School of Agriculture and Rural Development

Master of Science Program in Different Fields of Agricultural Science

Handbook

বাংলাদেশ উন্মুক্ত বিশ্ববিদ্যালয়
BANGLADESH OPEN UNIVERSITY

School of Agriculture and Rural Development (SARD)

A Handbook

on

Master of Science (MS)

in

Agronomy, Entomology, Irrigation and Water Management, Aquaculture, Poultry Science, Soil Science

Bangladesh Open University (BOU)
Gazipur-1705, Bangladesh

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A Handbook on Master of Science Program (Agronomy, Entomology, Irrigation and WaterManagement, Aquaculture, Poultry Science, Soil Science)

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Deans' Message

Dear Learners,

Congratulations on having the opportunity to attend the MS program of the School of Agriculture and Rural Development (SARD).

Access to higher agricultural education is limited in Bangladesh due to the few number of seats at related universities. BOU is the only alternative in the country that provides learners the opportunity to afford the educational cost while maintaining their jobs and other responsibilities. Both regular students and working professionals with a minimum bachelor's degree (in Agriculture, Fisheries, Animal Science, Agricultural Engineering/Civil Engineering) of any age are welcome to the MS program at SARD. Nonetheless, the working agriculture graduates are the main target group of these programs.

Bangladesh is an agricultural country with an area of 147,570 sq. km and a population of 160 million. Over 50% of the total area in Bangladesh is cultivated. The vast majority of the population depends on agriculture and natural resources for their livelihood. SARD aims to impart education through a blended mode comprising formal and non-formal programs in the field of agriculture. This approach boosts knowledge about different agricultural commodities, including crops, poultry, dairy, and fish.

The BOU authority has taken initiatives to produce professionally sound individuals by emphasizing higher education and research in agriculture. Therefore, various Agricultural Research Laboratories have already been established at the BOU main campus with modern equipment and facilities. The main objective of the MS program is to provide more skilled manpower for the agriculture sector of the country for its greater interest. This handbook is designed to help you understand the program's rules and regulations.

Thank you again for your interest in the MS programs offered by SARD.

Prof. Dr. Md. Serazul Islam
Dean
School of Agriculture and Rural Development
Bangladesh Open University

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Bangladesh Open University (BOU) at a Glance

Chancellor	Mohammed Shahabuddin Honorable President of the People's Republic of Bangladesh
Vice-chancellor	Professor Dr. A. B. M. Obaidul Islam
Pro-vice Chancellor (Academic)	Professor Dr. Dil Rowshan Zinnat Ara Nazneen
Pro-vice Chancellor (Administration)	Professor Dr. Sayeed Ferdous
Treasurer	Professor Dr. Abul Hasnat Md. Shamim
Established	October 21, 1992
Location	Board Bazar, Gazipur
Area	35 acres
No. of Schools	6
No. of Divisions	11
No. of Regional Centres (RC)	12
No. of Sub-Regional Centres (SRC)	80
No. of Study Centres	1547
Formal Programs	67
Non-formal Programs	19
Teachers (Full-time)	147
Teachers/Tutors (Adjunct)	22961

(Source: https://www.bou.ac.bd/About/BOU)

Vision, Mission and Objectives of Bangladesh Open University

Bangladesh Open University strives to ensure education for all in the country through the open and distance learning system and to excel as a caterer of higher education.

The mission of BOU is to spread quality education, both general and need specific, among all sections of citizens of the country irrespective of their age, gender, religion and caste in a flexible manner by using a suitable mixture of educational media and technologies.

The objectives of BOU are to spread multimedialy instruction of every standard and knowledge, both general and scientific, by means of any kind of communications technology, to raise the standard of education and to give the people educational opportunities by democratizing education and to create a class of competent people by raising the standard of education of the people generally.

Educational System of Bangladesh Open University

Welcome to ODL and the blended mode learning system in Bangladesh Open University. Through a wide variety of distance education programs, Bangladesh Open University extends the learning opportunities to the people all over the country. It allows you to choose your home as your campus and integrate the learning into an adaptable, self-determined schedule.

Bangladesh Open University uses a mix of media considering the access and affordability of the students. The choice of media varies from program to program. Both synchronous and asynchronous media are chosen for the effective delivery of the courses. The media used so far

in BOU programs are: print & e-books, lectures, Education Apps, Radio & TV programs, Web TV and Web Radio, Interactive Virtual Class Room (IVCR) supports, Learning Management System (LMS), internet, email, face book, etc. Recently a number of audio and video programs have been uploaded into the YouTube and mobile set compatible memory card containing the e-books and audio-visual materials is being provided to students. Now the students are able to browse their study materials on their mobile set. BOU has implemented Web TV & Web Radio where the students are able to watch the tutorial session live streamed directly from the classroom.

We hope that our commitments to distance learning will facilitate your pursuit of knowledge relevant to your life and career.

School of Agriculture and Rural Development (SARD) at a Glance

Bangladesh Open University (BOU) was established in 1992 with the aim of providing a wide range of formal and non-formal education, effectively meeting the diverse needs of the population. It is evident that agricultural education plays a vital role in the economic and social development of agro-based Bangladesh. Approximately 80% of the total population, mainly residing in rural and remote areas, are engaged in various agricultural activities, making agriculture a national occupation for their livelihood. However, the provision of need-based education, updated practical information, and contemporary technical know-how to the grassroots level is not adequately addressed. To address this need, the School of Agriculture and Rural Development (SARD) was established in 1996. Currently, the school offers a range of programs, including PhD, MS in Agronomy, MS in Entomology, MS in Irrigation and Water Management, MS in Aquaculture, MS in Poultry Science, MS in Soil Science, Master in Sustainable Agriculture and Rural Livelihood (MSARL), Bachelor of Agricultural Education (BAgEd), Diploma in Youth Development Work (DYDW), Certificate in Livestock and Poultry (CLP), and Certificate in Pisciculture and Fish Processing (CPFP).

To support these programs, SARD has set up laboratories and research farms at the main campus of BOU, equipped with sophisticated equipment. In addition to the existing programs, the authorities are working on launching new programs, such as Bachelor of Science in Agriculture (BScAg), Bachelor in Youth Development Work (BYDW), Certificate in Poultry Management (CPM), and Certificate in Fruits and Vegetables Processing (CFVP) to create opportunities for developing skilled manpower in the fields of agriculture and youth work. All academic activities are conducted under the direct supervision of the SARD faculty. They produce students' guides/handbooks, course books, and audio-video programs to support the educational experience. Furthermore, SARD faculty members actively engage in research, with their findings published in both internationally and nationally recognized journals and proceedings. Notably, SARD publishes the Journal of Agriculture & Rural Development (JARD) twice a year in English, featuring original research articles, short communications, review articles, case studies, and book reviews in the fields of agriculture, distance education, rural development and related areas.

List of Faculty Members

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Regulations for the Master of Science (MS) Programs (Amended)

01. Short Title: The Regulations may be called 'MS Regulations' of the School of Agriculture and Rural Development (SARD), Bangladesh Open University.

02. Definitions

Unless there is anything repugnant to the subject or context in the Regulations;

I. 'University and BOU' mean Bangladesh Open University;
II. 'Vice-Chancellor' means the Vice-Chancellor of Bangladesh Open University, appointed under the Section 12 of BOU Act 1992 and BOU (amended) Act, 2009.
III. 'School' and/or 'SARD' mean(s) the School of Agriculture and Rural Development of Bangladesh Open University;
IV. 'Committee' means the School Committee of the School of Agriculture and Rural Development, BOU constituted under the Section 4 of the First Statutes of BOU;
V. 'The Program' and/or 'MS Program' means the Master of Science (MS) Program in different fields of agricultural sciences of the School of Agriculture and Rural Development, BOU;
VI. 'Credit' means equivalent text of 15 (fifteen) hours' lectures along with equivalent activities of 15 (fifteen) study hours;
VII. 'Course' means the courses of the MS Program of the School of Agriculture and Rural Development, BOU;
VIII. 'Academic Council' means the Academic Council constituted under the Section 22 of BOU Act, 1992 and BOU (amended) Act, 2009.
IX. 'Board' means the Board of Governors constituted under the Section 19 of the BOU Act, 1992 and BOU (amended) Act, 2009.
X. 'RCs' and 'SRCs' mean the Regional Centre's and Sub Regional Centre's, respectively established by the Bangladesh Open University;
XI. 'Curriculum Committee' means the Curriculum Committee of the MS Program constituted under the Section 24 of BOU Act 1992 and BOU (amended) Act, 2009.
XII. A 'Student' means a person enrolled into the MS Program of the School of Agriculture and Rural Development, BOU;
XIII. An 'Applicant' means a person applied for getting admission into the MS Program in pursuance of the circular of the School in this regard;
XIV. A 'Candidate' means a student entitled to appear at the semester-end examinations of the MS Program.
XV. A 'Semester' means a period of six months commencing on the first days of every January and July of the calendar year.
XVI. A 'CA' means 'Course Assignment' to be used as a part of the evaluation procedure;
XVII. A 'Student Guide' means a booklet containing regulations to be followed/abide by students during the study period;
XVIII. A 'Tutor/Counselor/Course Teacher' means a person who will guide/counsel/teach the student(s) a particular course.
XIX. A 'Course Co-ordinator' means a person who will co-ordinate the particular subject/discipline.

03. Name of the Program

The name of the Program shall be the Master of Science (MS) in Agricultural Sciences.

04. Code of the Program

The code of the MS Program as follows:

Name of MS Program	Program Code
Master of Science in Agronomy	45
Master of Science in Entomology	47
Master of Science in Irrigation and Water Management	48
Master of Science in Aquaculture	49
Master of Science in Poultry Science	82
Master of Science in Soil Science	83

05. Aims and Objectives of the Program

The main objective of the MS Program to be offered by the School of Agriculture and Rural Development through open and distance mode, is to produce more skilled manpower for the agriculture sector in the greater interest of the country.

06. The Number of Courses and Credit Hours of the Program

The number of courses and credit hours of the MS Program in any field of agricultural sciences will be as follows:

Number of semesters	:	03 (Three)
Number of courses	:	12 (Twelve)
Number of credits per course	:	02 (Two)
Thesis	:	12 (Twelve) Credits
Thesis Defense	:	04 (Four) Credits
Total Program credits	:	(12×2)+12+04 = 40 (Forty)

Note: Each of the first two semesters will carry 12 credits. Another 16 credits shall be earmarked for the research, thesis and thesis defense to be carried out in the 3rd semester.

07. Language of the Program

The medium of instruction of the Program shall be English.

08. Academic Year and Semesters of the Program

The academic year of the Program shall be started from January and shall be ended in December of each calendar year and each academic year shall be divided into two semesters as January–June and July–December ones.

09. Application Procedure for the Admission into the Program

A candidate shall apply for getting admission into the Program in the prescribed form which may be collected from the respective RC or SRC or BOU website and shall submit the duly filled-in application form with necessary papers to the Dean of the SARD within the stipulated period of time.

10. Requirements to apply for the Admission into the Program

Applications will be invited twice in an academic year from the office of the Dean, SARD, BOU to enroll students into the MS Program through open competition. Applicants having minimum 4 (four) yearlong Bachelor degree in any discipline of agricultural sciences (i.e. BSc Ag/ BSc AgrilEngg /BSc Fisheries/ DVM/ BSc AH/ BSc

VetSc and AH/ BSc Food Engg/ BSc Agril Econ) or equivalent degrees from any recognized university shall be eligible to apply for the admission into the Program.

11. Selection Procedure for Admission into the Program

The Selection of students for admission into the Program shall be done on a competitive basis by assessing academic records and score of interview to be held in connection with the admission into the Program. Activities, formalities and functions relating to the selection of candidates for admission into the Program shall be determined by the respective Admission Committee.

12. Enrollment of Students into the Program

Applicants selected for admission in any semester shall be eligible for getting admission into the MS Program only in that particular semester.

13. Admission Committee

There shall be an 'Admission Committee' consisting of 10 (ten) members (Maximum) including at least one member from each of the advertised subject/discipline headed by a professor proposed by the school committee. The Vice-Chancellor shall approve the Committee for the semester concerned.

In the process of admission, if any problem of determining equivalence of a certificate arises, the Admission Committee shall send the respective certificate(s) to the Equivalence Committee of the University. The Equivalence Committee will determine equivalence of the certificate(s).

14. Registration

(i) A student shall require completing the registration formalities only for the courses s/he will take in the relevant semester.

(ii) The registration of a student shall remain valid for a period of four and a half years (i.e., consecutive nine semesters) since the admission into the Program, if s/he is not subject to:

- cancellation or suspension of registration, or
- discontinuation, or
- expulsion for adopting unfair means

Cancellation of Registration

In the event of any misconduct or breach of any of the provisions of the Regulations, the University Authority may take necessary disciplinary action against the student concerned and may cancel his/her registration.

15. Student Identification Number

Each enrolled student shall be given a specific Student Identification (SID) number at the time of getting admission into the Program. The student must use complete SID number for all purposes like CAs, examination, communication with the BOU and so on. The SID number shall have to be mentioned on the ID card of the student and on the Registration Card. The SID number along with the name of the student enrolled and registered in a semester must be sent by the respective RC to the School, Examination Division, Student Support Services Division and the respective course Coordinator

within 15 (fifteen) days after the last date of admission. Registration cards shall also be sent to the Examination Division by the respective RC within the same period of time.

If the ID card is lost, the student concerned shall require to make a GD entry in the nearest Police Station and to inform the matter to the relevant RRC within fifteen days of the incident.

16. Academic and Research Facilities

BOU shall create its own academic and research facilities for the MS in Agricultural Sciences Programs. There shall be provisions also for providing academic and research facilities partly or fully in other relevant universities/research organizations through official arrangements (MOU).

17. Appointment of Course Co-ordinator(s) and Tutors/Counselors/Course Teachers

Course co-ordinator(s) for the respective department/discipline of the Program as proposed by the SARD and Tutors/Counselors/Course Teachers for different courses of the respective department/discipline of the Program as proposed by the course co-ordinator shall be processed through the SSS Division of BOU and recommended by the School for the approval of the Vice-Chancellor. Course co-ordinator and Tutors/Counselors/Course Teachers shall normally be appointed for the period of tutorial sessions of each semester.

18. Committee of Supervisor

The research Program of every student shall be supervised by a supervisor and a co-supervisor. A panel of supervisor and co-supervisor shall be proposed by the course coordinator of the respective subject/discipline which shall be recommended by the School Committee for the approval of the Vice-Chancellor.

19. Examination Committee

i. There shall be an Examination Committee for relevant courses in each semester of the MS Program. The Examination Committee headed by a Chairman, not below the rank of an Associate Professor, shall consist of 3 (three) members including an external member to be appointed from outside the BOU. The School Committee shall propose the composition of the Examination Committee for the approval of the Academic Council.

ii. The Examination Committee shall propose the schedule of the examination and send it to the Controller of Examinations for necessary action at least four (4) weeks before the date of examination.

iii. The Examination Committee shall propose the name of two question setters and also examiners for each course from the panel of question setters and examiners recommended by the Curriculum Committee and approved by the Academic Council. The Chairman of the Examination Committee shall send the list of question setters and examiners to the Controller of Examinations at least eight (8) weeks before the respective semester-end examination starts.

iv. The Controller of Examinations shall send the appointment letters along with necessary documents like syllabus, question structure, previous year's question, prescribed question setting papers, inner and outer envelopes etc., to the question setters within ten (10) days from the date of receiving the list of question setters from

the Chairman of Examination Committee. The question setter shall be given two (2) weeks' time for the preparation of the question.

v. The Chairman of the respective Examination Committee shall receive the questions from the question setters and shall fix the date of moderation.

vi. Moderated questions shall be sent to the Controller of Examinations by the Chairman of the Examination Committee at least three (3) weeks before beginning of the examination. The Controller shall send the question papers along with the examination scripts and other necessary documents to the respective examination centers at least 48 hours before the holding of the examination.

vii. On completion of the examination of each course, the centre chief appointed by BOU shall send the answer scripts to the controller of examinations. On receipt the answer scripts the controller of examinations shall take necessary steps to distribute them among the respective script examiners along with necessary papers within one week of the receipt of the answer scripts concerned. The examiners shall send the marks sheets and examined scripts to the controller of examinations within stipulated time.

viii. The Controller of Examinations, on receipt all the mark-sheets, shall take necessary action for tabulation and send the tabulated mark sheets to the Chairman of the Examination Committee for verification as soon as possible. The Controller of Examinations shall take necessary steps for the finalization and publication of the result within 15 (fifteen) days after receiving the final mark sheets. The Chairman of the Examination Committee shall preserve a copy of the tabulated marks sheet.

20. Distribution of Marks

a) Distribution of Marks of 3 semesters are as follows

Semester	No of courses/thesis/thesis defense	Total Marks
1st	6	6 × 100 = 600
2nd	6	6 × 100 = 600
3rd	Thesis	600
	Thesis Defense	200
Total		2000

(b) Distribution of Marks of a Course

Each course shall be evaluated within 100 (hundred) marks. The breakup of the marks shall be as follows:

Assignment/Examination	Details	Total Marks
Course assignment	1 per course	1 × 10 = 10
Class attendance	All classes	10
Semester-end examination		= 80

Total	100

Pass marks shall be 40% in each course.

21. Evaluation:

(a) Course Assignment Evaluation: Course assignment shall be evaluated by the respective course tutor/counselor/course teacher.

(b) Script Evaluation of Semester-end Examination: Two examiners shall evaluate the scripts of each course of the semester-end examination. Two examiners to be recommended by the Examination Committee and approved by the Vice-Chancellor shall tabulate the result of the semester end examination. Average of marks given by two examiners shall be the marks of the 'semester-end examination' for each paper. If the variation of marks given by two examiners is more than 20% for any course, a third examiner shall be appointed by the Examination Committee from the list of examiners approved by the Vice Chancellor. S/he will evaluate that script and the average of the three marks shall be the marks of the 'semester-end examination' for the paper concerned. Total marks in each course including assignment shall be rounded up.

(c) Thesis Evaluation: Each thesis shall be evaluated by two examiners. Average of marks given by two examiners shall be the marks for the respective thesis. If the variation of marks given by two examiners is more than 20% for any thesis, a third examiner shall be appointed by the Examination Committee from the list of examiners approved by the Vice Chancellor. S/he will evaluate that thesis and the average of the three marks shall be the marks for the thesis concerned.

(d) Conduct of Research Work: A student enrolled in MS Program of SARD shall take steps to perform a research Program under a recognized research supervisor with a view to preparing a thesis. The research work may be started after enrollment in MS Program in consultation with the concerned research supervisor. The research work and preparation of thesis must be completed within the specific period of time for completion of the degree.

22. Course Assignment (CA)

Student shall submit one assignment for every registered course assigned by the course teacher/tutor during the respective semester within the specified date. If any student fails to submit CA in any course in due time, will be declared fail in that respective course.

23. Class Attendance

Students shall get proportionate marks based on attendance in the classes.

24. Semester-end Examination

(i) There shall be a semester-end examination to be conducted at centre(s) organized by the BOU authority as proposed by the School Committee of SARD. Duration of the examination of each course shall be of three (3) hours. At the end of each semester, students shall be required to appear at the semester-end final examination only for the courses offered in that semester.

(ii) Regular students shall not require to submit the 'examination registration form' to sit for the semester-end examination for the courses registered in the current semester. In order to sit for the semester-end examination for any course registered in the previous

semester, students shall fill up the examination registration form and submit to the respective RRC within the time specified by the school. An examinee must collect the Admit Card from the RRC concerned to appear at the semester-end examination.

25. Criteria of Supervisor/Co-Supervisor

Any tutor or faculty member of the SARD, BOU or any other teacher/researcher of a recognized university or research institute having at least three years teaching/research experiences and at least 2 publications in reputed journal (s) shall be eligible to act as a Supervisor/Co- supervisor of a student of the MS Program.

26. Criteria of Tutor/Counselor/Course Teacher

Any teacher/scientist having at least an MS degree in the relevant discipline from any recognized organization and/or university shall be eligible to act as a tutor/Counselor/Course teacher.

27. Thesis Defense Committee

A student who has already appeared at the 1st and 2nd semester-end examination and completed 12 courses of the Program shall be eligible for thesis defense (3rd semester). The thesis presentation and defense examination shall be conducted by a separate Examination Committee consisted of 3 (three) members including the Dean/Head/Course Co-ordinator of the respective department/discipline of SARD and at least two subject specialists recommended by the school committee and approved by the Academic Council.

28. Conversion of Marks into Grade Point

(i) For every completed course, the marks obtained by a student in respective CA and semester-end examination will be totaled and this total marks will be converted into Grade Point (GP) as per the following table:

Range of Marks	Letter Grade	Grade Point
80% or above	A^+ (A plus)	4.00
75% to less than 80%	A (A regular)	3.75
70% to less than 75%	A□ (A minus)	3.50
65% to less than 70%	B^+ (B plus)	3.25
60% to less than 65%	B (B regular)	3.00
55% to less than 60%	B□ (B minus)	2.75
50% to less than 55%	C^+ (C plus)	2.50
45% to less than 50%	C (C regular)	2.25
40% to less than 45%	C^- (C minus)	2.00
<40%	F (Fail)	0.00

(ii) A Student shall get individual GP for every completed course. In case of the completion of a number of courses, the 'Grade Point Average' (GPA) of those completed courses shall be calculated by using the following formula where the individual GP for every course and the respective credit of those courses will be taken into consideration:

Formula to Calculate CGPA

Upon successful completion of the Program requirements, Cumulative Grade Point Average (CGPA) of a student shall be calculated by using the following formula.

$$\text{CGPA} = \frac{\Sigma(\text{credit} \times \text{grade point})}{\text{Total Credit of the program}}$$

29. Requirements for obtaining the MS degree

Following are the requirements for obtaining the MS degree:

- Successful completion of 40 credit hours.
- Obtaining a minimum grade of C^- in each course.
- Secure a minimum 'Cumulative Grade Point Average' (CGPA) of 2.00.

30. Redo Examination

A student who will obtain grade C or C^- in any course may re-appear at the semester-end examination for that course in the next semesters to improve his/her grading in the Program. Appearance for redo examination requires additional payment of specified redo fees during the specified period of pre-registration for examination.

31. Obtaining 'F' grade in a course

A student failed to appear at the final examination for any of the courses in the current semester shall be assigned F (Failed) grade in that course. Such a student have to redo the course, subject to the payment of specified redo fees, within the next semesters where s/he can appear at the semester-end examination for that courses.

32. Retake a course

In the event of any retaken course, a student shall pay again the full fee for the re-registration of the course. Since passing of all courses individually is required for obtaining the degree, a student with 'F' grade in a course, must retake that course when that course will be offered in the subsequent semester. A course may be retaken only once. In case of a retake, a student shall require to submit assignments of the registration semester as required for the course retaken.

33. DE-NOVO Registration

If any student completed 50% course of the program within the stipulated period of four and a half years, s/he shall be given chance of de-novo registration for five years. He shall have to apply to the School for DE-NOVO registration after the expiry of the said registration duration. Under DE-NOVO registration, extended for a further period of five years, an applicant shall get admission as a new student and such student will be allowed exemption from the courses he/she has already successfully completed.

34. Activities to be Considered as Adoption of Unfair means by a Student

The following activities will be considered as adoption of unfair means:

i. copying from other students' assignment/script/paper/thesis.
ii. copying from writing on the desk or hand palm or from other incriminating documents;

iii. possession of any incriminating document whether used or not; and
iv. unruly behavior or misbehaviour with the invigilator(s) and/or teacher or course tutor.

Adoptions of unfair means may result in the punishment of the student as per the Disciplinary Rules of the BOU.

35. Modification of the Regulations

The School Committee shall have the power to propose any addition, alteration, change, modification, in the Regulations for the approval of the Academic Council.

Any matter, regarding the MS Program, not covered by this regulation the Vice-Chancellor shall have the power to resolve the matter in consultation with the relevant Examination Committee of the MS Program.

The regulation shall come into force immediately after the day on which it is ratified by the Board of Governors.

School of Agriculture and Rural Development
Bangladesh Open University

Master of Science (MS) in Agronomy

1. Requirement for registration: Bachelor of Science in Agriculture (BSc Ag) or related disciplines from any recognized University or Institute
2. Duration: One and a half ($1\frac{1}{2}$) years (Registration valid for consecutive four and a half years)
3. Semester: Three Semesters (Valid up to consecutive nine semesters), two semesters in a year each of six (6) months
4. No. of courses = 12
5. No. of credits = 40
6. Total Marks = 2000

Distribution of courses, credits and marks

M.S. in Agronomy shall be offered with 40 credits in 3 semesters each of six months duration. The courses worth 24 credits of which 12 credits shall be offered during the first semester and the other 12 credits during the 2nd semester respectively for the students. Another 16 credits shall be reserved for the research (thesis and thesis defense). The students have to start their research work for thesis (equivalent to 6 courses) under the guidance and supervision of his/her Research Supervisors after the completion of one semester and the same shall be carried through to the last semester when it will be evaluated. After the evaluation of thesis the students have to face thesis defense (equivalent to 2 courses). The distribution of courses, credits and marks are shown below:

Course Type		No. of Courses	Credits	Marks
Course (compulsory)		12	24	1200
Research	a) Thesis	equivalent to 6 courses	12	600
	b) Thesis defense	equivalent to 2 courses	4	200
Total			**40**	**2000**

N.B. 1 course = 2 credits = 100 marks; Thesis =12 credits = 600 marks, Thesis defense (4 credits) = 200 marks: Each course will carry 80 marks for theoretical examination and 10 marks for one course assignment and 10 marks for class attendance.

Course layout for MS in Agronomy

1st Semester

Sl.	Courses Title	Course code	Credit Hours	Marks
1	Advanced Production Technology of Field Crops	MSAGN 1201	2	100
2	Crop Yield Processes	MSAGN 1202	2	100
3	Seed Technology	MSAGN 1203	2	100
4	Weed Science	MSAGN 1204	2	100
5	Soil Fertility Management in Crop Production	MSAGN 1205	2	100
6	Water Management in Crop Production	MSAGN 1206	2	100
	Total 6 courses		**12**	**600**

2nd Semester

Sl.	Courses Title	Course code	Credit Hours	Marks
1	Crop Production in Changing Environment	MSAGN 2201	2	100
2	Framing Systems	MSAGN 2202	2	100
3	Agronomic Research Methodology	MSAGN 2203	2	100
4	Field Crop Agroforestry	MSAGN 2204	2	100
5	Fodder and Pasture Management	MSAGN 2205	2	100
6	Postharvest Technology of Field Crops	MSAGN 2206	2	100
	Total 6 courses		**12**	**600**

3rd Semester

Sl.	Courses Title	Course code	Credit Hours	Marks
1	Thesis	MSAGN 3121	12	600
2	Thesis defense	MSAGN 3042	4	200
	Thesis + Thesis defense		16	800
	Grand Total	**(12×2) +16 = 40 (Forty)**		**2000**

Syllabus for MS in Agronomy

Course Title: **Advanced Production Technology of Field Crops**
Course Code: **MSAGN 1201** **Credit Hrs:** **2**

Unit	Title	Lesson
1	Yield and Quality of Crops	Yield and yield components, Concept of yield improvement, Agronomic management for improvement of yield and quality of crops Introduction and selection as a mean of crop improvement
2	Production Technology of Field Crops (Importance, origin, distribution, climatic & edaphic requirements, cultivation technology)	Cereal crops: rice, wheat, maize, Millets: cheena, kaon, Fibre crops: jute, cotton, Sugar crops: sugarcane, sugar beet; Beverage crops: tea, coffee; Pulse crops: lentil, grass pea, mung bean, black gram, chickpea, pea Oilseed crops: mustard, sesame, groundnut, sunflower, soybean, linseed

Recommended Textbooks

1. Pia, M. Deia, J. and Rai, R.KI. 1996. Fundamentals of Cereal crop Production. Tata McGraw-Hill Publishing Company Limited, New Delhi.
2. Martin, J.H. Waldren, R.P. and Stamp, D.L. 2006. Principles of Field Crop Production 4th Ed. The McMillan Co., NewYork.
3. Reddy, S.R. 2004 Principles of Crop Production. 2nd Ed. Kalyani Publishers New Delhi.

Supplementary Textbooks

4. Leonard, W.H. and Martin, J.H. 1963. Cereal Crops. McMillan Pub. Co. Inc. New York.
5. Singh, C; Singh P. and Singh, R. 2003. Modern Techniques of Raising Field Crops, Oxford & IBH Publishing Co., New Delhi.
6. Gowda, C.L.L. and Kaul, A.K. 1982. Pulses in Bangladesh. BARI and FAO.
7. Maiti, S., Hedge,M.R. and Chhattopadhyay, S.B. 1988. Handbook of Annual Oil Seed Crops. Oxford & IBH Publishing Co., New Delhi.
8. Ninan, K.N. 1989. Edible Oilseeds. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.
9. Rathore, P.S. 1999-2000. Techniques and Management of Field Crop Production. Agrobios (India), Jodhpur.
10. Reddy, S.R. 2004. Agronomy of Field Crops. Kalyani Publishers, New Delhi.
11. Maiti, S. Hedge,M.R. and Chhattopadhyay, S.B. 1988. Handbook of Annual Oilseed Crops. Oxford & IBH Publishing Co. New Delhi.

