Curricula and Course Profile

B.Sc.Ag.(Hons.) Degree Program

Faculty of Agriculture
Bangladesh Agricultural University, Mymensingh
BANGLADESH
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CONTENTS

General Information

Vision

To produce graduates in the field of agriculture to serve the country towards self-sufficiency in food and nutrition and thereby ensuring food security and food safety of the country.

Mission

To produce world class agricultural graduates through quality teaching, research and extension services.

Objectives

The specific objectives of the B.Sc.Ag.(Hons.) degree program are :

1. to introduce the concept of soil, its use, fertility, erosion and management.
2. to provide knowledge on proper methods and technologies of agricultural production and varietal development.
3. to develop understanding on different pest & disease management systems & technologies of successful crop protection.
4. to explain the application of different scientific systems and technologies of harvesting and post-harvest management of crops.
5. to develop understanding on the characteristics of seed and seed propagation techniques.
6. to help understand the characteristics and interactions of bimolecular and physiology of plant growth and development.
7. to impart knowledge on food quality and health status for nutritional security.
8. to create awareness about the impact of climate change on agriculture as well as the importance of forestation in maintaining ecological balance.
9. to help acquire knowledge and skills to derive, analyze and interpret ecological, biological, social, technical and economic information from primary sources.
10. to provide knowledge on methods and strategies in the dissemination of newly developed technologies to the farmers.

Learning Outcomes

After completion of B.Sc.Ag.(Hons.) degree program the graduates will be able to :

Cognitive

1. describe the uses of modern technology and agricultural machinery for crop production and crop diversification.
2. summarize the importance and the role of agriculture and agricultural scientists in providing food and fiber as well as generating income of the population.
3. compare the agriculture of Bangladesh with that of other agro-based countries.
4. evaluate the necessity of using agricultural machineries for increasing crop production.
5. distinguish between weather and climate and discuss the influence of the factors affecting these phenomena in crop production.
6. analyze the risks and uncertainties and ways of mitigating them for better crop production.
7. describe the status of agriculture in various agro-climatic zones of Bangladesh.
8. evaluate symptoms and remedies of crop infection/infestation for successful crop production.
9. explain the impact of climate change on agriculture as well as the importance of forestation in maintaining ecological balance.
10. select and use appropriate production technologies of different crops under changing climate.

11. create agricultural enterprises of different scales in the areas of agricultural production, processing and trading.
12. demonstrate understanding of and appreciation for the importance of globalization and agricultural organization.
13. analyze and interpret the effect of current events and issues occurring in agriculture and determine their mitigation.

Psychomotor

1. demonstrate the procedure of different methods and techniques of various crop production.
2. perform the collection, processing, sorting and preservation of various agricultural products.
3. design the layout of agricultural farm for crop production and social forestation.
4. prepare communication materials to convey messages.
5. follow the process of nursery plantation.

Affective

1. justify the role of agriculture and agricultural scientists in our society and culture.
2. create awareness about the role of technologies in the modernization of agriculture.
3. appreciate the utilization of agricultural machineries in the eco-friendly agricultural production systems.
4. invite others to be inspired in agricultural production as well as in crop diversification.
5. passion for hands-on activities of agriculture.
6. ability and motivation to work with rural community.
7. create awareness about the impact of climate change on crop production and the importance of forestation in agriculture.

Generic Skills

After completion of B.Sc.Ag. (Hons.) degree program, the graduates will be able tom achieve :

1. intellectual skills of crop production, protection & improvement.
2. practical & problem solving skills required under changed climate and environmental conditions.
3. numeracy & analytical skills.
4. entrepreneurship and innovation skills.
5. communication & ICT skills.
6. interpersonal, teamwork & leadership skill.
7. self management & personal development skills like sincerity, punctuality and honesty.
8. commitment to community, country & humanity.
9. norms and ethical values.

Curriculum Structure

Course Distribution for B.Sc.Ag.(Hons.) Degree Program

		Course	Theory	Practical
1.	Total	80	41	39
2.	Core	68	34	34
3.	Collateral	6	4	2
4.	Elective	6	3	3
5.	Optional	1	1	English Language

Credit Distribution for B.Sc.Ag.(Hons.) Degree Program

		Credit	Theory	Practical
1.	Total	185	107	78
2.	Core	159	91	68
3.	Collateral	14	10	4
4.	Elective	12	6	6
5.	Optional	2	2	English Language

Level-wise Course and Credit Distribution for B.Sc.Ag.(Hons.) Degree Program

	Level	Course	Credit	Level	Course	Credit
1.	L-1 S-1	9	20	L-1 S-2	11	23
2.	L-2 S-1	10	23	L-2 S-2	10	23
3.	L-3 S-1	10	24	L-3 S-2	10	24
4.	L-4 S-1	10	24	L-4 S-2	10	24
	Total	39	91		41	94

Department wise Course & Credit Distribution

Sl.No.	Departments	No. of Courses T+P = Total	Credit Hour T+P = Total
1.	Agronomy	5+5 = 10	12+10 = 22
2.	Soil Science	4+4 = 8	11+8 = 19
3.	Entomology	3+3 = 6	9+6 = 15
4.	Horticulture	4+4 = 8	10+8 = 18
5.	Plant Pathology	3+3 = 6	9+6 = 15
6.	Crop Botany	3+3 = 6	8+6 = 14
7.	Genetics and Plant Breeding	3+3 = 6	8+6 = 14
8.	Agricultural Extension Education	3+3 = 6	8+6 = 14
9.	Agricultural Chemistry	3+3 = 6	8+6 = 14
10.	Biochemistry and Molecular Biology	2+2 =4	5+4 = 9
11.	Agroforestry	1+1 = 2	3+2 = 5
	Core Course Sub Total	34+34 = 68	91+68 = 159
12.	Agricultural Statistics	1+1 = 2	3+2 = 5
13.	Farm Power & Machinery	1+1 = 2	2+2 = 4
14.	Agricultural Economics	1+0 = 1	3+0 = 3
15.	Rural Sociology	1+0 = 1	2+0 = 2
	Collateral Course Sub Total	4+2 = 6	10+4 = 14
16.	Elective Course	3+3 = 6	6+6 = 12
	Grand Total	**41+39 = 80**	**107+78 = 185**

Curricula Layout for B. Sc. Ag. (Hons.) Degree Program

	Course No. & Title		Credit hour
Level -1	**Semester-1**	AGRON 1101: Fundamentals of Agronomy (T)*	2
		AGRON 1102: Introductory Agronomic Practices (P)*	2
		SS 1101: Introductory Soil Science (T)	2
		SS 1102: Introductory Soil Science (P)	2
		FPM 1101: Farm Mechanics (T)	2
		FPM 1102: Farm Mechanics (P)	2
		ACHEM 1101: Agroanalytical, Physical and Organic Chemistry (T)	3
		ACHEM 1102: Agroanalytical, Physical and Organic Chemistry (P)	2
		AE 1103 : Agricultural Economics (T)	3
		Optional courses (one T of 2 cr.) : Enclosure-1	
		Total (Excluding optional):	**20**
	Semester-2	AGRON 1201: Seed Science and Technology (T)	2
		AGRON 1202: Seed Science and Technology (P)	2
		HORT 1201: Fundamentals of Horticulture (T)	2
		HORT 1202: Fundamentals of Horticulture (P)	2
		BMB 1201:Chemistry of Biomolecules (T)	2
		BMB 1202: Chemistry of Biomolecules (P)	2
		STAT 1201: Agricultural Statistics (T)	3
		STAT 1202: Agricultural Statistics (P)	2
		RS 1201: Rural Sociology (T)	2
		Elective courses (one T & one P of 2+2 credit) : Enclosure-1 Optional courses (one T of 2 credit) : Enclosure-1	4
		Total (Excluding optional):	**23**
Level -2	**Semester-1**	AGRON 2101: Weed Science (T)	2
		AGRON 2102: Weed Science (P)	2
		SS 2101: Soil Survey, Classification and Conservation (T)	3
		SS 2102: Soil Survey, Classification and Conservation (P)	2
		HORT 2101: Ornamental Horticulture and Plantation Crops (T)	2
		HORT 2102: Ornamental Horticulture and Plantation Crops (P)	2
		CBOT 2101: Plant Morphology, Embryology and Taxonomy (T)	3
		CBOT 2102: Plant Morphology, Embryology and Taxonomy (P)	2
		BMB 2101: Metabolism and Human Nutrition (T)	3
		BMB 2102: Metabolism and Human Nutrition (P	2
		Total :	**23**
	Semester-2	ENTOM 2201: Fundamentals of Entomology (T)	3
		ENTOM 2202: Fundamentals of Entomology (P)	2
		PPATH 2201: Fundamentals of Plant Pathology (T)	3
		PPATH 2202: Fundamentals of Plant Pathology (P)	2
		GPB 2201: Cytology (T)	2
		GPB 2202: Cytology (P)	2
		AGEXT 2201: Fundamentals of Extension, Leadership and Motivation (T)	3
		AGEXT 2202: Extension Teaching Methods and Aids (P)	2
		ACHEM 2201: Nuclear and Agroindustrial Chemistry (T)	2
		ACHEM 2202: Nuclear and Agroindustrial Chemistry (P)	2
		Total :	**23**

*** T = Theory course P* = Practical course**

	Course No. & Title		Credit hour
Level-3	Semester-1	HORT 3101: Vegetable and Spice Crops (T)	3
		HORT 3102: Vegetable and Spice Crops (P)	2
		GPB 3101: Genetics and Cytogenetics (T)	3
		GPB 3102: Genetics (P)	2
		AGEXT 3101: Extension Communication and Group Approaches (T)	2
		AGEXT 3102: Data Collection, Processing and Report Writing (P)	2
		ACHEM 3101: Plant Nutrition, Pesticide and Environmental Chemistry (T)	3
		ACHEM 3102: Plant Nutrition, Pesticide and Environmental Chemistry (P)	2
		AGROF 3101: Principles of Agroforestry (T)	3
		AGROF 3102: Principles of Agroforestry (P)	2
		Total :	**24**
	Semester -2	AGRON 3201: Crop Husbandry (T)	3
		AGRON 3202: Crop Husbandry (P)	2
		SS 3201: Soil Physics and Soil Chemistry (T)	3
		SS 3202: Soil Physics and Soil Chemistry (P)	2
		ENTOM 3201: Insect Ecology and Pest Management (T)	3
		ENTOM 3202: Insect Ecology and Pest Management (P)	2
		PPATH 3201: Principles of Plant Pathology and Diseases of Field Crops (T)	3
		PPATH 3202: Principles of Plant Pathology and Diseases of Field Crops (P)	2
		CBOT 3201: Plant Physiology and Ecology-I (T)	2
		CBOT 3202: Plant Physiology and Ecology-I (P)	2
		Total :	**24**
Level-4	Semester-1	ENTOM 4101: Economic Entomology (T)	3
		ENTOM 4102: Economic Entomology (P)	2
		PPATH 4101: Diseases of Fruits, Vegetables, Cash Crops, Agroforest Trees and Seed Pathology (T)	3
		PPATH 4102: Diseases of Fruits, Vegetables, Cash Crops, Agroforest Trees and Seed Pathology (P)	2
		CBOT 4101: Plant Physiology and Ecology-II (T)	3
		CBOT 4102: Plant Physiology and Ecology-II (P)	2
		AGEXT 4101: Extension Organization Management (T)	3
		AGEXT 4102: Extension Program Planning and Outreach Programs (P)	2
		Elective courses (one T & one P of 2+2 credit) : Enclosure-1	4
		Total :	**24**
	Semester -2	AGRON 4201: Crop Production and Farm Management (T)	3
		AGRON 4202: Crop Production and Farm Management (P)	2
		SS 4201: Soil Microbiology and Soil Fertility (T)	3
		SS 4202: Soil Microbiology and Soil Fertility (P)	2
		HORT 4201: Pomology (T)	3
		HORT 4202: Pomology (P)	2
		GPB 4201: Plant Breeding (T)	3
		GPB 4202: Plant Breeding (P)	2
		Elective courses (one T & one P of 2+2 credit) : Enclosure-1	4
		Total :	**24**

Total credit hrs (T+ P): 107+78 = 185, Total no. of courses (T+ P) : 41+39 = 80

List of Elective and Optional Courses for B. Sc. Ag.(Hons) Degree Program

Level -1 Semester -1	Level -1 Semester -2
Optional courses (one T of 2 cr. may be taken):	Elective courses (one T & one P of 2+2 cr. to be taken):
LAN 1001: English Language (T)	CBOT 1201: Agricultural Botany (T)
	CBOT 1202: Agricultural Botany (P)
	BTECH 1201: Basic Biotechnology (T)
	BTECH 1202: Basic Biotechnology (P)
	ENVSC 1201: Introductory Environmental Science (T)
	ENVSC 1202: Introductory Environmental Science (P)
	AS 1201: Animal Science (T)
	AS 1202: Animal Science (P)
	CSM 1207: Computer Science (T)
	CSM 1208: Computer Science (P)
	Optional courses (one T of 2 cr. may be taken):
	LAN 1001: English Language (T)
Level -4 Semester -1	**Level -4 Semester -2**
Elective courses (one T & one P of 2+2 cr. to be taken):	Elective courses (one T & one P of 2+2 cr. to be taken):
AGRON 4101: Introductory Cropping Systems (T)	AGRON 4203: Forage Crops and Pasture Management (T)
AGRON 4102: Introductory Cropping Systems (P)	AGRON 4204: Forage Crops and Pasture Crops (P)
SS 4101: Soil Biology (T)	SS 4203: Soil Pollution (T)
SS 4102: Soil Biology (P)	SS 4204: Soil Pollution (P)
HORT 4101: Postharvest Management of Horticultural Crops (T)	HORT 4203: Commercial Horticulture (T)
HORT 4102: Postharvest Management of Horticultural Crops (P)	HORT 4204: Commercial Horticulture (P)
GPB 4101: Plant Biotechnology and Genetic Engineering (T)	PPATH 4201: Plant Disease Management (T)
GPB 4102: Plant Biotechnology and Genetic Engineering (P)	PPATH 4202: Plant Disease Clinic (P)
AGEXT 4103: Extension for Sustainable Agricultural Development (T)	CBOT 4201: Crop Physiology (T)
AGEXT 4104: Extension for Sustainable Agricultural Development (P)	CBOT 4202: Crop Physiology (P)
ACHEM 4101: Bioenergy-Principles and Practices (T)	CBOT 4203: Plant Biodiversity and Conservation (T)
ACHEM 4102: Bioenergy-Principles and Practices (P)	CBOT 4204: Plant Biodiversity and Conservation (P)
BMB 4101: Fundamentals of Molecular Biochemistry and Botechnology (T)	GPB 4203: Special Plant Breeding (T)
BMB 4102: Fundamentals of Molecular Biochemistry and Biotechnology (P)	GPB 4204: Special Plant Breeding (P)
BTECH 4001: Genetic Engineering and Biotechnology (T)	AGEXT 4201: Community Participation (T)
BTECH 4002: Genetic Engineering and Biotechnology (P)	AGEXT 4202: Community Participation (P)
ENVSC 4001: Management of Environment (T)	ACHEM 4201: Micronutrients in Agriculture (T)
ENVSC 402: Management of Environment (P)	ACHEM 4202: Micronutrients in Agriculture (P)
	BTECH 4001: Genetic Engineering and Biotechnology (T)
	BTECH 4002: Genetic Engineering and Biotechnology (P)
	ENVSC 4001: Management of Environment (T)
	ENVSC 4002: Management of Environment (P)

Course Code and Total Credit Hours of Compulsory (C), Elective (E) and Optional (O) Courses of Concerned Departments

AGRON : Agronomy (22:C + 8:E)	AGROF: Agroforestry (5:C)
SS : Soil Science (19:C+8:E)	BTECH : Biotechnology (8:E)
HORT : Horticulture (18:C+8:E)	ENVSC : Environmental Science (8:E)
ENTOM : Entomology (15:C)	AS : Animal Science (4:E)
PPATH : Plant Pathology (15:C+4:E)	AE : Agricultural Economics (3:C)
CBOT : Crop Botany (14:C+12:E)	RS : Rural Sociology (2:C)
GPB : Genetics and Plant Breeding (14:C+8:E)	STAT : Agricultural Statistics (5:C)
AGEXT: Agricultural Extension Education (14:C+8:E)	FPM : Farm Power and Machinery (4:C)
ACHEM: Agricultural Chemistry (14:C+8:E)	CSM : Computer Science and Mathematics (4:E)
BCHEM: Biochemistry (9:C+4:E)	LAN : Language (2:O)

Marks Distribution

Each course, theoretical or practical, irrespective of credit hours shall be evaluated on 100 marks in assigning letter grade and grade points.

Marks for class attendance shall be on percentage as :

Marks distribution		
i)	Class attendance	10
ii)	Class test(s)	20
iii)	Final examination	70
	Total	**100**

Class attendance	Marks
100%	10
90% to 99%	9
80% to 89%	8
70% to 79%	7
60% to 69%	6
Less than 60%	0

Grading of Results

Numerical Grade	Letter Grade		Grade Point
80% and 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%	D		2.00
Less than 40%	F	(Fail)	0.00

Finally the results are shown on GPA and CGPA basis. The basis of GPA and CGPA are as follows :

Grade Point Average, GPA = $\frac{\sum C_i G_i}{\sum C_i}$

Cumulative Grade Point Average, CGPA = $\frac{\sum (GPA_i \times TC_i)}{\sum TC_i}$

Where,

C_i = Credit earned of respective courses
G_i = Grade Point obtained in individual courses
GPA_i = Grade Point Average obtained in individual courses(s) passed/completed semesters earned
TC_i = Total credit earned in respective semesters
$\sum$ = Sum of

Academic Calendar

Academic calendar followed in a Semester for B.Sc.Ag.(Hons.) Degree Program

Level	Semester	Activities	Schedule
1	1	Freshers` orientation	1st week, Day-1
		Commencement of classes	1st week, Day-2
		Dropping out due to absence	3rd week, Day-1
		Class test	10th week
		Class suspension	At the end of the 16th week
		Preparatory recess	16 – 17th week
		Final examination	19 – 22th week *
		Publication of result	At the end of 24th week
1	2	Commencement of classes	1st week, Day-1
2	1 & 2	Class test	As in Level-1, Semester-1
3	1 & 2	Class suspension	
4	1 & 2	Preparatory recess	
		Final examination	
		Publication of result	
		Study tour**	

*Decided by the Faculty Committee
**Any suitable time as decided by the Dean, usually in first semester in Level-4

Study Tour

At level-3, semester-2 or level-4, semester-1, The students are required to go for a study tour in different areas or locations of Bangladesh for a period of two weeks. During the tour, the students are facilitated to visit different institutes, industries and historical places with the guidance of senior teachers of the faculty. Apart from this, there are also provisions for visits in different semesters as a part of syllabus of individual courses. These programmes vary in length and time depending upon the decisions taken by the course offering department(s).

Extension Field Trip

A week long extension field trip is organized by the Department of Agricultural Extension Education for the students at Level-4, Semester-1. Through this extension field trip the students get opportunities to learn about farmers' problems, farming systems, agro-ecological variations of different AEZs etc. The students also get acquainted about the development as well as project activities of different government and non-government organizations. This trip is mandatory and part and parcel of the practical course of the Department of Agricultural Extension Education.

Dean's List and Award

Names of students having GPA of Top 3 percent (decimal will be considered as full number) amongst the students passed in a level (academic year) will be included in the Dean's list published every year in recognition of their outstanding performances with provisions of free studentships and special merit scholarships tenable for twelve months. A student with record of "repeat" results and misconduct will not be considered for this merit award.

Department of Agronomy

Course number	:	**AGRON 1101**
Course title	:	**Fundamentals of Agronomy- Theory (Compulsory)**
Number of credits	:	**2**
Total Marks	:	**100**

Rationale

This course covers the understanding of the elementary principles and practices of field crop production and management of farm resources and inputs.

Objectives

- Introduce the concepts of agronomy and crop suitability in relation to agro-climate and agro-ecology
- Provide knowledge on field crop classification and cropping practices
- Make understand about the functions, sources and management of plant nutrients
- Impart knowledge on cultural and intercultural operations of field crops

Learning outcomes

- Explain the concepts of agronomy
- Justify crop suitability based on different agro-climatic and geographical condition
- Categorize crops and describe cropping practices
- State the functions, sources and management of plant nutrients
- Describe the cultural and intercultural operations of field crops

Course content

An Introduction to Agronomy: Concept, importance, scope and basic principles. Evolution of modern crop agriculture.

Agro-meteorology: Concept, weather and climate elements. Cropping seasons of Bangladesh and their characteristics. Rainfall and temperature pattern in Bangladesh and their influence on crop distribution.

Crops and Cropping: Agronomic classification of crops. Concept of cropping patterns, crop rotation and mono and multiple cropping.

Crop Geography: Distribution of crops in relation to climate and soil in world perspective. Agroecological zones of Bangladesh – their characteristics and crop suitability.

Tillage: Concept, objectives and types of tillage. Advantages and disadvantages of different types of tillage. Effect of tillage on soil characteristics and nutrient availability. Determinants of time, depth and number of ploughing. Characteristics of ideal tilth.

Crop Nutrition: Essential elements, their sources and forms of absorption. Function, deficiency symptoms and toxic effects of nutrient elements in crop plants. Manures and fertilizers, definition, characteristics, classification and nutrient contents. Preparation and preservation of manures. Methods of application of manures and fertilizers; their advantages and disadvantages. Soil fertility and productivity. Maintenance of soil productivity through agronomic manipulation.

Planting Practices: Concept, types of planting materials, planting methods, depth and density and their determinants. Field conditions for sowing.

Intercultural Practices: Mulching, thinning, weeding, gap filling, earthing up – their concepts and objectives.

Irrigation and Drainage: Concept, methods, advantages and disadvantages.

Teaching strategy

- Lecture
- Question and answering
- Tutorial

Assessment strategy

- MCQ
- Quiz
- Short question
- Essay type question
- Assignment

Books recommended

Balasubramaniyan, P. and Palaniappan, S. P. 2009. Principles and Practices of Agronomy. Second Edition. Agrobios, India.

Bhuiya, M. S. U., Islam, M. M., Uddin, M. R., Salam, M. A. and Rahman, M. M. 2009. Introductory Agronomy. Oracle Publications, Dhaka, Bangladesh.

Das, P.C. 1997. Manures and Fertilizers, Kalyani Publishers. Ludhiana, New Delhi, Calcutta. 130p.

De, G.C. 1995. Fundamentals of Agronomy. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi, Calcutta. 429p.

Morachan, Y.B. 1993. Crop Production and Management. 2nd Edition (Reprint). Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi, Bombay, Calcutta. 294p.

Reddy, T. Y. and Reddi, G. H. S. 2008. Principles of Agronomy. Kalyani Publishers, Ludhiana, New Delhi, Hyderabad, Kolkata, India.

Singh, S.S. 1996. Principles and Practices of Agronomy. 3rd Edition (Reprint). Kalyani Publishers. New Delhi.

Course number : **AGRON 1102**
Course title : **Introductory Agronomic Practices- Practical (Compulsory)**
Number of credits : **2**
Total Marks : **100**

Rationale

This course is designed to familiarize the students with different inputs and farm machineries, and practicing cultural operations of crop production.

