recognize different types of OM with their compositions • Explain the function of SOM in relation to nutrient status in soil • Summarize the role of SOM in soil pedogenic processes	**Soil organic matter-** Concept; Sources; types and composition of soil organic matter; role of organic matter in soil fertility and pedogenic processes	Lecture Discussion Visual presentation	Quiz/MCQ Short answer Essay type answer
• Describe the decomposition of OM as well as organic compounds • Recognize the different types of decomposition of OM • Explain different soil factors of organic matter decomposition including C: N ratio and nutrient availability. • Illustrate the decomposition procedure of different organic compounds	**Decomposition of OM in soil-** Types; factors affecting the decomposition; decomposition of organic compounds (protein, starch, cellulose, hemi-cellulose, lignin)	Lecture Discussion Visual presentation	Quiz/MCQ Short answer Essay type answer
• Define and explain the humus • Identify the properties of humus • Explain humus formation, C:N ratio and their importance in soil fertility and	**Humus-** Concept; biochemistry of humus formation; nature and properties of humus;	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report

productivity • Describe the extraction and fractionation processes of humus substances • Explain the clay-humus interaction and explain the importance of forming clay-humus complex	Extraction, fractionation and purification of humic substances; Clay-humus complex		
• Show and describe the organic matter status in Bangladesh soil • Discuss the reasons to deplete the OM in Bangladesh soil • Suggest for increasing/maintaining OM in Bangladesh soil	**Organic matter status of Bangladesh soils-** Present status; causes of organic matter depletion; Maintaining OM in soil	Lecture Discussion Visual presentation	Quiz/MCQ Short answer Essay type answer
• Define and describe different types of organic matter like farm yard manure (FYM), compost, vermicompost, green manure etc • Prepare and improve the quality of compost, vermicompost, FYM and green manure for increasing soil fertility and productivity • Explain integrated nutrient management (INM) and its importance in eco-friendly crop production.	**Organic matter improvement in soil**-Green manure; farm yard manure; compost; vermicompost- their production techniques; Integrated nutrient management	Lecture Discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• List greenhouse gas and describe the cause of greenhouse effect • Analyze the trend of global emission of GHGs emission by discussing the history of their emissions • Summarize OM stock in terrestrial ecosystem • Justify OM storage potential of soil • Develop a link between SOM stock and CO_2 emission mitigation as well as mitigating climate change	**SOM and mitigation of GHG emissions -** Greenhouse gas and greenhouse effect, GHG emission, SOM: source and sink of CO_2, CO_2 emission mitigation	Lecture Discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report

• Explain the latest research findings and information of Soil Organic Matter	Latest research findings and information regarding Soil Organic Matter	Assignment	Report

Reference Books

1. N. C. Brady and R. R. Weily. 2014. The Nature and Properties of Soils. 14thEdn. Macmillan Pub. Co., New York.
2. J. L. Havlin, J. D. Beaton, S. L. Tisdale and W. L. Nelson. 2006. Soil Fertility and Fertilizers, 6thEdn., Prentice-Hall of India
3. D. K. Das. 2014. Introductory Soil Science. Kalyani Publishers, India
4. E. A. Paul.2007. Soil Microbiology,Ecology and Biochemistry. 3rdEdn., Academic Press of Elsevier. USA
5. K. Mengel, E.A.Kirkby. 1987. Principles of Plant Nutrition. International Potash Institute, Switzerland
6. R. L. Donahue, R. W. Miller and J. C. Shickluna. 1992. Soils: An Introduction to Soils and Plant Growth. Prentice Hall of Ind. Pvt. Ltd., New Delhi.
7. Fertilizer Recommendation Guide, Bangladesh Agricultural Research Council
8. Chowdhury, S., Farrell, M., Greg, B. and Bolan, N. S. 2015. Assessing of the effect of crop residue removal on soil organic carbon storage and microbial activity. Soil Use and Management, 31:450-460.
9. Chowdhury, S., Farrell, M. and Bolan, N. S. 2014. Photoassimilated carbon allocation in a wheat plant-soil system as affected by soil fertility and different land-use histories. Plant So 383:173-189.
10. Chowdhury, S., Farrell, M. and Bolan, N. S. 2014. Priming of soil organic carbon by malic acid addition is differentially affected by nutrient availability. Soil Biology & Biochemistry 77: 158-169.
11. Chowdhury, S., Farrell, M., Butler, G. and Bolan, N. S. 2013. Stubble retention and soil carbon in long term no-till farming system. SANTFA No-Till Journal. 10 (1): 347.
12. Minasny et al. (2017) Soil carbon 4 per mille. Geoderma 292: 59–86.

Course Code: SOIL 509 Course Title: Environments and Soil Pollution (Elective)	Credit Hour: 03	Semester: January-June

Rationale: The course is designed to provide applied knowledge about the causes of environmental pollution and their remediation.

Course Outcomes: The students will be able to-

- Acquire knowledge on environmental segments, composition of atmospheric environment and reactions in atmospheric environment.
- Develop knowledge on the causes and processes of greenhouse gases production, global warming and ozone layer depletion.
- Explain the sources of soil pollution and different factors that affect the soil pollution recommend for solving the problems of soil and environmental pollution.
- Make land use plan for sustainable development of Environment and reduce land degradation

Intended Learning Outcomes (ILOs) The students will be able to-	Course Content	Teaching Learning Strategies	Assessment Strategies
• Describe different environmental segments and their functions. • Illustrate the structure of atmosphere, hydrosphere, lithosphere and biosphere.	**Environmental segments-** atmosphere, hydrosphere, lithosphere and biosphere, structure and functions of environmental segments.	Lecture Discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Explain the composition of atmospheric environment. • Show different photochemical reactions in atmospheric environment.	**Atmospheric environment-** composition, chemical and photochemical reactions.	Lecture Discussion Visual presentation Field visit Report writing	Quiz/MCQ Short answer Essay type answer Report
• Explain the different causes of nitrous oxides, carbon dioxide and CFCs gases formation and their effects in ozone layer depletion and global warming • Describe the effects of different soil factors in greenhouse gases production, ozone layer depletion and global warming • Make soil management plan for reducing greenhouse gases production	**Greenhouse gases-**methane, nitrous oxides, carbon dioxide and CFCs, their formation and effects, soil factors in relation to greenhouse gases, ozone layer depletion and global warming.	Lecture Discussion Visual presentation	Quiz/MCQ Short answer Essay type answer

• Elaborate different pollutions and their remedial measures in hydrosphere and biosphere • Recommend for reducing pollution in hydrosphere and biosphere	**Hydrosphere and biosphere**- their pollutions and remedial measures.	Lecture Discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Discuss the concept of soil pollution and composition of soil pollutants • Describe the different sources of soil pollution and their effects on soil and plants. • Manage polluted soils by implementing different remediation activities	**Soil pollution**- concept and importance; sources composition of soil pollutants: Fertilizers, pesticides, heavy metals, radioactive materials, industrial effluents, acid rain, city wastes, sewage sludge- effects on soil and crops. Management of polluted soils. Biodegradation of pesticides and other pollutants.	Lecture Discussion Visual presentation	Quiz/MCQ Short answer Essay type answer
• Explain the causes of different land degradation processes • Develop land use plan for sustainable development of the environment	**Environment and sustainable development:** Land use and land cover, land degradation, deforestation, desertification and urbanization.	Lecture Discussion Visual presentation Field visit Assignment	Quiz/MCQ Short answer Essay type answer Report presentation
• Explain the latest research findings and information of Environments and Soil Pollution	Latest research findings and information regarding Environments and Soil Pollution	Assignment	Report