Course Title: Crop Yield Processes
Course code: MSAGN 1202 **Credit Hrs:** 2

Unit	Title	Lesson
1	Concept of Yield	Growth and yield analysis, yield components, biological yields, economic yield and harvest index
2	Plant Characteristics in Relation to Yielding Ability	Plant heights, leaf characteristics, stem characteristics, canopy architecture and photosynthetic machinery
3	Production of Dry Matter	Root growth, shoot growth, leaf area index, source and sink, nitrogen and carbon assimilation, Photosynthetic rate and efficiency and respiratory losses
4	Partitioning of Dry Matter	Assimilate distribution within the plant and partitioning of dry matter between grain and non-grain parts
5	Crop Growth and Yield Capacity	Growth phases and stages, crop growth rate, determination of yield capacity, reproductive development and development of yield components
6	Effect of Growth Factors on Growth and Yield	Light, water, temperature, humidity, nutrients, growth regulators, cultivar, site and season
7	Seed/Grain Filling	Seed/grain growth, linear and exponential phases, sources of assimilates in the grain, contribution of different plant parts to grain filling, current photosynthesis, stored carbohydrates, green area duration, rate and duration of grain filling

Recommended Textbooks

1. American Society of Agronomy. 1976. Advances in Agronomy. Vol. 28. Academic Press, New York.
2. Charles-Edwards, D.A. 1987. Physiological determinants of crop growth. Academic Press. New York, London.
3. Estin, J.D. Parkins, F.A. Sullivan, C.Y. and Bavel, C.H.M. Van. 1969. Physiological Aspects of Crop Yield. ASA and CSSA.

Supplementary Textbooks

4. Evans, L.T. and Peacock, W.J. 1981. Wheat Science- Today and Tomorrow. Cambridge University Press, Cambridge.
5. Hawkins, A.F. and Jeffcoat, B. 1982. Opportunities for Manipulation of Cereals Productivity. British Plant Growth Regulators Group, Wantage.
6. Hard, R.G. Biscoe, P.V. and Dennis, C. 1980. Opportunities for increasing crop yields. Pitman, London.

Course Title: Seed Technology
Course Code: MSAGN 1203 **Credit Hrs:** 2

Unit	Title	Lesson
1	Introduction of Seed Technology	Concept of seed, Importance of seed in agriculture, Concept of seed technology, present status of seed research in Bangladesh
2	Principles and Methods of Quality Seed Production	Concept of quality seed, principles of seed production, factors influencing during seed production, processing and storage, distribution and marketing of quality seeds in Bangladesh
3	Varietal Development	Plant breeding system (including OP + Hybrid + recomb.); definition of a variety, importance of varietal development and variety; variety evaluation-DUS; variety release, registration maintenance, breeder seed production
4	Seed Multiplication	Factors influencing seed multiplication; techniques of seed multiplication
5	Seed Processing	Drying, cleaning, preservation, seed treatment, seed packaging
6	Quality Control and Certification of Seed	National seed policy, role of national seed board (NSB), concept and objectives of seed certification, procedure of seed certification, seed certification agency(SCA), seed quarantine in Bangladesh

Recommended Textbooks

1. Agarwal, R.L.1991. Seed Technology, Oxford & IBH Publishing Co. Delhi
2. Agarwal, P.K. 1999. Seed Technology, ICAR, New Delhi.
3. Copeland, L.O. 1976. Principles of Seed Science and Technology. Burgas Pub. Co. USA.

Supplementary Textbooks

4. Rhomson, H.C. and Kelley, W.C. 1957. Vegetable Crops. McGraw-Hill Book Co. Inc., New York. Toronto, London.
5. Thomson, J.R. 1979. An Introduction to Seed Technology, Leonard Hill Pub.
6. Kent, N.L. 1976. Technology of Cereals. Pergamon Press Ltd. Oxford, London.
7. Nema, N.P. 1989. Principles of Seed Certification and Testing. Allied Pub. Ltd. Ahmedabad, Bangalore, Bombay, Calcutta.
8. SCA and BARC. 1987. Proceedings of National Seed Technology, Workshop, January 27-28, 1985.
9. Subir Sen and Nabinanda Ghosh.1999. Seed Science and Technology, Kalyani Publishers. New Delhi.
10. Dhirenra Khare and Mohan S. Bhale.2000. Seed Technology. Scientific Publishers (India), Jodhpur.
11. A.K. Joshi and B.D. Singh.2005. Seed Technology. Kalyani Publishers, New Delhi.

Course Title: **Weed Science**

Course Code: **MSAGN 1204** **Credit Hrs:** **2**

Part 1: Weed Management

Unit	Title	Lesson
1	Concept and Approach of Weed Management	Evolution of weed control methods, concept of prevention, control and eradication of weed, complementary relationships between prevention and control, concept of integrated weed management
2	Crop Production Practices in Weed Management	Impact of time of land preparation, number and depth of ploughing, puddling, planting method, seeding rate, plant spacing, age of seedling soil moisture regime, soil fertility management, crop rotation and cropping pattern in weed management
3	Herbicide in Weed Management	Application of herbicides in weed management, herbicide selectivity, absorption, movement and translocation of herbicides in plant, fate of herbicide in plants and soil
4	Allelopathy in Weed Management	Concept of allelopathy and its historical background, significance of allelopathy in weed-crop ecology, allopathic weeds and crops, potential of allelopathy in weed management
5	Weed Management in Major Crops in Bangladesh	Present status and future strategy of weed management in rice, jute, wheat, sugarcane, pulses, mustard and tea

Part 2: Weed Biology and Ecology

Unit	Title	Lesson
6	Crop-Weed Completion	Concept, mechanism, measurement and elements of crop-weed competition, factors affecting crop-weed completion, critical period of weed crop completion, competitive ability of crops and weeds and factors affecting it.
7	Survival Mechanism of Weed	Reproduction of weed by means of seed and vegetative part, factors affecting weed seed production, germination of weed seed and factors affecting it, periodicity of weed seed germination, dormancy of weed seeds, dynamics of a soil seed bank and factors affecting the longevity of weed seed.
8	Biology of Weeds	*Cyperus rotundus, Echinochloa crusgalli, Echinochola colonum, Cyperus iria, Eichhornia crasipes and Striga densiflora.*

Recommended Textbooks

1. Aldlrich, R.J. and Kramer, R.J. 1997. Principles in Weed Management. Panama Pub, New Delhi.
2. Aldrich, R.J. 1984. Weed-crop Ecology. In: Principles in Weed Management. Bretion Publishers, Wardsworth Inc. Belment, California.
3. Naylor, R.E.L. 2002. Weed Management, Principles and Practices. Blackwell Science, UK.
4. Tanveer, A. 2008. Biology and Ecology of Weed. HEC, Pakistan.
5. Ziska, L.H. and J. S. Duke. 2011. Weed Biology and Climate Change. Willey Backward.

Supplementary Textbooks

6. Allieri, M.A. and Liebman, M. 1988. Weed Management in Agroecosystems: Ecological Approaches. CRC Press, Inc. Boca Raton, Florida
7. Ashton, P.M. and Crafts, A.S. 1981. Mode of action of herbicides, 2nd Edition. Wiley-Inter Science.
8. Gupta, O.P. 2000. Weed Management - Principles and Practices. Agrobios, India Pub.
9. Huddus, L.J. 1976. Herbicides. Vol. I and II, Academic Press, London, New York, Sanfrancisco.
10. Mandal, R.C. 1990. Weed, Weedicides and Weed Control- Principles and Practices. Agro-Botanical Pub, Bikaner.
11. Rao, VS. 2000. Principles of Weed Science. Oxford and IBH. Pub., New Delhi.
12. Subramanian, S. Ali, A.M. and Kumar, R.J. 1997. All About Weed Control, Kalyani Pub. New Delhi.
13. Walia, U.S. 2003. Weed Management. Kalyani Publishers, New Delhi – 110 002.
14. Zimdahl, R. 2013. Fundamentals of Weed Science 4th Edition. Academic Press. New York.

Course Title: **Soil Fertility Management in Crop Production**

Course Code: **MSAGN 1205** **Credit Hrs:** **2**

Unit	Title	Lesson
1	Soil Fertility Management	Maintenance and improvement of soil fertility in different agro-ecological zones of Bangladesh
2	Organic Matter and Manures	Organic matter as a means of soil amendment, maintenance of soil organic matter through crops and cropping
3	Fertilizer Management	Characteristics of different kinds of fertilizers, preparation of different grades of mixed fertilizers for crops and soils, nutrient recycling in soil by natural and artificial means, maximization of crop production through efficient use of fertilizers, factors affecting efficient fertilizer management, management of fertilizer efficiency under wet land, upland and irrigated conditions, fertilizer management in relation

		to development of crops at different environmental stimuli
4	Bio-fertilizers	Roles in crop production and maintenance of soil fertility and method of application, effects on soil, crops and environment
5	Micronutrients	Role of micronutrients in the maintenance of soil productivity, crop yield and quality; economy of crop production through micronutrient fertilization in Bangladesh

Recommended Textbooks

1. Alexander, M. 1968. Fertilizers and Fertilizing. McGraw Hill Book Co. Ltd. N.Y (USA).
2. Mengel, K., Kirby, E.A. 1987. Principles of Plant Nutrition. 4th Ed. International Potash Institute, Berne.
3. Russel, E.W. 1960. Soil Condition and Plant Growth. Oxford Univ. Press, London.
4. Tisdale, S.L. and Nelson, W.L. 1990. Soil Fertility and fertilizers, McMillan Pub. Co. N.Y.

Supplementary Textbooks

5. Davis, R.T. 1984. Potentials and Limitations of Biological Nitrogen Fixation. Proc. Int. Sym. BARC. Dhaka.
6. IRRI. 1967. Mineral Nutrients of rice. Los Banos, Laguna, Philippines.
7. Katyal, J.C. and Randhawa, N.S. 1983. Micronutrients., FAO Fertilizer and Plant Nutrition Bulletin No. 7, Rome.
8. Tandon, H.L.S. 1991. Secondary and Micronutrients in Agriculture. F.D.C.O. New Delhi 110048, India.
9. Tandon, H.L.S. 1992. Fertilizers, Organic manures. Recyclable Wastes and Biofertilizers. G.D.C.O. Bhanet Bhavan,
10. New Delhi 10048, India.
11. Venkataraman, G.S. 1981. Blue-green algae for rice production a manual for its promotion. FAO Soils Bull., 46, 102.
12. Brady, N.C. and Weil, R.R. 2002. The Nature and Properties of Soils. 13th Ed. Pearson Edu.
13. Fageria, N.K. Baligar, V.C. and Jones, C.A. 1991. Growth and Mineral Nutrition of Field Crops. Marcel Dekker.
14. Havlin, J.L. Beaton, J.D. Tisdale, S.L. and Nelson, W.L. 2006. Soil Fertility and Fertilizers. 7th Ed. Prentice Hall.
15. Prasad, R. and Power, J.F. 1997. Soil Fertility Management for Sustainable Agriculture. CRC Press.
16. Yawalkar, K.S. Agrawal, J.P. and Bokde, S. 2000. Manures and Fertilizers. Agri-Horti Publ.

Course Title: **Water Management in Crop Production**
Course Code: **MSAGN 1206** **Credit Hrs: 2**

Unit	Title	Lesson
1	Soil Moisture	Sources, relation and movement, soil-plant-water relationship, measurement of soil moisture.
2	Water Management	Water management of crops in different ecosystems, dry land, rainfed and irrigated farming.
3	Water Resources	Water availability, quality and uses, agronomic management for efficient water use in drought and flooded conditions
4	Water Requirement of Crops	Requirement and determination of water for different crops, guidelines for predicting crop water requirements.
5	Irrigation Efficiency and Scheduling	Efficiency of irrigation practices, Irrigation scheduling and water budgets for important field crops.

Recommended Textbooks

1. Brady, N.C. 1974. The nature and properties of soil. MacMillan Pub. Co. Inc. New York.
2. Singh, S.S. 1998, Crop Management: Under irrigated and rainfed conditions.
3. Panda, S.C. 2003. Principles and Practices of Water Management. Agrobios.
4. FAO. 1984. Irrigation Practice and Water Management. Oxford & IBH.

Supplementary Textbooks

5. Arakari, H.R. and Donhue, R. 1988. Principles of soil conservation and water management. Oxford and IBH Pub. Co. Pvt. Ltd. Calcutta.
6. Doorenbos, P. and Pruitt, W.O. 1977. Guidelines for producing crop water requirements. FAO Irrigation and Drainage Paper 24:144pp. UN, Rome.
7. Dov, N. and Finkel, H.J. 1982. Water requirement of crops and irrigation rates. In: Handbook of Irrigation Technology. Vol. 1 (Ed. H.J. Finkel) CRC Press. Inc. Boea Raton, Florida.
8. Prihar, S.S. and Sandhu, B.S. 1987. Irrigation of Food Crops - Principles and Practices. ICAR.
9. Mishra, R.R. and Ahmad, M. 1987. Manual on Irrigation and Agronomy. Oxford & IBH.
10. Panda, S.C. 2003. Principles and Practices of Water Management. Agrobios.
11. Sankara Reddy, G.H. and Yellamananda Reddy 1995. Efficient Use of Irrigation Water. In: Gupta US. (Ed.). Production and Improvement of Crops for Drylands. Oxford & IBH.
12. Singh, S.S. 2006. Principles and Practices of Agronomy. In: Gupta US. (Ed.). Production and Improvement of Crops for Drylands. Oxford & IBH.
13. Parihar, S.S. and Sandhu, B.S. 1978. Irrigation of Field Crops- Principles and

Practices, ICAR, New-Delhi.

Course Title: **Crop Production in Changing Environment**

Course Code: **MSAGN 2201** **Credit Hrs:** **2**

Unit	Title	Lesson
1	Deep Water Stress	Nature of deep water stress, crop response to deep water stress- characteristics of flood water, factors affecting survival, elongation of internodes and morphological change of submerged plants, development strategies,management of deep water stress, system based production technology options for flood vulnerable areas, screening of plants for drought tolerance and development of technology to reduce crop losses
2	Drought Stress	Concept, nature and causes of drought, effect of drought on growth, development and yield of crops, morphological basis of drought tolerance, screening plants for drought tolerance and development of technology to reduce crop losses
3	Temperature Stress	Nature of injury due to low and high temperature, agronomic manipulation to combat temperature stresses in crops
4	Light Stress	Nature and causes of light stress, effect of photoperiod, light intensity, cloud cover and mutual shading on nutrient uptake, growth, development and yield of crops
5	Stress due to Hailstorm, Storm and Cyclone	Occurrence, nature and extent of crop damage, agronomic means to mitigate crops losses
6	Salinity Stress	Occurrence, nature and extent of crop damage, agronomic means to mitigate crops losses

Recommended Textbooks

1. Acharya, M.S. and Gupta. A.P. 1990. Hydrological aspects of drought for stabilizing agricultural production in Rajasthan State. International Symposium on Natural Resources Management for Sustainable Agriculture. 6-10 February, New Delhi.
2. B. Venkateswarlu, Arun K. Shanker, Chitra Shanker, M. Maheswari, 2011. Crop Stress and its Management: Perspectives and Strategies. Springer Science & Business Media.
3. Evans, L.T. 1963. Environmental Control of Plant Growth. Academic Press, New York and London.
4. M. Ashraf, M. Ozturk, Habib-ur-Rehman Athar, 2008. Salinity and Water Stress: Improving Crop Efficiency. Springer Science & Business Media.
5. MohammadPessarakli, 2016. Handbook of Plant and Crop Stress, CRC Press, Taylor & Francis Publishing Group.

Supplementary Textbooks

6. Alim, M.S. 1991. Technological aspects of pre-monsoon climatic effects on agricultural production. Paper presented in the National Workshop on Risk Management in Bangladesh Agriculture, BARC, Dhaka, 24-27 August.
7. Anonymous. 1985. Agroclimate study for dry farming of Bangladesh. Gujrat Agril. Univ. Res. J. 11(1):30-34.
8. Choudhury, A.M. 1991. Use of remote sensitivity techniques in risk management in agriculture. Paper presented at the National Workshop on Risk Management in Bangladesh Agriculture, BARC, Dhaka. 24-27 August.
9. De Datta, S.K. and Banerji, B. 1972. Performance of flood resistant and deep water rice in relation to growth and yield under different cultural practices. Indian J. Agric. Sci. 12:664-670.
10. Eunus, M., Vergara, B.S., Peralta, J.A. and Ikehashi, H. 1980. Methods for screening rice seedling for drought tolerance during rapid generation advance. IRRN 5(4):10-12.
11. IRRI. 1976. Climate and Rice. Los Banos, Laguna, Philippines.
12. IRRI. 1989. Climate and Flood Security. P.O. Box 933, 1099 Manila, Philippines.
13. Platt, R.B. and Griffith, J.F. 1965. Environmental Measurement and Interpretation. Reinhold Pub. Corporation, New York.
14. R.K. Gaur, Pradeep Sharma, 2013. Approaches to Plant Stress and their Management, Springer Science & Business Media.
15. Rahman, M.S. 1991. Weather related conditions to crop production and technological support to avoid risk in agriculture. Paper presented at the National Workshop on Risk Management in Bangladesh Agriculture, BARC, Dhaka, 24-27 August.
16. Shamim, K. N. Singh, 2016. Biotic Stress Management in Rice. Apple Academic Press.
17. Zaman, S.M.H. 1986. Current Status and prospects for rainfed flood grain production in Bangladesh. BRRI, Bangladesh.

Course Title: **Farming Systems**

Course Code: **MSAGN 2202** **Credit Hrs:** **2**

Unit	Title	Lesson
1	System	Concept and properties agro ecosystem analysis, evolution of agricultural systems in Bangladesh.
2	Farming System	Concept, characteristics, resources, components and enterprises.
3	Determination of Farming System	Physical, biological, social, economic
4	Farming System Research	Concept and importance, characteristics, interdisciplinary

5	Farming System Research Methodology	Methodologies followed in national and international organization, methods of data collection-rapid rural appraisal, system identification, survey case study and monitoring.
6	Cropping Systems Research	Pattern, trail, component technology trails-research's manage, superimposed.

Recommended Textbooks

1. Beels, C.W. 1983. Multiple Cropping and Tropical Farming Systems. West view Press.
2. Edwards, 1990. Sustainable Agricultural Systems. CRC Press.

Supplementary Textbooks

3. Association for Farming Systems Research/Extension. 1992. Towards New, Paradigm for Farming Systems Research/Extension. Michigan State University, USA.
4. BARC, BARI and IRRI. 1990. Proc. Int. Crop-Animal Farming Systems Research, Dhaka. ARFSN, IRRI, Los Banos, Laguna, Philippines.
5. Canway, G.R. and Pretty, J.N. 1991. Pollution and Farming Systems. J. Asian Farm. Syst. Assoc. 1(2): 29-63.
6. Chambers, R., A. Paccoy and L.A. Thrupp. 1989. Farmer First (Farmer Innovation and Agricultural Research). Intermediate Technology Publications, London, UK.
7. Chowdhury, M.K., M.A. Razzaque, A.B.M.M. Alam, R.D. William, E.H. Giblert and R.N. Mallick. 1993. Methodological Guidelines for Farming Systems Research and Development in Bangladesh. BARC, Dhaka, Bangladesh.
8. Conway, G.R. 1985. Agroecosystem Analysis. Agricultural Administration. 20:31-55.
9. GTI (Graduate Training Institute). 1993. Farming Systems Research – A Training Manual.
   GTI, Bangladesh Agricultural University, Mymensingh.
10. Hans Ruthenberg, 1971. Farming System in the Tropics .Clasendon Press, Oxford
11. Rattan Lal, B.A. Stewart, 2013. Principles of Sustainable Soil Management in Agroecosystems. CRC Press.

Course Title: Agronomic Research Methodology

Course Code: MSAGN 2203 **Credit Hrs: 2**

Unit	Title	Lesson
1	Developing Concept of Research	Concept of research, development of hypothesis, collection of facts for testing hypothesis through experimentation
2	Agronomic Research in Bangladesh	Graphical development of agronomic research in Bangladesh, its present status

		and future strategies
3	Steps in Experimentation	Identification of research problems, experimentation for testing hypothesis, experimental designs, determination of treatments and fixation of replications for simple and factorial experiments, factors determining selection of experimental design, experimental layout, shape and size of plots, procedure of carrying out field and laboratory experiments
4	Collection and Analysis of Data	Collection, tabulation and analysis of data, interpretation of the results in light of the hypothesis
5	Reporting of Results	Principles and procedure of writing scientific reports

Recommended Textbooks

1. Ahmed, A.R., Bhuiya, M.A.A. and Hossain, M.Z. 2003. Experimental Design: Theory and Application. Rokeya Sultana Mili, Mohammadpur, Dhaka, Bangladesh.
2. Alan G. Clewer and David H. Scarisbrick, 2001. Practical Statistics and Experimental Design for Plant and Crop Science. John Wiley and Sons, Ltd. Chichester, England.
3. Gomez, K.A. and Gomez, A.A. 1984. Statistical Procedures for Agricultural Research. 2nd Edition, John Wiley & Sons. New York, Brisbane, Toronto, Singapore.

Supplementary Textbooks

4. Ahmed, A.R., Bhuiya, M.A.A., Reza, Z.A. and Hossain, M.Z. 2004. Methods of Statistics. S. Ahmed & Associates. Manikganj, Bangladesh.
5. Booth, V. 1993. Communicating in Science: writing a scientific paper and speaking at scientific meetings (2nded). Cambridge. Cambridge Univ. Press.
6. Cox, D.R. and Reid, N. 2000. The Theory of the Design of Experiments. Chapman & Hall/CRC. Boca Raton. London. New York, Washington, D.C.
7. Hamp-Lyons, L. and B. Heasley. 1987. Organizing texts: structuring texts. Study Writing. Cambridge Univ. Press.
8. Islam, M.T., Mirza, M.J.A. and Hossain, M.A. (eds.). 1993. Statistical Methods for Research: A Training Manual. Graduate Training Institute, Bangladesh Agricultural University, Mymensingh, Bangladesh.
9. Khalil, S K. and P. Shah, 2007. Scientific Writing and Presentation. HEC, Manaograph, Islamabad.
10. Little, T.M. and Hills, F.J. 1978. Agricultural Experimentation: Design and Analysis. John Wiley and Sons, New York, Chichester, Toronto, Singapore.
11. Mead, R. 2003. Statistical Methods in Agricultural & Experimental Biology. 3 rd Ed. Pak Book Corp. Lahore.
12. Montgomery, D.C. 2009. Design and Analysis of Experiments. 7th Edition, International Student Version, John Wiley & Sons, Inc.
13. Steel, R.D., Torrie, J.H. Dickey, T.A. 1997. Principles and Practice of Statistics: A Biomedical Approach. McGraw Hill, USA.
14. Turk, C. and J. Kirkman. 1989. Effective writing: Improving scientific, technical and

business communication (2nded). London: Chapman & Hall.
15. Woodford, F.P. (ed). 1968. Scientific writing for graduate students: a manual on the teaching of scientific writing, N.Y: The Rockefeller Univ. Press & London: McMillan & Co. Ltd.
16. Zaman, S.M.H., Rahim, K. and Howlader. 1982. Simple Lessons from Biometry. Bangladesh Rice Research Institute, Joydebpur, Dhaka, Bangladesh.

Course Title: **Field Crop Agroforestry**

Course Code: **MSAGN 2204** **Credit Hrs:** **2**

Unit	Title	Lesson
1	Concept and Potentials of Agroforestry	Definition, importance and components agroforestry system, linkage and interaction between components, agroforestry potentials in crop land
2	Agroforestry Practices in Bangladesh	Homestead agroforestry, crop land agroforestry, forest land agroforestry, khas land agroforestry
3	Nursery Management in Agroforestry	Tree establishment by seed, seedlings and cuttings, management of agroforestry nursery
4	Multipurpose Trees and Shrubs (MPT's)	Definition of MPT's, list of MPT's and their management with non-wood plants in agroforestry
5	Classification of Agroforestry	Agrosilviculture, silvopastoral and agrosiliopastoral, structural analysis based on arrangement
6	Soil and Water Management in Agroforestry	Management of soil fertility, soil erosion, conservation of soil moisture, flood control and soil water relations
7	Agroforestry Environmental Linkage	Agroforestry for environmental amelioration, agroforestry farming systems linkage

Recommended Textbooks

1. Anthony Young, 1990. Agroforestry for soil Conservation. CBA International
2. ICRAF. 1987. Professional Education in Agroforestry. Edited By Eastern Zulberti.
3. Sunil Puri and Pankaj Panwar, 2007. Agroforestry: System and Practices. New India Publication
4. The Role of Agroforestry in Soil and Water Management, 2015. Lap Lambert Academic Publishing

Supplementary Textbooks

5. Alam, M.K.,Siddique, N.A. and Das, S. 1985. Fodder Trees of Bangladesh. Bangladesh Forest Research Institute, Chittagong, Bangladesh.
6. Alim, M.K. and Mohiuddin, M. 1992. Some Potential Multipurpose Trees for Homestead. Published by BARC and Winrock International, Dhaka, Bangladesh.
7. BARC- Winrock International. 1991. Agroforestry Research Techniques.

Bangladesh Forest Research Institute, Chittagong.
8. Dagas, J.C. Singh, A. Kumar, Arunachalam, Ayyanadar, 2014. Agroforestry Systems in India: Livelihood Security & Ecosystem Services, Springer
9. FSRDP. 1990. Searching and intervention in Two FARDP Sites. Farming Systems Research and Development Program. BAU, Mymensingh.
10. Louise E. Buck, Jemes P. Lassoie, Erick C.M. Fernandes, 1999. Agroforestry in Sustainable Agricultureal System, CRC Press, Washington USA
11. Nursery Management, Tree Propagation and Marketing. ATraining manual for small holder farmers and nursery operators. World Agroforestry Center.
12. P.K. Ramachandran Nair,1993. An Introduction to Agroforestry. International Center for Research in Agroforestry
13. Racheleau, D. Weber, F. and Juma-Fuld, A.. 1988. Agroforestry in dry land Africa. ICRAF, Nairobi, Kenya

Course Title: **Fodder and Pasture Management**

Course Code: **MSAGN 2205** **Credit Hrs:** **2**

Unit	Title	Lesson
1	forage and Pasture Science	Concept, importance, scope, development, relationship with allied disciplines
2	Forage and Pasture Species and Their Crop Husbandry	Grass species: maize, sorghum, para grass, guinea grasses, napier grasses and other local grasses Legume species: cowpea, grass pea, chickpea, sun hemp, alfalfa, *sesbania* spp.
3	Pasture Land and Pasture Production	Agro-ecosystem distribution of forage land in Bangladesh, weather influence on forage and pasture crops, feasibility of improving area and production of forage and pasture, pasture seed production, pasture establishment, grazing management
4	Pasture Plant Nutrition and Nutrient Recycling	Essential plant nutrients, nitrogen-role, cycle, fixation, legume N versus artificial N, phosphorus, potassium, sulphur, calcium, soil acidity and liming
5	Pasture Conservation	Hay: Hay in Bangladesh, stage of cutting, field cutting, artificial drying, weather, losses effects on pasture Silage: silage in Bangladesh, fermentation, readily available carbohydrate, consolidation, decomposition, additives, quality, high moisture stage, state of cutting, losses, storages, effects on pasture

Recommended Textbooks

1. Langer, R.H.M. 1973. Pasture and Pasture plants. A.H. and A.W. Read. Wellington, Sydney, London.
2. Taylor, N.L. 1985. Clover science and Technology. Madison, Wisconsin: American Society of Agronomy.

Supplementary Textbooks

3. Donald, C.M. 1963. Competition among crops and pasture plants. Advanced in Agronomy. 15:1-118.
4. Heeblethwaite, P.D. 1980. Herbage seed production in New Zealand. Loughbrough University of Nottingham, School of Agriculture.
5. Sprague, R. 1953. USDA. Yearbook of Agriculture.
6. White, J.G.H. 1989. Herbage seed Production. Wellington, New Zealand.