Objectives

- Introduce the students with different field crops and their growth phases
- Demonstrate the fertilizer and manure applications and composting methods
- Identify different manures and fertilizers, soil and meteorological instruments
- Show different agricultural implements and demonstrate their operations for calculating efficiencies
- Identify deficiency symptoms of plant nutrients and calculate manure & fertilizer requirements for crops

Learning outcomes

- Identify different field crops, soil, manures and fertilizers, farm implements and meteorological instruments
- Familiarize with fertilizer and manure applications and composting methods
- Operate common farm implements and calculate their efficiencies
- Recognize deficiency symptoms of plant nutrients
- Calculate manure and fertilizer requirements for crops
- Identify different growth phases and performed intercultural operations of a crop raised by themselves

Course content

Identification of field crops

Study of different farm implements (a) identification, (b) practicing of different operations and (c) determination of their efficiency

Identification of soil by finger feel method

Identification of manures, fertilizers and studying their physical characteristics

Computation of manures and fertilizers for different crops

Preparation and preservation of compost / farm yard manure

Practicing different methods of application of manures and fertilizers

Raising a crop and studying its different growth phases

Practicing weeding, thinning, gap-filling, mulching and earthing up

Study on effect of plant nutrients – N, P, K on root and shoot growth and yield of a cereal crop in pot culture

Study of different meteorological instruments and climatic patterns of Bangladesh

Teaching strategy

- Lecture
- Demonstration
- Lab work
- Field work
- Problem solving
- Assignment

Assessment strategy

- Sample identification
- Illustration
- Oral examination
- Exercise

Books recommended

Mavi, H.S. 1974. Introduction to Agro-meteorology. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.

Simpson, K. 1986. Fertilizers and Manures. Longman Groups Limited. Hong Kong.

Bhattacharya, B. 2008. Advanced Principles and Practices of Agronomy. Kalyani Publishers, New Delhi.

Course number : **AGRON 1201**
Course title : **Seed Science and Technology- Theory (Compulsory)**
Number of credits : **2**
Total Marks : **100**

Rationale

This course is designed to provide basic knowledge on seed, their development, quality improvement, production and storage is vital for an agriculture graduate.

Objectives

- Give the students a basic idea about seeds and features of seed quality
- Illustrate quality seed production techniques
- Provide knowledge about seed rate, storage and treatment
- Make the student understand the concept of seed germination, vigour and dormancy
- Impart knowledge about seed certification and marketing systems in Bangladesh

Learning outcomes

- Gain the basic concept of seeds and seed quality attributes
- Interpret the seed crop production techniques
- Explain seed rate, storage conditions and treatment techniques
- Describe seed germination, vigour and dormancy
- Familiarize with seed certification and marketing systems in Bangladesh

Course content

Introduction to Seed: Definition, importance, classification and structure, formation and development of seed.

Seed Quality: Attributes of quality seed. Importance of quality seed. Importance of quality seed in crop production. Factors affecting seed quality during production and processing.

Seed Germination and Vigour: Definition and process of germination, Conditions necessary for germination. Concept of seed viability and vigour. Significance of seed vigour in crop production.

Seed Dormancy: Definition, kinds and causes. Importance of dormancy in crop production. Means of breaking seed dormancy.

Seed Rate: Concept, planting value of seed. Factors affecting seed rate.

Seed Crop Cultivation: Basic principles, methods of cultivation and harvesting of seed crop. Processing and grading of seed.

Principles of Seed Storage: Environmental factors affecting seed in storage. Types of storage facilities for seed. Safe conditions for seed storage. Factors affecting seed longevity deterioration. The processes involved in seed deterioration.

Seed Treatment: Objectives and procedures. Seed treating chemicals.

Seed Testing: Definition and objectives. Seed sampling. Testing of seeds for moisture, purity, germination, viability and vigour.

Quality Control of Seed: Definition and objectives. Seed certification procedure. Role of National Seed Board. Seed Certification Agency in the quality control of seed. Present status of production and supply of seed in Bangladesh.

Teaching strategy

- Lecture
- Question and answering
- Tutorial

Assessment strategy

- MCQ
- Quiz
- Short question
- Essay type question
- Assignment

Books recommended

Agrawal, R. L. 2009. Seed Technology. Second Edition, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, India.

Basra, A.S. (ed.). 1995. Seed Quality: Basic Mechanisms and Agricultural Implications. Food Product Press, New York.

Basra, A.S. (ed). 2006. Handbook of Seed Technology. Haworth Press New York, USA.

Bewley, J.D. and Black, M. 1994. Seed Physiology of Development and Germination. 2nd Edition, Springer-Verlag. London.

Copeland, L. O. and McDonald, M. B. 1995. Seed Science and Technology. 3rd Edition, Chapman & Hall, New York.

Copeland L.O. and McDonald, M.F. 2001. Principles of Seed Science and Technology – 4th Ed. Burgess Pub. Co., USA

Joshi, A. K. and Singh, B. D. 2005. Seed Science and Technology. Kalyani Publishers, New Delhi, India.

Course number	:	**AGRON 1202**
Course title	:	**Seed Science and Technology-Practical (Compulsory)**
Number of credits	:	**2**
Total Marks	:	**100**

Rationale

This course covers the practical aspects of seeds, their quality control, treatment and production.

Objectives

- Enable the students to identify and classify seeds of different field crops
- Demonstrate different seed structures
- Exhibit different seed sampling techniques
- Enable the student to perform the different seed quality tests
- Teach the students calculating seed rate of different crops
- Show seed crop cultivation technique

Learning outcomes

- Identify and classify seeds of different field crops
- Familiarize with different seed structures
- Perform different seed sampling techniques
- Test seeds for different quality attributes
- Calculate seed rate of different crops
- Raise seed crops

Course content

Identification of seed and preparation of seed album

Study of structures of monocotyledonous and dicotyledonous seeds

Techniques of seed sampling

Moisture test of seed

Purity test of seed

Germination test of seed

Viability test of seed

Vigour test of seed

Calculation of seed rate of crops

Practicing seed grading

Practicing seed treatment

Growing seed crop in students' individual plots/pots

Teaching strategy

- Lecture
- Demonstration
- Lab work
- Field visit

Assessment strategy

- Sample identification
- Illustration
- Exercise
- Oral examination

Books recommended

Hampton, J.G. and Tekrony, D.M. (eds.). 1995. Handbook of Vigour Test Methods. 3rd Edition. International Seed Testing Association, Zurich, Switzerland.

ISTA. 1999. International Rules for Seed Testing. 1999. Supplement to Seed Science and Technology. Vol. 27. pp. 27-32.

Nema, N. P. 1989. Principles of Seed Certification and Testing. Allied Publishers Limited. Ahmedabad, Bangalore, Bombay, Calcutta, Hyderabad, Lucknow, Madras, New Delhi, India.

Sen, S. and Ghosh, N. 2008. Seed Science and Technology. Kalyani Publishers, Ludhiana, New Delhi, Hyderabad, Kolkata, India.

Course number : **AGRON 2101**
Course title : **Weed Science-Theory (Compulsory)**
Number of credits : **2**
Total Marks : **100**

Rationale

This course is designed to provide basic knowledge on weeds, their deleterious effect on crops and their management.

Objectives

- Provide knowledge about concept of weeds, their characteristics, types and impact on agriculture
- Explain weed distribution, persistence and survival mechanisms
- Describe different dimensions of crop-weed competition
- Elucidate different weed management practices

Learning outcomes

- Explain the concept of weeds, their characteristics, types and impact on agriculture
- Interpret weed distribution, persistence and survival mechanisms
- Describe different dimensions of crop-weed competition
- Explain different weed management practices
- Judge the impact of chemical weed control on crop, weed and environment

Course content

Introduction to Weed: Definition, characteristics and classification. Agricultural and non-agricultural losses caused by weeds. Positive value of weed, brief account of the common weeds of Bangladesh with emphasis on the biology of major weeds.

Survival Mechanism of Weed: Propagation, dispersal and persistence.

Distribution of Weeds: Weed distribution in relation to soil, season, land topography, crop and crop production practices.

Crop-Weed Competition: Concept, critical period of seed competition and factors affecting crop-weed competition, competitive ability of weeds and the factors affecting it. Allelopathic effects of weeds on crops and vice-versa.

Weed Management: Concept and principle of integrated weed management. Weed eradication. Cultural, biological and herbicidal methods of weed control- their advantages and disadvantages. Classification, formulation and mode of action of herbicide. Methods of herbicide application. Factors affecting the foliage and soil applied herbicides. Herbicide selectivity and factors affecting it. Herbicidal weed control in major crops *viz.* rice, jute, wheat, cotton and sugarcane. Toxic symptoms of herbicides in weeds and crops. Effects of herbicides on environment.

Teaching strategy

- Lecture
- Discussion
- Tutorial

Assessment strategy

- MCQ
- Short question
- Essay type question
- Assignment

Books recommended

Aldrish, R.J. 1984. Weed-crop ecology- Principles in Weed Management. Breton Publishers, Massachusetts, U.S.A.

Alteri, M.A. and Liebman, M. 1988. Weed Management in Agroecosystem: Ecological Approaches, CRC Press, Inc. Boca Raton Florida, U.S.A.

Anderson, W.P. 2007. Weed Science: Principles and Applications. 4th edition. Waveland PR Inc.

Rao, V. S. 2000. Principles of Weed Science. Second Edition. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi, Calcutta, India.

Rice, E. L. 2012. Allelopathy. 2nd Edition. Academic Press. USA. eBook. ISBN: 9780080925394. ESBN: 9780125870559

Ross, M. A. and Lembi, C.A. 2009. Applied Weed Science: Including the Ecology and Management of Invasive Plants. 3rd Edition. Prentice Hall, USA

Salam, M. A. and Begum, M. 2017. Weed Science. University Grants Commission, Bangladesh. pp 223.

Zimdahl, R.L. 1980. Weed-crop competition- a review. International Plant Protection Centre, Oregon State University, Comallis, Oregon, U.S.A.

Course number : **AGRON 2102**
Course title : **Weed Science - Practical (Compulsory)**
Number of credits : **2**
Total Marks : **100**

Rationale

This course covers practical aspects of weeds and their management.

Objectives

- Identify major weeds, their morphology and propagation
- Explain the life cycle of major weeds and teach preparing weed herbarium
- Identify and characterize different herbicides
- Calculate herbicide doses for crops
- Describe sprayer calibration technique
- Hand-on practice on weed survey method

Learning outcomes

- Identify and classify weeds and their propagation
- Explain the life cycle of major weeds
- Prepare weed herbarium
- Identify and characterize different herbicides
- Calculate the herbicide doses for crops
- Demonstrate hands-on practice of herbicide application in the field
- Perform weed survey

Course content

Identification of weeds and weed seeds/propagules
Preparation of weed herbarium
Study of life cycle and morphology of major weeds- (a) grass, (b) sedge and (c) broadleaf weeds
Study on identification of herbicides and study of their physical characteristics
Calibration of a sprayer
Herbicide calculation
Spraying of non-selective, pre-emergence and post-emergence herbicides in crop field to study their effect on crop and weed
Weed survey in major crops of BAU farm and determination of importance value of weeds

Teaching strategy

- Lecture
- Experiment
- Field visit
- Group discussion

Assessment strategy

- Sample identification
- Illustration
- Exercise
- Assignment

Books recommended

Griffiths, W. 1990. Weed Guide. Published by Schenring Agriculture, Nottingham Road, Stapleford, Nottingham NG98AG, UK.

Hill, T.A. 1977. The biology of weeds. Studies in Biology. No. 79, Edward Arnold, London.

Holm, L.G.; Doll, J.; Holm, E.; Pancho, J. and Herberger, J.P. 1977. The Worlds Weeds: Distribution and Biology. University Press of Hawaii, Honolulu.

Monta, H. 1997. Handbook of Arable weeds in Japan- For correct identification. Published by Kumiai Chemical Industry Co. Ltd., Taitoh-ku, Tokyo 110, Japan.

Salam, M. A. and Begum, M. 2017. Weed Science. University Grants Commission, Bangladesh. pp 223.

Zimdahl, R. 2008. Fundamentals of Weed Science. Third edition. Academic Press, USA.

Course number : **AGRON 3201**
Course title : **Crop Husbandry- Theory (Compulsory)**
Number of credits : **3**
Total Marks : **100**

Rationale

This course is designed to familiarizing crop growth factors, agronomic management, production and post-harvest technology and economics of field crop production.

Objectives

- Provide knowledge on different factors that affect growth, development and yield of field crops
- Make the student familiar with different aspects of water, fertilizer and organic matter management during crop production
- Help the students getting an in-depth knowledge on managing different stresses that affect growth, development, yield and quality of field crops
- Enhance students' knowledge on crop production, post-harvest processing technology and computation of production cost of cereal, pulse, sugar, narcotic and green manuring crops

Learning outcomes

- Understand the role of different factors on growth, development and yield of field crops
- Describe the management aspects of water, fertilizer and organic matter during crop production
- Manage different stresses that affect growth, development, yield and quality of field crops
- State the production technology and post-harvest processing of cereal, pulse, sugar, narcotic and green manuring crops
- Elucidate the production cost of cereal, pulse, sugar, narcotic and green manuring crops

Course content

Crop Growth Factors: Factors affecting growth, development and yield of crops.

Water Management: Water use efficiency under irrigated farming. Water management in dry land farming. Irrigation scheduling.

Fertilizer Management: Balanced fertilization. Fertilizer management in relation to varietal characteristics, growth phases, cropping systems and irrigation.

Organic Matter Management: Maintenance and replenishment of organic matter in soil. Concept of organic farming.

Management of Stress: Moisture, drought and flood, cold, heat, salinity and alkalinity stress and their management for crop production.

Production Technology of Crops: Origin, climate and soil requirements, characteristics of species and cultivars, cultivation practices, post-harvest operations and cost of production of the following crops:

Cereal crops: Rice, wheat, maize, barley and millets.

Sugar crops: Sugarcane and sugarbeet.

Pulse crops: Lentil, mungbean, grasspea, pea, chickpea, pigeonpea and blackgram.

Narcotic crops: Tobacco.

Green manuring crops: *Dhaincha*, sunnhemp and cowpea.

Teaching strategy

- Lecture
- Question and answering
- Tutorials

Assessment strategy

- MCQ
- Short question
- Essay type question
- Assignment

Books recommended

Ancha Srinivasan. 2006. Handbook of Precision Agriculture – Principles and Applications. Food Product Press, an imprint of The Haworth Press, Inc. New York.

Gupta, U.S. 2005. Physiology of Stressed Crops: nutrient relations. Science Pub., India.

Martin, J.H., Waldren, R.P. and Stamp D.L. 2006. Principles of Field Crop Production, 4th Ed., the MacMillan Co., New York.

Reddy, S. R. 2006. Agronomy of Field Crops. Kalyani Publishers, Ludhiana, New Delhi, Hyderabad, Kolkata, India.

Singh, S. S. 2003. Crop Management under Irrigated and Rainfed Conditions. Kalyani Publishers, Ludhiana, New Delhi, Hyderabad, Kolkata, India.

Taize, L., E. Zeiger. 2006. Plant Physiology. Sinauer Pub. U.S.A.

Thakur, C. 1979. Scientific Crop Production. Volume 1 and II. 3rd Edition. Metropolitan Book Co. Ltd. 1, Netaji Subhash Marg, New Delhi 11002, India.

Course number	:	**AGRON 3202**
Course title	:	**Crop Husbandry- Practical (Compulsory)**
Number of credits	:	**2**
Total Marks	:	**100**

Rationale

This course offers practical aspects of field crop production, their management and economics.

Objectives

- Familiarize the students with procedures of conducting experiments on the effects of plant density
- Make student understand about the techniques of ideal nursery bed preparation for raising seedlings
- Demonstrate sugarcane cultivation techniques
- Show the students how the green manuring crop is grown and incorporated into the soil
- Prepare irrigation schedule for field crops
- Teach the students calculating production cost of cereal, pulse, sugar, narcotic and green manuring crops

Learning outcomes

- Understand the procedure of conducting experiments on plant density
- Prepare and manage ideal nursery bed
- Perform different sugarcane plantation methods
- Describe green manuring crop production technology and its incorporation techniques
- Prepare irrigation schedule for field crops
- Calculate cost of production of cereal, pulse, sugar, narcotic and green manuring crops

Course content

Study of plant density on the growth and yield of a crop grown in students' plot

Preparation of nurseries for raising seedlings of rice and tobacco.

Practising different methods of planting sugarcane

Practising irrigation scheduling for a crop

Raising a green manure crop and its incorporation in the soil

Evaluation of the effect of different moisture stresses on the growth and yield of a crop grown in pot

Computation of production cost of crops included in Course No. Agron. 3201

Teaching strategy

- Lecture
- Demonstration
- Field work
- Problem solving
- Assignment

Assessment strategy

- Illustration
- Oral examination
- Exercise

Books recommended

Micheal, M. A. 2003. Irrigation Theory and Practices. Vikas Pub. House,New Delhi, India.

Misra, R. D. and Ahmed, M. 1993. Manual on Irrigation Agronomy. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi, India

Pessaraskli, M. A. 2000. A. Hand Book of Stress Physiology, Marker and Deekar.

Kipps, M.S. 1978. Production of Field Crops. 6th Edition. Tata McGraw-Hill Publishing Company Ltd. New Delhi, India.

Mudaliar, V. I.S. 1984. Principles of Agronomy. 5th Edition. The Bangalore Printing and Publishing Co., Ltd. Mysore Road, Bangalore18, India.

Yawalkar, K.S., Agarwal, J.P. and Bokde, S. 1981. Manures and Fertilizers. Agri-Horticulture Publication House, Nagpur-440010, India.

Course number : **AGRON 4201**
Course title : **Crop Production and Farm Management- Theory (Compulsory)**
Number of credits : **3**
Total Marks : **100**

Rationale

The course is designed to provide knowledge on agro-ecosystems, cropping practices, land use pattern, farm management and technologies related to production and quality improvement of industrial crops.

Objectives

- Describe production technology and quality improvement of industrial crops.
- Provide knowledge on planning and management of agricultural farm.
- Familiarize students with land use systems and crop statistics of Bangladesh.
- Impart knowledge on agro-ecosystems and cropping systems of Bangladesh.

Learning outcomes

- Explain the production technology and quality improvement of industrial crops.
- Describe the planning and management of agricultural farm.
- Illustrate the land use systems and crop statistics of Bangladesh.
- Explain the agro-ecosystems and cropping systems of Bangladesh.

Course content

Production Technology of Crops: Origin, climate and soil requirements, characteristics of species and cultivars, cultivation practices, post-harvest operations and cost of production of the following crops:

Fibre Crops: Jute, cotton, sunnhemp and kenaf.

Oil Crops: Mustard, sesame, groundnut, soybean, linseed, sunflower, safflower and castor.

Beverage Crops: Tea, coffee.

Forage Crops: Maize, sorghum, grasspea, cowpea, naiper grass and guineagrass

Quality Control of Crops: Factors affecting the quality of crops. Agronomic means of improving quality of crops.

Land use and Crop Statistics in Bangladesh: Categories of land use system, area, production, and yield of crops of Bangladesh over time.

Farm Planning and Management: Factors to be considered for the establishment of a farm. Farm layout and farm budgeting. Farm record keeping. Principles of selection of farm enterprises.

Cropping Scheme: Utility and principles of preparation.

Agro-ecosystem: Concept, system properties, determinants, types, resources, characteristics of farming systems of Bangladesh.

Cropping Systems: Concept and determinants:

Multiple cropping: Objective, types, advantages and disadvantages.

Crop rotation: Planning of crop rotation.

Crop diversification: Concept, importance, present status and future strategy in Bangladesh.

Crop intensification: Concept, importance and limitations.

Cropping patterns of Bangladesh and possibilities of their improvement.

Crop Calendar: Objectives, utility, procedure of preparation.

Crop Evaluation: Crop yield estimation, crop cutting experiment, crop reporting and crop forecasting.

Teaching strategy

- Lecture
- Video clips
- Tutorial

Assessment strategy

- Written test
- Quiz
- Assignment
- Presentation

Books recommended

Beneke, R.R. 1955. Managing the Farm Business. John Wiley and Sons. Inc. New York, London.

Chatterjee, B.N., Maiti, S. and Mandal, B.K. 1989. Cropping Systems (Theory and Practice) Second Ed. Oxford and IBH Publishing Co. Pvt. New Delhi, Bombay, Calcutta, 345p.

Hoque, M.Z. 1984. Cropping Systems in Asia. On-Farm Research and Management. IRRI, Philippines.

Kent D. Olson. 2004. Farm Management – Principles and Strategies. Iowa State University Press.

Martin, J.H. R.P. and Waldren, Stamp, D.L.. 2006. Principles of Field Crop Production 4th Ed. The McMillan Co., New York.

Ronald D. Kay and William M. Edwards. Farm Management. 6th Edition. McGraw-Hill, Inc. 2004. (Chapters 1-14).

Wolfe, T.K. and M.S. Kipps. 2004. Production of Field Crop: A Textbook of Agronomy. McGraw Hill Book Co. NewYork.

Course number	:	**AGRON 4202**
Course title	:	**Crop Production and Farm Management-Practical (Compulsory)**
Number of credits	:	**2**
Total Marks	:	**100**

Rationale

This course covers practical aspects of crop production, farm management and field experimentation and report writing.

Objectives

- Demonstrate experimental work and project report writing.
- Explain layout of an agricultural farm and farm records
- Demonstrate crop cutting experiment and crop reporting
- Explain the land use systems and crop statistics of Bangladesh
- Acquaint students with the economics of crop production
- describe crop rotation, calendar and cropping scheme

Learning outcomes

- Conduct experimental work and write project report.
- Layout an agricultural farm and maintain farm records
- Perform crop cutting experiment and crop reporting
- Illustrate the land use systems and crop statistics of Bangladesh
- Compute the production cost and benefit of crop cultivation
- Prepare crop rotation, calendar and cropping scheme

Course content

Project paper: Conducting a simple experiment to study the effect of agronomic practices on crop production and to prepare a project report

Study of farm records and their maintenance

Preparation of cropping scheme

Laying out an agricultural farm

Conducting crop cutting experiment

Preparation of a crop report

Computation of production cost of crops included in Course No. Agron. 4201

Preparation of crop rotation schedules

Preparation of crop calendar

Study of land utilization and crop statistics of Bangladesh

Study of major cropping patterns of Bangladesh in relation to climatic parameters

Teaching strategy

- Lecture
- Practice
- Demonstration

Assessment strategy

- Written test
- Quiz
- Assignment
- Field visit
- Presentation

Books recommended

BBS, 2016. Statistical Yearbook of Bangladesh. Bangladesh Bureau of Statistics, Statistics Division. Ministry of Planning. Govt. of the People's Republic of Bangladesh.

Hedges, T.R. 1969. Farm Management Decision. Prentice Hall, Inc. Englewood Cliffs. London.

Hoque, M.Z. 1984. Cropping Systems in Asia. On-Farm Research and Management. IRRI, Philippines.

Course number : **AGRON 4101**
Course title : **Introductory Cropping Systems- Theory (Elective)**
Number of credits : **2**
Total Marks : **100**

Rationale

The course is designed to provide knowledge on site-specific cropping patterns, agro-ecosystems and cropping systems.

Objectives

- Familiarize the students with the concept of systems, agroecosystems, cropping systems and cropping pattern
- Provide knowledge regarding interactions and management practices in multiple cropping system
- Delineate the special cropping systems

Learning outcomes

- Explain systems, agro-ecosystems and cropping systems
- Categorize different multiple cropping systems
- Describe various kinds of special cropping systems
- Discuss about different management practices in intercropping systems

Course content

Systems: Concept and properties. Agro-ecosystems- importance, structure and function. Systems approach in agriculture- objectives and importance.

Cropping Systems: Concept and determinants. Cropping systems of Bangladesh.

Cropping Pattern: Concept, objectives. Types of multiple cropping patterns. Ecological framework for multiple cropping- diversity and productivity relationships.

Plant Interactions in Multiple Cropping Systems: Interference interactions- removal and addition interactions, mutualisms, interaction of mechanism. Factors affecting the selection of species combination- principles and practices.

Cultural Management of Crops in Intercropping Systems: Seeding environment-tillage, cultivation and weed control. Planting dates, patterns and densities. Soil fertility management- principles of fertilizer recommendation based on different cropping systems. Pest management in intercropping.

Special Cropping Systems: Rice-fish systems: alternate and simultaneous, importance and scope. Rice culture under the rice-fish systems- technology and management.