Reference Books

1. N. C. Brady and R. R. Weil. 2014. The Nature and Properties of Soils. 14thEdn. Macmillan Pub. Co., New York.
2. H. Brammer. 2000. Agro ecological Aspects of Agricultural Research in Bangladesh. University Press Ltd., Dhaka.
3. H. Brammer. 1996. The Geography of the Soils of Bangladesh. University Press Ltd. Dhaka.
4. FAO.1988. Agro ecological Regions of Bangladesh, Report No.2, UNDP-FAO, Rome.
5. M. M. Hassan. 1999. Soils of Bangladesh: Their genesis, classification and use potential.
6. M. S. Hussain. 1992. Soil Classification with special reference to the soils of Bangladesh.
7. M. Idris. 1987. Erosion Hazard Areas in Bangladesh. Report on Soil Conservation, SRDI, Dhaka.
8. Soil Survey Staff. 1951. Soil Survey Manual, USDA No. 18, US Govt. Printing Office, Washington, D.C.
9. Soil Survey Staff. 1978. Soil Taxonomy-A basic System of Soil Classification. Agricultural Handbook No. 456, Soil Conservation Service, USDA.

Course Code: SOIL 510 **Course Title: Soil Clay Mineralogy (Elective)**	**Credit Hour: 03**	**Semester: January-June/ July-December**

Rationale: The course is designed to enrich knowledge on soil clay mineralogy in relation to agriculture.

Course Outcomes:

- Explain genesis, classification and importance of clay minerals.
- Illustrate crystal chemistry of clay minerals.
- Describe physico-chemical properties of clay minerals.
- Discuss the clay minerals of Bangladesh soils and their effects on soil properties

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching Learning Strategies**	**Assessment Strategies**
• Classify silicate and non-silicate clays • Illustrate the structural unit and genesis of silicate clay • Explain the importance of clay	Classification of silicate and nonsilicate clays; structural units of clay minerals; genesis of silicate clays; importance of clay minerals.	Lecture Discussion Visual presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Show the crystal system, bonds and different ionic radii in the clay minerals. • Describe the isomorphous substitution and negative charge development in clay mine • Explain the cause of cation anion and water adsorption on the surface of clay	**Crystal chemistry of silicate clays-** crystal systems, bonds, ionic radii, coordination number and isomorphous substitution.	Lecture Discussion Visual presentation	Quiz/MCQ Short answer Essay type answer
• Illustrate and explain physico-chemical and mineralogical properties of phyllosilicates • Describe the surface chemistry of clay minerals.	Physico-chemical and mineralogical properties of phyllosilicates including micas, kaolinite, smectite, vermiculite, illite, chlorite and interstratified minerals. Clay-organic complexes, surface chemistry of clay minerals.	Lecture Discussion Visual presentation Problem solving Assignment	Quiz/MCQ Short answer Essay type answer Report
• Identify clay minerals • Explain clay-organic complexes and their role in soil productivity • Describe clay minerals of Bangladesh soils	Identification of clay minerals. Clay-organic complexes and their role in soil productivity. Clay minerals in Bangladesh soils and their impact on soil properties.	Lecture Discussion Visual presentation	Quiz/MCQ Short answer Essay type answer
• Describe the latest research findings and information of Soil Clay Mineralogy	Latest research findings and information regarding Soil Clay Mineralogy	Assignment	Report

Reference Books

1. N. C. Brady and R. R. Weily. 2014. The Nature and Properties of Soils. 14thEdn. Macmillan Pub. Co., New York.
2. J. L. Havlin, J. D. Beaton, S. L. Tisdale and W.L. Nelson. 2006.Soil Fertility and Fertilizers, 6thEdn. Prentice-Hall of India
3. B. P. Ghildyal and R. P. Tripathi. 1987. Soil Physics. Wiley Eastern Ltd. New Delhi, India.
4. F. N. Ponnamperuma. 1972. Chemistry of submerged soils. In : Advances in Agronomy. Ed. N.C. Brady. Vol.24. Academic Press, New York.
5. D. K. Das. 2014. Introductory Soil Science. Kalyani Publishers, India
6. K. H. Tan. 2013. Principles of Soil Chemistry. CRC Press, Boca Raton, New York.
7. D. Hillel. 1980. Applications of Soil Physics. Acad. Press, New York.
8. L. D. Baver. 1985. Soil Physics. John Wiley and Sons, Inc., New York.
9. T. D. Biswas and S. K. Mukherjee. 1997. Text Book of Soil Science. Tata McGraw Hill Publishing Co. Ltd., New Delhi.

Course Code: SOIL511 **Course Title:** **Biofertilizer Technology (Elective)**	**Credit Hour: 3**	**Semester: January-June/ July-December**	
Rationale: This course is designed to provide detailed knowledge on Biofertilizer Technology			
Course Outcomes: • Explain microbial inoculants bio-fertilizer, bio-fertilizer techno activities in soil fertility • Illustrate and apply production technologies of different types • Analyze and compare the effects of chemical fertilizer and bio matter and environment			
Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching Learning Strategies**	**Assessment Strategies**
• Explain biofertilizer, use of microbial inoculants and development of biofertilizer technology • Evaluate the effect of biofertilizer in soil fertility improvement	**Biofertilizer** Concept of biofertilizer, microbial inoculants used as biofertilizer, development of biofertilizer technology, microorganisms contributing to soil fertility- kinds, characteristics and beneficial activities.	Lecture Visual presentation Interactive discussion	
• Authenticate and maintain the different species of rhizobium • Select and use different strains of *Rhizobium* for the production of rhizobium • Select and use suitable azolla as biofertilizer • Explain and apply the measures for quality control of biofertilizer	**Production Technology of Biofertilizers** Collection, authentication and maintenance of the cultures of Rhizobium, Azotobacter, Azospirillum, Cyanobacteria, Phosphate solubilizing bacteria, Cellulolytic microbes and mycorrhizal fungi; Screening, selection and use of effective strains of Rhizobia and other microorganisms in the production of biofertilizers; collection and processing of suitable carrier material for biofertilizer production; screening and selection of Azolla suitable for use as biofertilizer; Application and quality control of biofertilizer.	Lecture Visual presentation Discussion	
• Compare bio-fertilizer and chemical fertilizer in soil fertility improvement • Explain the role of	**Interactions of Biofertilizers with Chemicals** Interactions of biofertilizer with chemical fertilizers and pesticides	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer

biofertilizers on organic matter build up in soil	applied in soils; contribution of biofertilizers on organic matter build up in soils.		
• Illustrate the effects of biofertilizer for reducing environmental pollution • Describe the role of biofertilizers for the improvement of soil fertility	**Biofertilizer and environment** Biofertilizer in reducing soil degradation and environmental pollution; Role of biofertilizers for the improvement of soil fertility and sustainable agriculture in Bangladesh	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Explain the latest research findings and information of Biofertilizer Technology	Latest research findings and information regarding Biofertilizer Technology	Assignment	Report

Reference Books

1. N.C. Brady and R.R. Weily. 2014. The Nature and Properties of Soils. 14thEdn. Macmillan Pub. Co., New York.
2. M. Alexander. 1977. Introduction to Soil Microbiology. John Wiley and Sons, New York.
3. T.D. Biswas and S.K. Mukherjee. 1989. Text Book of Soil Science. Tata McGraw-Hill Pub. Co., New Delhi, India.
4. D.K. Das. 2014. Introductory Soil Science. Kalyani Publishers, India.
5. R.L. Donahue, R.W. Miller and J.C. Shickluna. 1992. Soils : An Introduction to Soils and Plant Growth, 5thEdn. Prentice Hall of India Pvt. Ltd., New Delhi.
6. H.D. Foth. 1984. Fundamentals of Soil Science, 7thEdn., John Wiley and Sons, New York.
7. J.A. Daji. 1992. A Textbook of Soil Science.
8. ISSS. 2000. Fundamentals of Soil Science. Indian Society of Soil Science.