Course Title: **Post Harvest Technology of Field Crops**

Course Code: **MSAGN 2206** **Credit Hrs:** **2**

Unit	Title	Lesson
1	Postharvest Technology	Concept, objectives and importance, classification and steps of postharvest operations
2	Postharvest Operation Technology	Cereal crops: rice, wheat, maize, barley, sorghum and millets Oil seed crops: mustard, sesame, groundnut, sunflower, soybean, safflower, coconut, castor Pulses crops: lentil, gram, black gram, grass pea, pigeon pea, and cowpea Sugar crops: sugarcane and sugar beet Beverage crops: tea and coffee Tuber crops: potato and sweet potato Fibre crops: jute, cotton, kenaf and mesta Forage crops: para grass, napier grass, cowpea silage and hay preparation Green manure crops: dhaicha, sun hemp

Recommended Textbooks

1. Multon, J. L.; Reimbert, A. M.; Marsh, D.; Eydt, A. J. 1989 (First Ed.) Preservation and storage of grains, seeds and their by-products. Cereals, oilseeds, pulses and animal feed. CBS Publishers & Distributors.
2. Chakraverty, A.; Mujumdar, A.S.; Ramaswamy, H. S. 2003. Handbook of Postharvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices, CRC

group, Taylor and Francis group.
3. Lal, R.R. and Verma, P. 2007. Post-Harvest Management of Pulses. ICAR, Indian Institute of Pulses Research, Kanpur, India.

Supplementary Textbooks

4. Produce/Post Harvest Management, School of Science and Technology, National Open University of Nigeria, Online: www.nou.edu.ng/uploads/NOUN_OCL/pdf/pdf2/CPT514.pdf.
5. BARI, 2015. Krishi Prujukti Hatbai. Pub. Bangladesh Agricultural Research Institute, Gazipur.
6. Bakery Technology and Manufacture, By SBP board of Consultant and Engineers. Small business publications.
7. Post Harvest Processing, Sugar Processing Toolkit. FAO, USA, online: www.fao.org/3/a-au157e.pdf.
8. P.C. Das. 2012. Jute production Technology, WSIC Ebooks. Ltd.
9. John, M.M.1987. Cotton. Longman Scientific and Technical, New Delhi.

School of Agriculture and Rural Development
Bangladesh Open University

Master of Science (MS) in Entomology

1. Requirement for registration: Bachelor of Science in Agriculture (BSc Ag) or related disciplines from any recognized University or Institute
2. Duration: One and a half ($1\frac{1}{2}$) years (Registration valid for consecutive four and a half years)
3. Semester: Three Semesters (Valid up to consecutive nine semesters), two semesters in a year each of six (6) months
4. No. of courses = 12
5. No. of credits = 40
6. Total Marks = 2000

Distribution of courses, credits and marks

M.S. in Entomology shall be offered with 40 credits in 3 semesters each of six months duration. The courses worth 24 credits of which 12 credits shall be offered during the first semester and the other 12 credits during the 2nd semester respectively for the students. Another 16 credits shall be reserved for the research (thesis and thesis defense). The students have to start their research work for thesis (equivalent to 6 courses) under the guidance and supervision of his/her Research Supervisors after the completion of one semester and the same shall be carried through to the last semester when it will be evaluated. After the evaluation of thesis the students have to face thesis defense (equivalent to 2 courses). The distribution of courses, credits and marks are shown below:

Course Type		No. of Courses	Credits	Marks
Course (compulsory)		12	24	1200
Research	b) Thesis	equivalent to 6 courses	12	600
	b) Thesis defense	equivalent to 2 courses	4	200
Total			**40**	**2000**

N.B. 1 course = 2 credits = 100 marks; Thesis =12 credits = 600 marks, Thesis defense (4 credits) = 200 marks: Each course will carry 80 marks for theoretical examination and 10 marks for one course assignment and 10 marks for class attendance.

Course layout for MS in Entomology

1st Semester

Sl.	Courses Title	Course code	Credit Hours	Marks
1	Insect Ecology	MSENT 1201	2	100
2	Insect Morphology	MSENT 1202	2	100
3	Insect Physiology	MSENT 1203	2	100
4	Insect Taxonomy	MSENT 1204	2	100
5	Industrial Entomology	MSENT 1205	2	100
6	Insect Pathology	MSENT 1206	2	100
	Total 6 courses		**12**	**600**

2nd Semester

Sl.	Courses Title	Course code	Credit Hours	Marks
1	Principles of Acarology	MSENT 2201	2	100
2	Integrated Pest Management	MSENT 2202	2	100
3	Insecticide Toxicology	MSENT 2203	2	100
4	Stored Product Entomology	MSENT 2204	2	100
5	Biological Control	MSENT 2205	2	100
6	Entomological Technique	MSENT 2206	2	100
	Total 6 courses		**12**	**600**

3rd Semester

Sl.	Courses Title	Course code	Credit Hours	Marks
1	Thesis	MSENT 3121	12	600
2	Thesis defense	MSENT 3042	4	200
	Thesis + Thesis defense		16	800
	Grand Total	**(12×2) +16 = 40 (Forty)**		**2000**

Syllabus for MS in Entomology

Course Title: **Insect Ecology**

Course Code: **MSENT 1201** **Credit Hrs:** **2**

Unit	Title	Lesson
1	Population Ecology	Ecosystem and components of environment, Influence of physical (temperature, moisture and light) and biotic factors of environment on insect populations, variation in intensity of diapause and voltinism, population growth, Insect polymorphism,life table, population dynamics-conceptual aspects and modeling
2	Trophic Relationships	Primary and secondary metabolic products, host selection by insects, monophagy and polyphagy, predation models, numerical and functional responses, insect and host plant relationship, adaptive radiation and equilibrium in populations, insect- insect and microorganism mutualism
3	Communities and Diversity	Concept ofcommunities and diversity, component communities, succession anddiversity index, climatic stability
4	Dispersal and Migration	Dispersal and migration of insect population, factors of dispersal, dispersal of aphids and thrips and migration of locusts
5	Experimental Ecology	Types of insect distribution, methods of measuring distribution patterns, absolute methods of insect population estimation, relative methods of insect population estimation, monitoring of insects

Recommended Textbooks

1. Price, P.W. 1984. Insect Ecology. John Willey and Sons, New York, Toronto. Singapore.

Supplementary Textbooks

2. Andrewarth, H.G. and L.C. Birch. 1970.The Distribution and Abundance of Animals. The Univ. Chicago Press, Chicago and London.
3. Gillot,C. 1982. Entomology. Plenum Press, New York and London.
4. Huffaker, C.B. and A.P. Gutierrez. 1999. Ecological Entomology. John Willey & Sons, Inc. New York.
5. Odum,E.P. 1971. Ecology. Holt Rinehart & Winston, London, New York.
6. Schowalter, T.D. Insect Ecology. Academic Press, New York, London, Tokyo.
7. Speight, M.R., M.D. Hunter and A.D. Watt. Ecology of Insects : Concepts and Applications. Blackwell Science, Oxford.

Course Title: **Insect Morphology**

Course Code: **MSENT 1202** **Credit Hrs:** **2**

Unit	Title	Lesson
1	General body form, Segmentation and Integument	Introduction to general body formand segmentation, the Integumentand bodywall processes
2	The Head and its Appendages	General structure of head, head skeleton and tentorium,modification in head capsule and head orientation, the antennae and their functions, mouth parts-mandibles, maxilla, labium, labrum, hypopharynx and epipharynx, the chewing, rasping sucking, piercing sucking and chewing lapping type mouthparts, the sponging, cutting sponging, siphoning and degenerative type mouthparts
3	The Thorax	Legs and their modification, wings and their modification
4	The Abdomen	Abdominal segments, abdominal appendages
5	Digestive System	Organs of alimentary canal and salivary glands, structure of stomodeum, mesenteron and proctodeum
6	Respiratory System	Organs of respiration, classification of respiration, terrestrial respiratory organs, aquatic respiratory organs
7	Circulatory System	Components: haemolymph, haemocoel, dorsal vessel, accessory pulsatile organs, phagocytic organs, haemolymphs, types of haemocytes, functions of haemolymph and haemocytes
8	Excretory System	Excretory organs, the accessory organs for excretion
9	Nervous System	Neurons, its types and functions, types of nervous system
10	The Sense Organs	Mechanoreceptor : tactile organs, campaniform organ, chordotonal organ, static organ and johnston's organ, chemoreceptor : common, gustatory, olfactory chemoreceptor and their morphological classification
11	Reproductive System	Organs ofmale reproductive system, organs of female reproductive system, male and female genetalia, types of special modes of reproduction with examples

Recommended Textbooks

1. Snodgrass, R.E. 1935. Principles of Insect Morphology. McGraw Hill Book Co., New York.

Supplementary Textbooks

2. Borror, D.J., M.D. Delong and C.A. Triplehorn. 1976. An Introduction to the Study of Insects. Holt. Richart and Winston, New York.
3. Downer, R.G.H. 1987. Energy Metabolism in Insects. Plenum Publ. Crop., New York.
4. Essig, E.O. 1942. College Entomology. Macmillan Co., New York.
5. Imm's, A.D. 1957. A General Textbook of Entomology. Mathuen and Co., London.

6. Ross, H.H. 1965. A Textbook of Entomology. John Willey, New York.
7. Snodgrass, R.E. 1954. Insect Metamorphosis. Smithsonian miscellaneous collections. Vol. 122, No. 9, Smithsonian Institution. Washington, D.C., U.S.

Course Title: **Insect Physiology**

Course Code: **MSENT 1203** **Credit Hrs:** **2**

Unit	Title	Lesson
1	Insect Nutrition	Importance and principles of insect nutrition, general requirements of insect nutrition, artificial diet
2	Digestion and Absorption of Food	Functions of foregut, midgut, hindgut and salivary glands, process of digestion and absorption of food
3	Metabolism of Nutrients	Metabolism of carbohydrates, proteins and lipids
4	Circulation of Blood	Mechanism of blood circulation-main body and appendages
5	Respiration	Respiration in terrestrial, aquatic and endoparasitic insects
6	Nervous System and Neurophysiology	Physiology of nervous system, insect hormones, pheromones and their types, functions of insect hormones and their mode of action, functions of pheromones and their mode of action
7	Muscular Physiology and Locomotion	Structure and physiological properties of insect muscles, mechanism oflocomotion
8	Reproduction	Oogenesisandspermatogenesis, mating, impregnation and fertilization, factors controlling fertility and fecundity
9	Excretion	Physiology of excretion, excretory products and storage of excretion, salts and water balance
10	Growth and Development	The growth laws, moulting, metamorphosis, development of embryo, determination of characters during post-embryonic development, regeneration and diapauses

Recommended Textbooks

1. Wigglesworth, V.B. 1967. The Principles of Insect Physiology. Mathuen and Co., London.

Supplementary Textbooks

2. Borkevee, A.B. and T.J. kelly, 1984. Insect Neurochemistry and Neurophysiology. Plenum Press, No. 1. London.
3. Bhaskarau, G., S. Friedman and J.G. Rodgriguez. 1981. Current Topics of Insect Endocrinology and Nutrition. Plenum Publ. Co., New York.
4. Borrer, D.J., M.D. Delong and C.A. Triplehorn. 1976. An Introduction to the Study of Insects. Holt. Rinchart and Winston, New York.
5. Gillmour, D. 1966. The Metabolism of Insects. Oliver and Boyd., London.
6. Imms, A.D. 1957. A. General Textbook of Entomology. Mathuen and Co., London.
7. Nordland, D.A. 1981. Semiochemicals. Wiley, New York.

8. Novak, V.J.A. 1966. Insects Hormones. Mathuen and Co., London.
9. Patton, H.R. 1963. Introductory Insect Physiology. Saundres, Phila.
10. Richards, O.W. and R.G. Davis. 1977. Imms General Textbook of Entomology. Vols. I & II. Chapman and Hall, London.
11. Rodder, K.D. 1963. Insect Physiology. John Wiley, New York.
12. Ross, H.H. 1965. A Textbook of Entomology, John Wiley, New York.
13. Shorey, H.H. and J.J. Mekelvey, Jr. 1977. Chemical Control of Insect Behaviour: Theory and Application. John Wiley & Sons, London & New York.

Course Title: **Insect Taxonomy**

Course Code: **MSENT 1204** **Credit Hrs:** **2**

Unit	Title	Lesson
1	International Rules of Zoological Nomenclature	Historical and philosophical basis of nomenclature, origin of the binomial system, international codes of nomenclature and international commission, nomenclature type, method and its significance, formation of generic names. specific trivial names and intraspecific names
2	Taxonomic Categories and Species Concept	Different taxonomic categories, species concepts and their application, theories of biological classification
3	Taxonomic Characters, Collections and Identifications	Taxonomic characters, collections and identifications
4	Taxonomic Study of Insects	Classification and phylogeny of insects, study of some orders, genera and species of economic importance, methods of insect collection and preservation, study of adults and immature forms of economic groups, types of insect larvae and pupae and their identification
5	Chaetotaxonomy, Chemotaxonomy and Numerical Taxonomy	Chaeto and chemo taxonomy, numerical taxonomy
6	Presentation of Taxonomic Findings	Descriptions of taxonomic findings, keys and phylogenies of taxonomic findings
7	Taxonomic Publications and Literatures	Synopsis and reviews, revisions, monographs, atlases, faunal works, field guides and manuals, handbooks, catalogues and checklists, descriptions of new taxa, evolutionary and biological publications

Recommended Textbooks

1. Borror, D.J., D.M.Delong and C.A. Triplehorn. 1976. An Introduction to the Study of Insects. Holt, Rinehart and Winston, New York.

Supplementary Textbooks

2. Bisby, F.A.,J.G. Vaughan and C.A. Wright. 1980. Chaemosystematics, Principles and Practices. Academic Press, New York.
3. Chamberlin, W.J. 1952. Entomological Nomenclature and Literature. Wn. C. Brown, Dubuque, Iowa.
4. Goto, H.E. 1982. Animal Taxonomy, Edward Arnold, London.
5. Lincoln, R.J., G.A. Boxshall and P.F. Clark. 1981. A Dictionary of Ecology, Evaluation and Systematics. Cambridge Univ. Press, Cambridge.
6. Alam, M.Z. 1967. A Report on the Survey of Insect and Mite Fauna of East Pakistan. Agril. Res. Inst, Publ., Dhaka.
7. Ball, G.E. (Ed.). 1985. Taxonomy, Phylogeny and Zoogeography of Beetles and Ants. Dr. W. Junk Publishers, The Hague.
8. Gapud, V.P. 1992. Insect and Mite Pests of Plant Crops in Bangladesh and Their Natural Enemies, USAID/BARC/Checchi & Co. Publ.
9. Mani, M.S., 1982. General Entomology. Oxford & IBH Publ. Co., New Delhi.
10. McNutt, D.N. 1976. Insect Collecting in the Tropics. Centre for Overseas Pest Research, London.
11. Pruthi, H.S. 1969. A Textbook of Agricultural Entomology, Indian Council of Agicultural Research New Delhi.
12. Richards, O.W. and Davies, R.G. 1977. Imm's General Textbook of Entomology. Vol. 2. Classification and Biology, Chapman and Hall, London.

Course Title: **Industrial Entomology**

Course Code: **MSENT 1205** **Credit Hrs:** **2**

Unit	Title	Lesson
1	Introduction	Industrial insects and industrial entomology
2	Sericulture	Economic importance of silkworm and their host plants, biology of silkworm, silkworm rearing- environmental requirements, equipments space/houses and egg production, brushing, feeding and leaf quality, bed cleaning and care at moulting, methods of rearing (early and late stage larvae), mounting, cocoon harvesting and reeling, diseases of silkworm-protozoan and bacterial diseases, diseases of silkworm-fungal and viral diseases, enemies of silkworm-larval pests (uzi fly, ant, mite and other pests) and cocoon pests, technique of race development, moriculture-varieties and cultivation of mulberry plants, management of mulberry garden
3	Apiculture	Economic importance of honey bee, species, caste and life cycle of honey bee,bee box, catching and hiving of bee swarm, colony management, bee diseases- bacterial, protozoan, fungal and viral diseases, bee enemies-parasites, predators and mites, honey collection- extraction, refining and preservation, wax collection
4	Lac-culture	Prospect of lac culture in bangladesh, species, strains, host plants and life history of lac insect, rearing technique of lac insect,

	manufacture of shellac and its uses, enemies of lac insect

Recommended Textbooks

1. Pruthi, H.S. 1969. A Textbook of Agricultural Entomology. Indian Council of Agricultural Research, New delhi.

Supplementary Textbooks

2. Cooper, E.K. 1964. Silkworms and Science. Butterworth Press, London. 128 pp.
3. Mace, H. 1976. The Complete Handbook of Beekeeping. Ward Lock Limited. London. 192 pp.
4. Morie, Y. and M. Watanable. 1980. Recent Advances in Sericulture. Ann. Rev. Entomol. 25 : 49-71.
5. Islam, B.N. 1981. Improvement of Silkworm Multiplication and Silk Production under Bangladesh condition. Dept. of Entomology, BAU, Mymensingh. 83. pp.
6. Krishnaswami, S. *et al.* 1978. Sericulture Manual 2. Silkworm Rearing. Central Sericulture Research and Training Institute, Mysore, India. 131 pp.
7. Rahman, S.M. 1984. Studies on the Genetic Improvement of Eri-Silkworm. Philosamia ricini Boisd of Bangladesh. A PhD Thesis, Dept. of Zoology, Rajshahi University, Rajshahi. 419 pp.
8. Sarkar, D.C. 1980. Sericulture in India. Central Silk Board, Bombay, India. 51pp.
9. Singh, S. 1982. Beekeeping in India. Indian Council of Agricultural Research, New Delhi. 214 pp.

Course Title: **Insect Pathology**

Course Code: **MSENT 1206** **Credit Hrs:** **2**

Unit	Title	Lesson
1	Introduction	Insect pathology and its importance in Bangladesh
2	Insect Diseases	Definition and types of insect diseases, etiology-amicrobial and microbial diseases, diagnosis of diseases of natural enemies and their management
3	Physiopathology	Portals of entry and mode of infection- bacteria & delta-endotoxin, viruses, microsporidiaandfungi, nematodes and rickettsiae, physiopathology of insect-alimentationandrespiration, circulation and adipose tissues
4	Immunity in Insect	Definition and types of insect immunity, factors attributing immunity in insect, mechanism of insect resistance to pathogens
5	Microbial Pesticides	Microbial pesticides, methods of isolation, purification and counting- microsporidia, fungi, viruses, nematodes and bacteria, mass production technology- bacteria, virus (NPV) and fungi
6	Microbial Control	Integration of microbial pathogens- protozoa, nematodes and rickettsia, factors affecting efficacy of microbial pathogens, approaches, advantages and disadvantages of

		microbial control, application technology, potential microbial pathogens of Bangladesh
7	Epizootiology	Concept and modeling of epizootiology, factors influencing on insect epizootiology- pathogen population, host population, transmission of pathogen and environment
8	Genetically Engineered Pathogen	Concept and present status of genetically engineered pathogens, application of genetically engineered pathogens in pest management

Recommended Textbooks

1. Steinhaus, E.A. 1963. Insect Pathology. An Advanced Treatise. Vols. 1 & 2. Academic Press, New York, London.

Supplementary Textbooks

2. Bulla, L.A. Jr. and T.C. Cheng. 1977. Comparative Pathology. Vols. 1, 2 and 3, Plenum Press, New York and London.
3. Cantweel, G.E. 1974. Insect Diseases. Vols. 1 and 2. Marcel.
4. Debach, P. 1964. Biological Control of Insect Pests and Weeds. Chapman and Hall, London.
5. Fuxa, J.R. and Y. Tanada. 1987. Epizootiology of Insect Diseases. John Wiley and Sons, New York, Chichester, Brisbane, Toronto, Singapore.
6. Metcalf, R.L. and W.H. Luckmann. 1975. Introduction to Insect Pest Management. John Wiley and Sons. New York, London, Sydney, Toronto.
7. Smith, K.M. 1967. Insect Virology, Academic Press, New York and London.

Course Title: **Principles of Acarology**

Course Code: **MSENT 2201** **Credit Hrs:** **2**

Unit	Title	Lesson
1	Concept of Acarology	Introduction to acarology, different stages of acari
2	Classification of the Acari	Introduction , order norostigmata, holothyrida, ixodida, mesostigmata, prostigmata, astigmata and oribatida
3	Integument and Moulting	Integument, moulting
4	Segmentation, Musculature and Legs	Segmentation, musculature, legs
5	Mouthparts, Feeding and Adaptations of the Mouthparts	Mouthparts, feeding, adaptations of the mouthparts
6	Respiratory, Circulatory, Nervous System and Sense Organs	Respiratory system, circulatory system, nervous system, sense organs
7	Excretion, Reproduction, Development and Dispersal	Excretion, reproductive system - male and female, mating behaviour, methods. of sperm

	transfer and oviposition, development and dispersal

Recommended Textbooks

1. Evans, G.O. 1992. Principles of Acarology. CAB International, Wallingford, UK.563pp. (Web : http://www.cabi.org)

Supplementary Textbooks

2. Akimov, I.A. 1985.Biological Foundations of Harmfulness in Acaroid Mites. Naukova Dumka, Kiev., 160pp.
3. Anderson, D.T. 1973. Embryology and Phylogeny in Annelids and Arthropods, International Series of Monographs on Pure and Applied Biology: Zoology Division, Vol. 50. Pergamon Press, Oxford, 495pp.
4. Baker, E.W. and G.W. Wharton.1952. An Introduction to Acarology.Macmillon, New York, 465pp.
5. Evans, G.O.,J.G. Sheals and D.Macfarlane. 1961. The Terrestrial Acari of the British Isles. Vol. 1. British Museum, London, 219pp.
6. Fain, A., B. Guerin and B.J. Hart. 1988. Acariens Allergies. Allerbio, Belgium,179pp.
7. Gilyarov,M.S.(ed.)1978. Handbook for the Identification of Soil-Inhabiting Mites, *Trombidiformes.* Zoological Institute of the Academy of Science, SSSR, Leningrad,717pp.
8. Jeppson, L.R., H.H. Keifer and E.W. Baker.1975. Mites Injurious to Economic Plants.University of California Press,Berkeley.
9. Krantz, G.W. 1978. A Manual of Acarology, 2nd edn. Oregon State University Book Stores,Corvallis.
10. Treat, A.E. 1975. Mites of Moths and Butterflies. Comstock Publishing Associates, Ithaca & London.
11. Van der Hammen, L. 1989. An Introduction to Comparative Arachnology. SPB Academic Publishing, The Hague,576pp.

Course Title: Integrated Pest Management

Course Code: MSENT 2202 **Credit Hrs: 2**

Unit	Title	Lesson
1	Introduction to Integrated Pest Management	Origin of the term IPM, definitions of IPM, philosophy of IMP, ecological approaches in the pest control. the origins of pests, ecological causes of pest problems, genesis of pest control, major events in the history of pest control. basic principles of IPM and guidelines for IPM programs
2	Ecological Concepts of Pest Management	Definition of ecosystem, com ponents of ecosystem, biotic interactions in ecosystem, energy flow,colonization of island vis-a-vis theory

		of island biogeography,ecological/community succession, evolution of population and species, some ecological principles for application
3	The Economics of Pest Management	The economic threshold concept, economic research on IPM, economics of insect control in the farm/the private economics of pest management,impact of govt. activities on use of insect control systems, conflicts of interest in ecosystem management, the social implications of pest management decisions, environmental quality, hazard to health
4	The Quantitative Basis of Pest Management: Sampling and Measures	Absolute methods and relative methods, insect products, assessing plant damage and crop yield loss, dispersion and the sampling program
5	Analysis and Modeling in Pest Management	Analysis of natural and agro ecosystem, classes of descriptive models, life tables, building and using static models, the operating of pest management systems, designing/recommendation algorithm, using models to build and algorithm,IPM tactics/tools, decision-making in IPM, decision tree,use of computers in IPM, types of IPM models, tactical model, typical on-lime pest management system.
6	Cultural Practices in Pest Management	Destruction of residues, alternative hosts and volunteer plants, dates of sowing and harvesting chosen to avoid pest attack, good husbandry, rotation of crops to avoid building up of pests, cropping systems, plant density, other practices
7	Host Plant Resistance in Pest Management	Definition, historical development, insect-plant interactions, host plant selection and mechanisms of resistance, genetic basis of resistance, effect of environmental factors on the expression of resistance, implementation of programs in crop resistance, plant resistance in pest management
8	Parasitoids and Predators in Pest Management	Definitions and concepts, natural control and biological control, feasibility of biological control, management considerations, evaluation, conclusion
9	Insecticides in IPM	Advantages of insecticides for pest management, limitations in the use of insecticides for pest management, proper use of insecticides in pest management, selecting insecticides for pest management programs, model pest management programs using insecticides, conclusion

10	Use of Insect Pathogens in Pest Management	Characteristics of insect diseases, types of insect pathogens, insect diseases as naturally occurring mortality factors. Introduction and application of insect diseases for long term suppression, microbial insecticides, role of microbial control in pest management programs in future
11	Integrated Pest Management in Developing Countries including Bangladesh	IPM current status with examples, IPM constraints, prospects and future needs, the future strategy for IPM
12	Role of Extension Entomology in IPM	IPM and extension entomology, the forces that influenced extension entomology, future of extension entomology,from integrated control to integrated farming, intelligent crop management (ICM), evaluating the IPM implementation process

Recommended Textbooks

1. Apple, J.L. & R.F. Smith (Eds). 1976. Integrated Pest Management. New York: Plenum Press.

Supplementary Textbooks

2. Atwal, A.S. 1976. Agricultrual Pests of Indian and Southeast Asia. Kalyani publishers, New Delhi.
3. Bal, A. & J.C. Van Lenteren. 1987. Integrated Pest Management in the Netherlands: practice, policy and opportunities for the future. Med. Fac. Landbouww. Rijksuniv. Gent, 52: 385-93.
4. Boller, E.F. 1987. Genetic Control. In: Integrated Pest Mnagement, ed. A.J. Burn. T.H. Coaker & P.C. Jepson, pp. 162-87. London: Academic press.
5. Bottrell, D.G. 1799. Integrated Pest Management. President's Council for Environmental Quality. Washington, DC: US Government Printing Office.
6. Burgs, H.D. 1981. Microbial Control of Pest and Diseases, 1970-1980. Academic Press, New York.
7. Burn, A.J., T.H. Coaker & P.C. Jepson (Eds). 1987. Integrated Pest Management. London: Academic Press.
8. Coaker, T.H. 1987. Cultural Methods: The Crop. In: Integrated Pest Mangement, ed. A.J. Burn, T.H. Coaker & P.C. Jepson, pp. 69-88. London: Academic Press.
9. Dent, D. 1991. Insect Pest Management. C.R. International.
10. Evans. J.W. 1987. Insect Pest and Their Control, Soni Reprints Agency, Delhi.
11. Flint, M.L. & R. van den Bosch. 1981. Introduction to Integrated Pest Management. New York: Plenum Press.
12. Matcalf, R.L. & W.H. Luckmann (Eds). 1982. Introduction to Insect Pest Management, 2nd edn. New York: John Wiley & Sons.
13. Ramulu, U.S. 1985. Methods of Pesticides Analysis. Oxford and IBH Publ. Co., New Delhi, Bombay and Calcutta.
14. Shapa, V.A. 1986. Biological Plant Protection. Publ. Oxonian Prep. Pvt. Ltd, New York.
15. Van Enden, H.F. 1989. Pest Control, Edward Arnold, London.
16. Zelazny, B., L. Chiarappa & P. Kemore. 1985. Integrated Pest Control in Developing Countries. FAO Plant Prot. Bull 33: 147-58.

Course Title: **Insecticide Toxicology**

Course Code: **MSENT 2203** **Credit Hrs:** **2**

Unit	Title	Lesson
1	Introduction to Insecticide Toxicology	Insecticide toxicology, history and general groupings of insecticidal compounds, pesticides-classification and mode of action
2	Metabolism of Insecticides	General types of metabolic activities, oxidation, reduction and hydrolytic processes, glutathione-mediated metabolism, metabolism of organochlorine and organophosphorus insecticides, metabolism of carbonates and pyrethroids
3	Toxicological Studies in Insects	Penetration of insecticides into insects, factors influencing penetration rate, general principles of insecticide resistance, metabolism detoxication as resistance, mixed function oxidation, metabolism by esters and glutathione, genetic aspects of resistance, operational factors influencing resistance, management of resistance
4	Movement of Insecticides in Environment	General aspects, terrestrial plants including agricultural crops, movement in soil, water and air, degradation by sunlight and other physical factors
5	Insecticides Analysis	Principles of insecticide analysis, chromatographic analysis of insecticide residues, spectroscopic methods, analysis of physical properties of formulations, analysis of active ingredient content of insecticides
6	Insecticides and Environmental Health	Food contamination, hazards to man and domestic animals, acute poisoning by insecticidal chemicals, pathological and histological changes on chronic poison, human intake of insecticides through food, toxic effects on insects and wildlife, safety assessment

Recommended Textbooks

1. Matsumura, F. Toxicology of Insecticides(2nd edition). 1985. Plenum Press. New York and London.

Supplementary Textbooks

2. Agrwal, R.A., Gupta, G.P. Kishore prem and Chandra Dinesh. 1983. Principles and Concepts of Integrated Pest Management. ICAR, New Delhi-110012, India.
3. Evans, J.W. 1987. Insect Pest and Their Control. Soni reprints Agency, Delhi.