Teaching strategy

- Lecture
- Video clips

Assessment strategy

- MCQ
- Short question
- Essay type question
- Assignment

Books recommended

Beets, C.W. 1983. Multiple Cropping and Tropical Farming Systems. Westview Press.

Francis, C.A. 1986. Multiple Cropping System. Macmillan Publishing Co. New York.

Hossain, S.M.A. 1988. Agricultural and Rural Development in Bangladesh- Evolution of Cropping Systems in Mymensingh and Comilla regions. JSARD Pub. No. 12. Japan. International Cooperation Agency, Dhaka, Bangladesh.

Spedding, C.R.W. 1988. An Introduction to Agricultural Systems. (2nd Ed.). Elsevier Applied Science. London, New York.

Course number : **AGRON 4102**
Course title : **Introductory Cropping Systems- Practical (Elective)**
Number of credits : **2**
Total Marks : **100**

Rationale

This course provides knowledge on practical aspects of site-specific cropping patterns, agro-ecosystems and cropping systems.

Objectives

- Analyze agro-ecosystem of an area.
- Elucidate root distribution pattern of crops.
- Discuss fertilizer management in intercropping system.
- Explain land equivalent ratio and income equivalent ratio in intercropping system.

Learning outcomes

- Analyze an agro-ecosystem regarding crop production.
- Assess crop suitability in any particular agro-climatic condition.
- Measure root growth and development pattern of crops in intercropping system.
- Calculate fertilizer dose of different crops grown as intercrops.
- Evaluate land equivalent ratio and income equivalent ratio of crops in intercropping system.

Course content

Agro-ecosystem analysis of any village near BAU Campus.
Crop suitability assessment based on land and soil type.
Canopy measurement of shoot in inter and sole crop(s).
Study of root in intercropping pattern: root spread, pattern of distribution of roots in sole and intercrops
Computation of LER, IER and yield equivalent in intercropping patterns.
Analysis of resource utilization efficiency (RUE) in intercrops.
Computation of fertilizer requirement of crops based on cropping patterns.
A plot will be assigned to each student for growing intercrop(s) and evaluate their performance.

Teaching strategy

- Lecture
- Illustration
- Field visit
- Assignment
- Demonstration
- Practice

Assessment strategy

- Written test
- MCQ
- Field performance

Books recommended

Chatterjee, B.N., Mati, S. and Mandal, B.N. 1989. Cropping systems- Theory and Practice (2nd Ed.). Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

Zandstra, H.G., Price, L. and Morris, R.A. 1981. A Methodology for On-farm Cropping Systems Research. IRRI. Los Banos, Philippines.

Course number : **AGRON 4203**
Course title : **Forage Crops and Pasture Management- Theory (Elective)**
Number of credits : **2**
Total Marks : **100**

Rationale

The course provides knowledge on production technology of forage crops with high nutritional value and pasture management.

Objectives

- Familiarize students with the context about the present conditions, challenges, and prospects of pastures and pasture crop cultivation in Bangladesh
- Describe the latest production, processing, and preservation technologies of quality forage crops
- Discuss establishment and management strategy of pasture

Learning outcomes

- Explain the present scenario and prospects of forage crop cultivation and pasturing in Bangladesh
- Identify and classify forage crops and pasture
- Describe the production technology of forage crops
- Delineate pasture establishment and grazing management
- Describe different methods of preparation and preservation of hay, straw and silage

Course content

Forage and Pasture Management: Concept, types, classification, importance, scope, relationship with agriculture. Terminology of forage and pasture science. Feasibility of pasturing in Bangladesh. Forage crops production in the existing cropping systems.

Forage Crops: Concept, classification, characteristics.

Grass-legume combination and their contribution in pasture science. Crop husbandry of grass and legume species; Grass species, Maize, sorghum, guinea grass, Para grass, napier grass, pangola and carpet grass.

Legume species: Grasspea, barseem, cowpea, clovers, *Sesbania* and sunnhemp.

Forage and Pasture Plant Nutrition: Concept, importance, nutrient recycling- nitrogen fixation, nitrogen cycle, legume nitrogen versus artificial nitrogen, nutrient recycling and animal movement. .

Pasture Establishment: Distribution of previous vegetation. Preparation of seed bed; time, depth and method of sowing, cover crops, pasture renovation by over drilling, seed quality, inoculation and pelleting of legume seed, management of establishing pasture.

Grazing Management- Pasture herbage quality, pasture herbage yield, influence of animals on pasture composition and yield, grazing systems and livestock performance; pasture herbage utilization.

Forage and Pasture Conservation: Hay, straw and silage – On-site conservation and effect on animal health

Teaching strategy

- Lecture
- Video clips

Assessment strategy

- Written test
- Quiz
- Assignment
- Presentation

Books recommended

Holmes, W. 1987. Grass- its production and utilization. The British Grassland Society. Blackwall Scientific Publications, London.

Langer, R.H.M. 1973. Pasture and Pasture Plants. A.H. and A.W. Reed Ltd. Wellington, Sydney, London.

Pearson, C.A. and Ison, R.L. 1987. Agronomy of Grassland Systems. Cambridge University Press, New York, Sydney.

Van DerMeer. H.G., Fyden, J.C. and Ennik, G.C. 1986. Nitrogen fluxes in intensive grassland system. Nijhoff Publishers. The Netherlands.

White, J.G.H. 1989. Herbage Seed Production. Wellington, New Zealand.

Wintehead, D.C. 1970. The role of nitrogen in grassland productivity. Commonwealth. Agriculture Bureau, England.

Course number	:	**AGRON 4204**
Course title	:	**Forage and Pasture Crops – Practical (Elective)**
Number of credits	:	**2**
Total Marks	:	**100**

Rationale

The course is designed to provide knowledge on production technology of forage crops with high nutritional value and pasture management.

Objectives

- Familiarize students with forage crop species.
- Explain production technology of forage crops
- Provide knowledge on the measurement of nutritional composition of forage crops.
- Discuss the preparation and preservation techniques of silage, hay and straw.

Learning outcomes

- Identify forage and pasture species and their seeds and propagules.
- Prepare seed and plant herbarium of forage crops.
- Raise a forage crop with modern agronomic practices.
- Prepare and preserve quality silage, hay and straw.
- Measure the botanical composition of a pasture.

Course content

Identification of different forage and pasture species

Preparation of forage and pasture seed album

Preparation of forage and pasture plant herbarium

Preparation and preservation of hay, silage and straw

Measurement of botanical composition of a pasture

Raising a forage crop in individual plot

Teaching strategy

- Lecture
- Demonstration
- Field visit
- Practice
- Video clips

Assessment strategy

- Sample identification
- Illustration
- Written test

Books recommended

Holmes, W. 1987. Grass- its production and utilization. The British Grassland Society. Blackwall Scientific Publications, London.

Langer, R.H.M. 1973. Pasture and Pasture Plants. A.H. and A.W. Reed Ltd. Wellington, Sydney, London.

Pearson, C.A. and Ison, R.L. 1987. Agronomy of Grassland "Systems. Cambridge University Press, New York, Sydney.

Van der Meer. H.G., Fyden, J.C. and Ennik, G.C. 1986. Nitrogen fluxes in intensive grassland system. Nijhoff Publishers. The Netherlands.

White, J.G.H. 1989. Herbage Seed Production. Wellington, New Zealand.

Wintehead, D.C. 1970. The role of nitrogen in grassland productivity. Commonwealth. Agriculture Bureau, England.

Department of Soil Science

Course number	:	**SS 1101**
Course title	:	**Introductory Soil Science-Theory (Compulsory)**
Number of credits	:	**2**
Total Marks	:	**100**

Rationale

This course is designed to cover fundamental aspects of soils in relation to crop production

Objectives

- Discuss soil composition and their functions
- Describe soil genesis and explain importance of different soil properties
- Explain the functions of plant nutrients, compositions of manures and fertilizers
- Identify and classify the soil organisms involved in soil fertility

Learning outcomes

- Explain soil and its components
- Describe rocks and minerals and their weathering processes, soil forming processes and factors
- Illustrate and evaluate soil genesis and soil formation
- Interpret soil physical properties and processes and their significance in crop production
- Classify soil pH and explain its significance in crop production
- Describe essential plant nutrients, their functions and sources
- Categorize soil organisms and select beneficial organisms

Course content

Soil genesis: Concept of Soil, major components of soil, Rocks and minerals- classification and properties, Weathering - physical and chemical weathering, Soil forming factors (climate, biosphere, parent material, relief and time) and processes (laterization, podzolization and calcification), Soil profile

Soil physical properties: Soil particles - classification and properties, Soil texture - classification and importance, Soil structure - genesis, classification and importance, Soil density - particle density and bulk density, Soil porosity- factors and importance of soil porosity, Soil air - composition and importance, Soil colour - causes and importance, Soil water - classification and importance, Soil temperature - factors and importance of soil temperature,

Soil pH: Concept of soil pH and Grouping of soils according to pH values

Plant nutrients: Criteria for essentiality, available forms, macro and micronutrient, and functions

Soil fertility and soil productivity, Manure and fertilizer- kinds and composition

Soil organisms: Classification of soil organisms, Bacteria, fungi and algae - classification and functions, Earthworms- habitats and functions

Teaching strategy

- Lecture
- Tutorial
- Self study/e-learning

Assessment strategy

- MCQ
- Short question
- Essay type question
- Assignment

Books recommended

Alexander, M. 1977. Introduction to Soil Microbiology. John Wiley & Sons Inc., New York.

Baver, L.D., Gardner, W. H. and Gardner, W.R. 1972. Soil Physics, 4thedition. John Wiley & Sons. Inc., New York.

Biswas, L.D., and Mukherjee, S.K. 1991. Text book of Soil Science. Tata McGraw-Hill Pub. Ltd., New Delhi.

Brady, N.C. and Weil, R.R. 2006. The Nature and Properties of Soils. Thirteen edition Pearson Education Pvt. Ltd. New Delhi, India.

Foth H.D. 1991 Fundamentals of Soil Science. 8th edition, Willey and Black, USA.

Miller, R.W. and Donahue, R.L. 1990. Soils- An Introduction to Soils and Plant Growth. Prentice Hall Inc. USA.

Subba Rao, N.S. 1987. Advances in Agricultural Microbiology. Oxford and IBH Pub. Co., New Delhi.

Course number	**:**	**SS 1102**
Course title	**:**	**Introductory Soil Science- Practical (Compulsory)**
Number of credits	**:**	***2***
Total Marks	**:**	**100**

Rationale

This course is designed to cover practical aspects of biophysical properties of soil.

Objectives

- Provide knowledge about hands- on practice of soil properties
- Impart practical skill of collecting soil samples and measuring soil quality attributes
- Identify fertilizers, rocks and minerals that are involved in soil genesis
- Distinguish beneficial soil organisms that are involved in soil fertility and crop productivity

Learning outcomes

- Describe safety measures to conduct laboratory analysis
- Collect and process soil samples for quantifying soil density and porosity
- Identify rocks, minerals and fertilizers
- Demonstrate agents of sterilization
- Isolate, identify and classify bacteria
- Demonstrate bacterial movement

Course content

Precautions to be taken while working in the laboratory
Collection and preparation of soil samples
Determination of particle density of soil by volumetric flask method
Determination of bulk density of soil by core sampler method
Estimation of soil porosity
Identification of different fertilizers
Identification of different rocks and minerals
Techniques of sterilization
Identification of bacteria by Gram staining method
Motility test of bacteria by hanging drop method

Teaching strategy

- Lecture
- Tutorial
- Self study/e-learning

Assessment strategy

- MCQ
- Short question
- Essay type question
- Assignment

Books recommended

Klute, A. 1986. Methods of Soil Analysis, Part 1, Amer. Soc. Agron., Madison, Inc. Pub., Wis.,

USA

Page, A.L., Miller, R.H. and Keeney, D.R. 1982. Methods of Soil Analysis Part 3, Chemical methods, SSSA,

Madison, Inc. Pub., Wis., USA

Seeley, H.W. and Van Demark, J.J. 1975. Microbes in Action. A Laboratory Manual of

Microbiology. D.B. Taraporavala Sons Co. Pvt. Ltd., India.

Tyler, M.E. and Milam, J.R. 1969. Basic Bacteriology: Laboratory Manual. Department of Bacteriology, University of Florida.

Hesse , P.R. 1994. Textbook of Soil Chemical Analysis. Varun Exports, India

Jackson, M.L. 1962. Soil Chemical Analysis. Prentice Hall, New York.

Klute, A. 1986. Methods of Soil Analysis, Part 1. Amer. Soc. Agron., Inc. Pub. Madison, Wis., USA

Course number	:	**SS 2101**
Course title	:	**Soil Survey Classification and Conservation- Theory (Compulsory)**
Number of credits	:	**3**
Total Marks	:	**100**

Rationale

Students need to obtain knowledge and skill on soil survey, classification, mapping, reporting and conservation.

Objectives

- Provide knowledge on soil survey and classification
- Impart basic ideas of Bangladesh soils
- Explain soil organic matter, its decomposition and functions in soil health
- Describe problem soils of Bangladesh and their reclamation strategies

Learning outcomes

- Prepare soil survey map and report
- Interpret general soil types and agroecology of Bangladesh
- Analyze the soil related crop production constraints in Bangladesh
- Design land use for crops and cropping patterns and evaluate the soil-crop management strategies
- Explain soil erodibility and select methods for soil conservation
- Formulate remedial measures for preventing soil pollution

Course content

Soil survey: Purpose, kinds and methods of soil survey, mapping and report preparation

Soil classification, Systems of soil classification - Soil Taxonomy and their equivalent

General Soil Types and Agro ecological Zones (AEZ): General Soil Types of Bangladesh

Characteristics of GST, Geomorphology- hills, terraces and floodplains, Principles of AEZ, description of different AEZs

Problem soils: Saline soils, acid sulphate soils, peat soils and degraded rice soils

Land classification: Criteria for land evaluation, Land capability classification of Bangladesh

Soil organic matter: Sources and composition of soil organic matter, Effects of organic matter on soil properties, Humus formation, C/N ratio

Soil erosion and conservation: Soil erosion - types and factors of soil erosion, soil loss equations, Soil conservation - purpose and techniques of soil conservation

Soil pollution: Causes of soil pollution, Remedial measures of soil pollution

Teaching strategy

- Lecture
- Tutorial
- Self study/e-learning

Assessment strategy

- MCQ
- Short question
- Essay type question
- Assignment

Books recommended

Brammer, H. 1996. The Geography of the Soils of Bangladesh. University Press Ltd., Dhaka, Bangladesh.

Dent, D. and Yong, A. 1981. Soil Survey and Land Evaluation. George Allen and Unwin Pub. Ltd., London.

FAO report. 1988. Land Resources Appraisal of Bangladesh for Agricultural Development, Agroecological Regions of Bangladesh. Report-2.

Greenland, D.J. and Lal, R. 1977. Soil Conservation and Management in the Humid Tropics. Wiley & Sons Inc., New York.

Hussain, M.S. 1992. Soil Classification with Special Reference to the Soils of Bangladesh. University Dhaka.

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.

Zachar D. 1982. Soil Erosion, 1st edition, Elsevier, Netherlands.

Course number : **SS 2102**
Course title : **Soil Survey Classification and Conservation- Practical (Compulsory)**
Number of credits : **2**
Total Marks : **100**

Rationale

The course offers in-field knowledge about all aspects of soil survey, classification, mapping and conservation

Objectives

- Demonstrate various soil properties both in the field and laboratory
- Hands-on soil survey in the field
- Prepare soil map and report preparation

Learning outcomes

- Determine soil texture, colour and reaction (pH)
- Measure soil organic and inorganic carbon
- Interpret the salinity level
- Explain soil genesis and horizon differentiation
- Prepare soil survey map and report

Course content

Identification of different textual types of soil by finger feel method
Determination of soil colour by Munsell's colour chart
Measurement of pH by BAU Soil Testing Kit
Analysis of soil organic carbon by wet oxidation method
Assessment of carbonate and bicarbonate of soil by differential titration method
Estimation of electrical conductivity of soil by conductivity meter
Study of soil profile
Preparation of soil survey report

Teaching strategy

- Lecture
- Tutorial
- Self study/e-learning

Assessment strategy

- MCQ
- Short question
- Essay type question
- Assignment

Books recommended

Hesse , P.R. 1994. Textbook of Soil Chemical Analysis. Varun Exports, India

Jackson, M.L. 1962. Soil Chemical Analysis. Prentice Hall, New York.

Klute, A. 1986. Methods of Soil Analysis, Part 1. Amer. Soc. Agron., Inc. Pub. Madison, Wis., USA

Lal R. and Stewart B.A. Soil Management Experimental Basis for Sustainability and Environmental Quality.

Lal R., Kimble J.M., Follett R.F. and Stewart B.A. Assessment Methods for Soil Carbon, CRC press,USA.

Course number : SS 3201
Course title : Soil Physics and Soil Chemistry- Theory (Compulsory)
Number of credits : 3
Total Marks : 100

Rationale

This course deals with various physical and chemical processes for understanding water and nutrient dynamics in soils.

Objectives

- Provide basic ideas about various physical and chemical processes in soil
- Equip the students with knowledge of soil temperature and water management
- Elucidate mechanisms of nutrient dynamics in soil

Learning outcomes

- Illustrate water cycle and hydraulic properties of soils for irrigation scheduling
- Interpret thermal properties of soils and soil temperature management
- Depict mechanical processes in soils
- Describe soil colloids and silicate clays
- Explain the mechanisms of nutrient uptake by plants
- Interpret nutrient dynamics in submerged soils

Course content

Soil water: Hydrologic cycle, soil water constants, soil water potentials; Methods of measuring soil moisture, Water movement - infiltration, hydraulic conductivity, Evapotranspiration (ET) - factors affecting ET and methods of measuring ET

Soil temperature: Thermal properties of soils, Heat flow equation, Management of soil temperature

Soil Consistency: Forms of soil consistency, swelling, shrinkage, Tillage and puddling; Plough pan - formation, effects on soils and crops

Mechanical analysis: Principal and methods, Stokes' law

Soil colloids: Classification and properties of soil colloids; Types and properties of oxides and hydroxides of Fe, Al and Mn

Silicate clays: Classification and basic structures of clays; Characteristics of Kaolinite, mica, smectite, vermiculite, chlorite and interstratified minerals

Ion exchange: Development of charges in soil colloids, Cation exchange, anion exchange, base saturation Mechanism of nutrient uptake by plants

Soil Acidity and Liming: Types and causes of soil acidity; Buffering capacity of soil; Soil pH and nutrient availability. Liming - liming materials, effects on soil properties, mechanism of pH change

Submerged Soil: Characteristics of submerged soils, Electrochemical changes in submerged soils

Teaching strategy

- Lecture
- Tutorial
- Self-study/e-learning

Assessment strategy

- MCQ
- Short questions
- Essay type questions
- Assignment

Books recommended

Brady, N.C. and Weil, R.R. 2013. The Nature and Properties of Soils. Pearson Education Pvt. Ltd.

Delhi, India.

Dixon, J.B. and Wood S.B. 1989. Minerals in Environments 2nd Edition. Soil Sci. Soc. Amer.,Madison,Wis., USA.

Hanks, R.J. and Ashcroft, F.L. 1980. Applied Soil Physics. Springer - Verlag, Berlin

Hillel, D. 1980. Fundamental of Soil Physics. Acad. Press, New York, USA.

Sparks D.L. 2002 Environmental Soil Chemistry, Second edition, Academic press.

Tan K.H. 2010 Principles of Soil Chemistry, 4th edition, CRC press, USA.

Course number : **SS 3202**
Course title : **Soil Physics and Soil Chemistry- Practical (Compulsory)**
Number of credits : **2**
Total Marks : **100**

Rationale

The course is designed to develop generic skills on the measurement of soil physical and chemical properties

Objectives

- Determine soil moisture, hydraulic conductivity and infiltration rate
- Measure soil pH and cation exchange capacity
- Estimate lime requirement of soil

Learning outcomes

- Measure moisture status of soil in different conditions
- Assess water and solute movement in soil
- Determine lime requirement based on soil pH
- Categorize soils into different textural types

Course content

Determination of soil water by gravimetric and tensiometer methods
Assessment of maximum water holding capacity of soil
Measurement of soil moisture content at field capacity
Determination of soil water infiltration by double ring infiltrometer method
Study hydraulic conductivity of saturated soil by constant head method
Evaluate cation exchange capacity of soil by sodium saturation method
Analysis of soil pH by glass electrode pH meter
Estimation of lime requirement of soil
Particle size analysis of soil by hydrometer method

Teaching strategy

- Lecture
- Tutorial
- Self-study/e-learning

Assessment strategy

- MCQ
- Short question
- Essay type question
- Assignment

Books recommended

Klute, A. 1986. Methods of Soil Analysis, Part 1. Amer. Soc. Agron., Inc. Pub. Madison, Wis., USA

Singh, R.A. 1997. Soil Physical Analysis . Varun Exports, India.

Singh, D. Chhonkar, P.K. and Pandey, R.N. 1999. Soil Plant Water Analysis- A Methods Manual. ICAR, New Delhi.

Jackson, M.L. 1962. Soil Chemical Analysis. Prentice Hall, New York.

Course number	:	**SS 4201**
Course title	:	**Soil Microbiology and Soil Fertility-Theory (Compulsory)**
Number of credits	:	**3**
Total Marks	:	**100**

Rationale

The course is intended to provide understanding of the microbial role in nutrient cycling, soil fertility assessment and fertilizer management.

Objectives

- Explain the role of microbes in soil fertility and the factors regulating nutrient availability
- Interpret soil fertility status and estimate fertilizer recommendation for crops
- Design efficient fertilizer management for crops & cropping patterns
- Identify the principal causes of soil fertility depletion and its management in Bangladesh

Learning outcomes

- Explain soil microbial diversity and its role in soil fertility
- Describe biological nitrogen fixation systems and beneficial role of biofertilizers and mycorrhiza
- Comprehend the mechanisms and factors of nutrient availability in soils for crop uptake.
- Assess soil fertility status for formulating fertilizer recommendations for crops
- Develop fertilizer management practices for crops & cropping patterns
- Identify causes of soil fertility depletion in Bangladesh and management options

Course content

Soil microbes: Abundance and distribution in soil, microbial interactions in soils, microbes and soil fertility

Biological nitrogen fixation: Symbiotic N_2- fixation-Legume- *Rhizobium* symbiosis, *Azolla -Anabaena* symbiosis, Non-symbiotic N_2- fixation- *Azotobacter, Azospirillum, Cyanobacteria*

Bio- fertilizers: Biofertilizers - types and importance. Mychorrhiza - types and importance

Nutrient availability in soils: Nitrogen - occurrence, mineralization, immobilization, mechanisms of N loss, N cycle. Phosphorus and potassium - occurrence, fixation and availability. Sulphur - occurrence, mineralization, immobilization, oxidation and reduction. Zinc and boron - occurrence and availability

Soil fertility evaluation: Methods of soil fertility evaluation. Soil testing, fertilizer trial, critical limits, fertilizer recommendation

Fertilizer management: Principles of fertilizer use. Methods of fertilizer application. Fertilizer use efficiency

Soil fertility problem: Extent and causes of organic matter depletion, nutrient mining, unbalanced use of fertilizers, and land degradation.

Soil fertility management: Use of FYM, compost, green manure, organic wastes, crop residues, and integrated nutrient management

Teaching strategy

- Lecture
- Tutorial
- Self study/e-learning

Assessment strategy

- MCQ
- Short question
- Essay type question
- Assignment

Books recommended

Subba Rao, N.S. 1984. Biofertilizers in Agriculture. Oxford and IBH Pub.Co.Pvt. Ltd. New Delhi.

StevensonSons Inc., New York.

Mengel, K. and Kirkby, E.A. 1987. Principles of Plant Nutrition. Int. Potash Inst. Pub., Switzerland.

Elsan, J.V.D., Trevors, J.T. and Elizabeth, M.H.W.1997. Modern Soil Microbiology.Marcel Dakker.