Course Code : SOIL 512 Course Title: Soil and Water Conservation (Elective)	Credit Hour: 03	Semester: July-December	
Rationale: The course consists of soil erosion and its conservation measures. Apart that watershed concept, its importance and management also included. Overall this course is discussed elaborately how the soil erosion is occurred and can be managed for sustainable crop production.			
Course Outcomes: • Illustrate different types of soil erosion and their management. • Conceptualize universal soil loss equation (USLE). • Manipulate watershed management. • Establish sustainable crop production through soil and watershed management.			
Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching Learning Strategies**	**Assessment Strategies**
• Conceptualize the types and mechanism to occur soil erosion • Quantify the USLE and its limitations & application in a particular landscape.	**Soil Erosion:** Types, extent and mechanism of water and wind erosion, harmful effects of soil erosion. Methods of quantifying the impact of soil erosion. Universal soil loss equation (USLE)-qualification of its factors, limitations and application in Bangladesh.	Lecture Visual presentation Internet modules Field visit Assignment Report writing	Quiz Short answer Essay type answer Report
• Illustrate the various approaches for conservation. • Assess the soil conservation.	**Soil Conservation:** Concept, past, present and future approaches to soil conservation, principles of soil conservation.	Lecture Visual presentation Internet modules Field visit Assignment Report writing	Quiz Short type answer Essay type answer Report
• Measure the efficiency of different erosion control practices. • Assess the level of erosion in Bangladesh and their management.	**Control of soil erosion and soil conservation:** Agronomic and mechanical practices, methods for controlling wind erosion, problems of implementing soil conservation practices in the field. Soil erosion problems in Bangladesh, their management.	Lecture Visual presentation Internet modules Field visit Assignment Report writing	Quiz Short type answer Essay type answer Report
• Conceptualize watershed and its importance for crop production. • Conclude the watershed management for	**Watershed:** Concept, characteristics, importance and its management for sustainable crop production.	Lecture Visual presentation Internet modules Field	Quiz Short type answer Essay type answer Report

sustainable crop production.		visit Assignment Report writing	
• Explain the latest research findings and information of Soil and Water Conservation	Latest research findings and information regarding Soil and Water Conservation	Assignment	Report

Reference Books

1. Brady, N. C. and Weil, R. R. 2014. The Nature and Properties of Soils (14th edition). Macmillan Pub. Co., New York.
2. Idris, M. 1987. Erosion Hazard Areas in Bangladesh. Report on Soil Conservation, SRDI, Dhaka.
3. Tripathi, 1993. Soil erosion and conservation. New Age International, New Delhi.
4. Morgan, R. P. C. 2005. Soil Erosion and Conservation (3rd edition). Blackwell Publishing. Massachusetts, USA.
5. Agassi, M. 1995. Soil Erosion, Conservation, and Rehabilitation. Marcel Dekker, Inc., New York.
6. Avakeri, H.R. and Donahue, R.L. 1985. Principles of Soil Conservation and Water Management. Oxford & IBH publishers, New Delhi.
7. United States Department of Agriculture. 1974. A manual on conservation of soil and water. Oxford & IBH Pub. Co. New Delhi.
8. Easter, K.W., Dixon, J.A., Hufschmidt, M. M. 1986. Watershed resources management: an integrated framework with studies from Asia and the Pacific. Westview Press, Boulder.

Institute of Seed Technology

Course Layout

SL. No.	Course Code and Title		Cr. Hrs.
A. Compulsory Courses			
1	STEC 501: Seed Crop Improvement		3
2	STEC 502: Seed Production Technology of Field Crops		3
3	STEC 503: Seed Pathology		3
4	STEC 504: Seed Quality Assurance		3
5	STEC 505: Seed Technology of Horticultural Crops		3
6	STEC 506: Seed Entomology		3
		Total	**18**
B. Elective Courses 12			
7	STEC 507: Seed Morphology and Physiology		3
8	STEC 508: Seed Marketing and Business		3
9	STEC 509: Research Methodology		
10	STEC510: Plant Nutrition for Seed Crop		3
11	STEC 515: Heterosis Hybrid and Transgenic Seed Technology		3
12	STEC 516: Seed Processing and Preservation		3
13	STEC 517: Seed Biochemistry and Biotechnology		3
14	STEC 518: Seed Ecology		3
		Minimum	**12**
C. Seminar Course			
23	STEC 598		1
D. Thesis Research			
24	STEC 599		16
		Compulsory Courses	**18**
		Elective Courses	**12**
		Seminar Course	**1**
		Thesis Research	**16**
		Total	**47**

Curriculum Alignment / Skill Mapping

Curriculum must be aligned with program objectives, program learning outcome and intended learning outcomes through proper skill mapping.

Institute of Seed Technology

Courses	Program Learning Outcome							
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
STEC 501	x	x	x	x			x	x
STEC 502	x	x	x	x			x	x
STEC 503	x	x	x	x			x	x
STEC 504	x	x	x	x			x	x
STEC 505	x	x	x	x			x	x
STEC 506	x	x	x	x			x	x
STEC 508			x	x		x	x	x
STEC 509	x	x	x	x	x		x	x
STEC 515	x	x	x	x			x	x
STEC 516	x	x	x	x			x	x
STEC 598						x	x	
STEC 599					x	x	x	x

Course Code: STEC 501 Course Title : Crop Improvement (Compulsory)	**Credit Hour: 03**	**Semester: January-June**	
Rationale: This course is designed to enrich knowledge and skills on the crop improvement by using different breeding methods			
Course Outcomes: • Describe centres of origin and diversity of crops • Demonstrate and explain the different activities and methods for crop improvement • Explain and apply selection**,** hybridization, mutation, genetic engineering techniques for variety development • Maintain genetic purity by using different methods			
Intended Learning Outcomes (ILOs) The students will be able to	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Show and explain the origin, primary and secondary centres of diversity of different crops	**Origin of crops-** Centres of origin/diversity, primary and secondary centres of diversity	Lecture Discussion Visual presentation Group work	Quiz/MCQ Short answer Essay type answer Presentation performance
• Apply and explain selection, evaluation, multiplication methods for crop improvement	**Activities related to Crop Improvement-** Creation of variation, selection, evaluation, multiplication and seed distribution	Lecture Discussion Visual presentation Field visit Group work	Quiz/MCQ Short answer Essay type answer Report Presentation performance
• Apply and describe hybridization, mutation, polyploidization, somaclonal variation and genetic engineering techniques	**Creation of variation-** Hybridization, mutation, polyploidization, somaclonal variation, genetic engineering	Lecture Discussion Visual presentation Field visit Group work	Quiz/MCQ Short answer Essay type answer Report Presentation performance
• Demonstrate and illustrate selection, hybridization for Autogamous crops • Improve variety by selection and hybridization for Allogamous species • Apply and enumerate introduction, Clonal selection, hybridization for vegetatively	**Plant breeding methods-** **a) Autogamous crops-** Selection, hybridization and selection **b) Allogamous species-** Selection population improvement, hybrid and synthetic variety **c) Vegetatively propagated crops-** Introduction, Clonal selection, hybridization	Lecture Discussion Visual presentation Field visit Group work	Quiz/MCQ Short answer Essay type answer Report Presentation performance