4. Metcalr. E.R. 1981. Management of Insect Pests with Semiochemicals : Concept and Practices. Academic press, new York.
5. O'Brien, R.D. 1967. Insecticides, Action and Metabolism. Academic Press, Inc. New York-London.
6. Otto, D. and Weber, B. 1992. Insecticides : Mechanism of Action and Resistance. Intercept Andover.
7. Ramulu, U.S. 1985. Methods of Pesticides Analysis. Oxford and IBH Publ. Co., New Delhi, Bombay and Calcutta.
8. White-Stevens, R. Pesticides in the Environment. Vol. I Part II, Marcel Dekker, Inc., New York and Basel, 629P.

Course Title: **Stored Product Entomology**

Course Code: **MSENT 2204** **Credit Hrs:** **2**

Unit	Title	Lesson
1	Stored Products and Conservation	Types of stored products with characteristics, pest problems of consumers and suppliers, ecology of stored grain pests- temperature and moisture, ecology of stored grain pests-food and population density, assessment of grain moisture content by drying and aeration method
2	Pests of Stored Products	List of different groups of stored product pests with identifying characters, coleopteran insects-beetle and weevil pests, lepidopteran insects-moth pests, rats and mites in storage, types of damage-direct damage, selective eating, contamination and webbing by moth larvae, loss assessment by produce monitoring, physical parameters and sampling, loss assessment by trapping, detection of insect infestation in stored products
3	Storage Facilities Against Pest Attack	General considerations for grain storage, indoor and outdoor storage, modern grain storage, design for conventional installation of storage, installation for buffer reserves, merits and demerits of conventional godown
4	Insect Control	Various physical methods of control of stored grains, preventive and curative measures, moisture content of grains, general considerations of insecticides, insecticides mixed with grains, common fumigants and their composition, principles of fumigation, safety against fumigants and fumigation, insecticides residues and health hazards, use of botanicals, radiation control

Recommended Textbooks

1. Alam, M.Z. 1971. Pests of Stored Grain and Other Stored Products and Their Control. Agric. Inf. Serv., Dhaka.

Supplementary Textbooks

2. Brown, A.W.A. 1961. Insect Control by Chemicals. John Wiley, new York.
3. Cornwell, P.B. 1966. The Entomology of Radiation Disinfestation of Grains. Macmillan Co., New York.
4. Cotton, R.T. 1963. Pests of Stored Grain and Their Products. Burgess Publ. Co. Minn., USA.
5. Hill, D.S. 1990. Pests of Stored Products and Their Control. Belhaven Press, London.
6. Munro, J.W. 1966. Insect of Stored Products.
7. Pingale, S.V. 1978. Handling and Storage of Food Grains. Indian Council of Agricultural Research. New Delhi, India.

Course Title: **Biological control**

Course Code: **MSENT 2205** **Credit Hrs:** **2**

Unit	Title	Lesson
1	Introduction, Fostering pests	Introduction, definition, history of biological control, fostering pests through misuse of chemicals, some examples of local and foreign countries, insecticide-the ecological narcotics, why great insecticide boom, the pesticide syndrome-diagnosis and suggested prophylaxis
2	Pest and Their Natural Enemies (NE) Parasitoid & Predator	Pest and their natural enemies, parasitoid: hymenoptera, dipteral,predatory insects: coleoptera, neuroptera, hymenoptera, diptera,hemiptera and odonata
3	Pest and Their Natural Enemies (microorganism, NE of weed)	Pathogenic microorganism,natural enemies of weeds
4	Biological Control Ecology	Natural control, biological control and population phenomenon, the extent of natural biological control, ecological basis of classical biological control.
5	Measurement and Adabtability of NE	Measurement of natural enemy population,adaptability of introduced/local biological control agents
6	Foreign Exploration and Importation of NE	Introduction, planning and preparation, inventory search and investigation of selected species, importation of NE. example of first foreign explorer, cottony-cushion scale of California (1888-1890), example of modern foreign exploration and success:

		klamath weed, oriental fruit fly
7	Improvement of NE fitness	Variability in NE fitness, desirable characteristics of NE, improving adaptability of imported species
8	Conservation of NE	Conservation and diversification, methods of conservation
9	Augmentation of NE	Augmentation of NE through mass culture and periodic release in Bangladesh,augmentation of *Trichograma* in sugarcane field against sugarcane borers, management of pest population by manipulating densities of both hosts and NE
10	Evaluation of Impact of NE	Introduction, selection of study area and duration of study, population sampling, experimental or comparison method of evaluation, the addition methods, the exclusion method, interference method
11	Microbial Control	Microbial control as a tool in IPM program, virus, fungi, nematode and other pathogenic microorganism
12	Biological Control of Weed	Introduction and some examples of biological control of weed of foreign countries

Recommended Textbooks

1. DeBach, P. (Ed.). 1964a. Biological Control of Insect Pests and Weeds. New York: Reinhold Publishing Crop.

Supplementary Textbooks

2. Askew, R.R. 1971. Parasitic Insects. London : Heinemann Educational Books.
3. Birch, M.C. and K.F. Haynes. 1982. Insect Pheromones. Studies in Biology No.147.London : Edward Arnold.
4. Clausen, C.P.(Ed.). 1978. Introduced Parasites and Predators of Arthropod Pests and Weeds ; a World Review Agric. Handbook 480. Washington, DC ;US Department of Agriculture.
5. Croft, B.A. 1990. Arthropod Biological Control Agents and Pesticides. Somerset : john Wiley & Sons.
6. Deacon, J.W. 1983. Microbial Control of Plant Pests and Diseases. Aspects of Microbiology 7. Washington, DC : American Society of Microbiology.
7. DeBach, P. & K.S. Hagen. 1964. Manipulation of Entomophagous Species. In: Biological Control of Insect Pests and Weeds, ed. P. DeBach, pp. 429-58. New York: Reinhold.
8. Helle, W.& M. W. Sabelis (Eds). 1985. Spider Mites, Their Biology, Natural Enemies and Control. World Crop Pests, Vol. 1B. Amsterdam: Elsevier Science Publisher.
9. Huffaker, C.B. (Ed.). 1971b. Biological Control. New York: Plenum Press.
10. Papavizas, G. C. (Ed.). 1981. Biological Control in Crop Production, Beltsville Symposia in Agricultural Research 5, Totowa: Allanheld, Osmun.

11. Ridgway, R.L. & S.B. Vinson (Eds). 1977a. Biological Control by Augmentation of Natural Enemies. New York: Plenum Press.
12. Samways, M.J. 1981. Biological Control of Pests and Weeds. Studies in Biology No. 132. London: Edward Arnold.
13. Wood, K.R.S. & M.J. Way (Eds). 1988. Biological Control of Pests, Pathogens and Weeds. London: The Royal Society. (Phil, Trans. Roy. Soc. Lond. B 318: 109-376).

Course Title: **Entomological Technique**

Course Code: **MSENT 2206** **Credit Hrs:** **2**

Unit	Title	Lesson
1	Basic Procedures of Microtomy	Procedure for processing tissue, preparation of the fixatives, stains and staining, preparation of insect muscles, nerves and tracheae
2	Concept and Technique of Electron Microscopy	Introduction to electron microscopy, preparative procedures of electron microscopy, staining and examination of slides in electron microscopy
3	Tissue Culture Technique	Introduction to tissue culture, preparation of tissue extracts and tissues, methods for tissue culturing and histological techniques, photomicrography of tissue cultures and use of camera lucida
4	Bioassay of Pesticides	Probit analysis, estimation of LD_{50} and LD_{90} values of an insecticide.
	Measurement of Population Density and Distribution Patterns	Sampling techniques-random and sequential samplings, binomial distribution and index of dispersion
	Methods of Tagging Insects with Radioisotopes (Demonstrations)	Handling techniques of radioisotopes and marking methods, labels with p^{32} incorporated in insect tissues and its detection by autoradiograph

Recommended Textbooks

1. Ham, A.W. and D.H. Cormack. 1979. Histology. J.B. Loppincott., Phila. (8^{th}ed.).

Supplementary Textbooks

2. Andrewrtha, H.G. 1961. Introduction to the Study of Animal Populations. Methuen & Co., Ltd., London.
3. Finney, D.J. 1964. Probit Analysis. Cambridge Univ. Press, Great Britain.
4. Grimstone, A.V. 1976. The Electron Microscope in Biology. Edward Arnold, London.
5. Leeson, C.R. 1976. Histology, Saunders, Phila.
6. Pease, D.C. 1964. Histological Techiniques for Electron Microscopy, Academic Press, New York (2^{nd}ed.).
7. Ramulu, U.S.S. 1979. Electron Microscopy of Cells and Tissues. Academic Press, newYork.

School of Agriculture and Rural Development
Bangladesh Open University

Master of Science (MS) in Irrigation and Water Management

1. Requirement for registration: Bachelor of Science in Agricultural/Civil/Water Resources Engineering or related disciplines from any recognized University
2. Duration: One and a half ($1\frac{1}{2}$) years (Registration valid for three consecutive years)
3. Semester: Three Semesters (Valid up to consecutive six semesters), two semesters in a year each of six (6) months:
4. No. of courses = 12
5. No. of credits = 40
6. Total Marks = 2000

Distribution of courses, credits and marks

MS in Irrigation and Water Management shall be offered with 40 credits in 3 semesters each of six months duration. The courses worth 24 credits of which 12 credits shall be offered during the first semester and the other 12 credits during the 2nd semester respectively for the students. Another 16 credits shall be reserved for the research (thesis and thesis defense). The students have to start their research work for thesis (equivalent to 6 courses) under the guidance and supervision of his/her Research Supervisors after the completion of one semester and the same shall be carried through to the last semester when it will be evaluated. After the evaluation of thesis the students have to face thesis defense (equivalent to 2 courses). The distribution of courses, credits and marks are shown below:

Course Type		No. of Courses	Credits	Marks
Course (compulsory)		12	24	1200
Research	c) Thesis	equivalent to 6 courses	12	600
	b) Thesis defense	equivalent to 2 courses	4	200
	Total		**40**	**2000**

N.B. 1 course = 2 credits = 100 marks; Thesis =12 credits = 600 marks, Thesis defense (4 credits) = 200 marks: Each course will carry 80 marks for theoretical examination and 10 marks for one course assignment and 10 marks for class attendance.

Course layout for MS in Irrigation and Water Management

1st Semester

Sl.	Course Title	Course Code	Credit Hours	Marks
1.	Surface Water Hydrology	MSIWM 1201	2	100
2.	Irrigation System Design and Evaluation	MSIWM 1202	2	100
3.	Groundwater Development and Management	MSIWM 1203	2	100
4.	Soil-water-plant atmosphere Continuum	MSIWM 1204	2	100
5.	Water pollution and Environment	MSIWM 1205	2	100
6.	Integrated Water Resources Management	MSIWM 1206	2	100
	Total 6 Courses		**12**	**600**

2nd Semester

Sl.	Course Title	Course Code	Credit Hours	Marks
1.	Irrigation System Planning and Management	MSIWM 2201	2	100
2.	Drainage Engineering	MSIWM 2202	2	100
3.	River Engineering and Flood Management	MSIWM 2203	2	100
4.	Watershed Management	MSIWM 2204	2	100
5.	Hydraulic Structures	MSIWM 2205	2	100
6.	Remote Sensing and GIS in Water Resources	MSIWM 2206	2	100
	Total 6 Courses		**12**	**600**

3rd Semester

Sl.	Courses Title	Course code	Credit Hours	Marks
1	Thesis	MSIWM 3121	12	600
2	Thesis defense	MSIWM 3042	4	200
	Thesis + Thesis defense		16	800
	Grand Total	**(12×2) +16 = 40 (Forty)**		**2000**

Syllabus for MS in Irrigation and Water Management

Course Title: **Surface Water Hydrology**

Course Code: **MSIWM 1201** **Credit Hrs:** **2**

Unit	Title	Lesson
1	Hydrology and Its Development	Define hydrology, hydrologic cycle, broadest and narrower sense of hydrology, scale of hydrology, physical process of hydrology, hydrologic models, classification of deterministic models
2	Hydrograph Analysis and Relationship Between Unit Hydrograph and Catchment	Excess rainfall, interception, infiltration, φ index, instantaneous unit hydrograph, derivation of UH, determination of IUH, Nash model, general hydrologic system model (linear system in continuous time, response function of linear system), impulse response function
3	Hydrologic and Hydraulic Routing	Distinguish between channel routing and reservoir routing, lumped and distributed system routing, Saint-Venant equation with assumption, Kinematic wave velocity, kinematic wave model for rainfall runoff process, linear reservoir routing an impulse input and constant inflow, general and modified Muskingum routing equation
4	Hydrology of Agricultural Land	Define river basin, characteristics of river basin, physical description of the basin (drainage area, stream order, drainage density, area-elevation distribution), climatic factors, topographic factor
6	Catchment Modeling	Consideration in catchment modeling, model accuracy, consistency of model performance, parameter sensitivity studies, simple and elaborate models, isolation of model parts in optimization, optimization using appropriate output function, tests of residuals, progressive modifications, mode of fitting, mode of operation
7	Time Series Analysis: Forecasting and Updating Techniques	Define time series, stochastic process, stochastic models, stationary and non-stationary models, mean and variance of stationary process, auto-covariance and autocorrelation coefficients, auto-covariance and autocorrelation functions, estimation of auto-covariance and autocorrelation functions, general linear process, autoregressive process

Recommended Text Books

1. Hydrology in Practice – Elizabeth M. Shaw. 2nd edition, Van Westrand Reinhold (International) Co. Ltd., London, 1988.
2. Time Series Analysis: Forecasting and Control – G.E.P Box, G.M. Jenkins and G.C. Reinsel. 3rd edition, Prentice Hall, Englewood Clifs, NJ, USA, 1994.

Supplementary Text Books

3. Introduction to Hydrology – Warrant Viessman, Jr., John W. Knapp, G.L. Lewis and T.E.
4. Harbaugh. Harper and Row Publishers Inc., 1977.
5. Hydrology for Engineers – R.K Linsley, M. A. Kohler and J.H. Paullus. McGraw-Hill Book Company, New York, 1975.
6. Journal of Hydrology – Elsevier Science Publishers, Amsterdam, The Netherlands.
7. Hydrological Sciences Journal – Blackwell Scientific Publications, Oxford, U.K.
8. Journal of Hydrology and Earth Systems Sciences – European Geophysical Union.
9. Bangladesh Journal of Water Resource Research – Bangladesh University Engineering and Technology, Dhaka, Bangladesh.

Course Title: **Irrigation System Design and Evaluation**

Course Code: **MSIWM 1202** **Credit Hrs:** **2**

Unit	Title	Lesson
1	Design Fundamentals of Irrigation Systems	Define farm irrigation, functions, types of farm irrigation systems, water application methods
2	Surface Irrigation	Surface irrigation methods, delivery systems for surface irrigated farms (level basin, border irrigation, furrow irrigation), designing farm irrigation systems
3	Sprinkler Irrigation	Types of sprinkler systems, sprinkler systems components, sprinkler systems design
4	Drip Irrigation	Benefits of drip irrigation, drip irrigation methods, major advantages of drip irrigation system, problems associates with drip irrigation system, drip system components, control of drip system clogging, fertilizer injection, drip system design
5	Evaluation of Irrigation System	Evaluation of basin, furrow, border strip, sprinkler, buried pipe, and drip irrigation
6	Performance Evaluation	Evaluation of irrigation project performance

Recommended Text Books

1. Principles of Farm Irrigation System Design – Larry G. James. John Wiley & Sons, 1993.
2. Farm Irrigation System Evaluation: A Guide for Management – J. L. Merriam and J. Keller. Department of Agricultural and Irrigation Engineering, Utah State University, 1978.American Society of Agronomy, 1967.
3. Irrigation System Design Handbook – D.D. Davis. Rain Bird Sprinkler Manufacturing Corporation, California, USA, 1976.
4. Irrigation of Agricultural Lands – R. M. Hagan, H.R. Haise and T.W. Edminster (eds.).

Supplementary Text Books

5. Irrigation Engineering and Hydraulic Structures – S.K. Garg. Khanna Publishers, New Delhi, India, 1998.
6. Irrigation Engineering and Hydraulic Structures – S.R. Shahasrabudhe. Katson Publishing House, Ludhiana, India.
7. Irrigation Water Management – Training Manual – M. Kay and Hatcho, FAO Land and Water Division, Rome, 1992.
8. Journal of Agricultural Water Management, Elsevier Science Publishers, Amsterdam, The Netherlands.
9. Irrigation Science, Springer–Verlag, USA.

Course Title: **Groundwater Development and Management**

Course Code: **MSIWM 1203** **Credit Hrs:** **2**

Unit	Title	Lesson
1	Occurrence and Movement of Groundwater	Occurrence of groundwater, origin of groundwater, groundwater and hydrologic cycle, vertical distribution of groundwater, types of geologic formation and aquifers, water table and piezometric surface
2	Evaluation of Aquifer Properties and Characterization	Porosity, void ratio, specific yield, specific retention, storage coefficient, hydraulic conductivity, transmissibility, intrinsic permeability
3	Well Hydraulics for Steady and Unsteady Radial Flow Conditions	Steady radial flow into well, unsteady radial flow into well
4	Testing Water Wells for Analyzing Drawdown and Yield	Well flow near aquifer boundaries-image wells, Barrier and recharge boundaries-image wells,aquifer bounded by a research boundary, methods of images, methods of images for particular cases
5	Well Interference and Safe Spacing of Wells	Multiple well systems, partial penetration of the well, Spacing of tubewells, specific capacity and safe yield, well efficiency
6	Groundwater Quality: Physical, chemical and biological quality parameters	Importance of groundwater quality, physical, chemical and biological groundwater quality parameters
7	Saline Water Intrusion	Concept of saline water intrusion, slope of interference, shape of interference, dispersion, seawater intrusion methods, oceanic island aquifers
8	Groundwater Recharge and Safe Yield Assessment	Physical methods: saturated zone, water-budget methods
9	Groundwater Modeling Techniques	Porous media models, electric analog models, digital computer models

10	Groundwater Management	System wise and basin wise management concepts, conjunctive use of surface water and groundwater, groundwater management issues in Bangladesh

Recommended Text Books

1. Groundwater – H.M. Raghunath. 2nd edition, New Age International (P) Limited, Publishers, New Delhi, India, 1987.
2. Groundwater Assessment Development and Management – K.R. Karanth. 3rd edition, Tata, McGraw-Hill Publishing Company Limited, New Delhi, India, 1994.
3. Concepts and Models in Groundwater Hydrology – P.A. Domenico. McGraw-Hill Book Company, New York, USA, 1972.

Supplementary Text Books

4. Groundwater Resource Evaluation – W.C. Walton. McGraw-Hill Book Company, New York, USA, 1970.
5. Groundwater – R. A. Freeze and J. A. Cherry. Prentice-Hall Inc., New Jersey, USA, 1979.
6. Groundwater Hydrology - D.K. Todd. 2nd edition, John Wiley & Sons. New York, USA, 1980.
7. Groundwater Hydrology – H. Bouwer. McGraw-Hill Book Company, New York, USA, 1978.
8. Seepage and Groundwater Flow – K.R. Rushton and S.C. Redshaw. Wiley, Chichester, UK, 1979.
9. Groundwater – H. M. Raghunath. 2nd edition, New Age International (P) Limited, Publishers, New Delhi, India, 1987.
10. Groundwater Management – American Society of Civil Engineering (ASCE), Manual No. 40, 1972.
11. Groundwater – American Water Works Association (USA).
12. Journal of Irrigation and Drainage Division, American Society of Civil Engineering (ASCE).

Course Title: **Soil-Water-Plant Atmosphere Continuum**

Course Code: **MSIWM 1204** **Credit Hrs: 2**

Unit	Title	Lesson
1	Soil Physical and Chemical Properties	Soil physics, soil fertility, soil as a disperse three phase system, soil particle, pore space, density of solids, volume and mass relationship of soil constituents, dry bulk density, total/wet bulk density, dry specific volume, porosity, void ratio, soil wetness, air filled porosity, soil texture, soil structure, particle size analysis, soil profile, specific surface of a soil, behavior of clay, exchangeable cations, diffuse double layer, heat of wetting, swelling, hysteresis
2	Soil Water Characteristic Function:	Energy stare of soil water, relation of water by soil matrix, soil moisture characteristic curve, soil water retention function, general characteristics of water retention curves and

	Retention and availability	important parameters, water capacity function, soil water hysteresis, model fitting, soil as a store of water for plant, kinds of soil water, soil moisture tension, soil water constants
3	Methods of Soil-Water Measurement	Destructive methods- gravimetric/thermo gravimetric method, Non-destructive methods- TDR, capacitance probe, Direct methods- gravimetric method, neutron moderation, Indirect methods- tensiometer, gypsum block, Electrical methods- TDR, capacitance probe
4	Soil-Water Movement: Steady and unsteady state flow	Flux, flow velocity, tortuosity, hydraulic conductivity, permeability and fluidity, relationship of hydraulic conductivity and permeability to pore geometry, principle of water movement in soils, Poiseuille's equation, Darcy's law, limitation of Darcy's law, flow through saturated soils, flow through unsaturated soils, diffusivity, movement of water under temperature gradient
5	Plant-Water Physiology	Soil-plant-atmosphere continuum, plant water content, rate of transpiration, energy relations, pressure relations, metabolism and water relations
6	Root Pressure Theories and Crop-Water Uptake Functions	Structure and function of roots, flow of water to plant roots, water requirements of plant, water relation of plant cell and tissues
7	Stomatal Response and Physical Models	Osmotic adjustment, stomatal response to moisture stress
8	Crop Response to Water	Water potential, evapotranspiration, environmental factors affecting evapotranspiration, plant factor affecting evapotranspiration, potential evapotranpiration
9	Stress Tolerance and Critical Stress Periods of Crops	Moisture stress, physiological aspects of water stress, practical aspect of water stress, water stress effects on yield

Recommended Text Books

1. Plant and Soil Water Relationship: A Modern Synthesis – Paul J. Kramer. McGraw-Hill Book Company, 1975.
2. Water and Plant Life: Problems and Modern Approaches – O.L. Lange, L. Kappen and E.D. Schulze. Berlin, Springer-Verlag, New York, 1976.

Supplementary Text Books

3. Plant-Water Relationship – R.O. Slatyer. Academic Press, London, New York, 1967.
4. Water, Soil and the Plant – E.J. Winter. The Macmillan Press Ltd. London, 1978.
5. Irrigation: Theory and Practice – A.M. Michael. Bikash Publishing House (Pvt.) Ltd., New Delhi, India, 1987.
6. Transactions of the American Society of Agricultural Engineers (ASAE).

7. Journal of Agricultural Engineering Research, The British Society for Research in Agricultural Engineering.
8. Agricultural Meteorology, Elsevier Science Publishers, Amsterdam, The Netherlands.
9. Agronomy Journal, American Society of Agronomy, USA.
10. Soil Science, The Williams and Wilkings Company, Baltimore, Maryland, U.S.A.
11. Plant Physiology, American Society of Plant Physiologists.

Course Title: Water Pollution and Environment

Course Code: MSIWM 1205 **Credit Hrs: 2**

Unit	Title	Lesson
1	Introduction to Hydrologic Cycle and Role of Water in the Environment	Water cycle, water in atmosphere, surface water and groundwater relation, effects of global warming on water cycle, water and environment, surface water management, changes in land and water use, effects of flood, effects of drought, need water for the environment, role of water for the environment
2	Sources of Water Pollution and Attenuation Techniques of Pollution	Water pollution, types of water pollution, sources of water pollution, causes of water pollution, effects of water pollution, how to prevent water pollution
3	Environmental Problems Due to Water Resources Development and Use	Problems of agriculture due to water resources development and use, top environmental issues (climate change, deforestation, over population, waste management) should make worry
4	Future Trends in Water Development and Management	Key trends in water development and management, key threats and challenges to develop water resource management
5	Water Quality and Environment Pollution	Pollution and how it affects water, global crisis of water pollution, environmental water quality, types of chemical contaminants, impacts of chemical contaminants on water, steps to minimize chemical contamination on water, biological contaminants, impacts of water quality on health
6	Environmental Impacts of Water Resources Projects	Impacts caused by dam and reservoir, Impacts caused by channelization projects, Impacts caused for dredging projects
7	Measurement of Environmental Variables	Temperature, rainfall, wind speed and wind direction, light intensity, evapotranspiration, drought index, solar radiation
8	Environmental Rules and Regulations	Environmental law in BD, sectoral laws, Environmental Conservation Act 1995, Environmental Conservation Rules 1997, Environmental Court Act 2010, Clean

		Water Act 1972, Safe Drinking Water Act 1974
9	Environmental Impact Assessment (EIA)	Define EIA, importance of EIA, Objectives of EIA, Advantages of EIA, Current EIA procedures in BD, key relevant terms in water quality management
10	Environmental Management for Irrigation and Drainage Projects	Need for environmental assessment, major impacts of irrigation and drainage projects, major problems of irrigation and drainage projects

Recommended Text Books

1. Environmental Water and Soil Analysis – P. R. Trivedi and Gurdeep Raj. Akashdeep Publishing House, New Delhi, 1992.
2. Environmental Impact Assessment – W. Larry Canter. 2nd edition, McGraw Hill Series in Water Resources and Environmental Engineering, 1995.

Supplementary Text Books

3. Environmental Impact Assessment of Irrigation and Drainage Projects – T.C. Dougherty and A. W. Hall. 53 FAO Irrigation and Drainage Paper, Food and Agriculture Organization of the United Nations, HR Wallingford, United Kingdom, 1995.
4. Environmental Management – Bala Krisnamoorthy. Prentice Hall of India Pvt. Ltd., 2005.
5. Manual for Environmental Impact Assessment – Ministry of Water Resources, Government of the Peoples Republic of Bangladesh, 1997.
6. Water and the Environment, Water Resources and Development Service, Land and Water Development Division, Food and Agriculture Organization of the United Nations, Rome, Italy, 1990.
7. Advances in Environmental Research, Elsevier Science Publishers, Amsterdam, TheNetherlands.

Course Title: **Integrated Water Resources Management (IWRM)**

Course Code: **MSIWM 1206** **Credit Hrs:** **2**

Unit	Title	Lesson
1	Fundaments of Integrated Water Resources Management (IWRM)	Definition and concepts of IWRM, IWRM from a basin perspective, Communication & Learning: Gender perspective
2	Principles of IWRM	Water policy mechanisms, water act, by-laws and managementplans
3	Strategies of IWRM	Availability, use and scarcity of water resources, resilience and adaptive capacity, social vulnerability and disaster management, conflicting issues and their management
4	Challenges in IWRM	Water and climate change, water and food security, water and energy nexus
5	Environmental issues in IWRM	Water pollution, health and sanitation, water and wetland ecosystem
6	Water Governance	Institutional setting and governance, water right and

		equity, multi-sectoral water demand allocation principles, integration of sectors/stakeholders
7	IWRM Tools and stakeholder analysis	Different tools and techniques, participatory planning, visioning, problem analysis, setting objectives and strategies, final planning

Recommended Text Books

1. Global Water Partnership, 2000. Integrated Water Resources Management. Technical Advisory Committee (TAC) Background Paper No. 4, GWP Secretariat, Stockholm, Sweden.
2. Das Gupta, A. et al, 2005. Water Sector of Bangladesh in the context of Integrated Water Resources Management: A Review. J. Water Resources Development, Vol. 21, No. 2, London.
3. Hooper, B. P., 2005. Integrated River Basin Governance: Learning from international experience, International Water Association, London, U.K.

Supplementary Text Books

4. Global Water Partnership & International Network of Basin Organizations, 2009. A Handbook of Integrated Water Resources Management in Basins. Elanders, Sweden. Web site- www.gwpforum.org.
5. Jonch – Clausen, T., 2004. IWRM and Water Efficiency Plans by 2005. GWP TAC Background Paper – 10. Stockholm, Sweden.
6. Global Water Partnership, 2014. Integrated Water Resources Mnagement in Central Asia: The Challenges of Managing Large Transboundary Rivers. GWP Technical Focus Paper. Web site – www.gwp.org.