Havlin, J.L , Beaton, J.D., Nelson, W.L., and Tisdale, S.L. 1999. Soil Fertility and Fertilizers. Sixth

edition. Prentice Hall, Upper Saddle River, New Jersey.

BARC, 2012. Fertilizer Recommendation Guide. Soils Publications no. 41. Bangladesh Agricultural Research Council. Farmgate, Dhaka.

Brady, N.C. and Weil, R. R. 2012. The Nature and Properties of Soils. 14th Edition. Pearson Education Pvt. Ltd, F.J. 1985. Cycles of Soils- Carbon, Nitrogen, Phosphorus, Sulphur, Micronutrients. Wiley &

. New Delhi, India

Course number	:	**SS 4202**
Course title	:	**Soil Microbiology and Soil Fertility-Practical (Compulsory)**
Number of credits	:	**2**
Total Marks	:	**100**

Rationale

The course covers practical aspects of soil fertility assessment, fertilizer recommendation and isolation and characterization of beneficial microorganisms.

Objectives

- Describe different standard laboratory methods of soil analysis
- Determine nutrient concentration in soil and plant samples
- Isolate and characterize N_2-fixing microorganisms
- Prepararation and use of biofertilizers

Learning outcomes

- Perform rapid assessment of nutrients in soil
- Estimate urea demand for crop production
- Quantify TSP demand for crop production
- Determination of MoP and Gypsum demand for crop production
- Counting bacterial population in soil
- Design biofertilizer production technology

Course content

Determination of N, P and K in soil by BAU Soil Testing Kit

Measurement of total N in soil by Kjedahl method

Estimation of available P in soil by modified Olsen method

Assessment of available K in soil by ammonium acetate extraction method

Analysis of available S in soil by calcium chloride extraction method

Isolation and authentication of Rhizobium from legume root nodules

Preparation of Rhizobium inoculants

Total count of bacteria in Rhizobial inoculant

Isolation and identification of Azotobacter in soil

Preparation of Cyanobacterial inoculant

Teaching strategy

- Lecture
- Tutorial
- Self-study/e-learning

Assessment strategy

- MCQ
- Short questions
- Essay type questions
- Assignment

Books recommended

Hesse , P.R. 1994. Textbook of Soil Chemical Analysis. Varun Exports, India

Jackson, M.L. 1962. Soil Chemical Analysis. Prentice Hall, New York.

Klute, A. 1986. Methods of Soil Analysis, Part 1. Amer. Soc. Agron., Inc. Pub. Madison, Wis., USA

Page, A.L., Miller, R.H. and Keeney, D.R. 1989. Methods of Soil Analysis, Part 2. Amer. Soc.

Agron., Inc. Pub. Madison, Wis., USA.

Singh, D. Chhonkar, P.K. and Pandey, R.N. 1999. Soil Plant Water Analysis-A Methods Manual. ICAR, New Delhi.

Seeley, H.W. and Van Demark, J.J. 1975. Microbes in Action. A Laboratory Manual of

Microbiology. D.B. Taraporavala Sons Co. Pvt. Ltd., India.

Tyler, M.E. and Milam, J.R. 1969. Basic Bacteriology: Laboratory Manual. Department of

Bacteriology, University. Florida.

Course number	:	**SS 4101**
Course title	:	**Soil Biology- Theory (Elective)**
Number of credits	:	**2**
Total Marks	:	**100**

Rationale

This course provides knowledge on soil microorganisms and their functions in soil, and rhizosphere

Objectives

- Explain the abundance and functions of soil micro and macroorganisms
- Describe efficient use of soil microbes for better soil management
- Elucidate residual effects of hazardous materials and their biodegradation in soils

Learning outcomes

- Describe soil organisms and their functions in soil fertility
- Identify the beneficial microbes
- Explain biochemical processes in soils
- Formulate suitable technologies for biofertilizer production
- Assess residual effects of hazardous materials and their biodegradation in soils

Course content

Soil organisms: Soil as a habitat for organisms, Occurrence, diversity and classification of soil organisms; factors affecting activities and distribution of organisms in soils; Rhizosphere organisms and their influence on crops; beneficial and harmful organisms in soils.

Bioactivity in soil: Organisms involved in biochemical processes in soils; compost technology - macro and microorganisms involved in composting, vermicomposting, compost maturity

Soil organisms and the environment: Role of soil organisms in improving soil health, effects of agricultural practices on soil organisms, biodegradation of pesticides

Teaching strategy

- Lecture
- Tutorial
- Self-study/e-learning

Assessment strategy

- MCQ
- Short type questions
- Essay type questions
- Assignment

Books recommended

Alexander, M. 1977. Introduction to Soil Microbiology. John Wiley and Sons Inc. New York, USA

Pramer, D. and E.L.Schmidt. 1967. Experimental Soil Microbiology. Burgen Pub. Company.

Elsan, J.W.V., Trevors, J.T.and Elezabeth, M.H.W. 1997. Modern Soil Microbiology. Marcel Dakker.

Paul, E.A. and Clark, F.E. 1989. Soil Microbiology and Biochemistry. Academic Press Inc., London.

Rangaswami, G. and Bagyaraj, D.J.2004. Agricultural Microbiology, Prentice Hall of India Pvt. New Delhi.

Subba Rao, N.S. 1984. Biofertilizers in Agriculture. Oxford and IBH Pub. Co.Pvt. Ltd., New Delhi.

Tilak, K.V.B.R. 1998. Bacterial Fertilizers. Indian Council for Agricultural Research, New Delhi, India.

Course number : SS 4102
Course title : Soil Biology- Practical (Elective)
Number of credits : 2
Total Marks : 100

Rationale

This course provides knowledge and skills on the characterization and behaviour of soil organisms.

Objectives

- Assess the abundance of various soil organisms
- Isolate and characterize different soil organisms of agricultural importance

Learning outcomes

- Explain sampling procedure for microbial study
- Describe preparation of culture media for quantifying microbial population in soil
- Perform isolation and characterization of microbes in bulk soils and rhizosphere
- Categorize different earthworm species

Course content

Sampling of soils for microbial study.

Preparation of culture media for microbes.

Study on the microbial population of the soil, bacteria, fungi & Cyanobacteria.

Isolation and identification of Azospirillum and Cyanobacteria in soils.

Study of the rhizospheric organisms

Identification of earthworms.

Teaching strategy

- Lecture
- Tutorial
- Self-study/e-learning

Assessment strategy

- MCQ
- Short question
- Essay type question
- Experiment

Books recommended

Seeley, H.W. and Van Demark, J.J. 1975. Microbes in Action. A. Laboratory Manual of Microbiology. D.B. Taraporavala Sons Co. Pvt. Ltd., India.

Tyler, M.E. and Milam, J.R. 1969. Basic Bacteriology: Laboratory Manual. Department of Bacteriology, University of Florida.

Klute, A. 1986. Methods of Soil Analysis, part 1, Amer. Soc. Agron., Madison.

Page, A.L., Miller, R.H. and Keeney, D.R. 1982. Methods of Soil Analysis, Part2 . Amer. Soc.Agron., Madison.

Course number : **SS 4203**
Course title : **Soil Pollution- Theory (Elective)**
Number of credits : **2**
Total Marks : **100**

Rationale

This course focuses on heavy metals and other contaminants in soil and their remediation

Objectives

- Describe different kinds of soil pollution and their sources
- Elucidate different remedial measures for soil pollution

Learning outcomes

- Describe heavy metal pollution in soil-plant-water system
- Identify different sources of soil pollution
- Design waste management strategies for remediation of heavy metals and other contaminants

Course content

Introduction to pollution: Concept of pollution and soil pollution, Hazards of soil pollution, Arsenic pollution in Bangladesh

Sources of soil pollution: Fertilizers- residues and toxicity, Pesticides- residues, hazards and degradation

Heavy metals- sources and hazards, Radioactive materials- hazards, City wastes, sewage sludge, soil degradation and microbes

Remediation of soil pollution: Judicial of fertilizers and pesticides, waste management, soil management'

Teaching strategy

- Lecture
- Tutorial
- Self study/e-learning

Assessment strategy

- MCQ
- Short questions
- Essay type questions
- Assignment

Books recommended

Agrawal, S.B. and Agrawal, M. 2000. Environmental Pollution and Plant Responses. CRC Press, UK.

ASA. 1990. Impact of Carbon Dioxide, Trace Gases, and Climate Change on Global Agric. ASA Special Pub. No. 53, USA.

ASA. 1993. Agricultural Ecosystem Effects on Traces Gases, and Global Climate Change. ASA Special Pub.No.55, USA.

Kudesia, V.P. 1990 Pollution, Pragati Prakashani, India.

Mishra, P.C. 1989. Soil Pollution. Asia Pub. House, India.

Rahman, A.A.Huq, S., Huq, S., Haider, R. and Jansen, F. 1992. Environment and Development in Bangladsh. Bang. Cent. Adv. Stud., Dhaka.

Tan, K.H. 2000. Environmental Soil Science, 2nd edition, Revised and Expanded. Marcel Dekker USA & Canada.

Course number	:	**SS 4204**
Course title	:	**Soil Pollution-Practical (Elective)**
Number of credits	:	**2**
Total Marks	:	**100**

Rationale

This course deals with determination of heavy metals in soils, and phosphate and nitrate in water.

Objectives

- Determine heavy metal concentration in soil, water and fertilizers
- Analyze nitrate, phosphate, carbonate and bicarbonate in water

Learning outcomes

- Assess heavy metal status in soil and fertilizers
- Measure phosphate, nitrate, carbonate and bicarbonate concentration in polluted water
- Plan strategies for remediation of different soil pollutants

Course content

Determination of heavy metals (Zn, Cd, As,& Pb) in soils, fertilizers and manures

Analysis of DTPA extractable Fe, Zn, Mn & Cu in soils.

Assessment of As contamination in water.

Determination of phosphate and nitrate in water.

Measurement of HCO_3 concentration in submerged soils.

Books recommended

Hesse , P.R. 1994. Textbook of Soil Chemical Analysis. Varun Exports, India

Page, A.L., Miller, R.H. and Keeney, D.R. 1989. Methods of Soil Analysis, Part 2. Amer. Soc. Agron., Inc. Pub. Madison, Wis., USA.

Klute, A. 1986. Methods of Soil Analysis, Part 1. Amer. Soc. Agron., Inc. Pub. Madison, Wis., USA

Singh, D. Chhonkar, P.K. and Pandey, R.N. 1999. Soil Plant Water Analysis-A Methods Manual. ICAR, New Delhi.

Department of Entomology

Course number : **ENTOM 2201**
Course Title : **Fundamentals of Entomology- Theory (Compulsory)**
Number of credits : **3**
Total Marks : **100**

Rationale

This course is designed to provide the students with the detail knowledge on elementary aspects of insects and arachnids enabling them to identify and classify insects, mites and spiders.

Objectives

- Provide taxonomic knowledge for classification of insects and arachnids
- Acquaint students with insects' morphological structures and their functions
- Develop skills to categorize insects, mites and spiders in different orders and families
- Impart knowledge on physiology, reproduction and neurobiology of insects

Learning outcomes

- Identify insects and arachnids
- Explain insects morphological structures and features
- Describe systematics of insects and arachnids with their agricultural importance
- Outline physiological process of insects
- Describe neurological structures and functions in insects
- Illustrate insect reproduction

Course content

Insecta and Arachnida: General characters and classifications.

Insect morphology: External anatomy of insect. antennae, legs, mouthparts, wings, stridulatory organs and integument in insects.

Insect taxonomy: Diagnostic characters and economic importance of orders and families of insects, mites and spiders of agricultural importance.

Insect physiology: Insect nutrition. Endocrine glands- neurosecretory cells, corpora cardiaca, corpora allata and thoracic glands. Insect hormones- types of hormones and their functions. Moulting- Process of moulting. Metamorphosis- types of metamorphosis, hormonal control of metamorphosis.

Insect neurobiology: Neuron- Sensory neuron, motor neuron and associated neuron, reflex arc. Sense organs-mechanoreceptor, chemoreceptor, photoreceptor, auditory receptor, temperature and humidity receptor. Nervous system- central, peripheral and sympathetic nervous system.

Insect reproduction: Reproductive system and types of reproduction.

Teaching strategy

- Lecture
- Videos
- Presentation
- Self-study/E-learning
- Tutorial

Assessment strategy

- Written test (Short, descriptive type question)
- Quiz test
- Assignment

Books recommended

Borror, D.J., Delong, D.M. and Triplehorn, C.A. 1976. An introduction to the study of insects. Holt Rinchart and Winston, New York.

Gillot, C. 1995. Entomology. Plenum Publ. Corp., New York.

Imms, A.D. A General Text Book of Entomology. Springer Publ.

Mani, M.S. 1990. General Entomology. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

Nayar, K. K., Ananthakrishnan, T. N. and David, B. V. 1985. General and applied Entomology. Tata McGraw- Hill Publ. Co. Ltd., India.

Ross, H. H. 1965. A text book of Entomology. John Wiley, New York.

Saxena, S. C. 1996. Biology of insects. Oxford & IBH Publishing Company.

Course number : **ENTOM 2202**
Course Title : **Fundamentals of Entomology –Practical (Compulsory)**
Number of credits : **2**
Total Marks : **100**

Rationale

This course is designed to provide the students with the practical knowledge on elementary aspects of insects and arachnids.

Objectives

- illustrate insects, mites and spiders, and their appendages
- demonstrate the preparation of temporary and permanent slides of insect appendages
- Explain collection and preservation of insect specimen
- demonstrate dissection and display of anatomical organs of insect

Learning outcomes

- Explain external and internal anatomical features of insect
- Illustrate different appendages of insects with modifications
- Prepare slide for insect studies
- Collect and preserve insects
- Identify economically important insects, mites, and spiders relevant to agriculture

Course content

External anatomy of insect.

Study of various types of antennae, legs, mouthparts and wings of insects.

Techniques of preparation of temporary and permanent slides of insect appendages.

Internal anatomy of grasshopper, cotton bug and a lepidopteran insect.

Methods of collecting, killing, preparing, and preserving of insects.

Identification up to family of insects, mites, and spiders of economic importance in Bangladesh.

Teaching strategy

- Lecture
- Video clip
- Self-study/E-learning
- Demonstration

Assessment strategy

- Written test (MCQ, Short type question)
- Quiz test
- Assignment
- Interview

Books recommended

Borror, D.J., Delong, D.M. and Triplehorn, C.A. 1976. An introduction to the study of insects. Holt Rinchart and Winston, New York.

Blum, M.S. 1985. Fundamentals of insect physiology. John Wiley & Sons, New York.

Gibb, T and Oseto, C. 2005. Arthropod Collection and Identification- Laboratory and Field Techniques. Academic Press

Imms, A.D. A General Text Book of Entomology. Springer Publ.

Nayar, K. K., Ananthakrishnan, T. N. and David, B. V. 1985. General and applied Entomology. Tata McGraw- Hill Publ. Co. Ltd., India.

Ross, H. H. 1965. A text book of Entomology. John Wiley, New York.

Saxena, S. C. 1996. Biology of insects. Oxford & IBH Publishing Company

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Course number. : **ENTOM 3201**
Course title : **Insect Ecology and Pest Management-Theory (Compulsory)**
Number of credits : **3**
Total marks : **100**

Rationale

This course will provide detail knowledge on insect ecology and techniques of pest management for environmentally sound and sustainable crop protection.

Objectives

- Provide knowledge on the ecological aspects of insects.
- Explain monitoring and forecasting pest population.
- Describe the methods of pest management.
- Design approaches of Integrated Pest Management.

Learning outcomes

- Describe the basics of insect population and insect polymorphism
- Analyze pest status and methods of insect population and crop loss estimation
- Describe the basic concepts of insect pest management
- Explain and use different methods of insect pest management
- Develop and apply IPM in crop production

Course contents

A: Insect Ecology

Insect population: Ecological niche and habitats, agro-ecosystem, population dynamics. Influence of environmental factors on insect population. Growth forms of insect populations. Insect demography.

Insect polymorphism: Clonal, phase and social polymorphism. Adaptation of polymorphic insects in agro-ecosystem**.**

Monitoring and forecasting: Survey, field based and fixed position monitoring, pest migration, forecasting system of pest attack.

Population estimation and crop loss assessment: Aggregation pattern, types of pest damage, sampling, methods of population estimation, methods of crop yield loss assessment.

B: Pest Management

Pest management strategy: Concept of pest and pest management. Economic threshold, Economic injury level and General equilibrium position. Principles of insect pest management.

Methods of pest management: Conventional methods: Cultural, Mechanical, Physical, Legal and Chemical methods. Biotechnological methods: Biocontrol, Botanical control, Host plant resistance, Insect sterility technique, Insect growth regulators. Behavioral control- Attractants, Repellants, Antifeedants and Pheromones.

Integrated pest management (IPM): Prospects and limitations of IPM. Development and implementation of IPM.

Teaching strategy

- Lecture
- Assignment
- Video clip
- Self-study/E-learning
- Tutorial

Assessment strategy

- Written test
- Quiz test
- Assignment

Books Recommended

Andrewartha, H.G. and Birch, L.C. 1970. The distribution and abundance of animals. The University of Chicago Press Ltd., London.

Dent, D. 1991. Insect pest management. CAB International.

Ishaaya, I. 1998. Insecticides with novel modes of action. Narosa Pub., India.

Metcalf, R.L. and Luckmann, W.H. 1994. Introduction to insect pest management. John Wiley and Sons, New York.

Norris, R.F. Caswell-Chen, E.P. and Kogan, M. 2003.Concepts in Integrated Pest Management.Prentice Hall.

O'Brien, R.D. 1967. Insecticides action and metabolism. Academic Press, New York.

Saxena, A. B. 2000. Biological control of insects. Anmol Publ., India.

Course number	:	**ENTOM 3202**
Course title	:	**Insect Ecology and Pest Management-Practical (Compulsory)**
Number of credits	:	**2**
Total marks	:	**100**

Rationale

This course will provide practical knowledge on insect ecology and methods of pest management for environmentally sound and sustainable crop protection.

Objectives

- Describe commonly used pesticides in Bangladesh
- Illustrate calculation of pesticide doses according to the needs
- Explain safety measures of pesticide use
- Discuss different plant protection equipment, baits and traps
- Assess pest population and crop loss

Learning outcomes

- Identify commonly used pesticides in Bangladesh
- Compute pesticide dose related problems
- Apply precautionary measures during pesticide application
- Use different plant protection equipment, traps and baits
- Compute insect population density related problems
- Assess crop yield loss related problems

Course contents

Study of commonly used pesticides for controlling insects, mites and rodents.

Formulation of pesticides and computation of doses.

Precautionary measures to be taken during handling and using pesticides.

Plant protection equipment - their operation and maintenance.

Uses of commonly used traps and poison baits.

Measurement of insect population density with absolute and relative methods.

Techniques of crop yield loss assessment in pest infested fields.

Teaching strategy

- Lecture
- Role play
- Video clip
- Lab and field demonstration

Assessment strategy

- Written test
- Quiz test
- Assignment
- Oral test
- Presentation

Books recommended

Andrewartha, H.G. and Birch, L.C. 1970. The distribution and abundance of animals. The University of Chicago Press Ltd., London.

Dent, D. 1991. Insect pest management. CAB International.

Ishaaya, I. 1998. Insecticides with novel modes of action. Narosa Pub., India.

Metcalf, R.L. and Luckmann, W.H. 1994. Introduction to insect pest management. John Wiley and Sons, New York.

Norris, R.F. Caswell-Chen, E.P. and Kogan, M. 2003.Concepts in Integrated Pest Management.Prentice Hall.

Islam, Z and Catling,D. 2012. Rice Pests of Bangladesh: Their Ecology an Management. The University Press Limited, Dhaka, Bangladesh

Sathe, T. V. 2001. Insect pest predators. Daya Publ., India

Course number	:	**ENTOM 4101**
Course title	:	**Economic Entomology-Theory (Compulsory)**
Number of credits	:	**3**
Total marks	:	**100**

Rationale

This course provides knowledge on insect, mite and rodent pests, their biology, damage and appropriate control measures.

Objectives

- Impart knowledge on insect, mite and rodent pests and their control measures.
- Discuss insect transmission of plant pathogens.
- Describe rearing techniques of industrial insects and processing their products.

Learning outcomes

- Describe the characteristics, life cycle and nature of damage of major field crop pests, horticultural crop pests, forest pests, storage pests, and vertebrate pests
- Construct and design pest management strategy
- Identify the insects carrying plant pathogen
- Explain rearing techniques of industrial insects and address the processing problems

Course content

Field crop pests: Bio-ecology, nature of damage and control measures of major insect and mite pests of rice, wheat, jute, cotton, sugarcane, pulses, oilseeds, tobacco and tea.

Horticultural crop pests: Bio-ecology, nature of damage and control measures of major insect and mite pests of vegetables, fruits, ornamental plants and spices. Nursery pests.

Forest pests: Bio-ecology, nature of damage and control measures of major insect and mite pests of forest plants.

Vertebrate pests: Important vertebrate pests of field crops and stored products. Population dynamics. Rodent damage assessment. Control measures of rodents pests.

Storage pests: Important insect and mite pests in storage; their life cycle and nature of damage. General control measures of storage pests.

Insect borne plant diseases: Insects in relation to plant diseases. Role of insects in plant disease development. Methods of transmission of pathogens by insects. Toxicoses and cecidium.

Industrial insects: Silkworm, Honey bee and Lac insect.

Teaching strategy

- Lecture
- Video clips

Assessment strategy

- Written test
- Quiz test
- Assignment

Books recommended

Atwal, A.S. 1986. Agricultural pests of India and Southeast Asia. Kalyani Publ., New Delhi.

Fryer, J.C.F. 1999. Insect pests of fruit crops. Biotech Books, India.

Heinrichs, E.A. 1994. Biology and Management of rice insects. Wiley Eastern Ltd., India.

Islam, Z and Catling,D. 2012. Rice Pests of Bangladesh: Their Ecology and Management. The University Press Limited, Dhaka, Bangladesh.

Krishnaswami, S., Warasimhanna, M.N. Suryanarayan, S.K. and Kumararaj, S. 1979. Sericulture Manual 2 - Silkworm rearing. FAO, Italy.

Singh, S. 1982. Beekeeping in India. Indian Council of Agricultural Research, New Delhi.

Zakladnoi, G.A. and Ratanova, V.F. 1987. Stored- grain pests and their control. Oxonian Press Pvt. Ltd., New Delhi.

Course number	:	**ENTOM 4102**
Course title	:	**Economic Entomology-Practical (Compulsory)**
Number of credits	:	**2**
Total marks	:	**100**

Rationale

This course provides practical knowledge on insect, mite and rodent pests and their biology, damage and control measures.

Objectives

- Provide up-to-date knowledge and skills about insect, mite and rodent pests and their management strategies.
- Describe techniques of rearing and application of different bio-control agents.
- Elucidate the insect vectors of plant pathogens.
- Demonstrate the rearing techniques of industrial insects and processing of their products.

Learning outcomes

- Identify the pests of field crops, horticultural crops, forest plants, nursery, and stored products
- Explain pest management strategies and develop different IPM packages
- Categorize and characterize the bio-control agents
- Enlist and recognize the insects carrying plant pathogens
- Describe different beneficial insects and their rearing techniques

Course contents

Survey of major pests of field crops, horticultural crops, forest plants and stored products.

Identification of important nursery pests.

Identification of potential predators, parasitoids and pathogens of insect pests in Bangladesh.

Identification of insects carrying disease organisms of major crops in Bangladesh.

Development of IPM programme for a cereal, fibre, vegetable and fruit crop.

Mass culture of a pest insect and bio-control agent.

Mass culture of a pest insect and bio-control agent.

Teaching strategy

- Lecture
- Field visit
- Video clips
- Field demonstration

Assessment strategy

- Written test
- Quiz test
- Assignment
- Presentation

Books recommended

Atwal, A.S. 1986. Agricultural pests of India and Southeast Asia. Kalyani Publ., New Delhi.