propagated crops			
• Explain features and procedures of mutation breeding • Describe advantages and disadvantages of mutation breeding	**Mutation breeding-** Features of mutation breeding, procedures of mutation breeding, advantages and disadvantages of mutation breeding	Lecture Discussion Visual presentation Field visit Group work	Quiz/MCQ Short answer Essay type answer Report Presentation performance
• Show the techniques of genetic engineering • Apply genetic engineering for variety development	**Genetic engineering in variety development-** Technique of genetic engineering and application of genetic engineering	Lecture Discussion Visual presentation Field visit Group work	Quiz/MCQ Short answer Essay type answer Report Presentation performance
• Evaluate different variety by using different methods • Show and explain variety release procedures of notified and non-notified crops	**Variety evaluation and release-** Types of evaluation, DUS test, release procedures of notified and non-notified crops	Lecture Discussion Visual presentation Field visit Group work	Quiz/MCQ Short answer Essay type answer Report Presentation performance
• Illustrate and apply genetic principle of maintenance of varieties • Enumerate and apply principles of maintenance of genetic purity • Elucidate and apply methods of maintenance of breeder's seed	**Maintenance breeding-** Basis, genetic principle of maintenance of varieties, principles of maintenance of genetic purity, methods of maintenance of breeder's seed	Lecture Discussion Visual presentation Field visit Group work	Quiz/MCQ Short answer Essay type answer Report Presentation performance
• Explain the role of SCA in breeder's seed production • Describe and produce breeder's seed	**Breeder's seed production-** Procedures of production of breeder's seed, role of SCA in breeder's seed production	Lecture Discussion Visual presentation Field visit Group work	Quiz/MCQ Short answer Essay type answer Report Presentation performance
• Explain different types of intellectual property rights • Describe plant breeder's rights • Discuss about patent and trade secret	**Intellectual Property Rights-** Types, Plant Breeder's Rights, Patent and Trade secret	Lecture Discussion Visual presentation Group work	Quiz/MCQ Short answer Essay type answer Presentation performance

Reference Books

1. B.D. Singh. Plant Breeding-Principles and Methods. 7th Edn. Kalyani Publishers. , New Delhi
2. B.D. Sigh. Objectives of Plant Breeding. 1st Edn. Kalyani Publishers., New Delhi
3. Puhundan Singh. Essentials of Plant Breeding. Kalyani Publishers,. New Delhi
4. B.D. Singh. Plant Biotechnology. Kalyani Publishers., New Delhi
5. R.W. Allard. Principles of Plant Breeding. 3rd Eddn.. Wiley India Ptv. Ltd.
6. Singh. Essential of Plant Breeding. 6th Edn. Kalyani Publication.

Course Code: STEC 502 Course Title : Seed Production Technology of Field Crops (Compulsory)	**Credit Hour: 03**	**Semester: January-June**	
Rationale: This course is designed to provide detailed knowledge and skills on seed production and multiplication technologies of field crops; seed multiplication factor; seed multiplication planning; cost analysis; seed quality class, Inbreed, hybrid, synthetic, composite or GMO seed to be produced			
Course Outcomes: • Explain the causes and remedy of variety deterioration and factors of quality seed production • Illustrate and apply different techniques of quality seed production during sowing to harvesting • Apply and describe quality seed production technologies of cereal, pulse, fibre, oil seed, sugar and fodder crops			
Intended Learning Outcomes (ILOs): The students will be able to	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Identify and explain variety deterioration during seed multiplication • Apply and practice remediation techniques in variety deterioration during seed multiplication	**Genetic Principles:** Causes and remedy of variety deterioration during seed multiplication	Lecture Visual presentation Interactive discussion Field visit	Quiz/MCQ Short answer Essay type answer
• Describe different Agro-ecological and climatic considerations for suitability of quality seed production • Describe the characteristics of released varieties • Apply appropriate sowing time and doses of fertilizers for quality seed production	**Before sowing:** Agro-ecological and climatic considerations, Inputs and equipment requirements, Name of released varieties with characteristics, Appropriate sowing time for seed multiplication, Doses of fertilizer suitable for the production of quality seed	Lecture Visual presentation Interactive discussion Field visit	Quiz/MCQ Short answer Essay type answer
• Describe and demonstrate types of propagation, isolation and reason for keeping the isolation distance • Explain and apply techniques of field inspection for the crop and maintenance of field standard • Calculate off type percentage, disease percentage	**After sowing to harvesting:** Floral description, type of propagation, Isolation distance and reason for keeping the isolation distance, Technique of field inspection suitable for the crop and maintenance of field standard, off type and calculation of off type percentage, disease percentage, Special type of cultural practices it need be. Maturity, after ripening and harvesting of the seed, Method of seed collection	Lecture Visual presentation Interactive discussion Field visit	Quiz/MCQ Short answer Essay type answer

• Describe special type of cultural practices, ripening and methods of seed collection			
• Explain and produce quality seed of rice, wheat, maize, barley, sorghum etc.	**Cereal crops:** Seed production of Rice, Wheat, Maize, Barley, Sorghum etc.	Lecture Visual presentation Interactive discussion Field visit	Quiz/MCQ Short answer Essay type answer
• Describe and apply production techniques of pulse crops	**Pulse crops:** Seed production of Lentil, Mung bean, Grass pea, Chick pea, Field pea, Black gram, Yard long, Bush bean etc.	Lecture Visual presentation Interactive discussion Field visit	Quiz/MCQ Short answer Essay type answer
• Illustrate and demonstrate the techniques of fiber crops seed production	**Fiber crops:** Seed production of Jute, Kenaf, Sunhemp, Cotton etc.	Lecture Visual presentation Interactive discussion Field visit	Quiz/MCQ Short answer Essay type answer
• Illustrate and apply oil seed production techniques of oil crops	**Oil Seed crops:** Seed production of Mustard, Groundnut, Soybean, Sunflower, Linseed, Safflower, Niger, Castor, etc.	Lecture Visual presentation Interactive discussion Field visit	Quiz/MCQ Short answer Essay type answer
• Explain and apply seed production technology of sugar crops	**Sugar crops:** Seed production of Sugarcane, Sugar beet etc.	Lecture Visual presentation Interactive discussion Field visit	Quiz/MCQ Short answer Essay type answer
• Explain and produce quality seed of fodder crops	**Fodder crops:** Seed production of Dhaincha, Tritically, Para grass, Napier grass, German grass, Gini grass etc.	Lecture Visual presentation Interactive discussion Field visit	Quiz/MCQ Short answer Essay type answer

Reference Books

1. Farmers' seed production: new approaches and practices 1999 pp.310 pp. ref.39
2. Almekinders CJ, Louwaars NP. Farmers' seed production: new approaches and practices. Intermediate Technology; 1999
3. Merwade MN. INVESTIGATIONS ON SEED PRODUCTION TECHNIQUES AND STORABILITY OF CHICKPEA (Cicer arietinumL.) (Doctoral dissertation, UNIVERSITY OF AGRICULTURAL SCIENCES GKVK BANGALORE).
4. Chiipanthenga M, Maliro M, Demo P, Njoloma J. Potential of aeroponics system in the production of quality potato (Solanum tuberosum l.) seed in developing countries. African Journal of Biotechnology. 2012;11(17):3993-9.
5. Singh F, Rai KN, Reddy BV, Diwakar B. Development of cultivars and seed production techniques in sorghum and pearl millet.
6. Bishaw Z, Niane AA, Gan Y. Quality seed production. InLentil 2007 (pp. 349-383). Springer, Dordrecht.