Course Title: **Irrigation System Planning and Management**

Course Code: **MSIWM 2201** **Credit Hrs:** **2**

Unit	Title	Lesson
1	Introduction to irrigation system	Define irrigation system, benefits and problems of irrigation system management, types of farm irrigation system
2	Planning a farm for irrigation and data requirement	Planning and data requirement of climate, crop, soil, water source, energy and capital
3	Water source evaluation	Minimum expected source supply and source supply volume
4	Types of water supply	Diversion and pumping
5	Irrigation requirement	Design daily and seasonal requirements of an irrigation system
6	Irrigation system design capacity	Irrigation requirement at farm level and at source level, design fundamental and designing of an irrigation system
7	Water conveyance	Requirements of conveyance system, components of conveyance system, conveyance efficiencies
8	Irrigation system costs and reimbursement	Pump selection, costs involved in an irrigation system, comparative cost analysis of different pumps

	criteria	
9	Operation and maintenance of irrigation projects	Components for small scale pumped irrigation system, peak power and energy demand, power use efficiency
10	Choosing a new irrigation system	Choices design process of an irrigation system, preliminary design and decision for choosing irrigation system components, system capacity with design criteria, small-scale pumped irrigation scheme design: a small vegetable farm and a group scheme for paddy rice irrigation

Recommended Text Books

1. Principles of Farm Irrigation System Design – Larry G. James. John Wiley & Sons, 1993.
2. Irrigation of Agricultural Lands – R. M. Hagan, H.R. Haise and T.W. Edminster (eds.). American Society of Agronomy, 1967.

Supplementary Text Books

3. Irrigation Engineering and Hydraulic Structures – S.K. Garg. Khanna Publishers, New Delhi, India, 1998.
4. Irrigation Engineering and Hydraulic Structures – S.R. Shahasrabudhe. Katson Publishing House, Ludhiana, India.
5. Irrigation Water Management – Training Manual – M. Kay and Hatcho, FAO Land and Water Division, Rome, 1992.
6. Journal of Agricultural Water Management, Elsevier Science Publishers, Amsterdam, The Netherlands. Irrigation Science, Springer–Verlag, USA.

Course Title: **Drainage Engineering**

Course Code: **MSIWM 2202** **Credit Hrs:** **2**

Unit	Title	Lesson
1	Drainage and Crop Productions	Introduction to drainage and crop production, fundamentals of drainage systems, principles of drainage, crop responses to drainage
2	Drainage Problems in Bangladesh	Drainage issues in Bangladesh, Causes of drainage problems, technological interventions and solution
3	Drainage System	Types of drainage systems, design principles, components of drainage systems, hydrological considerations, maintenance and management
4	Theory, Design and Physics of Land Drainage	Theory of land, design principles, physics of land drainage
5	Drainage Investigation Methods	Remote sensing applications, geospatial analysis, soil and terrain analysis, data integration and decision support systems
6	Saturated and Unsaturated Flow	Introduction to saturated and unsaturated flow, theoretical background, hydraulic conductivity, flow characteristics and

	Theories and Their Applications	applications
7	Drainage for Salinity Control and Land Reclamation	Causes and effects of soil salinity, design and installation of drainage systems, integration of drainage with land reclamation, environmental and socio-economic considerations
8	Drain Tube Materials and Installation	Material types, installation methods, cost analysis, environmental impact
9	Design and Installation of Drain Envelop Materials	Drainage envelope materials: Types of drain envelope materials (e.g., geotextiles, drainage boards, composite drainage materials), properties and characteristics of each material; Design considerations: Factors influencing drain envelope design (e.g., soil type, slope, hydraulic conductivity), design standards and guidelines; Installation techniques: Pre-installation site preparation, installation procedures for different drain envelope materials, quality control measures during installation

Recommended Text Books

1. Land Drainage: Planning and Design of Agricultural Drainage Systems – K. Lambert Smedema and W. David Rycroft. BT Batsford Ltd., London, 1983.
2. Drainage Engineering – Jemes N. Luthin. Wiley Eastern Private Limited, 1966.

Supplementary Text Books

3. Drainage of Agricultural Lands – edited by James N. Luthin. Agronomy Vol. 7, American Society of Agronomy, USA, 1957.
4. Drainage of Agriculture – edited by Jan Van Schilfgaarde. Agronomy No. 17, American Society of Agronomy, USA, 1974.
5. Manual of Surface Drainage Engineering. – B. Z. Kinori. Vol I & II, Elsevier Scientific Publishing Company, NY. 1984.
6. Journal of Irrigation and Drainage Division - American Society of Civil Engineers (ASCE).
7. Irrigation and Drainage Papers – Food and Agriculture Organization of the United Nations.
8. Irrigation and Drainage Systems – An International Journal, Kluwer Academic Publishers.
9. Transactions of the American Society of Agricultural Engineering (ASAE).

Course Title: **River Engineering and Flood Management**

Course Code: **MSIWM 2203** **Credit Hrs:** **2**

Unit	Title	Lesson
1	Rivers Morphology and Flow	Classification, morphological processes of alluvial rivers, river flow equations
2	River Equilibrium	Regime theory, river bends and meandering

3	River Engineering	Navigation, dredging and bridge scour
4	Sediment Transport	Bed loads and suspended loads, sediment control measures
5	Modeling Techniques	Application of numerical methods and computer models in river hydraulics
6	Food and Its Estimation	Floods in Bangladesh, Estimation of design flood
7	Flood Control	Flood protection techniques, flood forecasting and warning, economics of flood control projects
8	Flood Management	Flood-plain management, flood management in Bangladesh

Recommended Text Books

1. Mechanics of Sediment Transport and Alluvial Stream Problems – R.J. Garde and K.H. Ranga Raju, Wiley Eastern Ltd. New Delhi, India.
2. Flood Control and Drainage Engineering – S.N. Ghosh. A. A. Balkema. Rotterdam, 1986.
3. River Engineering and Flood Protection – B. Z. Kinori and J. Mekorach. Elsevier Publishing Company, Amsterdam, 1984.
4. River Mechanics – Pierre Y. Julien. Cambridge University Press, 2002.

Supplementary Text Books

5. Hydraulics of Sediment Transport – W.H. Graf, McGraw Hill Book Company, New York.
6. Computational River Dynamics – Weiming Wu. Taylor & Francis, 2007.
7. Water Resources Engineering –R.K. Linsley and J.B. Franzini. MacGraw Hill-Book Company, New York, 1975.
8. Hydrology: Principles, Analysis and Design – H. M. Raghunath. Wiley Eastern Limited, 1985.
9. Irrigation Engineering and Hydraulic Structures – Santosh Kumar Garg. Khanna Publishing, New Delhi, India, 1998.
10. Handbook of Applied Hydraulics – C.V. Davis and T.E. Sorensen (eds.). McGraw-Hill Book Company, 1959.
11. Engineering Hydrology – K. Subramanya. Tata McGraw - Hill Publishing Company Limited, New Delhi, 1994.
12. Land and Water Management Engineering – V.V.N. Murty. Kalyani Publishers, New Delhi, Ludhiana, 1996.

Course Title: **Watershed Management**
Course Code: **MSIWM 2204** **Credit Hrs:** **2**

Unit	Title	Lesson
1	Introduction to Watershed Management	Concepts, principles and objectives of watershed management, importance of watershed management in Bangladesh
2	Hydrologic Cycle	Basic processes, forests in hydrologic cycle

3	Soil Erosion	Types, causes and agents of soil erosion, estimating soil erosion, effects of land use and land capability on watersheds
4	Soil Conservation Measures	Silvicultural operations, shifting cultivation
5	Forest in Watershed	Forest in watershed management, impacts of forests on the hydrological aspects, forestry practices affecting water quantity, quality and water balance
6	Planning for Watershed Management	Necessity, procedure, data requirements, economic analysis, preparation of watershed work plan
7	Integrated and Participatory Watershed Management	Classification, organization and institutional coordination, strategy and conceptual framework, participatory processes

Recommended Text Books

1. Watershed Management – L. R Khan. Field Document No. 44, UNDP/FAO-BGD/85/011, Inst. of Forestry, Chittagoan University, Bangladesh, 1991.
2. Land Use and Water Resources – H. C. Pereira. Cambridge Univ. Press, U.K., 1973.
3. Principles of Forest Hydrology – J. D. Hewlett. The University of Georgia Press, Athens, 1982.

Supplementary Text Books

4. Advances in Agroforestry – L. K. Jha. APH Publishing Corporation, New Delhi. India, 1995.
5. Watershed Management in Asia and the Pacific: Needs and Opportunities for Action. AS/85/017, Tech. Report, Food and Agriculture Organization of the United Nations, Rome, 1986.
6. Soil Conservation for Developing Countries. Soils Bull. No. 30, Food and Agriculture Organization of the United Nations, Rome, 1976.
7. Soil Conservation Needs in Bangladesh – D.Lazell. Food and Agriculture Organization of the United Nations, Rome, 1982.

Course Title: **Hydraulic Structures**

Course Code: **MSIWM 2205** **Credit Hrs:** **2**

Unit	Title	Lesson
1	Introduction to Hydraulic Structures	Types, properties and uses of hydraulic structures, importance of hydraulic design
2	Earth Dam and Rock Fill Dam	seepage control, stability and safety measures of earth dam and rock fill dam, Designing of earth dam and rock fill dam
3	Canal Head Works, Weir and Barrage	Design of canal head works, Design of weir and barrage
4	Control Structures	Design fall, regulators, canal escape, spillways, gate and lifting devices
5	Retaining Wall and Abutments	Design of retaining wall and abutments

Recommended Text Books

1. Theory and Design of Irrigation Structures – R. S. Varshney, S.C. Gupta and R. L. Gupta. 4th edition, Nem Chand & Sons, Roorkee, U.P. India, 1979.
2. Design of Low-head Hydraulic Structures. Water Resources Series No. 45, United Nations, 1973.

Supplementary Text Books

3. Irrigation Engineering and Hydraulic Structures – S.K. Garg. Khanna Publishers, Delhi, India, 1998.
4. Design of Small Dams. A Water Resources Technical Publication, 2nd edition, US Department of the Interior, Bureau of Reclamation, 1973.
5. Soil and Water Conservation Engineering – D. D. Fangmeier, W. J. Elliot, S. R. Workman, R. L. Huffman, G. O. Schwab. 5nd edition, John Wiley & Sons. Inc., New York, 2006.
6. Water Resources Engineering – R.K. Linsley and J.B. Franzini. 2nd edition. McGraw-Hill Book Company, New York, 1972.
7. Canals and Related Structure. Design Standards No. 3 U.S. Department of the Interior Bureau of Reclamation, Denver, Colorado, 1967.
8. Handbook of Applied Hydraulics – V. C. Davis, and K. Sorenson. 3rd edition, McGraw-Hill Book Company, New York, 1969.
9. Transaction of the American Society of Civil Engineers (ASCE).
10. Journal of Hydraulics Division, American Society of Civil Engineers (ASCE).

Course Title: **Remote Sensing and GIS in Water Resources**

Course Code: **MSIWM 2206** **Credit Hrs:** **2**

Unit	Title	Lesson
1	Introduction to Remote Sensing	Definition and Concepts of Remote Sensing, History of Remote sensing and GIS, Modern Remote Sensing Technology vs Conventional Aerial Photography, Remote Sensing Processes, Advantages of Remote Sensing, Limitations of Remote Sensing
2	Remote Sensing Applications	Applications of Remote Sensing Technology, Remote Sensing Sensors, Classification of Remote Sensing Sensors
3	Basic Principles of Photogrammetry	What is Aerial Photograph? Types of Aerial Photos, Basic Geometric Characteristics of Aerial Photographs
4	Stereoscopy, Photogrammetry, Image Interpretation and Radar Systems	Definition of Stereoscopy, Stereoscopic Vision, Stereoscopes, Visual Image Interpretation of Photographs and Images, Elements of Visual Interpretation, Real Aperture Radar, Synthetic Aperture Radar
5	Introduction and Application of GIS	Definition, Components, Contributing Disciplines, Work Flow, Standard Software, Applications of GIS, Map Projection System
6	GPS and its application	Components of GPS, How GPS Works? GPS Error, Sources of Error, Application of Global Positioning System
7	Land Use and Land Cover Mapping and Change Detection	Land Cover Mapping, Land use and Land Cover Change Detection
8	Soil Mapping and Soil Erosion Estimation	Soil Mapping, Soil Erosion Estimation and Best Management Practices
9	Water ResourcesDevelopment and Management	Water Resources Development: Space Technology Perspective, Water Resources Management issues through Space Technology: Rainfall, Irrigation management, Reservoir capacity monitoring, Ground water prospecting, Natural calamities; Future perspective; Application areas of Remote Sensing in Agricultural Engineering

Recommended Text Books

1. GIS for Water Resource and Watershed Management – John G. Lyon. CRC, 2002.
2. Arc Hydro: GIS for Water Resources – David R. Maidment. ESRI Press, 2002.

Supplementary Text Books

3. Modeling Our World – M. Zeiler. ESR Press, 1999.
4. Groundwater Modeling Using Geographical Information Systems – George F. Pinder. 1st edition, John Wiley & Sons. Inc., 2002.

School of Agriculture and Rural Development
Bangladesh Open University

Master of Science (MS) in Aquaculture

1. Requirement for registration: Bachelor of Science in Fisheries (Hon's) or related disciplines from any recognized University
2. Duration: One and a half ($1\frac{1}{2}$) years (Registration valid for three consecutive years)
3. Semester: Three Semesters (Valid up to consecutive six semesters), two semesters in a year each of six (6) months:
4. No. of courses = 12
5. No. of credits = 40
6. Total Marks = 2000

Distribution of courses, credits and marks

MS in Aquaculture shall be offered with 40 credits in 3 semesters each of six months duration. The courses worth 24 credits of which 12 credits shall be offered during the first semester and the other 12 credits during the 2nd semester respectively for the students. Another 16 credits shall be reserved for the research (thesis and thesis defense). The students have to start their research work for thesis (equivalent to 6 courses) under the guidance and supervision of his/her Research Supervisors after the completion of one semester and the same shall be carried through to the last semester when it will be evaluated. After the evaluation of thesis the students have to face thesis defense (equivalent to 2 courses). The distribution of courses, credits and marks are shown below:

	Course Type	No. of Courses	Credits	Marks
	Course (compulsory)	12	24	1200
Research	d) Thesis	equivalent to 6 courses	12	600
	b) Thesis defense	equivalent to 2 courses	4	200
	Total		**40**	**2000**

N.B. 1 course = 2 credits = 100 marks; Thesis =12 credits = 600 marks, Thesis defense (4 credits) = 200 marks: Each course will carry 80 marks for theoretical examination and 10 marks for one course assignment and 10 marks for class attendance.

Course layout for MS in Aquaculture

1st Semester

Sl.	Courses Title	Course code	Credit Hours	Marks
1	Advanced Freshwater Aquaculture	MSAQ 1201	2	100
2	Aquatic Animal Health Management	MSAQ 1202	2	100
3	Aquafarm Operation	MSAQ 1203	2	100
4	Advanced Aquaculture Feed Technology	MSAQ 1204	2	100
5	Mariculture	MSAQ 1205	2	100
6	Culture of Fish Food Organisms	MSAQ 1206	2	100
	Total 6 courses		**12**	**600**

2nd Semester

Sl.	Courses Title	Course code	Credit Hours	Marks
1	Advanced Coastal Aquaculture	MSAQ 2201	2	100
2	Integrated Aquaculture	MSAQ 2202	2	100
3	Aquaculture Nutrition	MSAQ 2203	2	100
4	Advanced Fish Pathology	MSAQ 2204	2	100
5	Aquarium Fish Culture	MSAQ 2205	2	100
6	Mangrove Aquaculture	MSAQ 2206	2	100
	Total 6 courses		**12**	**600**

3rd Semester

Sl.	Courses Title	Course code	Credit Hours	Marks
1	Thesis	MSAQ 3121	12	600
2	Thesis defense	MSAQ 3042	4	200
	Thesis + Thesis defense		16	800
	Grand Total	**(12×2) +16 = 40 (Forty)**		**2000**

Syllabus for MS in Aquaculture

Course Title: **Advanced Freshwater Aquaculture**

Course Code: **MSAQ 1201** **Credit Hrs: 2**

Unit	Lesson
1	Importance of fresh water aquaculture, present status and future potentials and recent advances in aquaculture
2	Culture of Indian Major Carps (Rui, Catla, Mrigal, Baus) and Their Hybrids
3	Culture of Endangered Species (Mohashoal, Shor Punti, Nandin)
4	Culture of Exotic Fishes (Silver carp, Bighead carp, Black carp, Common carp, Tilapia, Raj punti)
5	Culture of Catfishes (Magur, Shingi, Air, Pangus, Gulsha, Pabda, Rita and Bagair)
6	Culture of Frogs, Turtles and Molluscs
7	Culture of *Macrobrachium* sp.
8	Open Water Fish Culture : Cage, pen and raceway aquaculture ponds etc
9	National Fish Culture Policy of Bangladesh

Recommended Textbooks

1. Islam, M.A. 1979. Nana Deshe Macher Chash, Bangla Academy.
2. Jhingran, V.G. 1977. Fish and Fisheries in India. Hindustan Publishing Crop. Delhi.
3. Pillays, T.V.R. 1991 Aquaculture Principles and Practices. Fishing News Books, Blackwell Scientific Publications Ltd. Osney Meal, Oxford OX2 OEL UK 592 pp.
4. Huet, M. 1979. Text Book of Fish Culture: Breeding and cultivation of fish, Farming News Book Ltd. Faraham Surry, England.

Supplementary Textbooks

5. Islam, M.A. 1977. Matsya Chash, Ananda Press, Mymensingh.
6. Bardach, J.E., J.H. Ryther and H.O. Mclarney. 1972. Aquaculture, John Willey and Sons. Inc. New York.
7. FAO (Food and Agricultural Organization). 1990. Farming Systems. Developments. Guidelines for conduct of Training courses in farming systems development. FAO, United Nation.
8. Muir, J.F. and R.J. Roberts, (eds.), 1982. Recent Advances in Aquaculture, Vol. I. II, III and IV Croon Heln. London.
9. Joseph, M.M. (ed.) 1990. Aquaculture in Asia. Asian Fisheries Society, Indian Branch, Bangladesh, pp. 398.
10. Breverage, M.C.M. 1987. Cage Culture. Fishing News Book, Surry UK.

Course Title: **Aquatic Animal Health Management**

Course Code: **MSAQ 1202** **Credit Hrs: 2**

Unit	Title	Lesson
1	Introduction	General significance of disease in aquatic organisms, the relationship among host, aquatic environment, pathogens and disease, disease and stress adaptation with their control
2	Disease Diagnosis	Gross, clinical and laboratory diagnosis of fish and shellfish diseases
3	Shrimp Health Maintenance	Effects of intensification on shrimp health relationship between shrimp health and pond environment and their management
4	Chemotherapy	Chemotherapeutants including antibiotics commonly used in aquaculture, selection of drugs, mode of actions and their application for the control of diseases in aquaculture, resistance of fish pathogenic bacteria to different antibacterial agents, residual effects of drugs on the aquatic environment
5	Epidemiology	Concept, cause and disease frequency, natural history of a disease, population definition, timing of disease events, types of epidemiological studies
6	Ulcer Diseases	Types of ulcer diseases in fish, status of EUS, histology, actiology, prevention and control of ulcer diseases in fish
7	Fish Health Control	Management techniques for fish health control, quarantine and prevention of diseases in aquatic organisms, vaccination

Recommended Textbooks

1. Woo, P.T.K. and D.W. Bruno, 1999. Fish Diseases and Disorders (Vol.3). CABI Publishing.
2. Treves-Brown, K. 1998. Applied fish Pharmacology. Aquaculture Series. Chapman & Hall.
3. Egusa, S. 1992. Infectious Diseases of Fish. Oxonian Press Ltd. New Delhi, Argent: B-INFE-DF.
4. Roberts, R.J. 1989. Fish Pathology (2nded). Baillere Tindall, London.

Supplementary Textbooks

5. Brown, L. 1994, Aquaculture for Veterinarians: Fish Husbandry and Medicine. Pergamon Press. Oxford.
6. Plumb, J.A. 1994. Health Maintenance of Cultured Fishes: Principal Microbial Diseases. Argent: B-HEAL-MCF.
7. Thrusfield, M. 1995. Veterinary Epidemiology (2nd Ed). The University Press, Cambridge.
8. Charnatchkool, P., J.F. Turnbul and C. Limsuwen 1996. Health Management in Shrimp Ponds (3rd Ed). AAHRI, Kasetsurt University Campus, Bangkok.
9. Austin, B. and D.A. Austin. 1999. Bacterial Fish Pathogens: Diseases in Farmed and Wild Fish (3rdEd). Ellis Horwood, England.
10. Gudding, R., A. Lillenaug, P.J. Midtlyng and F. Brown 1997. Fish Vaccinology. Development of Biological Standardization, Karger.
11. Thoesen, J.C. (Editor). 1994. Bluebook: Suggested Procedures for the Detection and Identification of Certain Finfish and Shellfish Pathogens, AFS. Fish Health Section (4thEd). Argent. B-BLUE-SPD.

Course Title: **Aquafarm Operation**

Course Code: **MSAQ 1203** **Credit Hrs: 2**

Unit	Lesson
1	Criteria for site selection of different types of aquafarms and hatcheries
2	Aquarfarm and hatchery layout (finfish, shrimp and prawn) with different components including infrastructure, problems in existing aquafarms and hatcheries in Bangladesh and their possible improvements
3	Aquaculture Systems: Ponds, tanks and raceways, cages, pens, recirculation and flow through systems
4	Aeration-oxygen transfer processes, different kinds of aerators used in different aquaculture systems
5	Water supply and water quality management, sedimentation, filtration and disinfection in different aquafarms and hatcheries
6	Aquafarm and hatchery waste management, feed delivery systems used in aquaculture
7	Investment appraisal of aquafarm operation, return on investment, internal rate of return, cost-benefit analysis
8	Preparation of profitable aquaculture project profile

Recommended Textbooks

1. Barnabe, C. 1990. Aquaculture. Vol. I & II. Ellis Horwood Ltd. New York, USA.
2. Bose, A.N., S.N. Ghose, C.F. Yabag, A. Mitra, 1991. Coastal Aquaculture Engineering. Cambridge University Press, Cambridge, UK.
3. Huet, M. 1979. Text Book of Fish Culture. Fishing News Books, London, UK.
4. Pillay, T.V.R. 1993. Aquaculture Principles and Practices. Fishing News Books, London, UK.

Supplementary Textbooks

5. Lawson, T.B. 1995. Fundamentals of Aquacultural Engineering. Chapman and Hall, An International Thomson Publishing Companay, New York, USA.
6. Breverage, M.C.M.1987. Cage Aquaculture. Fishing News Book Surry, UK.
7. Coche, A.G. and J.F. Muri, 1992. FAO Training Service, Simple Methods for Aquaculture, FAO, UNO, Rome, Italy.
8. Gray, C.W. 1990. A guide to Shrimp and Prawn hatchery Techniques in Bangladesh. BAFRU, IOA, University of Stirling; Scotland, UK.
9. Huguenin, J.E. and J. Colt, 1989. Design and Operating guide for Aquaculture Seawater Systems. Development in aquaculture and fisheries science, 20. Elsvier, Amsterdam.
10. Jhingran, V.G. and R.S.V. Pullin, 1985. A Hatchery Manual for the common and Indian carps. ICLARM, Manila.
11. Mott, G. 1993. Investment Appraisal. Pitman Publishing Longman Groups UK Ltd.
12. Muir. J.F. and R.J. Roberts (eds.) 1982. Recent Advances in Aquaculture. Vol. I. Croon Helam, London, UK.
13. Nelson, K.D. 1985. Design and Construction of Earthen Dams. Inkarta Press, Melbourne.
14. Shephard, C.J. and N.R. Bromage, (eds.) 1988. Intensive fish farming Oxford, UK. Blackwell Sci. Pub.

15. Wheaton, F.W. 1985. Aquaculture Engineering. Robert E. Kriger Publications, Florida, USA.

Course Title: Advanced Aquaculture Feed Technology

Course Code: MSAQ 1204 **Credit Hrs: 2**

Unit	Lesson
1	Feed Stuffs: Conventional and unconventional feed stuffs, dietary ingredients available in Bangladesh, proximate composition of dietary ingredients, naturally occurring and adventitious toxins feed stuffs
2	Non-nutrient dietary components, water, hormone, antibiotics, fibers, binders, antioxidants, pigments and feeding stimulants
3	Feed Formulation, Preparation and Processing-Supplementary and Complete Diets : Feed formulation and preparation for culturable species, feed milling processes, effect of processing on the nutritional value of feed, quality control in feed manufacture, manufacture of compounded feeds in developing countries, microencapsulated diets for larval rearing
4	Digestibility Study of Fish Feed: Digestion co-efficient, determination of nutrient digestibility, apparent and true digestibility, factors affecting vv digestibility
5	Feeding Methods for Supplementary and Complete Diets : Selection of feed ingredients, feed preparation for supplemental and complete feeding
6	Techniques and Methodologies for Fish Feeding Experiments: Control environmental studies and field studies

Recommended Textbooks

1. Balkema, A. A. (Publisher). 1993. Fish Farming Technology. (Reinertsen, H., L., A. Dahle, L. Jqrgensen and K. Tvinnerein. Editrs). Brookfield, USA. 482pp. (eds.).
2. Aquaculture Development and Co-ordination Program. 1983. Fish feeds and feeding in Development Countries, ADCP/REP/83/18. UNDP/FAO, 97, pp.
3. Cowey, C.B., M.A. Mackie, and J.G. Bell, (eds), 1985. Nutrition and Feeding in Fish, Academic Press, Inc. (London) Ltd. London, 489 pp.
4. Lovell, T. 1989. Nutrition and Feeding of Fish. Van Nostrand Reinhold, New York, 260 pp.

Supplementary Textbooks

5. New, M.B., A.G.J. Tacon and I. Csavas (eds.). 1993. Farm-Made Aquafeeds. Proceedings of the Regional Expert Consultation on Farm-Made Aquafeeds, 14-18 Dec. 1992, Bangkok, Thailand. Prayurawong printing, Bangkok, Thailand. 434 pp.
6. Akiyama, D.M. and R.K.H. Tan, (eds.). 1991. Proceedings of the Aquaculture Feed Processing and Nutrition Workshop, American Soybean Association, Singapore 923, 241 pp.
7. Association of official Analytical Chemists. 1984, Official Methods of Analytical of the Association of official Analytical Chemists, AOAC, Washington DC, 1015.
8. Mozafar, A. 1994. Plant Vitamins-Agronomic, Physiological and Nutritional Aspects. CRC Press, Inc., Florida, USA, 412pp.
9. D Mello, J.P.F., C.M. Duffus and J.M. Duffus. 1991. Toxic Substances in Crop plants. The Royal Society of Chemistry, Cambridge, England. 339pp.

Course Title: **Mariculture**
Course Code: **MSAQ 1205** **Credit Hrs: 2**

Unit	Title	Lesson
1	Mariculture	Economics, principles of mariculture, history, present status and prospect in Bangladesh
2	Culture of Sea Weeds	Red algae, green algae, brown algae and kelp culture
3	Culture of Molluses	Oyster, pearl, scallop, abalone, clam, mussel, green snail and cattle fish
4	Culture of Crustaceans	Culture of shrimps, lobsters and crabs
5	Culture of Finfish	Flatfish, yellow tail and sea bass
6	Culture of Miscellaneous Organisms	Sea cucumber, sea urchin, sea turtle, green turtle and soft shelf turtle

Recommended Textbooks

1. Islam, M.A. 1988. Shomudra Upakule Macher Chash, 115 p. Bangla Academy, Dhaka.
2. Inverson, E.S. 1967. Farming the Edge of the Sea. Fishing News (Books) Ltd. London.
3. Shokita, S.K. Kakazu, A. Tomori and T. Toma, 1991. Aquaculture in Tropical Area. Midori Shobl Co. Ltd., Japan.
4. Novey, J. and J. Moore 1983. CRC Hand book of Mariculture. Vol. I. Crustaceans Aquaculture.

Supplementary Textbooks

5. Bardach, J.E.,J. Ryther and W.O. McLarney, 1972. Aquaculture: The Farming and Husbandry of Freshwater and Marinewater organisms: A Wiley-Interscience Publication; John Wiley and Sons, New York, USA.
6. Islam, M.A. 1979. Nana Deshe Macher Chash, Bangla Academy, Dhaka.
7. Lee, D.O.C. and J.F. Wickne 1991. Crustacean Farming. Blackwell Scientific Publication Ltd. Oxford, London.
8. Laevastu, T. and I. Hela. 1970. Fisheries Oceanography: New Ocean Environmental Sercices. Fishing News (Books) Ltd. London.
9. ODA. 1988. Buffalo/Fish and Duck/Fish Integrated System for small-scale Farmer at the family level. 130 p. AIT. Bangkok, Thailand.
10. Stirling. H.P. 1985. Chemical and Biological Methods of Water Analysis for Aquaculture. IAU, US. 119,p.