Fryer, J.C.F. 1999. Insect pests of fruit crops. Biotech Books, India.

Gapud, V. P. 1992. Insect and mite pests of plant crops in Bangladesh and their natural enemies. USAID/BARC/Checchi & Co. Publ.

Juan Morales-RamosM. Guadalupe RojasDavid Shapiro-Ilan(**Editors). 2014.** Mass Production of Beneficial Organisms Invertebrates and Entomopathogens, Academic Press.

Moite, D. K. 1994. Moumachi Palan (in Bengali). Ma Tara Printing Press, Kalikata, India.

Prodhan, S. 1992. Insect pests of crops. National Book Trust, India.

Singh, S. 1982. Beekeeping in India. Indian Council of Agricultural Research, New Delhi.

Department of Horticulture

Course number : **HORT 1201**

Course title : **Fundamentals of Horticulture-Theory (Compulsory)**

Number of credits : **2**

Total marks : **100**

Rationale

This course will focus on fundamental aspects of horticultural practices.

Objectives

- Provide knowledge on nursery management
- Explain the different methods of plant propagation
- Understand crop husbandry and postharvest management

Learning outcomes

- Describe the history, branches, importance and scope of horticulture
- Explain the principles and practices including planting methods, raising of seedlings and different intercultural operations
- Apply the skills of different nursery management and propagation practices
- Demonstrate training and pruning in horticulture
- Harvest and postharvest handling of different horticultural crops

Course contents

Introduction to horticulture: Definition, history, branches, importance and scope of horticulture

Principles and practices in horticulture: Planting methods and raising of seedlings, soil and land preparation, plant spacing, manure and fertilizer application, irrigation and drainage, intercultural operations

Nursery management: Definition, types, objectives, establishment and management of nursery and its structures, calendar of nursery activities

Propagation of horticultural crops: Definition, importance, methods and techniques, advantages and disadvantages, use of growth regulators in propagation

Training and pruning: Concept, objectives, principles, types, methods and their effects on plant structure and bearing

Harvesting and handling of horticultural crops: Harvesting, sorting, grading, packaging, transportation and marketing of horticultural crops

Teaching strategy

- Lecture
- Group discussion
- Video clip

Assessment strategy

- Short question
- Essay type question
- MCQ
- Pop quiz

Books recommended

Adams, C.R., K.M. Bamford and M.P. Early. 1993. Principles of Horticulture (2nd edn.). Linacre House, Jordan Hill, Oxford. (5th edition, 2011 available).

Bose, T.K., S.K. Mitra and M.K. Sadhu. 1986. Propagation of Tropical and Sub-tropical Horticultural Crops. Naya Prokosh, Calcutta. (1991 avaiable).

Davidson, H.R. Meckienburg, and C. Peterson, 1994. Nursery management: Administration and culture (3rd edition), Englewood cliffs, N.J. Prentice- Hall.

Hartmann, H.T., D.E. Kester and F.T. Davies Jr. 1990. Plant Propagation: Principle and Practices. Prentice-Hall, International editions. (7th edition, 2001 available).

Mondal, M.F.2000. Nursery and Plant Propagation (in Bangla). Mrs. Afia Mondal, BAU Campus, Mymensingh.

Prasad, S. and U. Kumar, U. 1999. Principles of Horticulture. Agro Botanica, New Delhi.

Thompson, A. K. 2003. Fruits and Vegetables: Harvesting, Handing and Storage (Second edition). Blackwell Publishing Ltd. Oxford, UK.

Course number	: **HORT 1202**
Course title	: **Fundamentals of Horticulture-Practical (Compulsory)**
Number of credits	: **2**
Total marks	: **100**

Rationale

This course will focus on practical aspects of nursery management, plant propagation, seedbed preparation, training, pruning and harvesting of horticultural crops.

Objectives

- Describe the skills on modern nursery management
- Demonstrate the techniques of plant propagation
- Demonstrate seedbed preparation
- Hands-on practice of different planting and harvesting methods

Learning outcomes

- Prepare layout of a nursery
- Identify and use of nursery equipments
- Practice planting methods and intercultural operations
- Prepare seedbed and nursery bed
- Practice potting, de-potting and repotting
- Conduct propagation practices of different horticultural crops
- Operate harvesting of different horticultural crops using various methods

Course content

Layout of a nursery

Identification and use of nursery equipment

Methods of planting horticultural crops

Preparation of seedbed and nursery bed

Practices on potting, depotting and repotting

Propagation practices of different horticultural crops

Pruning and training of important horticultural crops

Practicing different methods of application of manure and fertilizer

Practices on different intercultural operations

Harvesting methods of horticultural crops

Teaching strategy

- Lecture
- Demonstration and individual practice
- Group discussion
- Video clip
- Questioning and answering
- White and black board

Assessment strategy

- Short question
- Essay type question
- MCQ
- Pop quiz

Books recommended

Acquaah, G. 2008. Horticulture: Principles and Practices. Prentice Hall; 4 edition.

Bakhshai, J.C., D.U. UPPAL and H.N. Khajuria. 1997. (2nd edn.). The Prunning of Fruit Trees and Vines. Kalyani Publishers. India.

Bose, T.K., S.K. Mitra and M.K. Sadhu. 1986. Propagation of Tropical and Sub-tropical Horticultural Crops. Naya Prokosh, Calcutta. (1991 avaiable).

Edward, R. and C. S. 2010. Introductory Horticulture. Delmar Cengage Learning; 8th Revised edition. 5 Maxwell Drive, Clifton Park, NY 12065-2919.

Hartmann, H.T., D.E. Kester and F.T. Davies Jr. 1990. Plant Propagation: Principle and Practices. Prentice-Hall, International editions. (7th edition, 2001 available).

Mondal, M.F.2000. Nursery and Plant Propagation (in Bangla). Mrs. Afia Mondal, BAU Campus, Mymensingh.

Sharma, S. K. 2010. Postharvest Management & Processing of Fruits & Vegetables. New India Publishing Agency.

Course number : **HORT 2101**

Course title : **Ornamental Horticulture and Plantation Crops-Theory (Compulsory)**

Number of credits : **2**

Total marks : **100**

Rationale

This course will focus on the fundamentals ofornamental horticulture and its production and management practices, design landscape horticulture. .

Objectives

- Outline the scope, classification, production and management practices of ornamental plants and plantation crops
- Describe the theory and principles of landscape gardening

Learning outcomes

- Explain scope and importance and classify ornamental plants and plantation crops
- Perform production and management of flowers and ornamental plants
- Design and layout of landscape gardening
- Establish and decorate different formal and informal gardens
- Manage and develop the cut and dry flower business
- Produce, manage and process different plantation crops

Course content

Importance and classification: Scope, importance and classification of ornamental plants and plantation crops

Production and management of ornamental plants: a) **Bedding flowers:** Zinnia, cosmos, calendula, globe amaranth, phlox, antirrhinum, dianthus, balsam, corn-flower and lupin b) **Commercial flowers:** Rose, dahlia, chrysanthemum, carnation, tuberose, gladiolus, marigold, aster, jasmine and lilies c)

Ornamental shrubs, trees, palms, orchids, ferns and cacti

Landscape horticulture: Landscape horticulture and its classification, theory and principles of landscape gardening, development and maintenance of lawn, turf and hedge

Garden architecture and decoration: Formal and informal garden; principles and geometry; establishment and maintenance of home and institutional gardens, water garden, rock-garden, park, bonsai, topiary, pergola and arches

Commercial floriculture: Management of cut and dry flowers, production of perfumes and aromatics, business development

Production and management of plantation crops: Production, management and processing of plantation **crops:** Rubber, oil palm, cocoa, betel leaf, betel nut and bamboo

Teaching strategy

- Lecture
- Group discussion
- Video clip

Assessment strategy

- Short question
- Essay type question
- MCQ
- Pop quiz

Books recommended

Bose, T.K. and L.P. Yaday. 1989. Commercial Flowers. (1998, Pilgrims Publishing available) Naya Prakash, Calcutta.

Bose, T.K., R.S. Maiti, R.S. Dhua and P. Das. 1999. Floriculture and Landscaping. Naya Prokash Calcutta.

Chattopadhyay, P. K., T. K. Bose and V. A. Parthasarathy. 2006. Plantation Crops. Vol. 1. Naya Udyog, Calcutta.

Jack E. Ingels. 2001. Ornamental Horticulture: Science Operations and Management. Delmar Cengage Learning; 3rd Revised edition.

Kumar, N; J.B.M.M.A. Khader, P. Rangaswami and I. Irulappan.2000. Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants. Oxford & IBH Pub. Co. Pvt. Ltd., New Delhi.

Rashid, M.M. 1990. Phuler Chas. Bangla Academy, Dhaka.

Shanmugavelu, K. G., N. Kumar and K. V. Peter. 2002. Production Technology of Spices and Plantation Crops. Agrobios.

Course number	: **HORT 2102**
Course title	: **Ornamental Horticulture and Plantation Crops-Practical (Compulsory)**
Number of credits	: **2**
Total marks	: **100**

Rationale

This course will cover practical aspects of ornamental and landscape horticulture.

Objectives

- Demonstrate identification of important flowers and ornamental plants
- Prepare and pack cut flowers and bouquets
- Design landscape gardens and manage garden activities
- Demonstrate different techniques of bonsai preparation
- Describe the cost- benefit analysis of ornamental plants

Learning outcomes

- Identify the ornamental plants and their propagating materials
- Prepare seed album and herbarium of ornamental plants
- Generate strategies for preparation and packaging of cut flowers for marketing
- Construct bouquet and design of different flower arrangements
- Make bonsai and topiary, grow orchids and cacti and raise saplings of plantation crops
- Develop graphic design of different ornamental gardens and park
- Estimate the production cost and predict benefit cost analysis of ornamental plants

Course content

Identification of different flowers, ornamental plants, cacti, fern, orchid and plantation crops and their propagating materials

Preparation of seed album for ornamental plants

Preparation of herbarium

Preparation and packaging of cut flowers for marketing

Preparation of bouquet and flower arrangements for different purpose

Making bonsai and topiary

Techniques of growing orchids and cacti

Graphic design of different types of ornamental gardens and their components

Graphic design of park

Cost of production of rose and tuberose

Raising of saplings of plantation crops

Teaching strategy

- Lecture
- Group discussion
- Video clip

Assessment strategy

- Short question
- Essay type question
- MCQ
- Pop quiz

Books recommended

Bose T.K. and B. Choudhury. 1992. Tropical Garden Plants in Colour. Horticulture and Allied Publishers. Calcutta.

Byczynski, L. and R.Wimbiscus. 1997. The Flower Farmer: An Organic Grower's Guide to Raising and Selling Cut Flowers (Gardener's Supply Books). Chelsea Green Publishing Co.

Dirr, M. A. 1998. Manual of Woody Landscape Plants: Their identification, Ornamental Characteristics, culture, propagation and uses. Stipes Publishing; 5 edition.

Dole, J.M. and H.F. Wilkins. 1999. Floriculture: Principles & Species. (2004 available) Prentice Hall, Upper Saddle River, New Jersey 07458.

McMillan, H.E. 1962. Tropical Planting and Gardening. MacMillan, London.

Randhawa, G.S. and A. Mukhupadhyay. 1994. Floriculture in India. (New edition 1998 available) Allied Pub. Ltd., New Delhi.

Srivastava H.C., B. Vatsu and K.K.G. Menon. 1986. Plantation Crops: Opportunities and Constraints. Oxford & IBH Pub., New Delhi, India.

Course number	: **HORT 3101**
Course title	: **Vegetable and Spice Crops-Theory (Compulsory)**
Number of credits	: **3**
Total marks	: **100**

Rationale

This course focuses on different aspects of vegetable and spices including production and processing technologies, seed production technology and vegetable farming.

Objectives

- Provide knowledge on modern aspects of vegetable and spice production
- Explain the techniques of processing for vegetable and spices

Learning outcomes

- Explain background, status of production and export of vegetable and spice crops
- Classify vegetable and spice crops and summarize their morphology
- Outline soil and climatic factors in vegetable production
- Illustrate present situation of production, import and supply and develop quality seed production strategies of vegetable seeds
- Construct vegetable farming adopting kitchen and commercial garden, organic farming and polytunnel production
- Describe techniques of producing and processing different vegetable and spices

Course content

Vegetable and Spices in Bangladesh: Background, status of production and export, importance in human nutrition and economy

Classification and morphology of vegetable and spice crops: Origin, distribution, classification, morphology and growth habit

Soil and climatic factors in vegetable production: Influence of soil, temperature, light, air and water on physiology, vegetative growth, flowering, yield and quality of vegetables

Vegetable seeds: Present situation of production, import and supply, classes, quality, techniques of production, factors influencing quality during production and storage

Vegetable farming: Kitchen and commercial garden; organic farming, polytunnel production; inter-multiple-relay cropping, crop rotation

Production technology of vegetables: Technology of production and storage of fresh vegetables: cabbage, cauliflower, potato, tomato, brinjal, sweet potato, carrot, sweet gourd, pointed gourd, cucumber, watermelon, aroids, leafy vegetables and mushroom

Production and processing of spices: Production, processing and storage of onion, garlic, chilli, ginger, turmeric, coriander and black pepper

Teaching strategy

- Lecture
- Group discussion
- Video clips

Assessment strategy

- Short question
- Essay type question
- MCQ
- Assignment

Books recommended

Bose, T.K. and M.G. Som. 1990. Vegetable Crops in India. Naya Prokash, Calcutta.

George, R. A. T. 2010. Tropical Vegetable Production. CABI Publishing.

Hazra, P. 2011. Modern Technology in Vegetable Production. New India Publishing Agency.

Peter, K. V. 2004. Handbook of Herbs and Spices: Volume 2. Woodhead Publishing Ltd. and CRC Press LLC.

Purseglove, J.W., E.G. Brown, C.L. Green and S.R.J. Robbins. 1981. Spices, Vol I & II. Longman Group UK Ltd., London.

Shanmugavelu, K. G., N. Kumar and K. V. Peter. 2002. Production Technology of Spices and Plantation Crops. Agrobios.

Singh, P. and B. Asati. 2008. Seed Production Technology of Vegetables. Daya Publishing House.

Course number	: **HORT 3102**
Course title	: **Vegetable and Spice Crops-Practical (Compulsory)**
Number of credits	: **2**
Total marks	: **100**

Rationale

This course covers practical aspects of vegetable and spice production including seed extraction, estimation of seed rates, production cost and crop calendar.

Objectives

- Describe different categories of vegetable and spice crops
- Illustrate calculation of productions cost of vegetable and spices
- Explain seed quality assessment techniques
- Demonstrate planting, managing intercultural operations and harvesting of important vegetable and spice crops

Learning outcomes

- Identify the vegetable and spice plants and their propagating materials
- Plant different vegetable and spice crops following various methods
- Outline morphological features of important vegetable and spice crops
- Estimate the production cost and evaluate benefit cost analysis of vegetable and spice plants
- Extract seeds of different vegetable, determine the quality of vegetable seeds, and estimate seed rate and fertilizer dose for vegetable production
- Raise different vegetable and spice crops in plots and write report on these

Course content

Identification of important vegetable and spice plants, plant parts and their planting materials
Methods of planting vegetable and spice crops
Studies on morphological features of important vegetable and spice crops
Identification of important cultivated varieties of tomato, potato, brinjal and sweet potato
Estimation of cost of production and economic returns of tomato, cabbage, onion and potato
Studies on quality of vegetable seeds
Demonstration and report writing on homestead and commercial production of vegetables in a neighboring village
Extraction of bottle gourd, tomato and brinjal seeds
Studies on techniques of staking, trellising, artificial pollination and poly-tunnel making for vegetable production
Estimation of seed rate and fertilizer dose for vegetable production
Making of a crop calendar for vegetable and spice crops
Raising of vegetable and spice crops in plots and report writing

Teaching strategy

- Lecture
- Group discussion
- Demonstration and individual practice
- Video clips

Assessment strategy

- Short question
- Essay type question
- MCQ
- Assignment

Books recommended

George, R. A. T. 2010. Tropical Vegetable Production. CABI Publishing.

Peter, K. V. 2004. Handbook of Herbs and Spices: Volume 2. Woodhead Publishing Ltd. and CRC Press LLC.

Pruthi, J.S. 1986. Spices and Condiments. National Book Trust, New Delhi.

Rashid, M.A. and D.P. Singh. 2000. A Manual on Vegetable Seed Production in Bangladesh. AVRDC-USAID-Bangladesh Project, BARI, Joydebpur.

Sanmugavelu, K.G. 1989. Production Technology of Vegetable Crops. Oxford & IBH Pub. Co. Pvt. Ltd., New Delhi.

Sharfuddin, A.F.M. and M.A. Siddique. 1985. Shabji Biggan. Hasina Akter Beauty, Mymensingh.

Singh, N.P., A.K. Bhardueaj & A. Kumar. 2004. (1st edn.) Modern Technology on Vegetable Production. International Book Distributing Co.

Course number : **HORT 4201**

Course title : **Pomology-Theory (Compulsory)**

Number of credits : **3**

Total marks : **100**

Rationale

This course focuses on basic knowledge on different aspects of fruits including production technology, propagation practices, physiology and postharvest technology.

Objectives

- Provide knowledge on production technology of fruits and management of fruit orchards
- Describe different methods of plant propagation including micropropagation
- Explain the postharvest management strategies of different fruits

Learning outcomes

- Explain scope, importance, classification, distribution of fruits, and major fruit growing regions of the world
- Interpret physiological and anatomical aspects of vegetative propagation, stionic relationship and micropropagation
- Establish and manage fruit orchards and homestead gardens
- Describe techniques of producingdifferent fruit crops
- Illustrate physiology of flowering, fruit setting and fruit development
- Explain postharvest management strategies of fruits

Course content

General aspects of fruit production in Bangladesh: Scope, importance, classification, area, production and factors affecting distribution of fruits in Bangladesh, Major fruit growing regions of the world

Propagation of fruit plants: Physiological and anatomical aspects of vegetative propagation, Stionic relationship and incompatibility, Micropropagation and its principles, stages and techniques

Establishment and management of fruit orchards and homestead gardens: Concept, site selection, land development and planting plans and orchard management practices, Bearing habit and its implications, Unfruitfulness–causes and remedies, use of growth regulators in fruit industry

Physiology of flowering, fruit set and fruit development: Factors influencing flower bud initiation, differentiation, pollination, fertilization, fruit set, growth, development, parthenocarpy and seedlessness

Production technology of fruits: Origin, morphology, production statistics, soil, climate, varieties, propagation, cultural practices, pest management, harvesting, yield and improvement: Banana, pineapple, papaya, mango, jackfruit, litchi, guava, jujube, coconut, citrus fruits. Important minor and exotic fruits of Bangladesh

Postharvest management of fruits: Postharvest physiology, factors affecting postharvest quality and shelf life, causes of spoilage and remedies

Teaching strategy

- Lecture
- Group discussion
- Video clips

Assessment strategy

- Short question
- Essay type question
- MCQ
- Assignment

Books recommended

Bose T.K. and S.K. Mitra. 1995. Fruits: Tropical and Subtropical. Naya Prokash, 106, Bidhan Sarani, Calcutta-6, India.

Hartmann, H.T., D.E. Kester and F.T. Davies Jr. 2001. Plant Propagation: Principle and Practices. (7^{th} edition), Prentice-Hall, International Editions.

Mondal, M.F. 2000. Production and Storage of Fruits (in Bangla). Published by Mrs. Afia Mondal, BAU Campus, Mymensingh.

Singh, A. 2003. Fruit Physiology and Production. Kalyani Publishers; 5Rev Ed edition New Delhi.

Thompson, A. K. 2003. Fruits and Vegetables: Harvesting, Handing and Storage. (Second edition), Blackwell Publishing Ltd. Oxford, UK.

Hassan, M. K. 2010. A Guide to Postharvest Handling of Fruits and Vegetables. Department of Horticulture, Bangladesh Agricultural University, Mymensingh-2202. National Food Policy Capacity Strengthening Programme (NFPCSP).

Rahim, M. A., M. S. Alam, A. K. M. A. Islam and M. M. A. Hossain. 2011. Underutilized Fruits in Bangladesh. Bangladesh Agricultural University-Germplasm Center (BAU-GPC). Bangladesh Agricultural University. Mymensingh 2202.

Course number : **HORT 4202**

Course title : **Pomology-Practical (Compulsory)**

Number of credits : **2**

Total marks : **100**

Rationale

This course deals with different practical aspects of fruit production including planting systems, propagation practices, cost of production and determination of quality of fruits.

Objectives

- Discuss the important fruit plants of Bangladesh
- Illustrate designing different orchard plans
- Demonstrate different methods of plant propagation
- Demonstrate hands-on practice techniques of assessing fruit quality

Learning outcomes

- Identify the common fruit plants of Bangladesh
- Sketch diagram of morphological features of important fruit plants
- Prepare layout of different planting plans for orchards
- Practice planting, fertilizing, training, pruning and other cultural operations of orchards.
- Apply different vegetative propagation methods of common fruit plants of Bangladesh
- Estimate the production cost and calculate benefit cost analysis of fruit plants
- Determine the quality of fruits

Course content

Identification of common fruit plants of Bangladesh

Identification of cultivated varieties of important fruits

Morphological features of important fruit plants

Preparation of different planting plans for orchards

Practices on layout, planting, manuring, fertilizing, training, pruning and other cultural operations of orchards

Acceleration of fruit seed germination

Preparation and application of starter and hormone solutions

Practicing vegetative propagation methods of common fruit plants of Bangladesh

Costing of cultivation of mango, banana, papaya and pineapple

Determination of brix of fruits

Determination of fruit volume and texture

Determination of ripeness of fruits

Teaching strategy

- Lecture
- Group discussion
- Video clip

Assessment strategy

- Short question
- Essay type question
- MCQ
- Assignment

Books recommended

Anonymous. 1995. Fruit Production Manual. Hort. Res. & Dev. Project. FAO/UNDP/ASDP Project: BGD/87/025. DAE. BADC.

Gardner, V.E.F.C. Bradford and M.D. Hooker. 1952. Fundamentals of Fruit Production. McGraw Hill Book Company, New York.

Haque, M. A. 2008. Banana: Botany, Cultivation and Uses (in Bangla). Published by Dr. Abdul Wahab, Director (in charge), Textbook Division, Bangla Academy, Dhaka-1000, Bangladesh.

Hartmann, H.T., D.E. Kester and F.T. Davies Jr. 2001. Plant Propagation: Principle and Practices. (7^{th} edition), Prentice-Hall, International Editions.

Samson, J.A.1980. Tropical Fruits. Longman, London & New York.

Sharma, S. K. and M. C. Nautiyal. 2009. Postharvest Technology of Horticultural Crops. New India Publishing Agency.

Yadav, P. K. 2007. Fruit Production Technology. International Book Distributing Co.

Course number : **HORT 4101**

Course title : **Postharvest Management of Horticultural Crops-Theory (Elective)**

Number of credits : **2**

Total marks : **100**

Rationale

This course provides knowledge about postharvest management, factors affecting postharvest quality, physiology, harvesting & handling, storage technology, processing and preservation of horticultural crops

Objectives

- Impart knowledge on postharvest management and storage technologies of horticultural crops
- Describe processing and preservation methods for the preparation of value added products

Learning outcomes

- Analyze the existing status of postharvest management of horticultural crops in Bangladesh
- Outline the preharvest factors affecting postharvest quality
- Explain different postharvest physiological processes
- Formulate harvesting and postharvest handling strategies
- Demonstrate different storage technologies
- Employ processing and preservation methods to prepare value added products

Course content

Postharvest management of horticultural crops: Concept, importance, scope and present situation of postharvest activities on horticultural crops in Bangladesh

Preharvest factors affecting postharvest quality: Agroclimate, cultural management, and maturity

Postharvest physiology: Respiration, transpiration, ethylene production, ripening, sprouting, physical and chemical changes

Harvesting and postharvest handling: Harvesting, cooling, cleaning, curing, sorting, grading, packaging, transportation and marketing

Technology of storage: Principles and methods of different types of storage including CA, MA, refrigerated and traditional storage

Processing and preservation: Objective, principles and methods, preparation of value added products

Teaching strategy

- Lecture
- Group discussion
- Video clips

Assessment strategy

- Short and essay type question
- MCQ
- Pop quiz

Books recommended

Bose, T. K. and S. K. Mitra. 1990. Fruits: Tropical and Subtropical. Naya Prokash, 206 Bidhan sarani, India.