Course Code: STEC 503 Course Title: Seed Pathology (Compulsory)	Credit Hour: 03	Semester: January - June	
Rationale: This course is designed to acquaint students with basic and applied knowledge on important aspects of seed and seed borne diseases, detection and identification of seed borne pathogens, laws relating to seed business and management of seed borne diseases.			
Course Outcomes: • Explain importance of seed borne pathogens and seed diseases of important crops, • Illustrate factors influencing seed borne disease, seed transmission and how seed borne pathogen can be identified and examined, • Evaluate seed lot and take decision on seed lot planting value and trade value, • Design innovative and safe plan for national and international trade of seed and plant material, • Develop and design Teaching Learning Strategies for seed crop cultivation and utilize management aspects to combat seed borne diseases.			
Intended Learning Outcomes (ILOs) The student will be able to-	**Course Content**	**Teaching Learning Strategies**	**Assessment Strategies**
• Describe concept of Seed Pathology and its impact on crop production • Identify major seed borne diseases and pathogens affecting crop seeds • Outline and describe the transmission mechanisms of pathogen from seed to plant to seed	**Concepts of Seed Pathology** • History and concept of Seed Pathology Importance of seed health and its impact on food security • Significance of seed borne disease and effect of seed diseases on crop production • Mechanism of seed transmission of pathogens	Lectures Visual presentation Discussion Assignment	Quiz/ MCQ Short answer Essay type answer
• Evaluate seed lot and take decision based on its planting value and trade value • Examine seed health of different crops	**Seed sampling and seed health testing methods** • Seed sampling and related issues • Laboratory seed health testing methods • Detection and identification of seed borne pathogen(s) (Fungi, bacteria, virus and nematodes)	Lecture Visual presentation Laboratory exercise and Assignment	Quiz/ MCQ Short answer Essay type answer
• Explain national and international rules practicing in seed trade • Describe quarantine rules and related regulations • Design innovative and	**Rules and regulation for national and international seed transaction** • Seed supply chain management in Bangladesh • National laws related to seed and seed certification • NPPO and quarantine regulation • International rules related to seed	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer

safe plan for national and international trade seed and plant materials.	business • ISTA and IPPC in seed transaction and trade		
• Employ effective strategy to combat seed borne pathogens judiciously • Practice seed crop management and post harvest management for healthy seeds • Exercise storage management for quality control of seeds • Exercise seed treatment for controlling seed borne pathogens	**Management of seed borne pathogens** • Control of seed borne pathogens: • Seed crop management and post harvest management for healthy seed production. Storage management: principles and practices. Antipathogenic chemicals and eco-friendly agents for seed treatment	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer
• Perform a critical analysis of pathogen situation in an area or in the country • Develop and design Teaching Learning Strategies for seed crop cultivation	**Pest risk analysis** • Pest risk analysis: seed perspective • Pest risk analysis : Bangladesh perspective	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer

Reference Books

1. Seed Pathology (Volume 1-2), Paul Neergaard, ISBN 10: 8172337485 / ISBN 13: 9788172337483, Published by Scientific Publishers, 2011.
2. Common laboratory seed health testing methods for detecting fungi, S. B. Mathur and Olga Kongsdal, International Seed Testing Association, Bassendorf Switzerland, 2003. 425 pp.
3. Seed Technology and Seed Pathology, Editors: Tribhuwan Singh and K. Agarwal, Seed Technology and Seed Pathology, Tribhuwan Singh and K. Agarwal, 2012.

Course Code: STEC 504 **Course Title : Seed Quality Assurance (Compulsory)**	**Credit Hour: 03**	**Semester: July - December**	
Rationale: This course is designed to provide knowledge and skills on seed quality, seed quality control, seed processing, marketing and seed quality control through regulatory framework.			
Course Outcomes: • Describe and demonstrate seed quality and methods of seed quality determination in the laboratory and field • Apply and demonstrate techniques for maintaining seed quality in the field • Explain and manage techniques of seed processing and marketing • Describe seed regulatory framework for maintaining seed quality			
Intended Learning Outcomes (ILOs): The students will be able to	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Describe quality seed and Seed Quality aspects on the basis of Seed Technology	**Seed Quality:** Concept, definition, Seed Quality aspect on the basis of Seed Technology	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Determine, explain and demonstrate different methods of seed quality determination in the laboratory	**Seed quality control through laboratory:** Application, Sampling, Purity test, Moisture test, Germination test, Viability test, Vigor test, Seed health test, Other Seed counting, TSW (Seed size), DNA finger Printing	Lecture Visual presentation Discussion Method demonstration	Quiz/MCQ Short answer Essay type answer Students demonstration performance
• Determine, explain and demonstrate different methods of seed quality determination in the field	**Seed quality control in the field:** Pre-post control of seed/ Variety**,** Field inspection of different crops in different planting methods**,** Zaddok's scale**,** Grow out test (DUS, VCU test)	Lecture Visual presentation Discussion Field visit Method demonstration	Quiz/MCQ Short answer Essay type answer Report Students demonstration performance
• Apply and explain seed processing, packing and storing techniques • Describe and manage seed marketing	**Seed Processing and Marketing:** Seed treating, Seed cleaning, seed packing and storing; prilins policy and seed marketing	Lecture Visual presentation Discussion Organization visit Method demonstration	Quiz/MCQ Short answer Essay type answer Report Students demonstration performance

• Describe Seed quality regulatory framework • Explain seed certification, seed policy, seed Act and seed rules for maintaining seed quality	**Seed quality control through regulatory framework:** Seed quality control scheme- Seed certification, truthfully label and marketing, Seed Policy, Seed Act, Seed Rules	Lecture Visual presentation Discussion Organization visit Method demonstration	Quiz/MCQ Short answer Essay type answer Report Students demonstration performance

Reference Books

1. Seed System of Bangladesh. www.moa.gov.bd
2. Seed Testing International. ISTA News Bulletin No. 147.2014
3. Strengthening Seed Systems, Editors: Tudra Bahadur Shrestha, MA Estrella Penumia and Muhammad Asim.
4. Promoting Community Based Seed Systems for Biodiversity Conservation and Food & Nutrition Security in South Asia. Pages: 1-229. www.asianfarmers.org
5. The National Seed Policy. 1-10 pp. www.dea.portal.gov.bd
6. The Seed Act. 1-18 pp. www.sca.portal.gov.bd
7. Seed Processing and Storage: Principles and Practices. Editor: Teffrey H. Mclomack. Savings our seed. Version 1.6 July 2010. www.savingsgurseeds.org
8. Tonapi, VA, ArunKumar MB, Manjunath Prasad CT.2011. Seed Quality Assurance: A Training Manual. National Level Training on "Seed Quality Assurance" for officials of Seed Industry, 22-26th November, 2011. Division of Seed Science and Technology, Indian Agricultural Research Institute, New Delhi. 249 pp.
9. Seed Quality Assurance. www.seednet.com.an/quality-assurance.