Course Title: **Culture of Fish Food Organisms**

Course Code: **MSAQ 1206** **Credit Hrs: 2**

Unit	Lesson
1	Scope, history, importance, present and future prospect of fish food organisms
2	Culture of Phytoplankton: Enriched fresh and sea water media, isolation sterilization techniques for culture of phytoplankton, particular emphasis of Bacillariophyceae, Haptophyceae, Chlorophyceae and Dinophyceae, growth dynamics, problems and review of different methods used in various countries
3	Culture of Zooplankton: Water quality behaviour, feeding ecology, technique for culture of zooplankton particular emphasis on ciliated, copepods, rotifers and cladocerans
4	Culture of Artemia, tubifiscids, earthworms and snails
5	Culture of Micro-organisms: Preparation of media, isolation techniques, culture methods of important fish feed micro-organisms (yeast, fungi and bacteria), preparation of media, isolation techniques
6	Preservation and storage of cultured fish food organisms, economics of culture of fish food organisms

Recommended Textbooks

1. Fogg, G.E. 1965. Algal culture and phytoplankton ecology. University of Wiscon Press.
2. Spotte, S. 1970. Fish and Invertebrate Culture water management in closed systems. Willey-Interscience. New York.
3. Collins, C.H. and P.M. Lyne, P.M. 1976 Microbiological Methods, Butter worthies, London.
4. Sneath, P.H.A. 1984, Bergeys Manual of Systematic Bacteriology, Vol. I. N.R. Krieg. (eds.) Williams and Wailkins, Baltimore, London.

Supplementary Textbooks

5. Omori, M. and T. Jkeda. 1984. Methods in Marine Zooplandton Ecology, John Willy & Sons, 332 pp.
6. Jorgensen, C.B. 1988. Biology of Suspension feeding. Pergamon Press, London, 357 p.
7. MoVey, J. and J. Moore, 1983 CRC Hand Books of Mariculture. Vol. I. Crustacean Aquaculture.
8. Sorgoos. P., G., Persoone, M. Baeze-Mesa, E. Bossuyt, and E. Bruggemen, 1978. The use of Artemia Cysts in aquaculture: the concept of “Hatchin Efficiency” & description of a new method for cysts processing in Proc, The Annual Meeting World Mariculture Society. Avault, J.W., jr. Ed. Louasiana State University, Eaton, Reugela, 715 p.

Course Title: **Advanced Coastal Aquaculture**

Course Code: **MSAQ 2201** **Credit Hrs: 2**

Unit	Lesson
1	Present status and prospect of coastal aquaculture, problems of coastal aquaculture in Bangladesh, coastal aquaculture and the environment
2	Cultivable species of fishes, crustaceans and molluscs in coastal region of Bangladesh
3	Design, construction and management of brackish water fish and shellfish farms
4	Culture of live food for fish and shellfish larvae
5	Fish and shellfish seed production
6	Collection and transportation of natural fish and shellfish seed and its impact on coastal aquaculture
7	Aquaculture techniques of commercially important fish and shellfish of Bangladesh, sea bus *Lates, calcalifer, Mugil cephalus, Liza parsia, Macrobrachium and Penaeus*
8	Pest and predators in coastal aquaculture in Bangladesh
9	Handling, marketing and processing of coastal fish and shellfishes

Recommended Textbooks

1. Islam, A. 1988. Samudra Upakule Matsye Chash. Bangla Academy.
2. Pillay. T.V.R. 1973. Coastal Aquaculture in the Indo pacific region. Fishing News (Books) Ltd. London.
3. Chen, L.C. 1990. Abalone culture. In; *Aquaculture in Taiwan*, Fishing News Books.
4. Siddiqi, N.A. Islam, M.R. Khan, M.A.S. and Shahidullah, M. 1993. Mangrove Nurseries in Bangladesh. Mantigrove Ecosystems Ocasional Papers number 1. International Society for Mangrove Ecosystems.

Supplementary Textbooks

5. Imai, T. 1977. Aquaculture in shallow seas. Progress in shallow sea culture. Amerind publishing Co. Pvt. Ltd. New Delhi.
6. Acosta, B.O. and Pullin, T.S.V. 1989. Environmental impact of the golden snail (*Pamacea sp.*) on rice farming systems: the Philippines ICLARM conference proceedings 28 ICLARM, Manila, Philippines. 34 pp.
7. Barg, U.C. 1992. *Guidelines for the promotion of environmental management of coastal aquaculture development*. FAO Fisheries. Technical Paper 328. Food and Agriculture Organization of the United Nations, Rome.
8. Choo. P.S. 1983. *Mussel Culture* SAFIS Extension Manual Series No. 3. Southeast Asian Fisheries Development Centre in cooperation with the International Development Research Centre.
9. FAO, 1982. *Management and utilization of mangroves in Asian and the Pacific*. FAO Environment paper 3. Food and Agriculture Organization, Rome.
10. Haider, R. Rahman A. A. and Huq, S. (editors) 1991. *Cyclonel 1991 An environmental and perceptional study*. Bangladesh Centre for Advanced Studies.
11. Quale, D.B. 1980. Tropical oysters: Culture and methods. Ottawa, out. IDRC-TS 17 e.
12. Shigueno, K. 1975. Shrimp culture in Japan. Association for International Technical Promotion Tokyo, Japan.

13. Sitoy, H.S. Uoung, A.I. and Tabbu, M.Y. 1983. Raft Culture of Mussels. Extension Manual No. 8. Aquaculture Department, Southeast Asian Fisheries Development Center, Philippines.
14. Utting. S.D. and Spencer, B.E. 1991. *The Hatchery culture of bivalve mollusc larvae and juveniles*. Laboratory leaflet number 68. Directorate of fisheries research, Lowerstoft. MAFF.

Course Title: Integrated Aquaculture

Course Code: MSAQ 2202 **Credit Hrs: 2**

Unit	Lesson
1	Concept of integrated aquaculture and its importance, present status and prospects
2	Integrated Systems: (a) Crops-Animal-Fish; (b) Crop-Livestock-Fish; (c) Waste-Aquaponic Plant; and (d) Human Wastes-Fish-Plant
3	System Environment: Effects of wastes on fish pond, autotrophic and heterotrophic pathways; role of integration on fish production, waste loading and changes in environmental quality
4	Management of Waste Fed Ponds: Addition of wastes, stocking and harvesting procedure and maintaining environmental conditions
5	Economic and Resource Assessment: The effect of value of resource on integration, the economics of using waste in aquaculture, integrated use of land and water in aquaculture, social consideration and energy budgeting and nutrient transfer

Recommended Textbooks

1. Little, D and J. Muir, 1987. A guide to Integrated Warmwater Aquaculture, University of Stirling.
2. Edmods, P., K. E. MoCoy and C. Chantachaeng., 1986. Pilot small-scale crop/livestock/fish integrated farm 131 p. AIT Bangkok, Thailand.
3. Ruddle, K. and G. Zhong. 1988. Integrated Agriculture in South China. Cambridge University press, New York.
4. Martyshov, F.G. 1983. Pond Fisheries 454 p. Amerind Publishing Co. Pvt. Ltd. New Delhi, Bombay, Calcutta, India.

Supplementary Textbooks

5. Islam. M.A. 1985 Macher Chash Bebhastapana, 277p. Bangla Academy, Dhaka.
6. Islam. M.A. 1985 Shomudra Upakule Macher Chash, 115p. Bangla Academy, Dhaka.
7. Islam. M.A. 1985 Nana Deshe Macher Chash, 174p. Bangla Academy, Dhaka.
8. Islam. M.A. 1985 Macher Pukurer Pani, 229p. Bangla Academy, Dhaka.
9. Muir, J.F. and R.J. Robert, 1982. Recent Advances in Aquaculture, Vol. 3, Beckenham U.K. Croon helm. London 420 pp.
10. Shigeno, K. 1975. Shrimp culture in Japan. Association of International Technical Promotion Tokyo, Japan. 153 pp.

Course Title: **Aquaculture Nutrition**

Course Code: **MSAQ 2203** **Credit Hrs: 2**

Unit	Lesson
1	Importance of fish nutrition in aquaculture
2	Nutrients: a) Protein and amino acid, general, synthesis and deposition in fish amino acid metabolism, utilization of synthetic amino acid, biological availability of essential amino acid; b) Fat: General, fat and fatty acid metabolism, digestion, absorption, deposition and transportation of fat; c) Carbohydrate: General requirement and digestibility of carbohydrate; d) Energy: General, digestible and metabolizable energy ratio, specific dynamic action (SDA), energy contents of various foodstuffs; e) Fibre: General, digestibility and importance of fibre; f) Vitamin: General, recent advances in vitamin nutrition and metabolism in fish; g) Mineral: Major and minor elements, functions, mineral nutrition and metabolism with special emphasis in calcium and phosphorus
3	Digestive Enzymes and Their Role in Digestion: Proteinase, lipases, carbohydrase and other digestive enzymes
4	Recommended dietary nutrient specifications for cultureable species of fish and shrimp
5	Broodstock nutrition

Recommended Textbooks

1. Halvor, J.E. (ed.) 1989. Fish Nutrition, Second Edition. Academic press, Inc., California, 788 pp.
2. Steffens, W. 1989. Principles of Fish Nutrition. John Wile & Sone; New York.
3. Cho, C.Y., C.B., Cowey, T. Watanabe, (Ed). 1985. Finfish Nutrition in Asia: Methodological Approach to Research and Development. International Development Research Centre, Ottowa, Ont. 154 pp.
4. Kaushik, S.J. and P. Luguet, (Ed). 1993. Fish Nutrition in Practice. INRA, Paris, 972 pp.

Supplementary Textbooks

5. Hepher, B. 1988. Nutrition of Pond Fishes. Cambridge University Press, Cambridge, U.K. 38 pp.
6. Cowey, C.B. Mackie, M.A. and Bell, C.G. (Editors). 1905. Nutrition and Feeding in Fish. Academic Press, Inc. (London) Ltd. London, 499 pp.
7. De Silva, S.S. (Ed). 1991. Fish Nutrition Research in Asia. Asian. Fish Soc. Spec. Pub, 5, Asian Fisheries Society, Manila, Philippines 200 pp.
8. Muir, J.F. and R.J. Roberts (Ed). 1982. Recent Advances in Aquaculture. Vol. I. Croon Helm. London, 453 pp.
9. National Research Council. 1983. Nutrient Requirements of Warmwater Fishes and Shellfishes. National Academy of Sciences, Washington D.C. 102 pp.
10. Tytler, P, and P. Calow, (Ed). 1985. Fish Energetic New Perspective. Croom Helm. London, 343 pp.

Course Title: **Advanced Fish Pathology**

Course Code: **MSAQ 2204** **Credit Hrs: 2**

Unit	Lesson
1	Advanced knowledge of cell death, epizootiology, degree of infection, inflammation, neoplasm and immunopathology in fish
2	Systemic Pathology of Teleosts: Pathological changes in different organs of fish by infections and non-infectious diseases
3	Viral Diseases of Fish: Pathology epizootiology, pathogenesis, isolation and identification, transmission and maintenance of fish pathogenic viruses
4	Bacterial Fish Diseases: Pathology, epizootiology, pathogenesis. Experimental infections. Challenge test with pathogenic bacteria
5	Mycotic Disease of Fish: Fungi responsible for significant diseases in aquaculture, pathology epizootiology, pathogenesis and experimental infection of fishes, with pathogenic fungi
6	Shrimp Diseases: Infections agents including virus, bacteria and fungi, non-infectious diseases including toxic syndromes

Recommended Textbooks

1. Roberts, R.J. 1988. Fish Pathology (2nd Ed.). Bailliere Tindall, London, UK.
2. Woo. PT.K. and D.W. Bruno. 1999. Fish Diseases and Disorders (Vol.3), CABI Publishing.
3. Ferguson, H.W. 1989. Systemic Pathology of Fish. Iowa State University Press. Ames, Iowa, USA.
4. Egusa, S., 1991. Infectious diseases of fish. Oxonian press Ltd., New Delhi.

Supplementary Textbooks

5. Ken Wolf. 1988. Fish Viruses and fish viral diseases (1st Ed.)
6. Inglis, V., R.J. Roberts and N.R. Bromage (Eds). 1993. Bacterial diseases of fish. Blackwell Scientific Publ., Edinburgh, U.K.
7. Bruno D.W. and T.T. Poppe. 1996. A colour atlas of Salmonid Diseases. Academic Press. London.
8. Plumb, A. 1994. Health maintenance of culture fishes: Principal microbial diseases. CRC Press, Inc.
9. Austin, B. and D.A. Austin. 1999. Bacterial Fish Pathogens: Diseases in farmed and wild fish (3rd Edition). Ellis Horwood, England.
10. Chanratchakool, P., J.F. Turnbull and C. Limsuwan. 1996. Health Management in Shrimp ponds. AAHRI, Kasetsart University Campus, Jatujak, Bangkok, Thailand.

Course Title: **Aquarium Fish Culture**
Course Code: **MSAQ 2205** **Credit Hrs: 2**

Unit	Lesson
1	History and importance of aquarium fish culture, important species (indigenous and exotic)
2	The Aquarium: Types and size, preparation, photosynthesis, decomposition and aeration
3	Maintenance of the Aquarium: Biological filter and water exchange, handling of aquarium species, biological filters pruning and manuring plants, removing dust and sediments, disinfection
4	Food and Feeding: Life food, balanced artificial feed, feeding regime, waste removal
5	Breeding of Aquarium Species: Brood selection, conditioning, breeding, fry rearing
6	Showing: Choosing and preparing fish for show, show standards
7	Health management of aquarium fishes

Recommended Textbooks

1. G.E. Hervey, and J. Hems. 1965. Freshwater tropical fishes. Spring Books. London.
2. Dick, M. 1992. Tropical Aquarium Fishes, How to keep freshwater fish, Chancellor Press, London.
3. Roherts. R.J. 1989. Fish Pathology, Bailliere Tindall, London.

Supplementary Textbooks

4. Islam, M.A. 1985. Macher Roog, Bangla Academy, Dhaka.
5. Islam. M.A. 1985 Macher Pokurer Pani, 229 p. Bangla Academy, Dhaka.

Course Title: **Mangrove Aquaculture**

Course Code: **MSAQ 2206** **Credit Hrs: 2**

Unit	Lesson
1	Mangrove Resources: Flora and fauna, fauna, importance, present status and prospect of mangrove aquaculture in Bangladesh
2	Aquafarm practices and management in mangrove areas
3	Utilization of mangrove areas for aquafarms
4	Mangrove dependent fisheries in Sundarban areas with special reference to cultivable species
5	Sustainable exploitation of the mangroves for aquaculture in Bangladesh
6	Role of mangrove plant as nursery ground of important cultivable species of fisheries importance
7	Factors affecting the recruitment of fish and shellfish in mangrove areas
8	Management of acid sulphate soil for aquaculture operation
9	Integration of mangrove aquaculture with agriculture, livestock and wildlife

Recommended Textbooks

1. Imai, T. 1977. Aquaculture in Shallow seas. Progress in shallow sea culture. Amerind publishing Co. Pvt. Ltd. New Delhi.
2. Lee, D.O.C. and J.F. Wickens, 1992. Crustacean farming Oxford; Blackwells Scientific.
3. Milne, P.H. 1979. Fish and shellfish farming in coastal water. White friars press Ltd. London and Tonbridge.
4. Bailey, C., S. Jentoft and P. Sinclair eds. 1996. Aquaculture development: Social dimensions of and emerging industry. Boulder, Co. U.S.A. Westview Press.

Supplementary Textbooks

5. Bandayopadhyay, A.K. and T.S. Sinha. 1985. Rice Cultivation in coastal saline soils. Inf. Brochure cent. Soil Salin. Res. Inst. Karnal, 10; 1-11.
6. Brinkuman, R. and V.P. Singh. 1982. Rapid reclaimation of fish ponds on acid sulphate soils. In: Proceedings of the Bangkok Symposium of acid sulphate soils edited by H. Dost and N. Vam breeman. Publ. Inst. Land Reclam. Improve. Wageningen, 31: 318-330.
7. Primavera, J.H. 1995. Mangroves and brackishwate Pond culture in the Philippines Hydrobiologia 295 (1-3); 303-309.
8. Shang, Y.C. 1981. Aquaculture economics: basic concepts and methods of analysis. Boulder, C.A. U.S.A. Westview Press.
9. Shigueno, K. 1975. Shrimp Culture in Japan. Association for International Technical Promotion Tokyo, Japan.
10. Smith, P. 1993. Prawn farming in Australia. Sediment is a major issue, Australian fisheries, 52 (12): 29-32.

School of Agriculture and Rural Development
Bangladesh Open University

Master of Science (MS) in Poultry Science

1. Requirement for registration: Bachelor of Science in Animal Husbandry or Bachelor of Science in Veterinary Science & Animal Husbandry degree from any recognized University
2. Duration: One and half ($1\frac{1}{2}$) years (Registration valid for three consecutive years)
3. Semester: Three Semesters (Registration valid up to consecutive six semesters)
4. Two semesters in a year each of six (6) months (January-June/July-December)
5. No. of courses = 12
6. No. of credits = 40
7. Total Marks = 2000

Distribution of courses, credits and marks

MS in Poultry Science shall be offered with 40 credits in 3 semesters each of six months duration. The courses worth 24 credits of which 12 credits shall be offered during the first semester and the other 12 credits during the 2nd semester respectively for the students. Another 16 credits shall be reserved for the research (thesis and thesis defense). The students have to start their research work for thesis (equivalent to 12 credits) under the guidance and supervision of his/her research supervisors after the completion of first semester and the same shall be carried on up to the last semester when it will be evaluated. After the evaluation of thesis the students have to face thesis defense (equivalent to 4 credits). The distribution of courses, credits and marks are shown below:

Course Type		No. of Courses	Credits	Marks
Course (compulsory)		12	24	1200
Research	e) Thesis		12	600
	b) Thesis defense		4	200
	Total		**40**	**2000**

N.B. 1 course = 2 credits = 100 marks; Each course will carry 80 marks for theoretical examination and 10 marks for course assignment and 10 marks for class attendance.

Course layout for MS in Poultry Science

1st Semester

SL.	Course Title	Course Code	Credit Hours	Marks
1.	Layer Breeder and Commercial Layer Management	MSPS 1201	2	100
2.	Incubation and Hatchery Management	MSPS 1202	2	100
3.	Poultry Nutrition and Feeding	MSPS 1203	2	100
4.	Poultry Farm Planning and Design	MSPS 1204	2	100
5.	Poultry Farm Machineries and Feed Mill Technology	MSPS 1205	2	100
6.	Family Poultry Production	MSPS 1206	2	100
	Total 6 Courses		**12**	**600**

2nd Semester

SL.	Course Title	Course Code	Credit Hours	Marks
1.	Broiler Breeder and Commercial Broiler Management	MSPS 2201	2	100
2.	Poultry Processing and Value Added Products	MSPS 2202	2	100
3.	Poultry Reproduction and Breeding	MSPS 2203	2	100
4.	Specialized Fowl Production	MSPS 2204	2	100
5.	Poultry Business Management	MSPS 2205	2	100
6.	Poultry Health and Hygiene	MSPS 2206	2	100
	Total 6 Courses		**12**	**600**

3rdSemester

Sl.	Courses Title	Course code	Credit Hours	Marks
1	Thesis	MSPS 3121	12	600
2	Thesis defense	MSPS 3042	4	200
	Thesis + Thesis defense		16	800
	Grand Total	**(12×2) +16 = 40 (Forty)**		**2000**

Syllabus for MS in Poultry Science

Course Title: **Layer Breeder and Commercial Layer Management**

Course Code: **MSPS 1201** **Credit Hrs: 2**

Unit	Title	Lesson
1	Production Traits	Body weight, age at sexual maturity, hen-day production, hen-house production, feed consumption, FCR, egg weight, fertility, hatchability, disease resistance.
2	Layer Industry	Production strategies of grandparent stock (GP), parent stock (PS) and commercial stock (CS); Statistics of layer industry.
3	Modern Poultry Houses and Rearing Systems	Types, uses, equipments and their maintenance; Controlling environmental factors for higher productivity; Advantages and limitations of different rearing system such as cage, floor and floor-cum-slatted floors.
4	Management Procedures	Early growth period, growing period, laying period; Egg size management; Male management; Key points to increase fertility, timing and control of egg laying, nest site selection; Pre-laying and post-laying behavior.
5	Egg Quality	Importance, ultrastructures, structure, composition, physical & chemical properties; Food value of eggs; Quality identification of shell eggs; Factors affecting egg quality; Misconceptions about the nutritive value of eggs.
6	Organic and Nutritionally Enriched Egg Production	Concept, importance, consideration and limitations; ω-3 eggs, designer egg, Se-enriched egg.

Recommended Books

1. A Text book of Chicken Production, 1995. Nahm. K. H. and Chung. S. B. Munun Dang Publishing Company, Seoul, Korea.
2. Avian Physiology, 1965. 2nd Ed. Sturkie, P. D. Comstock Publishing Associates. A Division of Cornell University Press, Ithaca, New York.
3. Poultry Production, 1990. 13th Ed. Austic, R. E. and Nesheim. M. C. Lea and Febigar, Philadelphia.
4. Commercial Chicken Production Manual, 1978. North, M. O. and Bell, D. D. AVI Publishing Company. Inc. Westport, Connecticut. USA

Course Title: **Incubation and Hatchery Management**

Course Code: **MSPS 1202** **Credit Hrs: 2**

Unit	Title	Lesson
1	Incubation and Incubators	Worldwide incubation systems; Modern incubators; Activities of modern hatcheries.
2	Handling of Hatching Eggs	Storage, transportation, selection, disinfection, pre-warming and other hatchery practices.
3	Incubator Environment and Hatchability	Role of internal environmental factors affecting hatchability and their regulatory activities; Trouble shooting; Analysis of poor hatchability.
4	Embryonic Development	Gradual development from day-old to hatching point; Examination of embryonic death.
5	Taking off Hatches and Post Hatching Management	Procedures, care and management in relation to take off, handling, sexing, vaccination, packaging, transportation and delivery.
6	Quality Chick Production	Concept of quality chick; Points to be considered for quality chick production; Practices and monitoring related to quality chick production.

Recommended Books

1. The Incubation Book, 1982. Anderson-Brown, A.F. Super Publications, Saiga Publishing Co. Ltd. 1 Royal Parade Survey, U.K.
2. Hatchery Operation and Management, 1955. Funk, F.M. & Irwin, M.R. John Wiley & Sons. Inc. New York. Chapman & Hall Ltd. London.
3. Hatchery Management, 1953. Hartman, R.C. and Vicks. G.S. New York.
4. Incubation and Hatchery Practice, Research Bulletin No. 148. Ministry of Agriculture. Fisheries and Food. London Her Majesty's Stationery office.
5. Early Embryology of the Chicks, 1978. Pattern. B. M. and Lata, Mc. Graw-Hill Publishing Company. Ltd. Mohan Makiujani at Rekha Printers Pvt. Ltd. New Delhi-110020
6. Avian Incubation, 1991. Tullet, S.G. Butterworth Heinemann. Reed Book Series Ltd. P.O. Box 5 Rushden, Northants, NN 10 9YX, England.

Course Title: **Poultry Nutrition and Feeding**

Course Code: **MSPS 1203** **Credit Hrs: 2**

Unit	Title	Lesson
1	Poultry Feed Stuff	Poultry feed stuff used for different nutrient.
2	Nutrients	Source of different nutrients; Interrelationship among nutrients affecting production; Anti-nutritional factors (ANF) affecting growth and production; Techniques to eliminate/ reduce ANF to improve production.
3	Nutritional	Nutritional requirements for GP, PS and CS; Nutritional

	Requirements	aspects of controlling body weight.
4	Feed Additives	Different feed additives used in poultry industry.
5	Feeding of Poultry Stocks	Distinguishing features, feeding programmes and strategies related to GP, PS and CS production; Mash vs. pellet feeding; Least cost feed formulation for aquaculture and farm animals.
6	Biotechnology in Poultry Feeds and Nutrition	Importance, modern tools and their applications in poultry industry; Biotechnological intervention to reduce yolk cholesterol; Production technology of nutritionally enriched eggs and meat; Types, mode of action and application of bio-technological tools as productivity enhancers, antibiotic replacers and heat stress eliminators; Use of medicinal plants and fermented products; Production of safe meat and eggs.

Recommended Books

1. Nutrition of the Chicken, 4th Edn. 2001. Leeson, S and Summers, J. D. University Books, P.O Box. 1326, Guelph, Ontario, Canada N1H 6N8.
2. Commercial Poultry Nutrition, 1991. Leeson, S., Summers, J. D. University Books, P. O. Box 1326, Guelph, Ontario, N1H, Canada.
3. Poultry Nutrition, 1951. Ewing, M. R. The Ray Ewing Company, Publishers. Division of Hoffman La Roche, Inc. 2690. Foothill Blvd. Pasadasrn, California.
4. Nutrient Requirements of Poultry, 1994. 9th Edn. National Research Council. National Academy Press, Washington, D. C. USA.
5. Poultry Nutrition, 2nd Edn, Sing, K. S. and Panda, B. 1988 Kalyani Publishers. Ludhiana- 141008, India.
6. Recent Development in Poultry Nutrition-2, 1999. Wiseman, J. and Gamsworthy, P. C. Nottingham University Press, Manor Farm, Main Street, Thumpton, Nottingham, NG11 OAX, England.
7. Nutritional Biotechnology in the Feed and Food Industry, 2006. Proceedings of Alltech's 22nd Annual Symposium, Nottingham University Press, Nottingham, UK.

Course Title: Poultry Farm Planning and Design

Course Code: MSPS 1204 **Credit Hrs: 2**

Unit	Title	Lesson
1	Farm Planning	Factors affecting farm planning; Site selection of poultry farm; General consideration of farm planning and layout; Planning of most common poultry units; Management of farm personnel.
2	Biosecurity in Planning	Biosecurity of poultry farm; Other operational practices for hygiene and sanitation of poultry farm.
3	Economics of Planning	Benefits and limitations of poultry farming; Marketing strategies and financial statement; Steps in writing a poultry business plan.

4	Design of Modern Poultry Sheds/Houses	Open-sided, tunnel-ventilated and environment-controlled houses; Management of poultry housing environments; Layout, planning and design of modern commercial, breeder, hatchery and processing plant.
5	Poultry Production and Environment	Environment and environment pollution; Reasons of environment pollution and reducing risk on environment through effective management; Management of poultry waste, dead birds and hatchery wastes; Climate change and weather management.

Recommended Books

1. Poultry Production, 1990. R. A. Singh, Kalayani Publishers. New Delhi.
2. Commercial Broiler Production, 2001. Johari, D. C. and Hussain K. Q. International Book Distributing Co., Lucknow, India.
3. Commercial Chicken Production Manual, 1999. 4th edition. North, M. O. and Bell, D. D. Chapman and Hall. Dept. B. C., 115 Fifth Avenue, New York, NY 10003, USA,
4. Poultry Production in Hot Climates, 1995. Deghir, N. J. CAB International, Walling Ford, Oxon Ox 108 DE, UK,
5. Farm Building Design, 1961. 1st Ed. Neubauer L. W. and Walker, H. B. Prentice-Hall, Inc., N. J. USA.
6. Agricultural Building and Structure, 1979. Whitaker, J. H. Reston Publishing Company, Prentice-Hall Company, Reston, Virginia

Course Title: **Poultry Farm Machineries and Feed Mill Technology**

Course Code: **MSPS 1205** **Credit Hrs:** **2**

Unit	Title	Lesson
1	Hatchery Room Machineries	Principles of operation of different incubators and their maintenance.
2	Poultry House Equipment	Electric brooder, gas brooder, thermostatic control of brooder; Power supply system, temperature controller, thermostat, color and intensity of light; Cages, automatic feeder and waterer, chain feeder system; Tunnel ventilation, exhaust fan maintenance, inspection and monitoring, humidity control systems; Laying box and automatic conveyer belt for egg collection.
3	Poultry Processing Machineries	Principles of operation of poultry processing plant and their maintenance.
4	Feed Manufacturing	Feed grinding, mixing and pelleting machines; Silo of feed;Storage and handling of raw materials and finished product; Manufacturing operations, weighing, packing and labeling, quality control, control of toxic substances.
5	Plant	Plant manager's duties and responsibilities; Planning and budgeting; Manufacturing cost control; Product costing;

	Management	Production planning and scheduling; Shrink control of feeds manufacturing.
6	Feed Mill Planning and Feed Act	Concept; Site selection; Size and capacity of the feed mill; Feed acts and regulation.