Hassan, M. K. 2010. A Guide to Postharvest Handling of Fruits and Vegetables. Department of Horticulture, Bangladesh Agricultural University, Mymensingh-2202. National Food Policy Capacity Strengthening Programme (NFPCSP).

Mondal, M.F. 2000. Production and Storage of Fruits (in Bangla). Published by Mrs. Afia Mondal, BAU Campus, Mymensingh.

Sharma, S. K. 2010. Postharvest Management & Processing of Fruits & Vegetables. New India Publishing Agency.

Singh, A. 1990. Fruit Physiology and Production. New Delhi, India.

Thompson, A. K. 2003. Fruits and Vegetables: Harvesting, Handing and Storage (Second edition). Blackwell Publishing Ltd. Oxford, UK.

Wills, R.B.H. 1989. Postharvest: An introduction to the Physiology and Handling of Fruits and Vegetables. N.S.W. Australia. 2033.

Course number : **HORT 4102**

Course title : **Postharvest Management of Horticultural Crops-Practical (Elective)**

Number of credits : **2**

Total marks : **100**

Rationale

This course focuses practical knowledge on maturity indices, postharvest quality, packaging, transportation, storage technology, processing and preservation of horticultural crops.

Objectives

- Equip with practical aspects of efficient postharvest management through postharvest quality assessment and storage of horticultural crops
- Demonstrate the techniques of processing and preservation of horticultural crops

Learning outcomes

- Describe the maturity indices of horticultural crops
- Assess the quality of horticultural commodities through modern techniques
- Develop improved packaging technologies for transport and marketing
- Formulate traditional and refrigerated storage methods for horticultural produce
- Demonstrate traditional and chemical methods of ripening
- Prepare various value added products like juice, jam, canned products, jellies and sauces

Course content

Determination of maturity indices of horticultural crops.

Quality assessment of fruits through determination of colour, texture and brix.

Preparation of packaging materials for transport and marketing.

Visit and report writing on traditional and refrigerated storage of horticultural crops.

Regulation of ripening through traditional methods.

Regulation of ripening through chemicals.

Preparation of juice, jam, canned products, jellies and sauces.

Teaching strategy

- Lecture
- Demonstration
- Video clips
- Field visit
- Industry visit

Assessment strategy

- MCQ
- Short and essay type question
- Assignment
- Pop quiz

Books recommended

Anonymous. 1995. Training Manual on Postharvest Handling and Marketing. HRD Project. FAO/UNDP/ASDB Project: BGD/87/025.

Bose, T. K. and S. K. Mitra. 1990. Fruits: Tropical and Subtropical. Naya Prokash, 206 Bidhan sarani, India.

Hassan, M. K. 2010. A Guide to Postharvest Handling of Fruits and Vegetables. Department of Horticulture, Bangladesh Agricultural University, Mymensingh-2202. National Food Policy Capacity Strengthening Programme (NFPCSP).

Mondal, M.F. 2000. Production and Storage of Fruits (in Bangla). Published by Mrs. Afia Mondal, BAU Campus, Mymensingh.

Sharma, S. K. 2010. Postharvest Management & Processing of Fruits & Vegetables. New India Publishing Agency.

Thompson, A. K. 2003. Fruits and Vegetables: Harvesting, Handing and Storage (Second edition). Blackwell Publishing Ltd. Oxford, UK.

Wills, R.B.H. 1989. Postharvest: An introduction to the Physiology and Handling of Fruits and Vegetables. N.S.W. Australia. 2033.

Course number : **HORT 4203**

Course title : **Commercial Horticulture-Theory (Elective)**

Number of credits : **2**

Total marks : **100**

Rationale

This course will enable the graduates to learn about commercial horticulture including seed industry, export oriented production, organic farming and year round production

Objectives

- To equip the graduates with modern and updated knowledge on commercial aspects of horticultural crops.

Learning outcomes

- Analyze the agribusiness opportunities of horticultural crops in Bangladesh
- Outline the production of seeds of self and cross pollinated crops, hybrid seed
- Explain the production technology of export oriented horticultural crops
- Formulate seed storage, technology and marketing strategies
- Demonstrate preparation of value added products
- Interpret production of crops using organic manures, pest control using plant extracts and biological means
- Develop scopes of self-employment strategies

Course content

Commercial horticulture: Concept, importance and scope of commercial horticulture in Bangladesh, agribusiness opportunities in horticulture

Seed industry for horticultural crops: Production of seeds of self and cross pollinated crops, hybrid seed production and seedlessness, seed storage, technology and marketing

Export oriented production of horticultural crops: French bean, mushroom, cashew nut, asparagus, bamboo shoot, baby corn, orchids, bonsai, cacti and cut flowers.

Value added horticultural products: Preparation of juice, jam, jelly, pickles and sauce; chemicals used as additives for colour, flavour, vitamins and minerals

Year round production of horticultural crops: Special management practices, use of growth regulators, crop production under controlled condition and polytunnel

Organic farming: Concept, importance, scope of organic farming, production of crops using organic manures, pest control using plant extracts and biological means.

Self employment through horticulture: Seedling and sapling raising, T-budding in rose, grafting in mango, patch and ring budding in jujube, flower shop and market development, production of quick growing fruits.

Teaching strategy

- Lecture
- group discussion
- video clip
- Questioning and answering
- white and black board
- multimedia

Assessment strategy

- Short question
- Essay type question
- MCQ
- Pop quiz

Books recommended

Agraueal, R. L. 2004. Seed Technology. Oxford & IBH Publishing Co. New Delhe. India.

Bose, T.K. and L.P. Yadav. 1989. Commercial Flowers. Naya Prakash, Culcutta.

Hussain, M.M. 1995. Seed Production and Storage Technology. Meer Imtiaz Hossain, Dhaka

MacMillan, H.E. 1962. Tropical Planting and Gardening. MacMillan, London.

Rashid, M.M. 1990. Phuler Chas. Bangla Academy, Dhaka.

Rashid, M.A. and D.P. Singh. 2000. A Manual on Vegetable Seed Production in Bangladesh. AVROC-USAID-Bangladesh Project, BARI, Joydebpur.

Rashid, M.M. 1999. ShabjiBiggyan. 2nd ed., Rashid Pub. House, Dhaka.

Course number : **HORT 4204**

Course title : **Commercial Horticulture – Practical (Elective)**

Number of credits : **2**

Total marks : **100**

Rationale

This course will enable the graduates to learn practical knowledge of commercial horticulture including modern nursery management, growth regulators, hybrid seed production and export oriented crop production.

Objectives

- To equip the graduates with practical aspects of commercial horticulture

Learning outcomes

- Demonstrate the sterilization of soil and growing media of nursery bed
- Make use of growth regulators for commercial use in horticulture.
- Demonstrate lifting and packaging of mother plants and saplings.
- Illustrate growing of vegetables through organic farming
- Develop improved packaging technologies for transport and marketing
- Prepare various value added products dry flowers
- Outline orientation of farm management

Course content

Sterilization of soil and growing media of nursery bed
Demonstration of mist-house, fog house, poly-tunnel
Preparation and use of growth regulators for commercial use in horticulture.
Lifting and packaging of mother plants and saplings
Different methods of packaging and preservation of seeds
Preparation of dry flowers
Cut flower packaging and flower arrangement
Growing of mushroom, asparagus, orchids
Techniques of hybrid seed production-flower characters, emasculation, control of cross pollination and artificial pollination
Growing of vegetables through organic farming
Orientation for farm management.

Teaching strategy

- Lecture
- Demonstration
- video clip
- Field visit
- industry visit

Assessment strategy

- Multiple Choice Question (MCQ)
- Short question
- Essay type question
- Assignment
- Pop quiz

Books recommended

Agraueal, R. L. 2004. Seed Technology. Oxford & IBH Publishing Co. New Delhe. India.

Bose, T.K. and L.P. Yadav. 1989. Commercial Flowers. Naya Prakash, Culcutta.

MacMillan, H.E. 1962. Tropical Planting and Gardening. MacMillan, London.

Rashid, M.M. 1990. Phuler Chas. Bangla Academy, Dhaka.

Hussain, M.M. 1995. Seed Production and Storage Technology. Meer Imtiaz Hossain, Dhaka.

Rashid, M.A. and D.P. Singh. 2000. A Manual on Vegetable Seed Production in Bangladesh. AVROC USAID-Bangladesh Project, BARI, Joydebpur.

Rashid, M.M. 1999. Shabji Biggyan. 2nd ed., Rashid Pub. House, Dhaka.

Department of Plant Pathology

Course Number : **PPATH 2201**
Course Title : **Fundamentals of Plant Pathology-Theory (Compulsory)**
Number of credits : **3**
Total Marks : **100**

Rationale

This course deals with a basic knowledge and understanding of the plant diseases and their causes.

Objectives

- Interpret the significance of plant diseases.
- Explain and illustrate the basic concept of different plant pathogens.

Learning Outcomes

- Explain the concept of Plant Pathology
- Describe and distinguish different plant pathogens.

Course content

Introduction to Plant Pathology and its history. Concept, Causes and Significance of Plant diseases with special reference to Bangladesh.

Introduction to fungi:

(a) General characteristics of fungi including morphology, reproduction and nutrition, nomenclature and classification of fungi. Study of the following genera including their Families and orders: *Synchytrium, Pythium, Phytophthora, Peronospora, Albugo, Rhizopus, Saccharomyces, Penicillium, Aspergillus, Erysiphe, Claviceps, Puccinia, Ustilago* and *Agaricus.*

(b) Detailed study of the orders, families and genera of Deuteromycotina.

Introduction to Bacteria:

General morphology, reproduction and nutrition infection process, classification of plant pathogenic bacteria, symptoms of bacterial diseases with examples.

Introduction to Plant Viruses and Mycoplasmas:

Nature of viruses, physical and chemical structures, infection process and replication, transmission, identification and classification of viruses; viroids and mycoplasmas.

Introduction to Plant Parasitic Nematodes:

Morphology, anatomy, physiology with special emphasis to feeding and reproduction; classification of plant parasitic nematodes, symptoms of nemic diseases with examples.

Plant diseases caused by parasitic phanerogams.

Teaching strategy

- Lecture
- Demonstration
- Group discussion

Assessment strategy

- MCQ
- Short question
- Essay type question
- Presentation of assignment

Books recommended

Bawden, F. C. 1964. Plant Viruses and Virus Diseases. The Ronald Press.

Christic. J. R. 1959. Plant Nematodes: Their Dynamic and Control. Florida Agricultural Experimental Station. USA.

Corbett. J. K. and H. D. Sister (Ed). 1964. Plant Virology. University of Florida Press. Gainsville.

James, B. Sinclair, Onkar Dev Dhingra. 1995. Basic Plant Pathology Methods. CRC Press.

Goto, M. 2012. Fundamentals of Bacterial Plant Pathology. Academic Press.

Mathews. R. E. E. 1991. Plant Virology. Third Edition. Academic Press. INC.1250 Sixth Avenue. San Diego. California. USA.

Mehortora. Brahm Swarlep. 1967. The Fungi. 2nd ed. Oxford & IBH publishing Co. New Delhi.

Barnett. H. I. 1960. Illustrated Genera of Imperfect Fungi. Burgess Publishing Company.

Forbisher. M. 1953. Fundamentals of Microbiology. Fifth Edition. London. Saunders.

Course Number : **PPATH 2202**
Course Title : **Fundamentals of Plant Pathology-Practical (Compulsory)**
Number of credits : **2**
Total Marks : **100**

Rationale

The course deals with practice of basic techniques for identification of causes of plant diseases

Objectives

- Demonstrate basic techniques for the identification of the causes of plant diseases.

Learning outcomes

- Measure the size of plant pathogens.
- Prepare microscopic slides.
- Isolate, culture and identify plant pathogens.

Course content

Calibration of microscope and measurements of plant pathogens.

Techniques involved in preparation of slides for microscopic study.

Preparation of culture media.

Sterilization: Methods and techniques.

Isolation and detection of fungi, bacteria and nematodes from diseased plant materials and soil. Isolation and detection of viruses from diseased plant materials.

Study of the following genera of fungi : *Synchytrium, Pythium, Mucor, Rhizopus, Aspergillus, Penicillium, Agaricus, Alternaria, Curvularia, Pyricularia, Fusarium, Rhizoctonia* and *Sclerotium.*

Teaching strategy

- Lecture
- Demonstration and practice
- Group discussion

Assessment strategy

- MCQ
- Short question
- Practical job
- Assignment

Books recommended

Alexopoulos. C. J. and E.S. Beneke. 1962. Laboratory Manual for Introductory Mycology. Bargees Publishing Co.

Ashrafuzzaman M.H. 1976. 1st ed. Laboratory Manual for Plant Pathology. Department of Plant Pathology. BAU.

Ashrafuzzaman M.H. 1976. A Lecture Guide to Crop Diseases. 1st ed. Department of Plant Pathology. BAU.

Funder. S. 1968. Practical Mycology. Hafner Publishing Co.

N. W. Sehaad. 1980. Laboratory Guide for Identification of Plant Pathogenic Bacteria. Bacteriological Committee of American Phytopathological Society. St. Paul. Minnesota.

Course Number : PPATH 3201

Course Title : Principles of Plant Pathology and diseases of Field Crops-Theory (Compulsory)

Number of credits : 3

Total Marks : 100

Rationale

Providing knowledge on principles of plant pathology, diseases of field crops and their management.

Objectives

- Explain host-pathogen interaction to disease development.
- Describe field crop diseases, etiology and effect of factors for disease development.
- Impart the knowledge on management of field crop diseases.

Learning Outcomes

- Describe the pathogenesis of different plant diseases. .
- Explain the mechanism of dispersal of plant pathogens.
- Illustrate the interactions of different components of disease development.
- Describe the different methods of plant disease control.
- Explain the detail information on diseases of different field crops.

Course Content

Pathogenesis:

Parasitism and Pathogenicity, chain of events in disease developments. Enzymes and toxins in disease development, pathogenic effects on physiological functions of plants.

Dissemination of plant pathogens:

Importance, factors and mechanisms. Disease Development, Predisposition.

Epidemiology and Forecasting of Plant Diseases.

Methods of plant disease control:

Cultural, Legislative, Chemicals, Host resistance, Biological, Integrated approach-concepts, components and economics.

Disease of Field Crops-

Cereal crops: Rice, Wheat, Maize, Barley and Millets.

Fiber crops: Jute and Cotton.

Pulse crops: Pea, Gram, Lentil, Blackgram, Mungbean, Grasspea and Pigeonpea.

Oilseed crops: Mustard, Groundnut, Sesame, Soybean and Sunflower.

Sugar Crop: Sugarcane.

Teaching Strategy

- Lecture
- Demonstration
- group discussion

Assessment Strategy

- MCQ
- Short question
- Essay type question
- Assignment

Books recommended

Carter. W. 1962. Insects in Relation to Plant Diseases. McGraw Hill Book Company.

Leech. J. G. 1940. Insects Transmission to Plant Diseases. McGraw Hill Book Company.

R. S. Mehrotra. Plant Pathology. Tata McGraw-Hill Publishing Company Limited. New Delhi. India.

G. Rangaswami. 1962. Diseases of Crop Plants in India. Practice Hall of India Private Limitid.

G. Rangaswami. 1972. Bacterial Plant Disease in India. Bombay. Asia Publishing House.

S. H. Ou. 1972. Rice Diseases. C. M. I. Kew Surrey. England.

R.S. Singh. 1978. Introduction to Principles of Plant Pathology. 2nd edition. Oxford & IBH Publishing Co. Delhi.

Ven der Plank. J. E. 1963. Plant Diseases. Epidemics & Control. Academic Press. New York. London.. Ven der Plank. J. E. 1968. Diseases Resistance in Plants. Academic Press. New York. London.

The Compendium of Plant Disease Series.

Course Number : PPATH 3202
Course Title : Principles of Plant Pathology and diseases of Field Crops-Practical (Compulsory)
Number of credits : 2
Total Marks : 100

Rationale

Providing practical knowledge on field crop diseases.

Objectives

- Describe different field crop diseases through symptoms study and field visit.
- Demonstration of identification of causal organisms A of field crop diseases in the laboratory.

Learning outcomes

- Identify plant diseases with their causal organisms of different field crops.
- Relate host-pathogen interactions in disease development.

Course content

a) Detailed study (symptoms, preparation of slides and identification of pathogens) of the followings: Brown spot, Blast & BLB of Rice. Stem rot, Black band & Anthracnose of Jute. Leaf blight, leaf rust, Foot rot & Loose smut of Wheat and Covered smut of Barley. Tikka, Leaf rust & collar rot of Groundnut. Root-Knot diseases. Cercospora leaf spot of Blackgram & Mungbean. Alternaria blight of Mustard.

b) Brief study (symptoms aided by permanent slieds of the pathogen) of the followings: BLB,Stem rot, Bakanae, False smut, NBS, Sheath blight, Sheath rot, Leaf scald, Ufra, BLS, Grassy stunt, yellow dwarf and Tungro of rice. Leaf spot, Soft rot & Mosaic of Jute. Angular leaf spot & Ball rot of cotton. Foot and root rot, mosaic, rust, wilts & blights of pulses and oilseed crops. Smut, Wilt, White leaf, Pineapple disease and Red rot of Sugarcane.

Demonstration of Koch's postulates by using Fungi, Bacteria, Nematodes and viruses.

Teaching strategy

- Lecture
- Demonstration and practice
- Group discussion

Assessment strategy

- MCQ
- Short question
- Practical job
- Assignment

Books recommended

Alexopoulos. C. J. and E.S. Beneke. 1962. Laboratory Manual for Introductory Mycology. Burgees Publishing Co.

Ashrafuzzaman M.H. 1976. 1st ed. Laboratory Manual for Plant Pathology. Department of Plant Pathology. BAU.

Ashrafuzzaman M.H. 1976. A Lecture Guide to Crop Diseases. 1st ed. Department of Plant Pathology. BAU.

Funder. S. 1968. Practical Mycology. Hafner Publishing Co.

S. W. Sehaad.1980. Laboratory Guide for Identification of Plant Pathogenic Bacteria. Bacteriological Committee of American Phytopathological Society. St. Paul. Minnesota.

Course Number : PPATH 4101
Course Title : Diseases of Fruits, Vegetables, Cash Crops, Agroforest Trees and Seed Pathology-Theory Compulsory)
Number of credits: 3
Total Marks : 100

Rationale

This course is intended to impart knowledge of crop diseases and pathogen/disease cycle to plan strategy for adopting both preventive and curative measures against crop diseases.

Objectives

- Provide knowledge on the concept of diseases of fruits, vegetables, cash crops and agroforest trees and their management.
- Discuss about the seed-borne pathogens, their mechanism of transmission and their management.

Learning outcomes

- Describe diseases of fruits, vegetables, cash crops and agroforest trees and their management.
- Explain seed-borne pathogens and their impact on crop production.
- Assess crop loss owing to diseases.

Course content

Diseases of fruits: Mango, banana, papaya, coconut, pineapple, jackfruit, citrus and guava.

Diseases of Vegetables: Potato, tomato, sweet potato, cabbage, cauliflower, chilli, brinjal, lady's finger, amaranth, cucurbits and beans.

Diseases of cash crops: Tobacco, tea, betelnut, betelvine, turmeric, ginger, onion & garlic.

Diseases of agroforest trees: Root rots, dieback, wilts and cankers of important forest trees.

Introduction to Seed Pathology: Importance of Seed-borne diseases in Bangladesh, significance & mechanism of seed transmission of pathogens, seed health testing methods.

Assessment of Crop loss owing to plant diseases.

Teaching strategy

- Lecture
- Demonstration
- Group discussion

Assessment strategy

- MCQ
- Short question
- Essay type question
- Assignment

Books recommended

Boyce. J. S. 1961. Forest Pathology. 3rd ed. McGraw Hill Book Co.

Cooke, B.M. Gareth Jones D., Kaye B. 2006. The Epidemiology of Plant Diseases. Springer Science & Business Media.

Meah M. B. and A. A. Khan. 1985. Check List of Fruit and Vegetables Diseases in Bangladesh. Department of Plant Pathology. Bangladesh Agricultural University, Mymensingh.

Neil Boonham, Jenny Tomlinson, Rick Mumford. 2016. Molecular Methods in Plant Disease Diagnostics: Principles and Protocols. CABI.

Pathak. V. N. 1986. Diseases of Fruit Crops. Published by Mohan Primlani. Oxford & IBH Publishing Co. Janapath. New Delhi 110001.

R.S. Singh. 2009. Plant Diseases. 3rd Edition. Oxford & IBH publishing Co. New Delhi.

Walker. J. C. 1952. Diseases of Vegetable Crops. McGraw Hill Book Co.

The Compendium of Plant Disease Series.

Course Number : PPATH 4102
Course Title : Diseases of Fruits, Vegetables, Cash Crops, Agroforest Trees and Seed Pathology-Practical (Compulsory)
Number of credits : 2
Total Marks : 100

Rationale

This course deals with the diagnosis of the disease problem in the lab and field for planning and designing proper control measures.

Objectives

- Demonstrate different methods of diagnosis of diseases of fruits, vegetables, cash crops and agroforest trees through symptoms study and field visits.
- Demonstrate hands-on practice for identification of the disease causing agents of fruits, vegetables, cash crops and agroforest trees.
- Explain detail procedure of different seed health testing methods.

Learning Outcomes

- Prepare plant disease herbarium.
- Diagnose diseases of fruits, vegetables, cash crops and agroforest trees.
- Detect health status of seeds.
- Write prescription following ethical principles of pesticide use..

Course content

Methods of Collection and Preservation of diseased plant-materials. Preparation of herbarium of disease specimen of important crops.
Field and Laboratory studies of plant diseases:
(a) Detailed study of the following diseases: Late blight and Early blight of potato and tomato. Anthracnose of Chilli, Okra, Guava and Amaranth. Fruit rot of chilli. Alternaria leaf spot of Cabbage. Alternaria leaf spot and stemphylium blight of onion. Powdery and downy mildew of cucurbits. Rhizopus fruit rot of Jackfruit and kul. Brown spot and Frogeye leaf spot of Tobacco. Anthracnose and Taphrina leaf spot of Turmeric. Anthracnose and leaf spot of Betelvine.
(b) Brief study of the following diseases: Dry rot, Hollow heart, Black heart and Scab of potato. Yellow vein mosaic of okra , little leaf and fruit rot of brinjal. Anthracnose, stem end rot and malformation of mango. Bud rot and leaf spot of coconut, Leaf spot, Wilt, Bunchy top, Anthracnose and fruit rot of banana, Anthracnose, Stem end rot and mosaic of Papaya. Wilt of guava. Scab, Canker, Die back and greening of lemon. Tobacco mosaic. Blister blight and Gery blight of tea. Foot rot and Leaf rot of betelvine. Phanerogamic parasites (Cuscuta, Loranthus and Orobanche). Damping-off and seedling blight.

Seed health testing: Dry inspection, Incubation methods (Blotter and agar plate methods) and Growing on test.
Chemical Control: a) Handling of plant protection equipment.
b) Preparation and application of foliar fungicides. Calculation of concentration, percentage of active ingredients, and rates of application of fungicides.
c) Students in groups are required to conduct a spray experiment

with foliar fungicides for controlling specific foliar diseases of a crop.

d) Seed and soil treatment.

e) Prescription for control of some important diseases.

Field excursion for plant disease study. Each student is required to submit a comprehensive report on the prepared herbarium, spray experiment and field excursion.