Course Code: STEC 505 **Course Title**: **Seed Technology of Horticultural Crops** (**Compulsory)**	**Credit Hour: 03**	**Semester: July-December**
Rationale: This course is designed to provide applied knowledge about seed technology of horticultural crops in advanced level.		
Course Outcomes: • Acquire knowledge on seed technology and their development practices • Analyze the different environmental factors affecting seed production. • Acquire knowledge about different techniques for improvement and multiplication of seeds • Acquaint with seed production and their business strategies • Conceptualize about seed processing and marketing		

Intended Learning Outcomes (ILOs) The students will be able to	**Course content**	**Teaching strategies**	**Assessment strategies**
• Discuss about seeds, its importance and production status • Describe the problems of flower, vegetable, spices and fruit seeds production in Bangladesh	Introduction: Basic concept of seed, background of seed technology, present status, problems and prospect of seed production in Bangladesh.	Lecture Discussion Multimedia presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Differentiate different types of seeds and their certification policies • Discuss national seed policy and seed rules	Principles of horticultural crops seed production: Genetics principles and agronomic principles.	Lecture Discussion Multimedia presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Explain/Criticize the present scenario of seed business in Bangladesh • Explain the prospect of seed industry development in Bangladesh	Vegetable seeds business in Bangladesh: Present status, scope, role of public and private seed sector, potentialities and opportunities, challenges of private seed sector for development of seed industry in Bangladesh. Steps to promote private seed industry, seed management, demand & supply of vegetable seed in Bangladesh.	Lecture Discussion Visual presentation Group work	Quiz/MCQ Short answer Essay type answer Presentation
• Describe the seed production and management techniques of ornamentals and fruit crops. • Explain the latest research findings and information of advanced seed production.	Seed production technology of ornamentals and fruit crops : Marigold, Dahlia, chrysanthemum, gladiolus, tuberose, rose, orchids (true seed and vegetative seeds) papaya, melon crops, banana, pineapple, mango , coconut and areca nut,	Lecture Discussion Visual presentation Group work	Quiz/MCQ Short answer Essay type answer Presentation

• Demonstrate/Operate the advance seed production techniques for crop improvement • Apply advanced seed production technology for horticultural crops.	Seed production of vegetable and spice Crops: Seed production technology oftomato, cauliflower, cabbage, radish, french bean, pumpkin, onion, chilli and coriander, factors affect quality seed production.	Lecture Discussion Multimedia presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Explain and use the improvement techniques for quality seed production of different horticultural crops.	Preharvest technology of seeds: Selection, tagging, harvest index, harvesting method.	Lecture Discussion Multimedia Presentation Assignment	Quiz/MCQ Short answer Essay type answer Report
• Describe & implement the postharvest Processing and handling of seeds and their marketing system • Analyze factors affecting seed marketing and seed demand.	Postharvest technology: Harvesting, drying, processing and storage of seed, use of instrument for threshing, cleaning, drying, grading and packaging, seed marketing, marketing structure, factors affect seed marketing.	Lecture Discussion Multimedia presentation Assignment	Quiz/MCQ Short answer Essay type answer Report

References Books

1. Copeland, L.O. 1988. Principles of seed science and technology.Surjeet Publications. 7-K,
2. Kamla Nagar. Delhi. Pp110-127.
3. Agrawal, R.L. 1999. Seed technology. Second edition. Oxford &Pubilishing Co. PVT Ltd. New Delhi. Pp 230-342.
4. Hossain, M.M. 1995. Technology of production and storage of seeds (in Bangla). Mirpur, Dhaka. Pp 156-180.
5. McDonald, M.B. and Copeland, L.O. 1997. Seed Production: principles and practices. Chapman and Hall, New York. Pp 540-623.
6. Rashid, M.A., Singh, D.P. 2000. A manual on vegetable seed production in Bangladesh. AVRDC-USAID Bangladesh project. Horticulture Research centre, BARI. Gazipur. pp 86-105
7. Jayanthi, M and Sumathi, S. 2018. Seed Production of Horticulture Crops: Principles and Practices. New India Publishing Agency. Pp 23-340.
8. Kumar, S. D. Seed production technology of vegetable crops (practical manual). Department of vegetables science. Navsari Agricultural University.

Course Code: STEC 506 Course Title : Seed Entomology (Compulsory)	Credit Hour: 03	Semester: July-December

Rationale: This course is designed to enrich student knowledge and skills on seed entomology --- bionomics of pollinators, harmful insect and rodent pests, and their effective management practices.

Course Outcomes:

- Explain and apply beneficial effects of insects on pollination and manage pollination in green house and field for quality seed production.
- Describe field identification, economic importance, pest status, distribution, life history, ecology, origin and nature of damage of different species of insects and rodents directly associated with seed both at harvest and storing stage in Bangladesh.
- Gain insight knowledge on principles and methods of traditional and modern storage facilities, store hygiene, pesticides and non-toxic materials and protectants against most frequently encountered insects found in grain.
- Apply and describe IPM in quality seed production and fumigation for insect control in seed storage.

Intended Learning Outcomes (ILOs): The students will be able to	Course Content	Teaching-Learning Strategies	Assessment Strategies
• Explain the relation between insect and seed technology • Describe the impacts of insects in pollination of crop plants • Manage pollination in the field and green house • Elucidate harmful impacts of insects during seed production • Illustrate infestation and control measures of major insect pests in important crops of Bangladesh	Insect and seed technology, Beneficial impacts of insect, Pollination of crop plants; Insect pollination; Managed pollination in the field; Insects and green house seed production; Pollination management in the field and in the green house; Harmful impacts of insects during seed production; Major insect pests of key crops of Bangladesh.	Lecture Discussion Visual presentation Field visit Group work	Quiz/MCQ Short answer Essay type answer Presentation performance
• Apply IPM and other strategies for insect control • Explain and apply Pest Risk Analysis (PRA) • Describe and apply detection methods of storage insects pests and their control • Illustrate and apply fumigation for insect and rodent pests control in seed storage	Integrated pest management (IPM): Strategies & tactics in seed production, Pest Risk Analysis (PRA). Stored grains pests; Detection methods of storage insect pests, Insecticides in storage pest control. Fumigation in storage, Rodent pests in storage & their control;	Lecture Discussion Visual presentation Field visit Group work	Quiz/MCQ Short answer Essay type answer Presentation performance

Reference Books

1. Coste, R. 1987.The Storage of Food Grains and Seeds. CTA and Macmillan. 146p.
2. Hill, D.S. 2003. Pests of Stored Foodstuffs and Their Control. Kluwer Academic Publishers. 476p.
3. Khare, B.P. 2011. Stored Grain Pests and Their Management. Kalyani Publishers, India. 266p.
4. Kumar, R. 2017. Insect Pests of Stored Grain- Biology, Behavior, and Management Strategies. Apple Academic Press and CRC Press. 394p.
5. Rees, D. 2004. Insects of Stored Products. CSIRO Publishing. 181p.
6. Rees, D. 2007. Insects of Stored Grain- A Pocket Reference. 2nd edition, CSIRO Publishing. 77p.