Recommended Books

1. Feed Manufacturing Technology- IV; Robert R. McEllhiney; American Feed Industry Association, Inc., Suite 1100, 1500 Wilson Blvd., Arlington, VA 22209; 1994.
2. Feed milling; N.O. Simmons Leonard Hill (Books) Limited London.1963
3. Management Feed and Milling (Training Manual); A.P Wingelaar; IPC Livestock, Barneveld College, 32, Wesselseweg, PO Box 64-3770 AB Barneveld, The Netherlands; 1995.
4. An Introduction to Compound Animal Feed Production (Training Manual) ; A.P. Wingelarr; IPC Livestock, Barneveld College, 32 Wesselseweg, PO Box 64- 3770 AB Barneveld ,The Netherlands; 1996
5. Some Aspects of Feed Milling; M. Shahjalal; Poultry Sector Development Project, CIDA DLS Farmgate, Krishi Khamar Sarak, Dhaka; 2001.
6. Forage Conservation and Feeding. (1978). Authors-F. Raymond G-Sheppersm and R. Waltham Farming Press Limited Suffalk, U.K.

Course Title: Family Poultry Production

Course Code: MSPS 1206 **Credit Hrs: 2**

Unit	Title	Lesson
1	Introduction	Definition; Socio-economic importance; Challenges and opportunities in developing countries; Introduction with International Network for Family Poultry Development (INFPD); Analysis of production costs, cost and return.
2	Native Chicken Breeds and Productivity	Local breeds; Performance of native hen; Critical issues for low productivity; Breed improvement; Characterization of native poultry; Selection of local breeds.
3	Housing	Housing for free-range chickens; Small-scale housing; Housing equipment- feeders, drinkers, perches, laying nests; **S**helters for the mother hens and chicks.
4	Nutrition	Nutritional requirements; Feeding methods; Feed composition; Available feed resources; Scavenging Feed Resource Base (SFRB); Methods of estimating SFRB; Factors affecting SFRB; Utilization of different feed ingredients.
5	Health Care	Hygiene and bio-security; Common diseases; Disease control; Parasites and feather pecking;Vaccination program and constraint.
6	Hatching and Raising Chicks	Natural hatching; Artificial hatching; Methods and principles of rice husk incubation; Raising the chicks; Chick rearing and its

	challenges; Management system for reducing chick mortality.

Recommended Books

1. Commercial Chicken Meat and Egg Production, 2002. Bell, D.D. and Wearer, Jr, W.D., Kluwer Academic Publishers, Distribution Centre, P.O. Box- 322, 3300AH Dondrecht, The Netherlands.
2. Commercial Chicken Production Manual, 1978. North, M.O and Bell, D.D. AVI Company, INC. Westport, Connecticut, USA.

Course Title: Broiler Breeder and Commercial Broiler Management
Course Code: MSPS 2201 Credit Hrs: 2

Unit	Title	Lesson
1	Introduction	Broiler breeding stock and its performance; Commercial broiler rearing systems and operations; Concept of modern broiler farming.
2	Feeding Management	Preferential and challenged feeding for broiler breeder; Control of body weight, flock uniformity, significance of maintenance flock uniformity to achieve desirable production.
3	Breeder Management	Controlling body weight, mixing with female, spiking and intra-spiking; Broiler grandparent and parent stock management.
4	Commercial Broiler Management	Mixed sex and separate sex rearing of commercial broiler; Methods of estimating fatness in broiler; Modern broiler harvesting and harvester; Trouble shooting in broiler production.
5	Stress Mechanism	Heat regulating mechanism of broilers; Environmental influence on broiler production; Different stressors and stresses and their management in broilers production.
6	Organic Broiler Production	Concept, importance, consideration and limitations; Automation and mechanization of broiler farms and its importance.
7	Broiler Farm Performance	Bio-security in broiler farming; Factors influencing profit of broiler farming; Key Performance Indicator (KPI) of broiler production; Prevention and control of broiler diseases.

Recommended Books

1. Commercial Chicken Meat and Egg Production, 2002. Bell, D.D. and Wearer, Jr, W.D., Kluwer Academic Publishers, Distribution Centre, P.O. Box- 322, 3300AH Dondrecht, The Netherlands.
2. Commercial Chicken Production Manual, 1978. North, M.O and Bell, D.D. AVI Company, INC. Westport, Connecticut, USA.
3. Poultry Production, 1990. 13th Edn. Austic, R. E. and Nesheim, M. C., Lea and Febiger, Philadelphia.

4. Broiler Utpadan (Broiler Production), 1994. Latif, M. A., Bangla Academy, Dhaka.
5. Growth and Poultry Meat Production, Freeman and Boorman, British Poultry Science Ltd., UK.

Course Title: Poultry Processing and Value Added Products

Course Code: MSPS 2202 **Credit Hrs: 2**

Unit	Title	Lesson
1	Egg Technology	Physicochemical changes of preserved eggs; Maintenance of albumen, yolk and egg shell quality; Functional properties of eggs in foods; Development of value-added products from egg; Freezing and drying of eggs and egg-products; Pasteurization of eggs and egg-products; Non-food uses of eggs; In-edible products of egg industry and their utilization; Egg products industry.
2	Meat Technology	Standard and quality criteria for live and dressed poultry; Inspection of live and killed birds by antemortem and postmortem examinations; Pre-slaughter factors affecting poultry meat quality; Steps in poultry processing; Effects of processing on meat quality; Preservation of market quality of poultry meat; Evaluation of poultry meat quality; Microorganisms in poultry meat.
3	Egg and Meat in Food Items	Uses of egg and meat in different food items; Preparation of different egg recipes; Preparation of different products such as sausage, nuggets, meat ball, jerky, mayonnaise etc.
4	Poultry Processing Plant Design	Layout and construction of processing plant; Water supply, sanitation and health regulations in a processing plant.
5	Food Safety	Hazard Analysis and Critical Control Point (HACCAP); Standard Operating Procedure (SOP).
6	Byproducts of Poultry Industry	Use of inedible poultry by-products.

Recommended Books

1. Avian Eggs, 1963. Romanoff, A. L. and Romanoff, A. J. John Wiley and Sons, Inc. New York
2. Poultry Products Technology, 1989. 2nd Edn. Mountney, G. J. Food Products Press. Inc. New York.
3. Food Safety and Quality Assurance (Food of Animal Origin), 1996. William T. Hubbert, Harry. V. Hagstad, Spangler, Michael H. Hinton and Keith L. Hughes, Iowa State University, Press, Ames, Iowa 50014.
4. The Avian Egg – Chemistry and Biology, 1989. Burly R.W. and Vadehra. D.V. John Willy and Sons. Inc. Singapore.
5. Egg Uses and Processing Technologies – New Developments, Sim, J. S. and Wakei, S, CAB international, Walling ford, Oxon, Ox 10 8DE, U.K.
6. Egg Science and Technology, 1995. 4th Ed. Stadelman, W.J. and Cotterill, O. W. The Haworth Press Inc. New York.

Course Title: **Poultry Reproduction and Breeding**

Course Code: **MSPS 2203** **Credit Hrs: 2**

Unit	Title	Lesson
1	Reproductive System	Features of avian reproduction; Endocrine regulation of male and female reproduction in avian species; Photosensitivity in follicular development; Production, maturation and transport of sperm in the male reproductive system; Sperm quality and factors affecting sperm quality; Artificial insemination (AI) in poultry and benefits of practicing AI in poultry industry; Mechanism of acrosome reaction and process of fertilization in poultry; Role of inner perivitelline layer in the process of fertilization; Factors affecting production of fertile eggs.
2	Poultry Genetic Resources	Species, breeds, strains, lines and families, pigmentation in the feather, skin, meat and egg; Biochemical polymorphism, immunogenetics and disease resistance; Genetic parameters of economic traits in poultry; Heritability, repeatability and genetic correlation.
3	Selection for Meat Production	Growth rate, feed conversion efficiency, viability, dressing percentage and carcass quality.
4	Selection for Egg Production	Number of eggs laid; Rate of lay; Persistency of production; Age and weight at sexual maturity; Feed conversion efficiency; Egg size and egg quality.
5	Breeding for Meat Production	Breed crossing, strain crossing, heterosis or hybrid vigor.
6	Breeding for Egg Production	Pure breeding, strain crossing and line crossing; Breeding for general and specific combining abilities; Development of a large scale poultry breeding program.

Recommended Books

1. Biological Rhythms in Birds: Neural and Endocrine Aspects. 1980. Y. Tanabe, K. Tanaka and T. Ookawa. Japan Scientific Societies Press, Tokyo.
2. Reproductive Physiology. 1964. A. V. Nalbandov. 2nd Edition. W. H. Freeman and Company, San Francisco and London.
3. Molecular Biology of the Cell (Part I-IV). 1994. B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts and J. D. Watson. 3rd edition. Garland Science, New York.
4. Poultry Breeding and Genetics. 1990. Crowford, R.D. Elsevior Science Publishers, B.v. Amsterdam, The Netherlands.
5. Biometrical Methods in Poultry Breeding. 1994. R.P. Singh and J. Kumer. Kalyani Publishers, Ludhiana, New Delhi, India.

Course Title: Specialized Fowl Production
Course Code: MSPS 2204 **Credit Hrs:** 2

Unit	Title	Lesson
1	Duck Farming	World distribution and recent trend of duck production; Duck farming in Bangladesh- advantages and limitations; Duck production systems and management practices; Mule duck production- principles and prospects; Advances in the nutrition management of meat and egg type ducks; Integrated duck farming- concepts, advances and limitations.
2	Quail Farming	Present status of quail production in Bangladesh; Advantages of quail farming; Incubation and hatchery management; Brooding, growing and laying management of quail; Feed formulation for different types of quails; Economics of quail farming; Future scopes of development.
3	Geese Farming	Advantages of geese farming; Grower and layer geese management; Hatchery management; Feed formulation and requirement for different types of geese; Future scopes of development.
4	Turkey Farming	Advantages of turkey farming; Turkey management; Hatchery management; Feed formulation and requirement for different types of turkey; Future scopes of development.
5	Pigeon Farming	Advantages of pigeon farming; Pigeon management; Squab production; Feed formulation for pigeon; Future scopes of development.
6	Guinea fowl Farming	Present status and future scope of guinea fowl production in Bangladesh; Advantages of guinea fowl farming; Management of guinea fowl at different ages; Hatchery management; Feed formulation and requirement for guinea fowl.

Recommended Books

1. Water Fowl Production, 1988. Proceedings of the International Symposium on Waterfowl Production. Beijing. Pergawon Press plc, Hill Hall. Oxford OX3, OBW, UK.
2. Duck Production Science and World Practice, 1986. Farrell, David J. and Stapleton, P. University of New England, Armidale, Australia.
3. Micro Livestock, 1991. National Academy Press, Washington, D. C.
4. Water Fowl Ecology, 1991. Owen, M. and Black, J. M. Chapman and Hall, 29 West 35th Street, New York, 10001-2291, USA.
5. Quail Palan (In Bangla), 2nd Edn. Rahman, A. N. M. Aminoor. Porua, 45, Aziz Super Market, Shahbag, Dhaka, Bangladesh.

Course Title: **Poultry Business Management**

Course Code: **MSPS 2205** **Credit Hrs: 2**

Unit	Title	Lesson
1	Introduction to Poultry Marketing	Definition of marketing, marketing process, growth and role of marketing, consumers and poultry marketing; Poultry marketing management; Marketing problems.
2	Price Analysis	Supply and demand analysis; Application of supply and demand analysis; Price fluctuation.
3	Marketing Cost	Marketing margin; Cost component; Interrelationships of the marketing margin and food prices, price and consumption; Poultry and egg marketing channel.
4	Cooperatives in the Food Factory	Definition; Classification; Purposes of cooperative; Problems of cooperatives; Integration of poultry industry.
5	Market Development and Demand Expansion	Market Development in the food industry; Varieties of food demand; Role and criticism of advertising; Advertising in the food system; Problems of market news and information.
6	Current Asset Management	Working capital management- concepts, determinants and estimation of working capital; Cash management-motive for holding cash, factors determining cash needs, determination of optimum cash balance; Inventory management- objectives and techniques of inventory management.
7	Risk Management	Nature and types of risk in poultry marketing; Risk and uncertainty; Techniques to reduce risk in poultry farming.

Recommended Books

1. Marketing of Agricultural Products, 2002.Richard L. Kohls and Joseph N. Uhl. Prentice-Hall, Inc, New Jersey, USA.
2. Financial Management in Agriculture, 1983. Barry, P.J., Hopkin, J.A. and Baker, C.B. The Interstate Printers and Publishers, Inc., Danville, Illinois.
3. Financial Management- Theory and Practice, 1988.Brigham, E.F. and Gapenski, L.C. The Dryden Press, New York.
4. Fundamentals of Financial Management, 1995.Prentice. Horne, J.V.C. and Wachowicz, J.M. Hall of India Private Limited, New Delhi.
5. Financial Management, 1989. Khan, M.Y. and Jain, P.K. Tata McGraw-Hill Publishing Company Limited, New Delhi.
6. Financial Management- a Conceptual Approach, 1987. Kulkarni, P.V. Himalaya Publishing House, Bombay.

Course Title: **Poultry Health and Hygiene**
Course Code: **MSPS 2206** **Credit Hrs: 2**

Unit	Title	Lesson
1	Hygiene and Sanitation	Poultry health, hygiene and sanitation; Factors influencing health and diseases of avian species; Maintenance of poultry health practice of hatchery, flock hygiene and management.
2	Waste Management	Disposal of wastes, litters and carcasses.
3	Disease Transmission	Disease transmission cycle; Source of disease producing agents; Stress, epidemiological and ecological investigation of poultry diseases.
4	Infectious Disease	Spread of infectious agents of important poultry diseases;
5	Disease Prevention	Hygienic and other measures to be adopted for the prevention, control and eradication of important infestations and infections of avian species.
6	Immunization	Importance, methods and precaution of vaccination. Causes of vaccination failure. Vaccination schedule for GP, PS and CS.

Recommended Books

1. Complete Pet Bird Owners Handbook. 2003 by Gallerstein,D.G., http://www.amazon.com/complete-pet-bird-owners-handbook/dp/1895270251.
2. Poultry Diseases. 1996 by Jordan, F.T.W and Pattison, M., 4th edn., W.B. Saunders Company, Philadelphia.
3. Diseases of Poultry. 1984 by Hofstad, M.S., 8th edn., Iowa State University Press, Iowa, USA.
4. Environmental Health Field Practice. 1983 by *Brown*, S.M., Clark, W.N., Steven L. Zuieback and Praeger, Society for Veterinary Epidemiology and Preventive Medicine, USA.
5. Livestock Health and Housing. 1979 by David Sainsbury and Peter Sainsbury, 2nd edn., Bailliere Tindall, London.

School of Agriculture and Rural Development
Bangladesh Open University

Master of Science (MS) in Soil Science

1. Requirement for registration: Bachelor of Science in Agriculture (BSc Ag) or related disciplines from any recognized University or Institute
2. Duration: One and a half ($1\frac{1}{2}$) years (Registration valid for consecutive four and a half years)
3. Semester: Three Semesters (Valid up to consecutive nine semesters), two semesters in a year each of six (6) months
4. No. of courses = 12
5. No. of credits = 40
6. Total Marks = 2000

Distribution of courses, credits and marks

M.S. in Soil Science shall be offered with 40 credits in 3 semesters each of six months duration. The courses worth 24 credits of which 12 credits shall be offered during the first semester and the other 12 credits during the 2nd semester respectively for the students. Another 16 credits shall be reserved for the research (thesis and thesis defense). The students have to start their research work for thesis (equivalent to 6 courses) under the guidance and supervision of his/her Research Supervisors after the completion of one semester and the same shall be carried through to the last semester when it will be evaluated. After the evaluation of thesis the students have to face thesis defense (equivalent to 2 courses). The distribution of courses, credits and marks are shown below:

Course Type		No. of Courses	Credits	Marks
Course (compulsory)		12	24	1200
Research	f) Thesis	equivalent to 6 courses	12	600
	b) Thesis defense	equivalent to 2 courses	4	200
Total			**40**	**2000**

N.B. 1 course = 2 credits = 100 marks; Thesis =12 credits = 600 marks, Thesis defense (4 credits) = 200 marks: Each course will carry 80 marks for theoretical examination and 10 marks for one course assignment and 10 marks for class attendance.

Course layout for MS in Soil Science

1st Semester

Sl.	Courses Title	Course code	Credit Hours	Marks
1	Advanced Soil Physics	MSSS 1201	2	100
2	Advanced Soil Chemistry	MSSS 1202	2	100
3	Advanced Soil Fertility and Plan Nutrition	MSSS 1203	2	100
4	Soil Microbiology and Biochemistry	MSSS 1204	2	100
5	Soil, Plant and Water Analysis	MSSS 1205	2	100
6	Research Methodology	MSSS 1206	2	100
	Total 6 courses		**12**	**600**

2nd Semester

Sl.	Courses Title	Course code	Credit Hours	Marks
1	Waste Management and Organic Manure	MSSS 2201	2	100
2	Soil and Water Pollution	MSSS 2202	2	100
3	Soil Ecology and Biodiversity	MSSS 2203	2	100
4	Soil Water Management	MSSS 2204	2	100
5	Soil degradation and Conservation	MSSS 2205	2	100
6	Soil Survey	MSSS 2206	2	100
	Total 6 courses		**12**	**600**

3rd Semester

Sl.	Courses Title	Course code	Credit Hours	Marks
1	Thesis	MSSS 3121	12	600
2	Thesis defense	MSSS 3042	4	200
	Thesis + Thesis defense		16	800
	Grand Total	**(12×2) +16 = 40 (Forty)**		**2000**

Syllabus for MS in Soil Science

Course Title: **Advanced Soil Physics**
Course Code: **MSSS 1201** **Credit Hrs: 2**

Unit	Title	Lesson
1	Soil Density	Compactness, penetration, resistance, mass-volume relationship, importance and management of soil density, porosity, consistence
2	Soil Aggregate	Formation, importance, degradation and management of soil structure
3	Soil Temperature	Soil temperature fluctuation and plant growth regulation of soil temperature
4	Soil Water	Retention and availability, characteristics of moisture release curve, pF curve and hysteresis, soil moisture constant, water flow in soil-saturated and unsaturated condition, Darcy's law, Poiseuille's equation, flux density, inflow and outflow boundaries, steady state flow in a homogeneous and layered profile, soil water potential-principle and methods of measurement, soil water determination
5	Evapotranspiration (ET)	Measurement of ET-water balance and soil water depletion method, irrigation scheduling-approaches, application of ET values in irrigation scheduling, management and regulation of ET, water use efficiency, critical soil moisture deficits
6	Irrigation and Drainage	Irrigation in relation to soil properties, importance of supplemental irrigation for deficient crops, water requirement of crops, drainage-importance and methods of draining agricultural lands

Recommended Textbooks

1. Baver, L.D., Gardner, W.H. and Gardner, W.R. 1972. Soil Physics. 4th edition. John Wiley & Sons. Ins., New York.
2. Ghildyal, BP. and Tripathi, R.P. 1987. Soil Physics. Wiley Eastern Ltd., New Delhi.
3. Hanks. R.J. and Ashcroft, F.L. 1980. Applied Soil Physics. Springer-Verlag, Berlin, Heidelberg.
4. Hillel, D. 1980. Applications of Soil Physics. Acad. Press, New York, USA.
5. Hiller, D. 1980. Fundamentals of Soil Physics. Acad. Press, New York, USA.
6. William A.Jury, Robert Horton. 2004. Soil Physics, 6th Edition, John Wiley and Sons, NY.

Supplementary Textbooks

7. Brady, N.C. and Weil, R.R. 2002. The Nature and Properties of Soils. Pearson Education Pte. Ltd. New Delhi, India.
8. James, D.W., Hanks, R.J. and Jurianak, J.J. 1982. Modern Irrigated Soils, John Wiley & Sons., NY.
9. Lambert, K.S. and Rhcroft, D.W. 1983. Land Drainage-Planning & Design of Agric. Drain. System. Batsf. Acad. & Edn. Ltd.

10. Michael, A.M. 1978. Irrigation-Theory and Practice, Vikas Publishing House Pvt. Ltd. New Delhi.

Course Title: Advanced Soil Chemistry

Course Code: MSSS 1202 **Credit Hrs: 2**

Unit	Title	Lesson
1	Ion Sorption	Chemical composition of soil, types and nature of soil colloids, sorption, adsorption and desorption phenomena, adsorption isotherm-Freundlich and langmuir adsorption isotherms
2	Ion Exchange	Ion exchange phenomena, principles of cation exchange, cation exchange equations-Kerr and Gapon equation, double layer theories Stern and GouyChapman theories, zeta potential, anion exchange
3	Clay Minerals	Classification of silicate and non-silicate clays, genesis of silicate clays,physico-chemical and mineralogical properties of silicate clays, surface chemistry of soil clays, identification of clay minerals-X-ray diffraction technique, differential thermal analys (DTA), clay mineral distribution of soils in Bangladesh
4	Metal-organic Complex	Complex formation and chelation, metal-organic complex reactions, clay-humus complexes, importance of clay-humus complex in soil
5	Chemistry of Submerged Soils	Chemical behavbior of submerged soils, electrochemical changes p^H, redox potential, Transformation of C, N, P, S, Fe and Mn

Recommended Textbooks

1. Bear, F.E. 1967. Chemistry of the Soil. Reinhold Pub. Crop. Inc., USA.
2. Bohn, H.L., Mc Neal, B.L. and O'Connor, G.A. 1974. Soil Chemistry, John Wiley & Sons, New York.
3. Kim H. Tan. 2010. Principles of Soil Chemistry, 4th Edition, CRC Press.
4. Lindsay, W.L. 1979. Chemical Equilibria in Soils. John Wiley & Sons Ltd., New York.
5. Saleque, M.A. 2004. Review of Soil Chemistry. Anik Printers, Dhaka. Bangladesh.
6. Sposito, G. 1989. The Chemistry of Soils. Oxford University Press, New York.

Supplementary Textbooks

7. Greenland, D.J. and Hayes, M.H.B. 1981. The Chemistry of Soil Processes. John Wiley & sons Ltd., New York.
8. Grim, R.E. 1953. Clay Mineralogy, McGraw Hill Book Co., Inc., New York.
9. Mengel, K. and Kirkby, E.A. 1987. Principles of Plant Nutrition. Int. Potash Inst. Pub., Switzerland.
10. Miller, R.W. and Donahue, R.L. 1990. Soils-An Introduction to Soils and Plant Growth Prentice Hall Inc., USA.
11. Ponnamperuma, F.N. 1972. Advances in Agronomy, Vol. 24. Amer. Soc. Agron., Inc. Pub., Wis., USA.

Course Title: **Soil Fertility and Plant Nutrition**

Course Code: **MSSS 1203** **Credit Hrs: 2**

Unit	Title	Lesson
1	Soil Fertility	Soil fertility & plant growth, plant growth equations, soil fertility assessment-soil analysis, crop response to fertilizers, plant analysis, diagnosis & recommendation integrated system (DRIS) and nuclear techniques, soil fertility management-use of manures, fertilizers and biofertilizers, soil management, integrated plant nutrition system, fertilizer management-mixed, compound & slow release fertilizers, soil amendment, strategies for fertilizer application for crops & cropping patterns, nutrient balance, fertilizer use efficiency
2	Plant Nutrition	Macro and micronutrients, mechanisms of nutrient uptake, movement of nutrients in soil, nutrient mobility, nutrient interactions, nutritional disorders-deficiency and toxicity symptoms, nutrient concentration-normal, deficiency and toxic levels, biofortification of seeds-methods of biofortification and micronutrients biofortification
3	Problem Soils of Bangladesh	Nutrient deficiency in Bangladesh soils, types of problems soils, their location extent, potentiality, constraints to crop production and management for improving productivity

Recommended Textbooks

1. BARC, 2005. Fertilizer Recommendation Guide. Soils Publication no. 41. Bangladesh Agricultural Research Council, Farm-gate, Dhaka.
2. Bennelt, W.F. 1996. Nutrient Deficiencies and Toxicities in Crop Plants. Amer. Phytopath. Soc., St. Paul Minnesota, USA.
3. Havlin, J.L., Beaton, J.D., Nelson, W.L., and Tisdale, S.L. 1999. Soil Fertility and Fertilizers. Prentice Hall, Upper Saddle River, New Jersey.
4. Mengel, K. and Kirkby, E.A. 1987. Principles of Plant Nutrition. Int. Potash Inst. Pub. Switzerland.
5. Miller, R.W. and Donahue, R.L. 1990. Soils An Introduction to Soils and Plant Growth. prentice Hall Inc., USA.
6. Thomson, L.M. and Troeh, F.R. 1978. Soils and Soil Fertility, McGraw Hill, New York.

Supplementary Textbooks

7. Brady, N.C. and Weil, R.R. 2002. The Nature and Properties of Soils. Pearson Eduation Pte. Ltd. New Delhi, India.
8. Kanwar, N.C. 1976. Soil Fertility-Theory and Practice. ICAR. New Delhi.
9. Mortvedt, J.J., Cox, F.R., Shuman, L.M. and Welch, R.M. 1991. Micronutrients in Agriculture. 2nd ed. Soil Sci. Soc. Amer. Inc., Madison, Wis., USA.
10. Stevension, F.J. 1985. Cycles of Soils-Carbon, Nitrogen, Phosphorus, Sulphur, Micronutrients. John Wiley & Sons Inc., New York.

Course Title: **Soil Microbiology and Biochemistry**

Course Code: **MSSS 1204** **Credit Hrs: 2**

Unit	Title	Lesson
1	Soil Microbes	Soil microorganisms and their nutrition, biological equilibrium in soil, soil enzymes and their significance, biochemical activities of soil microbes
2	Biochemical Transformations	Protein mineralization-proteolysis, ammonification, nitrification and denitrification, phosphorus-mineralization of organic phosphorus, phosphatase activity, solubilization of inorganic phosphates, sulphur-mineralization of organic sulfur, oxidation and reduction of sulfur, iron and manganese-oxidation and reduction of sulfur, iron and manganese-oxidation and reduction, carbohydrate metabolism
3	Biological Nitrogen Fixation	Symbiotic fixation, non-symbiotic and associated nitrogen fixation systems, rhizosphere environment, biochemistry of nitrogen fixation, nitrogenase enzyme, oxygen protection mechanisms and regulation, nif genes, methods for measuring nitrogen fixation

Recommended Textbooks

1. Alexander, M. 1977. Introduction to Soil Microbiology. John Wiley & Sons Inc., New York.
2. Coney, 1999. Soil Microbiology: An Exploratory Approach. Delmar Publishers, Albany, New York.
3. Jan Dirk van Elsas et. al. 2006. Modern Soil Microbiology, 2nd Edition, CRC Press.
4. Rangaswami, G. and Bagyaraj, D.J. 2004. Agricultural Microbiology, Prentice Hall of India (Pvt.) New Delhi.
5. Subba Rao, N.S. 1987. Advances in Agricultural Microbiology. Oxford and IBH. Pub. Co. New Delhi.
6. Sylvia, D., Fulhrmann, J., Hartel, P. and Zuberer, D. 1997. Principles and Applications of Soil Microbiology. Upper Saddle Rivs, N.J. Prentice Hall.

Supplementary Textbooks

7. Keister, D.L. and P.B. Cregan 1991 The Rhizosphere and Plant Growth. Kluwer Academic Publishers, Dordrecht, The netherlands.
8. Roger, L.J. and Gallon, J.R. 1988. Biochemistry of algae and cynnobacteria. oxford University press, London.
9. Modigan, M.T., J.M. Martiinko and J. Parker, 1997. Brock Biology of Microorganisms. 8th ed. Prntice hall, Upper Saddle River, N.J.
10. Roger, L.J. and Gallon, J.R. 1988. Biochemistry of Algae and Cyanobacteria. Oxford university press, London.
11. Tugel, A.J. and Lewand Owski, A.M. 1999. Soil Biology Primer. Natural Resource Conservation Service. Soil Quality Institute. Iowa.
12. Vincent, J.M. 1982. Nitrogen Fixation in Legumes. Academic Press, Paris, San, Diego, Tokyo, Toronto.