Teaching strategy

- Lecture
- Demonstration and practice
- Group discussion

Assessment strategy

- MCQ
- Short question
- Experiment
- Assignment

Books recommended

Ashrafuzzaman M.H. 1976. 1st ed. Laboratory Manual for Plant Pathology. Department of Plant Pathology. BAU.

Fulton. J. P., D. A. Stack., N. D. Fulton., J. L. Dale., M. J. Eoodet and G. E. Templeton1965. Plant Pathology Laboratory Manual. Burgress Publishing Company.

Course Number : PPATH 4201
Course Title : Plant Disease Management-Theory (Elective)
Number of credits : 2
Total Marks : 100

Rationale

This course is designed to impart knowledge on different approaches of plant disease management.

Objectives

- Impart knowledge on the diagnosis of different diseases
- Describe the techniques of soil and seed treatment for raising healthy seedlings and field crops.
- Explain post harvest management practices.

Learning outcomes

- Describe diagnostics of different diseases
- Explain the techniques of soil and seed treatment for raising healthy seedlings and field crops.
- Practise post harvest management techniques.

Course content

Field visit and plant disease diagnosis.
Soil treatment.
Seed treatment.
Seed bed preparation and raising of healthy seedlings.
Field plot experiment for raising healthy crop.
Post harvest practices for crops and seeds for disease management.
Cost-benefit analysis.
Photography.

Teaching strategy

- Lecture
- Demonstration
- Question & answering
- Group discussion

Assessment strategy

- MCQ
- Short question
- Essay type question
- Presentation of assignment

Books recommended

G. Rangaswami. 1984. Diseases of Crop Plants in India. Practice Hall of India Private Limitid.

Agrios G. N. 1969. Plant Pathology. Academic Press. New York.

Harold E. Moline. 2003. Edited by Harlod E. Moline. Post Harvest Pathology of Fruits and Vegetables. Post Harvest Losses in Perishable Crops. Publication NE-87 (UC Bulletin 1914)

H. Mian. 1995.Methods in Plant Pathology. IPSA-JICA Project. Institute of Post Graduate Studies in Agriculure. Gazipur, Bangladesh.

R. S. Mehrotra. 2003. Plant Pathology. Tata McGraw-Hill Publishing Company Limited. New Delhi. India.

R.S. Singh. 2009. Plant Diseases. 3rd Edition. Oxford & IBH publishing Co. New Delhi.

Course Number : PPATH 4202
Course Title : Plant Disease Clinic-Practical (Elective)
Number of credits : 2
Total Marks : 100

Rationale

The course is designed to demonstrate techniques and procedure of disease diagnosis and issuing prescription for the farmers.

Objectives

- Demonstrate different clinical equipment and microscopic examination of diseased specimen.
- Demonstrate isolation and identification of disease causing organisms
- Explain writing prescription.

Learning outcomes

- Handle different clinical equipment.
- Enlist diseased specimen.
- Identify plant diseases with their respective causal organisms.
- Suggest remedy of plant diseases.
- Prepare pictorial archives of plant diseases.

Course content

Handling and care of clinical equipment.
Registration of diseased specimen.
Microscopic examination of diseased specimen.
Isolation and identification of causal agents.
Purification and preservation of isolated plant pathogens.
Preparation of diseased sample and isolated organism (s) for mailing.
Writing prescriptions.
Photography.

Teaching strategy

- Lecture
- Demonstration and practice
- Group discussion

Assessment strategy

- MCQ
- Short question
- Practical job
- Assignment

Books recommended

Baudoin. B. A. M. 1990. Laboratory Exercise in Plant Pathology:An Instruction Kit. American Phytopathological Society Publishers. Ratanada Road. P.O. Box 91. Jodhpur-342001. India.

Alexopoulos. C. J. and E.S. Beneke. 1962. Laboratory Manual for Introductory Mycology. Burgees Publishing Co.

Walker. J. M. Ritchie B. J. and Holderness M. 1998. Plant Clinic Handbook. IMI Technical Hand Books no. 3. An Institute of CAB International.

Ashrafuzzaman M.H. 1976. 1st ed. Laboratory Manual for Plant Pathology. Department of Plant Pathology. BAU.

N. W. Sehaad. 1980. Laboratory Guide for Identification of Plant Pathogenic Bacteria. Bacteriological Committee of American Phytopathological Society. St. Paul. Minnesota.

Lellinott R. A. and Stead D. E. 1991. Methods for the Diagnosis of Bacterial Diseases of Plants.

The Compendium of Plant Disease Series: Ornamental Foliar Plant Diseases (ISBN 0-89054-077-2). APS Press The American Phytopathological Society 3340 Pilot Knob Road St. Paul. MN 55121-2097 USA.

Department of Crop Botany

Course number	:	**CBOT 2101**
Course title	:	**Plant Morphology, Embryology and Taxonomy-Theory (Compulsory)**
Number of credits	:	**3**
Total Marks	:	**100**

Rationale

This course has been designed to offer knowledge on morphology of crop plants in relation to classification, production, tolerance and improvement

Objectives

- Describe detail morphological, anatomical and embryological features of crops in relation to plant taxonomy
- Explain ethno-botanical resources and their utilities.

Learning outcomes

- Understand descriptors of different crop plants for identification, compare and contrast.
- Illustrate the structure, function of cells and tissues of roots and shoots
- Compare and contrast internal structures of field crops for varietal identity.
- Describe embryogenesis & its relation to embryo, endosperm, seed and fruit development.
- Explain techniques of somatic embryogenesis *in-vitro* and its application in crop improvement
- Describe field recognition features to distinguish different crop families for plant classification and biodiversity management
- Describe medicinal plants, their functions and industrial uses.

Course content

External morphology of the following crops: 1) Mustard, 2) Jute, 3) Tobacco, 4) Groundnut, 5) Cotton, 6) Onion, 7) Rice, 8) Wheat, 9) Tea, 10) Rubber and 11) Betel leaf.

Cell: Concept, structures and ultra-structures of protoplasmic components of cell, functions of important organelles.

Cell wall: Components and composition of cell wall, patterns of thickening, cell wall organization, plasmodesmata, pit- structures of simple and bordered pits and their functions, primary pit field.

Tissue: Concept, classification and morphology of meristematic, simple, vascular and secretory tissues, structures and their functions, tracheary elements and sieve elements, vascular bundles and major types, tissue systems- epidermal, procambial and vascular; epidermal appendages. Variations of different tissues in response to abiotic & biotic stresses and their defense mechanisms against insect pests and diseases.

Primary structure: Concept of primary growth, structures of root and stem of monocot and dicot plants, structures of isobilateral and dorsiventral leaves.

Secondary structure: Concept of normal and anomalous secondary growth, activities of typical vascular cambium, formation of periderm and its functions.

Anatomy of field crops: 1) Rice, 2) Sugarcane, 3) Jute, 4) Cucurbit, 5) Mustard and 6) Lentil.

Embryology: Concept of sporogenesis and gametogenesis in cryptogams, microsporogenesis and microgametogenesis, megasporogenesis and megagametogenesis, pollination, fertilization, parthenogenesis, development of embryo, endosperm, seed and fruit, *in-vitro* fertilization and embryo culture.

Taxonomy: Modern concept of taxon and botanical nomenclature, principles and systems of plant classification.

Distinguishing characters of the following families: 1) Gramineae, 2) Leguminosae, 3) Solanaceae, 4) Cucurbitaceae, 5) Compositae, 6) Umbelliferae, 7) Rutaceae, 8) Anacardiaceae, 9) Moraceae, 10) Orchidaceae and 11) Palmae.

Economically important plants: Fibre, oil, timber, medicinal, rubber, narcotic and beverage yielding plants & their products of economic importance.

Teaching strategy

- Lecture
- Demonstration and practice
- Group discussion

Assessment strategy

- MCQ
- Short question
- Practical job
- Assignment

Books recommended

Brian, C. 2005. Botany for Gardeners. Timber Press, Inc., Cambridge.

Esau, K. 1965. Plant Anatomy. John Wiley, New York.

Evert, R. F. 2006. Esau's Plant Anatomy: Meristems, Cells, and Tissues of The Plant Body: Their Structure, Function, and Development. 3rd ed., John Wiley & Sons, New Jersey.

Henry, R. J. 2005. Plant Diversity and Evolution Genotypic and Phenotypic Variation in Higher Plants. CABI Pub., Cambridge.

Lersten, N. R. 2004. Flowering Plant Embryology. Blackwell Pub., Oxford.

Pandey, B.P. 2000. Economic Botany. 6th ed. S. Chand & Co., New Delhi.

Purseglove, J.W. 1985. Tropical Crops. Vol. 1 & 2. Longmans, London.

Simpson, M.G. 2010. Plant Systematics. 2nd ed., Elsevier Acad. Press, New York.

Course number	:	**CBOT 2102**
Course title	:	**Plant Morphology, Embryology and Taxonomy-Practical (Compulsory)**
Number of credits	:	**2**
Total Marks	:	**100**

Rationale

This course has been designed to offer hands-on practices on structure & function of crop plants.

Objectives

- Equip the students with practical knowledge and understanding of crop morphology
- Demonstrate ethno-botany and economically important plants.

Learning outcomes

- Identify plant families to compare and contrast the external morphology of different crops;
- Prepare temporary and permanent slides for microscopy
- Identify cells, cell organelles, plant tissues, pollen, placenta and leaves;
- Identify seeds and seedlings of monocot and dicot plants.
- Illustrate anatomical features of roots, leaves and stems of crops.
- Prepare herbarium sheets;
- Use different software and computer aided tools for plant classification and biodiversity management

Course content

External morphology of the following crops and their relatives: Mustard, onion, groundnut, lentil, brinjal, jute, cotton, cucurbit, sunflower, rice, wheat, maize, sugarcane, coriander, mango, guava, jackfruit and pineapple.

Slide preparation: Sectioning, staining and mounting, temporary and semi-permanent slides, demonstration of microtome and maceration techniques.

Demonstration of the following:

1. Nucleus, nucleolus, plastids, compound middle lamella, primary wall, secondary wall, thickening of cell wall;

2. Parenchyma, collenchyma, sclereid, fibre and secretory cells both in transverse and longitudinal sections/macerated materials;

3. Tracheid, vessel, wood fibre, wood parenchyma, sieve cell, sieve tube, companion cell, bast fibre and epidermal appendages and

4. Structure of anther, pollen grain, pollen germination, hand pollination technique, ovary, ovule and placenta.

5. Internal structures of isobilateral and dorsiventral leaves.

Identification: Monocot and dicot seeds and their seedlings.

Anatomy of field crops: Stem and root of maize, rice, wheat, cucurbit, groundnut, country bean and jute; leaves of monocot and dicot plants

Preparation of herbarium

Preparation of herbarium sheet and field visit.

Field visit

Field laboratory/botanical garden visit.

Teaching strategy

- Lecture
- Demonstration and practice
- Group discussion

Assessment strategy

- MCQ
- Short question
- Practical job
- Assignment

Books recommended

Brian, C. 2005. Botany for Gardeners. Timber Press, Inc., Cambridge.

Esau, K. 1965. Plant Anatomy. John Wiley, New York.

Henry, R. J. 2005. Plant Diversity and Evolution Genotypic and Phenotypic Variation in Higher Plants. CABI Pub., Cambridge.

Lersten, N. R. 2004. Flowering Plant Embryology. Blackwell Pub., Oxford.

Pandey, B.P. 2000. Economic Botany. 6th ed. S. Chand & Co., New Delhi.

Purseglove, J.W. 1985. Tropical Crops. Vol. 1 & 2. Longmans, London.

Simpson, M.G. 2010. Plant Systematics. 2nd ed., Elsevier Acad. Press, New York.

Course number	:	**CBOT 3201**
Course title	:	**Plant Physiology and Ecology-I –Theory (Compulsory)**
Number of credits	:	**2**
Total Marks	:	**100**

Rationale

The course has been designed to cover fundamental aspects of plant physiology and ecology relevant for growth, development, adaptation and distribution of plants.

Objectives

- Provide knowledge on physiological processes of plants
- Understand agro-climatic and environmental factors; and their influence on growth, development, adaptation and distribution of plants

Learning outcomes

- Describe the physiological aspects of osmoregulation, evapotranspiration, water use efficiency (WUE) and dry matter (DM) production;
- Evaluate photosynthetic pathways, carbon use efficiency, metabolic limitations to DM yield, chloroplastic antioxidant defense system
- Explain energy expenditure during respiration & growth and evaluate modified atmospheric conditions for handling and storability of plant products;
- Classify world and Bangladesh climates with their variables, crops and vegetation suitability therein;
- Evaluate ecological impacts and significances of light, temperature, water, wind, drought, etc. on growth, development and distribution of plants;
- Modify agro-climatic variables for optimization of crop production;
- Demonstrate morphological, anatomical & physiological adaptive features of plants in aquatic, xeric, shade and saline habitats.

Course content

A. PLANT PHYSIOLOGY:

Plant water relationship: Concept and measurement of water potential, absorption mechanisms, path of absorption and water movement, factors affecting absorption, theories of ascent of sap, water loss phenomenon in leaf and other plant parts, mechanisms of opening and closing of stomata, stomatal conductance, factors affecting evapotranspiration and its significance in crop production.

Photosynthesis: Photosynthetic apparatus, light and dark reactions, photosynthetic pathways and their significance, factors essential for photosynthesis, photosynthesis-transpiration compromise.

Respiration: Types, mechanisms, importance, relationship of carbohydrate metabolism to other compounds, factors affecting respiration, controlling measures for photorespiration, relationship between respiration, and growth and storage of plant products.

B. PLANT ECOLOGY:

Climate and weather: Concept, climatic classification of World and Bangladesh and their influence on crop.

Agro-climatological parameters: Concept, fundamentals of ecology, ecological factors- biotic, atmospheric and physiographic; light-classification and distribution, quality, quantity and duration, effects on vegetation, solar radiation and light environment; temperature- minimal, optimal and maximal temperature for different categories of plants, night and day temperature, temperature profiles and adaptation to temperature, temperature's modification for better crop production; water- significance, cycles, forms of water and precipitation, evapotranspiration and energy relation, movement of water through soil-plant-atmosphere continuum, causes and effects of droughts, dry wind, dust, storms and hails on crop production; wind- effect on vegetation, wind profiles, modification of wind environment.

Adaptation of plants to different habitats: Hydrophytes, xerophytes, mesophytes, halophytes, heliophytes and sciophytes.

Teaching strategy

- Lecture
- Demonstration
- Group discussion

Assessment strategy

- MCQ
- Short question
- Essay type question
- Assignment

Books recommended

Chang, J.H. 1971. Climate and agriculture. Aldine Pub., Chicago.

Datta, S.C. 1994. Plant physiology. Wiley Eastern Ltd., Calcutta, India.

Hans, M. 1984. Class experiments in plant physiology. George Allen & Unwin Pub. Ltd., London.

Mohr, H. and Schopfer, P. 1994. Plant physiology. Springer, Berlin.

Pundey, S.N. and Sinha, B.K. 1972. Plant physiology. Vikas Publishing House Pvt. Ltd., New Delhi.

Rosenberg, N.J.; Blad, B.L. and Verma, S.B. 1983. Microclimate: The biological environment. John Wiley, New York.

Salisbury, F.B. and Ross, C.W. 1986. Plant physiology. Wadworth Pub., USA.

Shukla, R.S and Chandel, P.S. 2014. A textbook of Plant Ecology including Ethnobotany and Soil Science (Twentith Revised & Enlarged Edition). S. Chand & Company Pvt. Ltd. New Delhi. 526p.

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Course number	:	**CBOT 3202**
Course title	:	**Plant Physiology and Ecology-I – Practical (Compulsory)**
Number of credits	:	**2**
Total Marks	:	**100**

Rationale

This course has been designed to offer practical knowledge on basic cellular functions and structural modifications in plants for adaptation in different habitats.

Objectives

- Enrich knowledge on fundamental physiological processes of plants
- Examine morphological and anatomical features of hydro-, meso- and xerophytes in relation to eco-physiological adaptations.

Learning outcomes

- Demonstrate important physiological processes in plants;
- Determine water potential in plant tissues;
- Demonstrate the distribution & abundance of stomata in dorsiventral & isobilateral leaves;
- Evaluate variation in C3, C4 & CAM plants;
- Demonstrate basic phenomena on photosynthesis and respiration;
- Separate photosynthetic pigments;
- Illustrate morphological and anatomical structures, and assume eco-physiological adaptive features of plants in aquatic, xeric, shade and saline habitats;
- Generate knowledge on ecosystem of different agro-ecological zones (AEZ) of Bangladesh.

Course content

Experiments to demonstrate- osmosis, plasmolysis, transpiration and ascent of sap.

Measurement of water status and water potential in plant tissues.

Study of distribution and abundance of stomata in different types of leaves.

Study of anatomical structures of leaves in C_3, C_4 and CAM plants.

Experiments to demonstrate photosynthesis and respiration.

Experiments on plant pigments: separation, quantification and chorophyll stability index.

Study of adaptive features of different ecological plant types e.g. mesophytes, xerophytes, hydrophytes, halophytes, heliophytes and sciophytes.

Field visit to different agro-ecological zones (AEZ) of Bangladesh.

Books recommended

Chang, J.H. 1971. Climate and agriculture. Aldine Pub., Chicago.

Datta, S.C. 1994. Plant physiology. Wiley Eastern Ltd., Calcutta, India.

Hans, M. 1984. Class experiments in plant physiology. George Allen & Unwin Pub. Ltd., London.

Jackson, I.J. 1982. Climate, water and agriculture in tropics. Longman, London.

Mohr, H. and Schopfer, P. 1994. Plant physiology. Springer, Berlin.

Pundey, S.N. and Sinha, B.K. 1972. Plant physiology. Vikas Publishing House Pvt. Ltd., New Delhi.

Rosenberg, N.J.; Blad, B.L. and Verma, S.B. 1983. Microclimate: The biological environment. John Wiley, New York.

Salisbury, F.B. and Ross, C.W. 1986. Plant physiology. Wadworth Pub., USA.

Shukla, R.S and Chandel, P.S. 2014. A textbook of Plant Ecology including Ethnobotany and Soil Science (Twentith Revised & Enlarged Edition). S. Chand & Company Pvt. Ltd. New Delhi. 526p.

Course number	:	**CBOT 4101**
Course title	:	**Plant Physiology and Ecology-II –Theory (Compulsory)**
Number of credits	:	**3**
Total Marks	:	**100**

Rationale

The course has been designed to offer advanced knowledge on physiological and ecological processes in plants/plant communities related to crop production.

Objectives

- Provide knowledge on growth-, flowering-, seed- and stress physiology of plants
- Describe ecosystems, their succession processes, modification, adaptation and distribution of plants in relation to climate change and environmental pollution.

Learning outcomes

- Analyze radiation use efficiency, growth parameters, assimilate partitioning and yield attributes
- Explain flowering physiology in relation to photo- and thermoperiodism, application of PGRs in plant growth and development
- Narrate the causes of dormancy with remedial measures and explain the physiological aspects of osmopriming for germination;
- Describe the stress-specific responses of plants with physiological, biochemical and molecular means of overcome;
- Explain the components of cultivated and natural ecosystems with their functions, succession processes and vegetation formation in different habitats along with the losses of biodiversity and conservation strategies.
- Enumerate phytogeography, vegetation regions of world and Bangladesh and ecology of some important crops in line with biotic association and means of microclimatic manipulation for their improvement.
- Explain the causes and consequences of various environmental pollutions, greenhouse effects and global warming with their remedial measures for agricultural production;

Course content

A. PLANT PHYSIOLOGY:

Carbon fixation by crop canopies: Canopy structure, leaf area index and dry matter (DM) production, strategies for maximizing solar energy utilization.

Transport and partitioning of assimilates: Nature of solution in phloem transport, mechanism, phloem loading and unloading, source-sink relationships, assimilate partitioning and harvest index.

Growth regulators: Classification, effects of phytohormones (auxins, gibberellins, cytokinins and others) on growth and development in field and *in vitro* plants.

Seeds and germination: Structure and chemical composition, sources of assimilate and maturation, stored seed reserves and its control; dormancy- causes, releases and its significance.

Growth and development: Concept, factors affecting growth, determinate and indeterminate growth, growth correlation and growth dynamics, vegetative and reproductive growth, plant growth and yield analyses techniques.

Flowering and fruiting: Transition to flowering, photoperiodism, thermoperiodism, flower induction, minimum age, photoinductive cycles, night breaks, factor modifying photoinduction, fruiting- fruitset, seed growth and ripening.

Stress physiology: Types, nature of injury, causes, mechanisms and survival measures to overcome.

B. PLANT ECOLOGY:

Ecosystems: Concept, structures, components, classification and functions of natural and cultivated ecosystems, flow of energy and matter, biogeochemical and nutrients cycling.

Plant succession: Causes, formation of vegetation, process and types- hydrosere, xerosere, lithosere, psammosere.

Phytogeography: Principles, major vegetation regions of Bangladesh and World, agro-ecological zones (AEZ) of Bangladesh and crop suitability. Causes of depletion of forest in Bangladesh and ways and means to check them.

Ecology of some important crops: Rice, wheat, sugarcane, jute, cotton, tea, tobacco, important vegetables, fruits, pulses and oils.

Halophytes and Mangrove vegetation: Concept, distribution, characters, succession in coast.

Plant diversity and conservation: Concept, causes of diversity losses, methods of conservation and management, and national conservation policy (NCP).

Biotic relation: Types, interrelationship among biotic factors, vegetation and crop production, principles of crop-weed association.

Micro- and macro-environment: Concept, components, microclimate manipulation and improvement of crop production.

Environmental pollution: Types, causes, atmospheric gases, their cycling and implications in agriculture, green house effects- causes and remedies, effects and control of environmental pollution, waste management.

Teaching strategy

- Lecture
- Video clips
- Group discussion

Assessment strategy

- MCQ
- Short question
- Essay type question
- Assignment

Books recommended

Ambasht, R.S. and Ambasht, P.K. 1999. Environment and pollution. 3rd ed. CBS Pub., New Delhi.

Bewley, J.D. and Black, M. 1994. Seeds: Physiology of development and germination. 2nd ed. Plenum Press, New York.

Fosket, D.E. 1994. Plant growth and development. Academic Press Inc. California.

Hall, D.O., Scurlock, J.M.O., Bolhar-Nordenkampf, H.R., Leegood, R.C. and Long, S.P. 1993. Photosynthesis and production in a changing environment: A field and laboratory manual. Chapman and Hall, U.K.

Kumar, H.D. 1995. General ecology. Vikas Pub. House, New Delhi.

Nilsen, E.T. and Orcutt, D.M. 1996. The physiology of plants under stress. John Wiley and Sons, Increased., New York.

Salisbury, F.B. and Ross, C.W. 1986. Plant physiology. Wadsworth Pub. Co., USA.

Santra. S.C. 2012. Environmental Science. New Central Book Agency (P) Ltd. New Delhi. 1529p.

Shukla, R.S and Chandel, P.S. 2014. A textbook of Plant Ecology including Ethnobotany and Soil Science (Twentith Revised & Enlarged Edition). S. Chand & Company Pvt. Ltd. New Delhi. 526p.

Wilson, O.E. 1988. Biodiversity. Nat. Acad. Press, Washington, DC.

Course number	:	**CBOT 4102**
Course title	:	**Plant Physiology and Ecology-II –Practical (Compulsory)**
Number of credits	:	**2**
Total Marks	:	**100**

Rationale

The course has been designed to offer practical knowledge on physiological and ecological processes and functions of plants in field condition.

Objectives

- Provide practical knowledge on measurement methods/tools for growth and development in plants;
- Demonstrate aut- and syn-ecological action & re-action processes in agro-ecosystems and their explanation through data collection and analyses.