Course Code: STEC 508 **Course Title : Seed Marketing and Business (Elective)**	**Credit Hour: 03**	**Semester: January-June**
Rationale: This course is designed to provide knowledge and skills on seed marketing and business.		
Course Outcomes: • Describe traditional, organized seed sectors and explain government and private seed sectors of Bangladesh • Develop seed policy and manage seed enterprise • Organize seed production, contract growing, seed drying, seed processing, storage, packing and seed pricing. • Manage seed marketing, accounting system and banking		

Intended Learning Outcomes (ILOs): The students will be able to	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Describe evolution of seed system of Bangladesh • Explain traditional and organized seed sectors • Show public and private sectors of seed enterprise	**Introduction-** Traditional and organized seed sector, evolution (Historical) of seed system. Government (public) sector and commercial (private) enterprise	Lecture Discussion Visual presentation Organization visit Group work	Quiz/MCQ Short answer Essay type answer Presentation performance
• Explain general considerations in the development of seed enterprise • Describe seed development policy and essential pre-requisites	**Politics for Enterprise Development:** General considerations, Development of Seed Policy, essential pre-requisites, Enterprise Development Resource Institute.	Lecture Discussion Visual presentation Group work	Quiz/MCQ Short answer Essay type answer Presentation performance
• Show organizational structure of seed enterprise • Illustrate the steps of seed enterprise management • Conduct training for seed enterprise and genetic resource management	**Seed Enterprise Management:** Objectives, Organizational structure, management steps, Genetic resource, Training.	Lecture Discussion Visual presentation Organization visit Group work	Quiz/MCQ Short answer Essay type answer Presentation performance
• Maintain quality of seed • Explain seed production targets • Organize quality seed production through contract growing • Illustrate and apply seed drying, processing, storing, packing and	**Seed Supply:** Quality Assurance, Production targets, Organizing seed production, Contract growing, Seed drying, Seed processing, storage, Packing, seed pricing.	Lecture Discussion Visual presentation Organization visit Group work Assignment	Quiz/MCQ Short answer Essay type answer Report Presentation performance

pricing			
• Prepare seed marketing plan • Make plan for seed selling and publicity and organize seed marketing	**Seed Marketing:** Organization, plan, selling, promotion, and publicity.	Lecture Discussion Visual presentation	Quiz/MCQ Short answer Essay type answer
• Maintain accounting system and record keeping • Calculate profit and loss Prepare balance sheet	**Management of the Accounts and Financial Analysis:** Establishing accounting system; Record keepings, Profit and loss, Balance sheet.	Lecture Discussion Visual presentation Organization visit Group work Assignment	Quiz/MCQ Short answer Essay type answer Report Presentation performance
• Explain credit requirement, bank credit, banking policy and financing • Calculate financial requirement	**Credit and Banks:** Credit requirement, Bank credit, Calculating financial requirement, Approaching bank, Banking policy and Financing.	Lecture Discussion Visual presentation Organization visit Group work Assignment	Quiz/MCQ Short answer Essay type answer Report Presentation performance

Reference Books

1. Seed business Management, 2001. Seed industry Promotion unit, crop diversification Program, Khamarbari, Dhaka, Bangladesh
2. A handbook of Seed processing and marketing, Suresh Chandra Guar, Agrbios Publications, India
3. Seed Marketing, 1994. G. Mumby. FAO Agricultural Services Bulletin, Issue 114.
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5. Seed Business Management in Africa, John F. Macrobert, 2009. Mt pleasant, Harare, Zimbabwe, CIMMTY.

Course Code: STEC 509 **Course Title : Research Methodology (Elective)**	**Credit Hour: 03**	**Semester: January-June**	
Rationale: This course is designed to develop students' knowledge and skills on Research Methodology in the relevant field.			
Course Outcomes: • Explain the activity or NARS, National and International organizations involved in agricultural research • Prepare and execute research plan • Apply and explain experimental design and describe their merits and demerits • Data analysis using statistical packages • Write and present scientific paper and thesis			
Intended Learning Outcomes (ILOs) The students will be able to	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Describe national agricultural research system of Bangladesh • Enumerate the activity of national agricultural research organization • Explain the activity of international organizations involved in agricultural research	**Agricultural Research System in Bangladesh:** NARS, National and International organizations involved in agricultural research.	Lecture Discussion Visual presentation Organization visit Group work Assignment	Quiz/MCQ Short answer Essay type answer Report Presentation performance
• Describe the purpose of agricultural research • Make and execute appropriate research plan • Identify and prioritize research problems and solve the research problems	**Research Planning Methodology:** Purpose of conduction research, Research planning, Identification of researchable problems, Prioritization of research problems and their possible solution through research, data collection for different crops.	Lecture Discussion Visual presentation Group work Assignment	Quiz/MCQ Short answer Essay type answer Report Presentation performance
• Describe different types of experimental design • Select appropriate design for field and laboratory experiment • Explain the merits and demerits of different types of experimental design	**Experimental design:** Types of experiments. Experimental designs appropriate for field and Laboratory, their merits and demerits.	Lecture Discussion Visual presentation Group work Assignment	Quiz/MCQ Short answer Essay type answer Presentation performance Report

• Analyse variance by using different Statistical packages • Compare of treatment means by using different methods • Conduct Regression and correlation analysis	**Statistical packages for data analysis** **Statistical Analysis of Experiments data:** Analysis of variance, Comparison of treatment means. Regression and correlation analysis.	Lecture Discussion Visual presentation Group work Assignment Practice data analysis	Quiz/MCQ Short answer Essay type answer Presentation performance Report Analysis performance
• Explain and interpret the data • Prepare a scientific paper as assignment	**Thesis/Scientific paper writing:** Structure and procedure of data interpretation. Write up a scientific paper as assignment.	Lecture Discussion Visual presentation Group work Assignment	Quiz/MCQ Short answer Essay type answer Presentation performance Report
• Prepare slides from research findings • Present the slides properly in seminar	**Presentation of Research Findings:** Slide preparation. Points to be considered for effective presentation.	Lecture Discussion Visual presentation Group work	Quiz/MCQ Short answer Essay type answer Presentation performance

Reference Books

1. Anonymous. 1990. Research Planning and Evaluation Training Course Resource Manual, BARC, Dhaka & BARI, Joydebpur.
2. K.A. Gomez and A.A. Gomez. 1984. Statistical Procedures for Agricultural Research. Second Edition, International Rice Research Institute, John Wiley & Sons, New York, pp. 01-340.
3. R.I. Mondal, M.S. Islam, M.A,J. Bhuiya, M.M. Rahman, M.S. Alam and M.H.H. Rahman. 2011. Krishi Projukti Hatboi, 5th Edition, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur.
4. S.C. Panda. 2014. Agronomy, AGROBIOS Publication, New Delhi, India.
5. S.M.H. Zaman, K. Rahim and M. Howlader. 1982. Simple Lessons from Biometry, Bangladesh Rice Research Institute, 170p.
6. V.C. Srivastava. 2014. Modern Principles of Agronomy, AGROBIOS (India).