Course Title: **Soil, Plant and Water Analysis**

Course Code: **MSSS 1205** **Credit Hrs: 2**

Unit	Title	Lesson
1	Principles of Analytical Methods	Volumetric, gravimetric, turbidimetric, spectrophotometric, flame emission spectroscopy, atomic absorption spectroscopy, errors in analysis
2	Soil Analysis	Collection, preparation and preservation of soil samples, total nutrient analysis-acid digestion and fusion, fractionation of plant nutrients in soil, available nutrient analysis-concepts, selection of extractant, for determining available nutrients, interpretation of soil analytical data
3	Plant Analysis	Sampling, processing and preservation of plant samples, principles of plant analysis, plant tissue test, leaf analysis, and total analysis, critical nutrient range in plants, interpretation of plant analysis data
4	Water Analysis	Collection, preservation and analysis of water samples, rating of water for irrigation, water quality

Recommended Textbooks

1. Singh, D., Chhonkar, P.K. and Pandey, R.N. 199. Soil Plant and Water Analysis: A Methods Manual. Indian Agricultural Research Institute. New Delhi, India.
2. Hesse, P.R. 1994. A Text Book of Soil Chemical Analysis. CBS Publischrs & Distributors, Shadara, New Delhi, India.
3. J. Benton Jones, Jr. 2001. Laboratory guide for conducting soil tests and plant analysis, CRC Press.
4. Kim H. Tan, 2005. Soil sampling, preparation and analysis, 2nd Edition, CRC Press.
5. Page, A.L., Miller, R.H. and Keeney, D.R. 1982. Methods of Soil analysis, Part 2. Amer. Soc. Agron., Madison.

Supplementary Textbooks

6. Havlin, J.L, Beaton, J.D., Nelson, W.L., and Tisdale, S.L. 1999 soil Fertility and Fertilizers. Prentice Hall, Upper Saddle River, New Jersey.
7. Klute. A. 1986. Methods of Soil Analysis, Part 1, Amer, Soc. Agron., Madison.
8. Skoog, D.A. and West, D.M. 1980. Analytical Chemistry. 3rd edition. Saunders College Pub. Washington.
9. Vogel, A.I. 1961. A Text Book of Quantitative Inorganic Analysis. 3rd edition. Lowe & Brydone Ltd., London.
10. West, C.D. 1987. Essentials of Quantitative Analysis. McGraw-Hill Book Co., New York.

Course Title: **Research Methodology**

Course Code: **MSSS 1206** **Credit Hrs: 2**

Unit	Title	Lesson
1	Field Experimentation	Research protocols and proposals, selection of experiment site, soil sampling, treatments, experimental design, randomized completely block design, latin square design and split-plot design, basic principles of experimental design-layout, plot size and shape, block size and shape,

		number of replications, intercultural operations sampling, data collection
2	Data Analysis	Transformation of data-square root and logarithmic transformation, analysis of variance and multiple comparison tests, simple and multiple correlation, linear and non-linear regression
3	Report Writing	Types of report, procedure of scientific report writing, tabular and graphical forms of data presentation

Recommended Textbooks

1. Anonymous, 2004. A Handbook of Scientific Report Writing. Graduate Training Institute (GTI), Bangladesh Agricultural University (BAU), Mymensingh.
2. Cochran, W.G. and Cox, G.M. 1961. Experimental Designs. John Wiley & Sons, Inc., New York.
3. Gomez, K.A. and Gomez, A.A. 1984. Statistical Procedures for Agricultural Research. Second Ed. John Wiley & Sons, New York.
4. Stell, R.G.D. and Torrie, J.H. 1960. Principles and Procedures of Statistics with Special Reference to the Biological Sciences. McGraw Hill Book Co., Inc., New York.
5. Zaman, S.M.H., Rahman, K. and Howlader, M. 1982. Simple Lessons from Biometry. Bangladesh Rice Research Institute (BRRI), Joydebpur, Gazipur, Dhaka.

Supplementary Textbooks

6. Babbie, E.R. 2007. The basics of social research, 4th Edition, Australia, Thomsin/Wadsworth.
7. Graduate, W.G. and Cox, G.M. 1964. Experimental Designs. John Wiley & Sons, Inc., New York.
8. Mead, R., Curnow, R.N. and Hasted, A.M. 1993. Statistical Methods of Agriculture and Experimental Biology, Chapman and Hall, London.

Course Title: Waste Management and Organic Manure

Course Code: MSSS 2201 Credit Hrs: 2

Unit	Title	Lesson
1	Waste Management	Concept, types and availability of wastes, scope and importance of wastes utilization in Bangladesh, organic recycling of wastes, composting of wastes, methods of composting, acceleration and enrichment of compost, maturity of composts, vermicomposting
2	Organic Manure	Concept, composition of manure, preparation of compost, classification of compost, effects of organic manures on soils and crops, green manure-green leaf manure, importance of manure, nutrient content of manure, farm yard manure-major & miner nutrients classification of organic and inorganic manure

Recommended Textbooks

1. Diaz, L.F., Savage, G.M., Eggerth, L.L. and Goluke, C.G. 1993. Composting and Recycling Municipal Soild wastes, Lewis Publishers, Boca raton.
2. Krishna Murthi, R. 1978. A Manual on Compost and Other Organic Manures. Today and Tomorrown Printers and Publishers, New Delhi-110005.

3. Oregon Tilth, 2014. Nutrient Management Plan for Organic Systems, USDA.
4. Ram Chandra, 2015. Environmental Waste Management, CRC Press.
5. Subba Rao, N.S. 1984. Biofertilizers in Agriculture. Oxford and IBH Pub. Co. Pvt. New Delhi.
6. Subba Rao, N.S. 1987. Advances in Agricultural Microbiology. Oxford and IBH Pub. Co., New Delhi.

Supplementary Textbooks

7. Hamdi, Y.A. 1982. Application of Nitrogen Fixing Systems in Soil Improvement and Management. FAO Soils Bulletin 49. Rome, Italy.
8. Malik, K.A. Naqvi, S.H.M. and Aleem, M.I.H. 1985. Nitrogen and the Environment, NIAB, Faisalabad, Pakistan,
9. Vincent, J.M. 1982. Nitrogen Fixation in Legumes. Academic Press, Paris, San Diego, Tokyo, Toronto.
10. Xinthian. D. 1993. Current Development in Soybean Rhizobium Symbiotic Nitrogen Fixation. Heilongjiang Sci. & Tech. Pub. House.

Course Title: Soil and Water Pollution

Course Code: MSSS 2202 Credit Hrs: 2

Unit	Title	Lesson
1	Soil Pollution	Heavy metals-sources, interactions with soil components, critical limits and hazards of As, Cd, Cr and Pb in soils and their remedial measures, pesticides-residues, degradation, hazards and remediation, fertilizers-residues, soil degradation and control measures, greenhouse gases-formation of CH_4, nitrous oxide and carbon dioxide, ozone layer depletion, global warming and changes in soil properties, other pollutants-acid rain and radioactive materials
2	Water Pollution Sources	Heavy metals, fertilizers, pesticides, sewage sludge, industrial effluents, biochemical aspects of water pollution, maximum permissible limits of contaminants in water for potable and irrigation purpose, control of water pollution

Recommended Textbooks

1. Agrawal, S.B. and Agrawal, M. 2000. Environmental Pollution and Plant Responses. Cat. No. L. 1341, CRC Press, UK.
2. Kudesia, V.P. 1990. Soil Pollution, Pragati Prakashani, India.
3. Mishra, P.C. 1989. Soil Pollution: Soil Organisms. Asia Pub. House, India.
4. Tan, K.H. 2000. Environmental Soil Science, 2nd edition, Revised and Expanded. Marcel Dekker Inc. USA/Canada/South America.
5. Marcel van der Perk, 2013. Soil and Water Contamination, 2nd Edition, CRC Press.

Supplementary Textbooks

6. ASA. 1990 Impact of Carbon Dioxide, Trace Gases, and Climate Change on Global Agriculture. ASA Special Pub. No. 53. USA.
7. ASA. 1993. Agricultural Ecosystem Effects on Traces Gases and Global Climate Change. ASA Special Pub. No. 55, USA.
8. Orlov, D.S. 1992. Soil Chemistry. Oxford Pub. Co. Cal. India.

9. Rahman, A.A. Huq, S., haider, R. and Jansen, F. 1992. Environment and Development in Bangladesh. Bang. Cent. Adv. Stud., Dhaka.

Course Title: Soil Ecology and Biodiversity

Course Code: MSSS 2203 **Credit Hrs: 2**

Unit	Title	Lesson
1	Ecology	Concept of ecology and ecosystems, ecology of soil organisms, ecological relationships among soil organisms, soil-plant-microbes relationship, soil ecology and plant growth, soil ecosystems, ecosystems of Bangladesh-high and low lands, hills and coasts, wetland ecosystems-prospects and constrains, ecological hazards
2	Biodiversity	Concept, classification and causes, factors affecting biodiversity, bio-adaptability-constrains and adaptation on biological equilibrium in soil, biodiversity of crops and forests in Bangladesh, effect of manuring, fertilization and pesticide application on biodiversity, status of ray and endangered species, methods of biodiversity conservation, management of biodiversity and sustainable farming, global and national biodiversity conservation policies

Recommended Textbooks

1. Adrian Newton, 2007. Forest Ecology and Conservation, A Handbook Techniques, Oxford University Press.
2. Kotwal, P.C. and Banerjee, S. 2002. Biodiversity Conservation. Agrobios, India.
3. Kumar, H.D. 1994. Modern Concepts of Ecology. Vikas publishing House Pte., Ltd, New Delhi, India.
4. Solbrig, Ot., van Emdew, H.M. and Van Oordt, P.G.W.J. 1994. Biodiversity and Global change. Cab International, UK.
5. Trivedi, P.R. and Roy, G. 2002 Environmental Ecology. Akashdeep publishing House, New Delhi, India.
6. Volobuev, V.R.1964. Ecology of Soils. Israel Program for Scientific Publication. Jerusalem.

Supplementary Textbooks

7. Chowdhury, Q.I.2001. Bangladesh: State of Biodiversity, forum of Environmental journalists, Bangladesh, Dhaka.
8. Faurie, C., Ferra, C., Medori, P. and Devaux, J. 2001. Ecology Science and Practice Oxford and IBH publishing Co. Ltd. New Delhi and Calcutta.
9. Smith, RL, 1990. Ecology and Field Biology, Harper Collins publishers, USA.
10. Adrian Newton, 2007. Forest Ecology and Conservation: A Handbook Techniques. Oxford University Press

Course Title: Soil Water Management

Course Code: MSSS 2204 **Credit Hrs: 2**

Unit	Title	Lesson
1	Soil Water	Sources, structure and properties of water, ground water distribution-aquifer depth, seasonal and yearly fluctuation,

		soil water losses and water balance, soil water stress-plant tolerance, ionic uptake, turgidity, osmotic adjustment, protein and hormone imbalance, plant rooting depth, growth and yield
2	Soil Moisture and Nutrient	Soil air-water interaction, nutrient uptake at different moisture levels, eater uptake by soil-root-stem-leaves due to water potential gradient, components of soil water potential and plant water potential
3	Irrigation	Irrigation water quality-ground and surface water, predicting irrigation needs for crops, efficiency and frequency of irrigation water, measurement of irrigation water, irrigation water quality and soil properties, irrigation projects of Bangladesh
4	Soil Water Conservation	Methods of soil water conservation-mulching, tillage, no tillage and crop varieties

Recommended Textbooks

1. Hiller, D. 1980. Fundamentals of Soil Physics. Acad. Press, New York, USA.
2. Michael, A.M. 1978. Irrigation-Theory and Practice. Vikas Publishing House Pvt. Ltd. New Delhi.
3. Nilsen, E.T. and Ocrutt, D.M. 1996. The Physiology of Plants under Stress, John Wiley and Sons, Inc. New York.
4. Pedro Martinet-Santos, et. al. 2014. Integrated Water Resources Management in the 21st Century: Revisiting the Paradigm.
5. Turner, N.C and Kramer, P.J. 1980 Adaptation of Plants to Water and High Temperature Stress. John Wiley and Sons, Inc, New York.

Supplementary Textbooks

6. Ghildyal, B.P. and Tripathi, R.P. 1987. Soil Physics. Wiley Eastern Ltd. New delhi.
7. James, D.W., Hanks, R.J. and Jurianak, J.J. 1982. Modern Irrigated Soils, John Wiley & Sons. NY.
8. Kramer, P.J. 1983. Water Relation of Plants. Academic press, New York, London.
9. Lambert, K.S. and Rhcroft, D.W. 1983. Land Drainage-Planning & Design of Agric. Drain. System. Batsf. Acad. & Edn. Ltd.
10. Levitt, J. 1972. Reponses of Plants to Environmental Stress. Academic press. New York. London.
11. Mengel, K. and Kirkby, E.A. 1987. Principles of Plant Nutrition. Int. Potash Inst. Pub. Switzerland.

Course Title: Soil Degradation and Conservation

Course Code: MSSS 2205 **Credit Hrs: 2**

Unit	Title	Lesson
1	Soil Quality	Concept of soil quality, indicators of soil quality, soil resistance and soil resilience, factors affecting soil quality and agricultural productivity
2	Soil Degradation	Concept, causes of degradation, soil degradation classes, types of soil degradation-physical, chemical and biological, soil erosion, agents and processes of degradation: losses due to

		degradation-soil, nutrients, vegetation, properties of degraded soil, degraded rice soils, management of degraded soil
3	Soil Conservation	Concept of soil conservation, soil conservation methods: vegetative methods-cover crops, crop rotation, companion crops, strip cropping, crop residue utilization, mulching and windbreaks, mechanical methods-no tillage, minimum tillage, land leveling and bounding, contour and terrace cultivation, modification of soil properties-soil structure, infiltration, drainage, land reclamation

Recommended Textbooks

1. BARC 2001. Impact of Land Degradation in Bangladesh: Changing Scenario in Agricultural Land use. Ed. Karim, Z. and Iqbal, A. Soils Publication No. 42, Soils Division, BARC, Dhaka.
2. FAO. 1994. Land Degradation in South Asia: Its Severity, Causes and Effects Upon the People. Rome, Italy.
3. Greenland, D.J. and Lal, R. 1977. Soil Conservation and Management in the Humid Tropics. John Wiley & Sons Inc., New York.
4. Stallings, J.H. 1962. Soil Conservation. Prentice-Hall Inc., USA.
5. Troeh, F.R., Hobbs, J.A. and Donhue, R.L. 1980. Soil and Water Conservation for Productivity and Environmental Protection. Prentice Hall, Inc., USA.

Supplementary Textbooks

6. Brady, N.C. and Weil, R.R. 2002. The Nature and Properties of Soils. Pearson Education Pte. Ltd. New Delhi, India.
7. Lal, R. 1988. Soil Erosion Research Methods. ISSS, Wageningen, The Netherlands.
8. Miller, R.W. and Donahue, R.L. 1990. Soils An Introduction to Soils and Plant Growth. Prentice Hall Inc., USA.
9. Schwab, G.O. Frevent, R.K. Edminister, T.W. and Barmes, K.K. 1981. Soil and Water Conservation Engineering. John wiley & sons Inc., New York.

Course Title: Soil Survey

Course Code: MSSS 2206 **Credit Hrs: 2**

Unit	Title	Lesson
1	Principles and Methods	User of soil surveys, application of soil survey in land use planning and development, planning a soil survey, orders of soil survey, base maps, generalized soil maps and schematic soil maps, planimetric and topographic maps, aerial photographs and mosaics, photo interpretation, mapping, units in soil survey, map legends soil survey reports, remote sensing, GIS and stereo imagery in soil survey, collection display of information and interpretation, field observations, examination and description of soils, use of land utilization guides, soil survey in Bangladesh

Recommended Textbooks

1. Dent, D. and Yong, A. 1981. Soil Survey and Land Evaluation. George Allen and Unwin Pub. Ltd., London.
2. Hussain, M.S. 1992. Soil Classification with Special Reference to the Soils of Bangladesh. Univ. Dhaka.

3. Lillesand, T.M. and Kiefer, R.W. 1994. Remote Sensing and Image Interpretation. 3rd edition. wiley, New York.
4. Soil Survey Staff, 1993. Soil Survey Manual. Hand Book No. 18. Washington, D.C. USDA
5. Soil Survey Staff, 2014. Keys to Soil Taxonomy, 12th Edition, USDA-Natural Resources Conservation Science, Washington DC.
6. USDA, 1978. Soil Taxonomy-A Basic System of Soil Classification for making and Interpreting Soil Surveys. National Bureau of Soil Survey and Land Use Planning (ICAR), New Delhi.

Supplementary Textbooks

7. Soil Survey Staff, 1992. Keys to Soil Taxonomy. SMSS Technical monograph no. 19, Pocahontas Press, Inc., Blacksburg, Virginia.
8. Star, J. and Estes, J. 1990. Geographical Information Systems: An Introduction. Prentice Hall, Englewood Cliffs, N.J.
9. USDA, 1951. Soil Survey Manual. Agriculture HandBook No. 18.

Sample of Assignment Cover Page

Master of Science (MS) in (Subject Name)

Assignment

on

(Assignment Title)

Course Name& Code:_____

Submitted by	**Submitted to**
Student's Name: ID: Semester: Study Center:	Course Teacher's Name: Designation: Address:

SCHOOL OF AGRICULTURE AND RURAL DEVELOPMENT
BANGLADESH OPEN UNIVERSITY
GAZIPUR-1705

Instructions for Thesis Writing

A.Guidelines for the Soft Bindingof Thesis

The structure of soft binding thesis should include the followings:

- Cover Page (without Student Name, but SID must be mentioned)
- Inner Pages
  - ✓ Inner Cover Page (without Name of Student, but SID must be mentioned)
  - ✓ Signatory Page (without Name of Supervisor and Chairman, Student ID must be mentioned)
  - ✓ Original Literary Work Declaration Form (without Name of Student and Supervisor but their Signatures must be present)
  - ✓ Abstract (Project Title must be included at the Top of the Page)
  - ✓ Table of Contents
  - ✓ List of Figures
  - ✓ List of Tables
  - ✓ List of Abbreviations
  - ✓ List of Appendices
- Main Text
  - ✓ Chapter 1: Introduction
  - ✓ Chapter 2: Reviewof Literatures
  - ✓ Chapter 3: Materials and Methods
  - ✓ Chapter 4: Results
  - ✓ Chapter 5: Discussion
  - ✓ Chapter 6: Conclusion
  - ✓ References (APA style)
- Supplementary
  - ✓ Appendices

B. Guidelines for the Hard Binding of Thesis

The structure of hard binding of thesis should include the followings:

- Cover Page
- Inner Pages
  - ✓ Inner Cover Page
  - ✓ Signatory Page
  - ✓ Original Literary Work Declaration Form
  - ✓ Acknowledgements
  - ✓ Abstract (Project Title with Student Name must be included at the Top of the Page)
  - ✓ Table of Contents
  - ✓ List of Figures
  - ✓ List of Tables

- ✓ List of Abbreviations
- ✓ List of Appendices

- Main Text
  - ✓ Chapter 1: Introduction
  - ✓ Chapter 2: Reviewof Literatures
  - ✓ Chapter 3: Materials and Methods
  - ✓ Chapter 4: Results
  - ✓ Chapter 5: Discussion
  - ✓ Chapter 6: Conclusion
  - ✓ References (APA style)
- Supplementary
  - ✓ Appendices

Printing Quality

a) 1.5 spacing for all sections. Single-spacing can be used for footnote, appendices, tables and diagrams.
b) Font type: Times New Roman
c) Font size: 12 for all text and 8 for footnotes
d) The intends of pages are as follows:

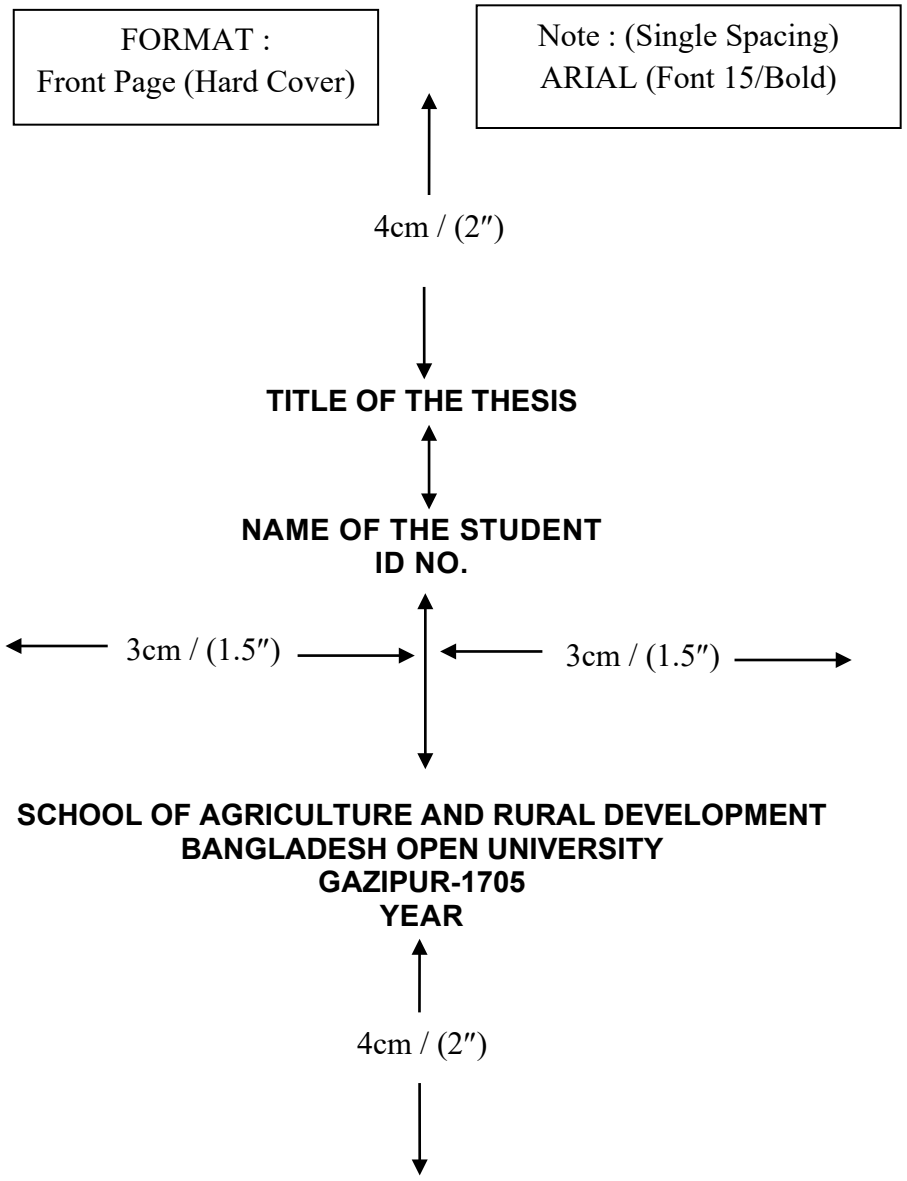
Top	: 2.0cm	Right	: 2.0cm
Bottom	: 2.0cm	Left	: 4.0cm

e) Document should be printed at one side using A4 size offset paper.
f) Page numbering
   i. Font size 8 is recommended for page numbering.
   ii. All page numbers should be printed 1.0 cm from the bottom margin and placed on the right-hand side.
   iii. Roman numerals (i, ii, iii etc) should be used in the preface section.
   iv. The title page and the first page of the Preface should not be numbered. Numbering begins on the second page with 'ii'.

Submission of Thesis for Examination

- Student shall submit three (03) soft bounded copies of the thesis to the chairman of the respective examination committee for examination.
- After examination, the student shall correct the thesis accordingly and submit five (05) hard bounded copies to the chairman of the respective examination committee and one softcopy in PDF format for final submission.
- Any corrections or re-examination required for the thesis must be submitted before expiry of the prescribed period. Failure to do so shall be deemed a failure in the examination of the thesis unless an extension to the prescribed period is approved. Student shall not be allowed to withdraw from an examination for a thesis where the report has already been submitted for examination.

Sample of Cover Page of Thesis



Sample of Inner Cover Pageof Thesis

FORMAT : Title Page
First Page (Inside)

Note : (Single Spacing)
TIME NEW ROMAN (Font 15/Bold)

4cm / (2″)

TITLE OF THE THESIS

NAME OF THE STUDENT
ID NO.

Thesis submitted to the School of Agriculture and Rural Development in partial fulfillment of

← 3cm / (1.5″) → *the requirements for the degree of* ←3cm / (1.5″) →

MASTER OF SCIENCE (MS) IN (SUBJECT NAME)

SCHOOL OF AGRICULTURE AND RURAL DEVELOPMENT
BANGLADESH OPEN UNIVERSITY
GAZIPUR-1705

YEAR

4cm / (2″)

Sample of Signatory Pageof Thesis

FORMAT : Title Page Second Page (Inside)	Note : (Single Spacing) TIME NEW ROMAN (Font 15/Bold)

TITLE OF THE THESIS

Submitted By

Name of the Student

ID No. ……

Semester: January-June/July-December, Year

Approved as the style and contents by

.....	.....
(Name of the Co-supervisor)	**(Name of the Supervisor)**
Co-Supervisor	Supervisor

.....

(Name of the Chairman)

Chairman

Examination Committee

School of Agriculture and Rural Development

Bangladesh Open University

Gazipur-1705

Month and Year

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SCHOOL OF AGRICULTURE AND RURAL DEVELOPMENT

কৃষি ও পল্লী উন্নয়ন স্কুল

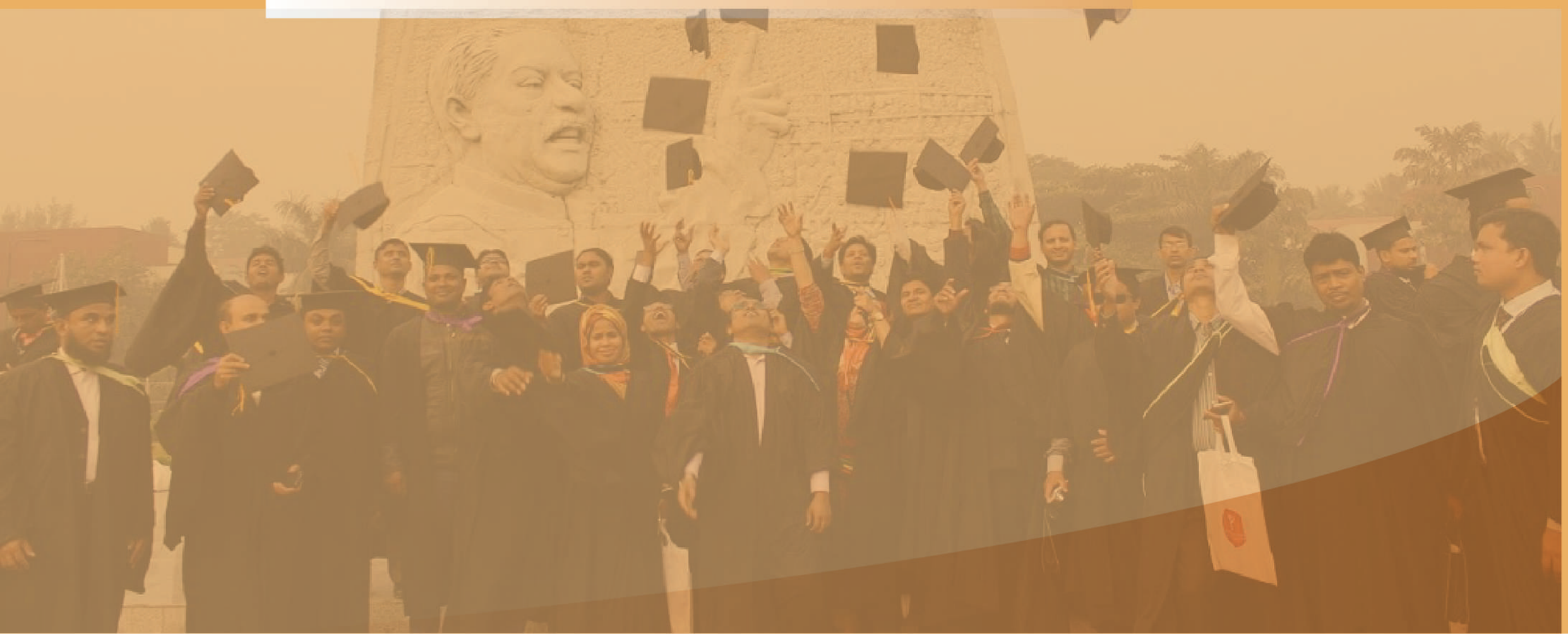
Master of Science Program in

Different Fields of Agricultural Science

Handbook

About the Program

Bangladesh is predominantly an agricultural country. Most of the people depend on agriculture for their livelihood. The economy and development of this country depend on agriculture. The main aims of higher education in agriculture are to generate new knowledge, explore research findings and produce skilled professionals. We have highly qualified and experienced faculty members at the SARD to provide quality education and research. Recently, BOU has established a modern agricultural laboratory and research farm in its main campus at Gazipur under the direct supervision of SARD to ensure hands-on experience applied education and research for the learners. In the near future, BOU will also establish an agricultural training and research center for providing field level facilities to the learners and professionals.



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