Course Code: STEC 515 Heterosis, Hybrid and Transgenic Seed Technology (Elective)	**Credit Hour: 03**	**Semester: July-December**	
Rationale: This course is designed to provide knowledge, skills and updated information on heterosis, hybrid and transgenic seed technology			
Course Outcomes: • Explain evolutionary concept of heterosis, pollination control mechanisms and hybrid seed production • Describe genetic biochemical, organelle and biometrial aspects of heterosis. • Develop, evaluate and maintain of parental lines • Develop of hybrid varieties in field crops and horticultural crops			
Intended Learning Outcomes (ILOs): The students will be able to	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Describe evolutionary concept of heterosis and types of heterosis • Explain and apply pollination control mechanisms in crops • Illustrate and apply hybrid seed production • Elucidate inbreeding depression and hybrid vigor	**History of heterosis-** Evolutionary concept of heterosis, types and measurement. Pollination control mechanisms in crops; reproduction systems and hybrid seed production. Inbreeding, inbreeding depression and hybrid vigor.	Lecture Discussion Visual presentation Field visit Group work	Quiz/MCQ Short answer Essay type answer Report Presentation performance
• Illustrate genetic biochemical, physiological, plasmatic or organelle • Explain biometrial aspects of heterosis • Develop, evaluate and maintain parental lines. • Identify superior parent and hybrids.	**Basis of hetorosis-** genetic biochemical, physiological, plasmatic or organelle and molecular. Biometrial aspects of heterosis. Development, evaluation and maintenance of parental lines. Combining ability and identification of superior parent and hybrids.	Lecture Discussion Visual presentation Field visit Group work	Quiz/MCQ Short answer Essay type answer Report Presentation performance
• Develop field crops hybrid varieties	**Development of hybrid varieties in field crops:** Rice, Barley, Maize, Wheat, Sunflower, Mustard.	Lecture Discussion Visual presentation Field visit Group work	Quiz/MCQ Short answer Essay type answer Report Presentation performance
• Develop horticultural crops hybrid varieties • Explain and apply genetic improvement of	**Hybrid variety development in horticultural crops:** Tomato, Brinjal, Onion, Cucurbits. Genetic improvement of hybrid, fixation of	Lecture Discussion Visual presentation	Quiz/MCQ Short answer Essay type answer

hybrid, fixation of heterosis • Develop composite and synthetic variety • Use of modern techniques in hybrid seed production	heterosis. Development of composite and synthetic variety. Use of modern techniques in hybrid seed production.	Field visit Group work	Report Presentation performance

Reference Books

1. B.D. Singh. Plant Breeding-Principles and Methods. 7th Edn. Kalyani Publishers. , New Delhi
2. B.D. Sigh. Objectives of Plant Breeding. 1st Edn. Kalyani Publishers., New Delhi
3. R.L. Ararwal. Fundamental of plant breeding and hybred seed production. Science Publication
4. M. Krishnan. Plant breeding and hybrid seed production. Dominant publishers.

Course Code: STEC 516 **Course Title : Seed Processing and Preservation (Elective)**	**Credit Hour: 03**	**Semester: July-December**	
Rationale: Importance of seed processing, physical properties of seeds, seed processing on the basis of physical properties of seed			
Course Outcomes: • Apply different methods of seed drying, processing, grading and packing • Determine seed moisture content and • Explain dynamic equilibrium moisture content and latent heat of vaporization of moisture • Predict of temperature and MC changes during storage of seeds			
Intended Learning Outcomes (ILOs): The students will be able to	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Describe and apply drying, cleaning, sorting and grading processes • Demonstrate the methods of seed treatment for disease control	**Methods and operations of seed processing-** Drying, cleaning, sorting, grading, seed treatment (Its impact on germination and disease control.), packing and handling of seeds.	Lecture Discussion Visual presentation Organization visit Method demonstration Group work Assignment	Quiz/MCQ Short answer Essay type answer Students demonstration performance Report Presentation performance
• Explain the principles and importance of drying • Illustrate the features of sun-drying & mechanical drying • Describe the factors affecting seed drying • Enumerate thin layer seed drying models • Elucidate constant drying rate period, falling rate period of seed drying and drying constants	**Drying of seeds:** Definition, principles and importance of drying. Features of sun-drying & mechanical drying and factors affecting drying. Definition of thin-layer drying, constant drying rate period, falling rate period, theoretical and semi-theoretical approaches to the study of thin layer drying, drying models. Drying constants.	Lecture Discussion Visual presentation Organization visit Method demonstration Group work Assignment	Quiz/MCQ Short answer Essay type answer Report Students demonstration performance Presentation performance
• Describe impacts of cleaning on seed quality • Explain and apply the methods of seed cleaning and grading	**Cleaning and grading :** Methods, impacts on seed quality	Lecture Discussion Visual presentation Organization visit Method demonstration	Quiz/MCQ Short answer Essay type answer Report Students demonstration performance

• Determine of MC and static equilibrium moisture content • Illustrate dynamic equilibrium moisture content. • Show equilibrium moisture content (EMC) models • Determine EMC and latent heat of vaporization of moisture.	**Moisture Content of seeds:** Representation of moisture content (MC) to seed. Determination of MC, Static equilibrium moisture content and dynamic equilibrium moisture content. Equilibrium moisture content (EMC) models, Determination of EMC and latent heat of vaporization of moisture.	Lecture Discussion Visual presentation Organization visit Method demonstration Group work Assignment	Quiz/MCQ Short answer Essay type answer Report Students demonstration performance Presentation performance
• Describe the impact of seed storage on seed longevity and vigour • Explain prerequisites of seed storage and demonstrate storage methods • Demonstrate and explain bagged storage, bulk storage,airtight storage and aerated storage methods • Enumerate the factors affecting the storage of seeds and their interrelationship	**Storage of seeds:** Prerequisites of seed storage, methods of storage and' their impact on seed longevity and vigour. Storage on plant, Bagged storage, bulk storage, airtight storage, aerated storage and controlled atmosphere. Fumigation and spraying. Factors affecting the storage of seeds and their interrelationship.	Lecture Discussion Visual presentation Organization visit Method demonstration Group work Assignment	Quiz/MCQ Short answer Essay type answer Report Students demonstration performance Presentation performance
• Predict and relate seed storage with change of MC and temperature • Describe the effects of MC, relative humidity and temperature on storage seed quality	Prediction of temperature and MC changes during storage of seeds due to changing surrounding weather conditions. Influence of MC, relative humidity and temperature	Lecture Discussion Visual presentation Organization visit Group work Assignment	Quiz/MCQ Short answer Essay type answer Report Presentation performance

Reference Books

1. Barton LV. Seed preservation and longevity. Seed preservation and longevity.. 1961.
2. Gremillion KJ. Seed processing and the origins of food production in eastern North America. American Antiquity. 2004 Apr 1:215-33
3. Thomson JR. An introduction to seed technology. Leonard Hill.; 1979
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14. Kolotelo D, Steenis EV, Peterson M, Bennett R, Trotter D, Dennis J. Seed handling guidebook. British Columbia Ministry of Forests, Tree Seed Centre; 2001.
15. Pedrini S, Lewandrowski W, Stevens JC, Dixon KW. Optimising seed processing techniques to improve germination and sowability of native grasses for ecological restoration. Plant Biology. 2019 May;21(3):415-24.
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17. Chakraverty A, Mujumdar AS, Ramaswamy HS, editors. Handbook of postharvest technology: cereals, fruits, vegetables, tea, and spices. CRC press; 2003 Jan 22.