Learning outcomes

- Analyze and interpret data from field and pot experiments and calculate different crop growth parameters & energy utilization efficiencies for interpretation of plant growth;
- Use the PGRs on growth and yield of crops effectively;
- Assess the effects of different stresses on growth and yield of crops;
- Evaluate the different types of biotic relations, association, co-existence and competition of crops and weeds in plant communities;
- Quantify community structure, vegetation values & stability;
- Calculate flow of energy through different trophic levels;
- Collect micro-climate and crop survey data, and interpret crop response to micro-climate variation.

Course content

A. PLANT PHYSIOLOGY:

Demonstration of crop research in the Field Laboratory of Crop Botany Department.

Estimation of dry matter (DM) production, determination of moisture content, leaf area (LA), leaf area index (LAI), light interception measurement.

Techniques of crop growth and yield analysis.

Experiments on ecophysiological aspects of imbibition and germination of seeds, methods of breaking seed dormancy.

Demonstration of the effects of different stresses on growth and yield in crops.

Demonstration of the effects of different PGRs on growth and yield in crops.

B. PLANT ECOLOGY:

Study of biotically related plants-commensals, ammensals, parasites, symbionts, etc.

Methods of ecological survey of plant communities and field study of plant habitats.

Experiments on flow of energy in agro-ecosystem on light, heat transfer and radiant energy.

Experiments on crop-weed association and mulches, and their effects on crop production.

Ecophysiological aspects of data collection in relation to soil moisture and temperature, and root-growth and their interpretation.

Teaching strategy

- Lecture
- Experiment
- Demonstration
- Group discussion
- Video clips

Assessment strategy

- MCQ
- Short question
- Essay type question
- Assignment

Books recommended

Ambasht, R.S. and Ambasht, P.K. 1999. Environment and pollution. 3rd ed. CBS Pub., New Delhi.

Bewley, J.D. and Black, M. 1994. Seeds: Physiology of development and germination. 2nd ed. Plenum Press, New York.

Dimond, J. and Case, T.J. 1980. Community ecology, Harper & Row, New York.

Gardner, F.P., Pearce, R.B. and Mitchell, R.L. 1985. Physiology of crop plants. Iowa State Univ. Press, USA.

Hall, D.O., Scurlock, J.M.O., Bolhar-Nordenkampf, H.R., Leegood, R.C. and Long, S.P. 1993. Photosynthesis and production in a changing environment: A field and laboratory manual. Chapman and Hall, U.K.

Hunt, R. 1982. Plant growth curves: The functional approach to plant growth analysis. Edward Arnold, London.

Nilsen, E.T. and Orcutt, D.M. 1996. The physiology of plants under stress. John Wiley and Sons, Increased., New York.

Pandey, S.N. and Sinha, B.K. 1986. Plant Physiology. Vikas Pub. House Pvt. Ltd., New Delhi.

Shukla, R.S and Chandel, P.S. 2014. A textbook of Plant Ecology including Ethnobotany and Soil Science (Twentith Revised & Enlarged Edition). S. Chand & Company Pvt. Ltd. New Delhi. 526p.

Course number	:	**CBOT 1201**
Course title	:	**Agricultural Botany – Theory (Elective)**
Number of credits	:	**2**
Total Marks	:	**100**

Rationale

The course has been designed to offer knowledge on descriptors related to plant structure, forms & functions.

Objectives

To understand the features of different plant parts, their role in crop production, tolerance and development.

Learning outcomes

- State principles and practices of plant taxonomy, palaeobotany and fossil plants with their importance.
- Classify and describe roots, stems & tendrils with their modifications and functions.
- Describe various types of leaves, inflorescence and flowers with their modifications and functions.
- Explain the formation of seeds and fruits with their types, importance and ways of dispersal.
- Narrate vegetative and reproductive propagations and seed germination with their significances.
- Illustrate sporophytic and gamtetophytic generations in plants.
- Classify plant cells and tissues and various forms of defensive structures in plants.

Course content

Taxonomy :

Principles and objectives of plant taxonomy, modern trends in plant taxonomy and its major phases.

Plant structures, functions and modifications:

Root: System, classification and functions; modified roots in different plants.

Stem: Characteristics, types, and functions. Modifications of stem in different plants, branching pattern.

Tendril: Forms, functions and modifications in cucurbit, pea, lentil, vines and creepers.

Leaf: Characteristics, types, functions, modifications of leaf in relation to plant morphology, phyllotaxy and function.

Flower: Type of inflorescences, floral parts and their modifications, spikelets and florets of crop plants.

Fruit: Formation, type, modification, and dispersal in relation to important crops.

Seed: Formation and structure, types, modification, dispersal and seed germination in crops.

Reproduction: Vegetative, reproductive, sporophytic and gametophytic generation.

Defensive mechanisms in plants: Armature, thorns, spines, prickles, bristles, hairs and other devices-latex, alkaloids, poisons, and allied substances.

Cell: Structures, functions, variations in relation to plant organs, maturity and storage.

Palaeobotany: Concept, descriptions, fossil plants, and their significance.

Books recommended

Balfour, A. 2016. Plant Taxonomy. Syrawood Publishing House, USA.

Brian, C. 2005. Botany for Gardeners. Timber Press, Inc., Cambridge.

Dodd, J.D. 1977. Course Book in General Botany. Ames lowa State Univ. Press.

Esau, K. 1965. Plant Anatomy. John Wiley, New York.

Hichey, M. 2001. The Cambridge Illustrated Glossary of Botanical Terms. Cambridge University Press, Cambridge.

MacAdam, J.W. 2009. Structure and Function of Plants. Willey-Blackwell, USA.

Sivarajan, V.V. 1991. Introduction to the Principles of Plant Taxonomy. 2nd ed. Cambridge.

Course number : CBOT 1202
Course title : Agricultural Botany – Practical (Elective)
Number of credits : 2
Total Marks : 100

Rationale

The course has been designed to offer practical knowledge on descriptors related to plant structure and functions.

Objectives

- To identify different vegetative, reproductive and storage parts of cereals, pulses and horticultural crops with their roles in production, protection and improvement.

Learning outcomes

- Identify cell and cell organelles, stomata, pollen, carpels, placenta etc. with their functions.
- Demonstrate the descriptor of different crop plants for identification;
- Compare and contrast plant taxa.
- Dissect and display the spikelets and florets of rice, wheat, maize, sugarcane and sunflower.
- Prepare herbarium sheets.
- Identify vegetations in Botanic garden and related field laboratories.

Course content

Demonstration of cell, nucleus, plastids, cell wall; tissues in bulb, tuber, aroids petiole; floral parts, pollen grains and fruits; stomata; starch grains in cereal, tuber and pulses; syncarpous and apocarpous carpels with their placentation.

Identification of modified structures of stem, root, leaf, flower and fruits of important crops.

Identification of different parts of the fruits and seeds: rice, wheat, maize, apple, orange, litchi, cashew, jack-fruit, pineapple, chalta, coconut, siliqua, legume, capsule, berry, custard-apple, palmyra-palm, pomegranate, date-palm and grape.

Study of variation in spikelets and florets in rice, wheat, maize, sugarcane and sunflower.

Assignment on herbarium sheet preparation.

Botanic garden and different field laboratory visit.

Books recommended

Balfour, A. 2016. Plant Taxonomy. Syrawood Publishing House, USA.

Brian, C. 2005. Botany for Gardeners. Timber Press, Inc., Cambridge.

Cutter, E.G. 1971. Plant Anatomy: Experiment and Interpretation. Edward Arnold, London.

Dodd, J.D. 1977. Course Book in General Botany. Ames lowa State Univ. Press.

Hichey, M. 2001. The Cambridge Illustrated Glossary of Botanical Terms. Cambridge University Press, Cambridge.

MacAdam, J.W. 2009. Structure and Function of Plants. Willey-Blackwell, USA.

Sivarajan, V.V. 1991. Introduction to the Principles of Plant Taxonomy. 2nd ed. Cambridge.

Course number	:	**CBOT 4201**
Course title	:	**Crop Physiology-Theory (Elective)**
Number of credits	:	**2**
Total Marks	:	**100**

Rationale

The course has been designed to offer physiological basis of yield development of selective crops

Objectives

- Describe eco-physiology of cereals, pulses, oil seeds, roots and tubers
- Explain the synthesis of carbohydrates, proteins, fats and oils

Learning outcomes

- Describe energy relation in production practices of crops
- Explain source-sink relationship and their limitations on crop yield
- Describe canopy architecture, photosynthesis and biomass production, respiration, partitioning of assimilates and storage capacity as a limitation on yield
- State eco-physiological requirements of important crops
- Differentiate classical and functional analyses of crop growth with their merits and demerits
- Explain the formation and development of seeds with their physiological maturity, dormancy and priming
- Interpret the use of seed germination in agro-industry

Course content

Introduction: Objective, energy relation and production factors.

Physiological basis of crop yield: Limiting process- source or sink, canopy structure, photosynthesis and biomass production, crop respiration, partitioning of assimilates, storage capacity as a limitation on yield.

Physiology of rice, wheat, sugarcane, maize, potato, jute, important oils, pulses and other crops.

Plant growth and yield analysis: Concept, classical and functional approaches, technique of measurement, their merits and demerits.

Seed physiology: Formation and development, physiological maturity, dormancy and priming, and control of germination, importance of seed in agro-industry**.**

Teaching strategy

- Lectures
- Video clips
- Group discussion

Assessment strategy

- MCQ
- Short question
- Assignment

Books recommended

Bewley, J.D. and Black, M. 1994. Seeds: Physiology of development and germination. 2nd ed., Plenum Press, New York.

Evans, L.T. 1975. Crop physiology: some case histories. Cambridge Univ. Press, Cambridge.

Hall, D.O., Scurlock, J.M.O., Bolhar-Nordenkampf, H.R., Leegood, R.C. and Long, S.P. 1995. Photosynthesis and production in a changing environment: A field and laboratory manual. Chapman and Hall, New York.

Hay, R.K.M. and Walker, A.J. 1989. An introduction to the physiology of crop yield, Longman Scientific & Technical, U.K.

Hunts, R. 1982. Plant growth curves: The functional approach to plant growth analysis. Edward Arnold, London.

Milthorpe, F.L. and Moorby, J. 1981. An introduction to Crop Physiology (2nd ed.), Cambridge Univ. Press, Cambridge.

Goldsworthy, P.R. and Fisher, N.M. 1984. The physiology of tropical field crops. John Wiley, N.Y.

Squire, G.R. 1990. The physiology of tropical crop production. CAB International, Oxon., U.K.

Yoshida, T. 1987. Rice crop science, IRRI, Philippines.

Course number	:	**CBOT 4202**
Course title	:	**Crop Physiology-Practical (Elective)**
Number of credits	:	**2**
Total Marks	:	**100**

Rationale

The course has been designed to offer hands-on skills on physiological basis of yield in selected important crops

Objectives

- Impart knowledge on harvest index of crops
- Explain yield attributes in cereals, pulses and oil seed crops

Learning outcomes

- Measure above and below ground plant biomass with destructive and non-destructive ways
- Estimate net primary production by green plants
- Differentiate classical and functional analyses of crop growth in practice
- Determine functions for fitted curves in crop growth analyses
- Perform yield component analysis
- Determine physiological maturity in cereals, legumes and other crops

Course content

Measurement of plant biomass: Measurement of above ground and below ground biomass, non-destructive measurement of biomass, estimation of net primary production.

Plant growth and yield analysis (PGA): Growth Concept of PGA, classical approach, functional approach in practice, choice of functions and fitted curves; yield-yield and yield component analysis.

Physiological maturity (PM): Concept, determination of PM in cereals, legumes and other crops, seed viability and PM.

Teaching strategy

- Lectures
- Video clips
- Group discussion

Assessment strategy

- MCQ
- Short question
- Assignment

Books recommended

Bewley, J.D. and Black, M. 1994. Seeds: Physiology of development and germination. 2nd ed., Plenum Press, New York.

Evans, L.T. 1975. Crop physiology: some case histories. Cambridge Univ. Press, Cambridge.

Hall, D.O., Scurlock, J.M.O., Bolhar-Nordenkampf, H.R., Leegood, R.C. and Long, S.P. 1995. Photosynthesis and production in a changing environment: A field and laboratory manual. Chapman and Hall, New York.

Hay, R.K.M. and Walker, A.J. 1989. An introduction to the physiology of crop yield, Longman Scientific & Technical, U.K.

Hunts, R. 1982. Plant growth curves: The functional approach to plant growth analysis. Edward Arnold, London.

Milthorpe, F.L. and Moorby, J. 1981. An introduction to Crop Physiology (2nd ed.), Cambridge Univ. Press, Cambridge.

Goldsworthy, P.R. and Fisher, N.M. 1984. The physiology of tropical field crops. John Wiley, N.Y.

Squire, G.R. 1990. The physiology of tropical crop production. CAB International, Oxon., U.K.

Yoshida, T. 1987. Rice crop science, IRRI, Philippines.

Course number : **CBOT 4203**
Course title : **Plant Biodiversity and Conservation-Theory (Elective)**

Number of Credits : **2**
Total Marks : **100**

Rationale

The course is designed to offer overall knowledge on the biodiversity and conservation strategies of plant genetic resources.

Objectives

- Provide knowledge on plant biodiversity;
- Explain the causes and threats of biological diversity losses
- Describe the conservation strategies for plant genetic resources.

Learning outcomes

- Explain the status and importance of biodiversity and biological resources
- Identify the causes of biodiversity losses and address the threatened plant species
- Formulate strategies for *in situ* and *ex situ* conservation of rare and endangered plant species.
- Evaluate the indicators for measuring biodiversity in different ecosystems.
- Assess the forest resource management and their utilization
- Illustrate germplasm exploration, collection and conservation strategies.

Course content

The nature and value of plant biodiversity: Nature, importance and types of biological diversity, direct and indirect values of biological resources.

Biodiversity loss and causes: Dimension of the loss of agricultural and forest biodiversity, principal causes of biodiversity losses, threats from the loss of plant species. IUCN Red list of plant species.

Conservation strategy: National strategy for *in situ* and *ex situ* conservation of agricultural and forest biodiversity. Conservation of rare and important wild plant genetic resources in protected areas and in different farming systems.

Biodiversity indicators: Indicators for measuring diversity, indicators of wild species and genetic diversity, community diversity and domesticated species diversity.

Plant products and uses: Resource assessment, uses, domestication and commercialization of timber and non-timber forest products.

Plant exploration and germplasm collection: Germplasm exploration, collection, conservation, evaluation and utilization.

Teaching strategy

- Lecture
- Video clips

Assessment strategy

- Written exam
- Quiz
- Assignment

Books recommended

Arora, R.K. and Rao, V.R. (edited). 1995. Proceedings of the South Asia National Coordinators Meeting on Plant Genetic Resources. 10-12 January 1995. BARC, Dhaka.

CBD. 1999. Convention on Biological Diversity- Text and Annexes. Montreal, Canada.

FAO. 1996. Global Plan of Action for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture, and the Leipzig Declaration, Rome, Italy.

Gurung, J.D. (edited). 1994. Indigenous Knowledge Systems and Biodiversity Management. Proceedings of a MacArthur Foundation, ICIMOD Seminar, 13-15 April 1994, Kathmandu, Nepal.

Jeffrey *et al.* 1997. Conserving the World's Biological Diversity. IUCN, WRI, CI, WWF-US, the World Bank. Gland, Switzerland, and Washington, D.C.

Lori Ann Thrupp. 1998. Cultivating Diversity- Agrobiodiversity and Food Security, World Resources Institute

WRI, IUCN, UNEP, FAO, UNESCO. 1992. Global Biodiversity Strategy- Guidelines for action to save, study, and use earth's biotic wealth sustainably and equitably. Gland, Switzerland.

Course number : **CBOT 4204**
Course title : **Plant Biodiversity and Conservation-Practical (Elective)**

Number of Credits : **2**
Total Marks : **100**

Rationale

The course is designed to offer practical aspects of biodiversity and conservation strategies of plant genetic resources.

Objectives

- Describe the biodiversity status using different methods
- Explain the conservation strategies for plant genetic resources

Learning outcomes

- Analyze vegetation and community structures
- Identify medicinal and threatened plant species of Bangladesh
- Prepare monographs of threatened plant genetic resources.
- Evaluate genetic resources of forest conservatories, botanical garden through field visits.

Course content

Principles and procedures of plant collection, documentation and data management

Preparation of monographs on important and rare plant genetic resources (medicinal and aromatics, bamboo, rattan, fruit and nuts, spices, timber plant species).

Field visit to different *in situ* and *ex situ* conservation areas in Bangladesh

Assignment

Teaching strategies

- Lecture
- Field visit
- Designing
- Video clips

Assessment strategies

- Written exam
- Identification
- Quiz
- Assignment

Books recommended

Arora, R.K. and Rao, V.R. (edited). 1995. Proceedings of the South Asia National Coordinators Meeting on Plant Genetic Resources. 10-12 January 1995. BARC, Dhaka.

CBD. 1999. Convention on Biological Diversity- Text and Annexes. Montreal, Canada.

FAO. 1996. Global Plan of Action for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture, and the Leipzig Declaration, Rome, Italy.

Gurung, J.D. (edited). 1994. Indigenous Knowledge Systems and Biodiversity Management. Proceedings of a MacArthur Foundation, ICIMOD Seminar, 13-15 April 1994, Kathmandu, Nepal.

Jeffrey *et al.* 1997. Conserving the World's Biological Diversity. IUCN, WRI, CI, WWF-US, the World Bank. Gland, Switzerland, and Washington, D.C.

Lori Ann Thrupp. 1998. Cultivating Diversity- Agrobiodiversity and Food Security, World Resources Institute

WRI, IUCN, UNEP, FAO, UNESCO. 1992. Global Biodiversity Strategy- Guidelines for action to save, study, and use earth's biotic wealth sustainably and equitably. Gland, Switzerland.

Department of Genetics & Plant Breeding

Course number	:	**GPB 2201**
Course title	:	**Cytology-Theory (Compulsory)**
Number of credits	:	**2**
Total marks	:	**100**

Rationale

The course will provide fundamental knowledge on cell structure, genetically important cellular components and cellular events for advanced cytogenetical studies.

Objectives

- Describe different cellular organelles with genetic importance
- Explain cell division processes
- Distinguish among different types of chromosomes
- Describe the effect of different agents on chromosomes
- Interpret the karyotype and evolution in speciation

Learning outcomes

- Describe cell organelles of genetic importance
- Explain different events of cell division processes
- Illustrate the structure of different types of chromosome and their function
- Describe the effect and application of different agents on chromosomes
- Interpret the causes of karyotypic variation

Course content

Plant cell constituents of genetic importance

Principal events of mitosis and meiosis in diploid organisms.

Morphological structure of eukaryotic chromosomes and their nomenclature, Prokaryotic chromosomes and their characteristics

Euchromatin, heterochromatin, allocycly and heteropycnosis.

Special types of chromosomes: Polytene chromosome, Lambrush chromosome, B-chromosome, Sex-chromosome, Iso-chromosome, Telocentric chromosomes, Diplo chromosome.

Effects of different types of physical and chemical agents on chromosomes.

Karyotype: Characteristics, variation and its role on speciation

Teaching strategy

- Lecture
- Small group discussion
- Tutorial

Assessment strategy

- Written exam
- Quiz
- Drawing
- Assig

Books recommended

Verma, P.S. and Agarwal, V. K. 1998. Cytology. S. Chand & Co. Ltd. Ram Nagar, New Delhi.

Perry, J. and Appels, R. 1998. Chromosome structure and Function. Plenum press, New York and London.

Burns, G.W. 1980. The Science of Genetics 4th ed. Macmillan publishing co. Inc. New York.

Sarma, A. 1991. Chromosomes. Oxford & IBH Pub. Co. New Delhi

Sharma A.K. and Sharma, A. 1980. Chromosomes Technique-theory and practice 3rd ed. Butterworthes. London.

Swanson, C.P.; Merz, J. and Young, W. J. 1988. Cytogenetics. The chromosome in Division, inheritance and evolution. Prentice Hall of India private Ltd.

Cytologia - International Journal of Cytogenetics and Cell Biology. 1998.

Course number	:	**GPB 2202**
Course title	:	**Cytology-Practical (Compulsory)**
Number of credits	:	**2**
Total marks	:	**100**

Rationale

The course will provide practical knowledge on important events of cell division

Objectives

- Introduce basic laboratory rules on microscopy for cytological studies
- Demonstrate and identify stages of mitosis and meiosis
- Explain the effects of physical and chemical agents on chromosomal aberrations

Learning outcomes

- Prepare slides from plant samples to describe and identify different stages of mitosis and meiosis
- Examine the effect of colchicine and gamma-ray on somatic cell division

Course content

Study of mitosis in onion root tip cells.

Study of meiosis in the pollen mother cells of onion/maize

Effect of colchicine treatment on onion/garlic root tip chromosomes

Effect of gamma-ray irradiation on onion/garlic root tip chromosomes.

Teaching strategy

- Lectures
- Demonstration of different stages of cell division
- Demonstration of normal versus aberrations in dividing cells
- Tutorial

Assessment strategy

- Quiz
- Identificaton of diffrent phases of cell divisions
- Experiment
- Assignment

Books recommended

Verma, P.S. and Agarwal, V. K. 1998. Cytology. S. Chand & Co. Ltd. Ram Nagar, New Delhi.

Perry, J. and Appels, R. 1998. Chromosome structure and Function. Plenum press, New York and London.

Burns, G.W. 1980. The Science of Genetics 4th ed. Macmillan publishing co. Inc. New York.

Sarma, A. 1991. Chromosomes. Oxford & IBH Pub. Co. New Delhi

Sharma A.K. and Sharma, A. 1980. Chromosomes Technique-theory and practice 3rd ed. Butterworthes. London.

Swanson, C.P.; Merz, J. and Young, W. J. 1988. Cytogenetics. The chromosome in Division, inheritance and evolution. Prentice Hall of India private Ltd.

Cytologia - International Journal of Cytogenetics and Cell Biology. 1998.

Course number	:	**GPB 3101**
Course title	:	**Genetics and Cytogenetics-Theory (Compulsory)**
Number of credits	:	**3**
Total marks	:	**100**

Rationale

The course covers the the basic principles of genetics & cytogenetics

Objectives

- Understand the basic concepts of Mendelian inheritance
- Explain the genetic mechanisms involved in linkage-crossing over, multiple allelism, sex determination and extra nuclear inheritance
- Provide knowledge on mutation, mutagenes and their effects
- Describe the meiotic behaviors and cytogenetic consequences of genetic variations
- Deliver a comprehensive idea on the evolution & cytogenetics of cultivated crops

Learning outcomes

- Describe the Mendelian pattern of inheritance
- Outline the concept and significance of linkage & crossing over, multiple allelism, quantitative inheritance, extra-nuclear inheritance and sex determination
- Explain Gene, its structure and function
- Describe the concept of mutation and their possible implications in crops improvement
- Outline and explain the chemical organization, structural and numerical changes of chromosome
- Analyze chromosome structures and identify individual chromosomes
- Describe the evolutionary pathway of cultivated wheat

Course content

Introduction: historical background development and scope of genetics.

Physical basis of heredity: Chromosome theory of inheritance; experimental evidence to prove that genes are situated on chromosomes.

Mendel's laws of inheritance: Mendel and his experiments; Law of segregation and independent assortment.

Modifications of Mendel's monohybrid and dihybrid F_2 phenotypic ratios: Modifications due to allelic and non-allelic gene interaction.

Linkage and crossing over: Concept; Mechanism and theories of crossing over; Significance of crossing over; Genetic map using three –point test cross progeny.

Multiple alleles: Test of allelism; Inheritance of multiple alleles; and Pseudoalleles.

Quantitative inheritance: Multiple factor hypothesis; Comparison of multiple factor inheritance with Mendelian inheritance.

Extra-nuclear inheritance: Features and types of extranuclear inheritance; maternal inheritance and its significance.

Sex determination and sex related inheritance: Mechanism of sex determination; Sex - linked genes in plants and animals; Sex - limited and sex influenced characters.

Gene: Classical and modern concept; Evidence of DNA as genetic material; Molecular structure of DNA and its replication; Function of gene in protein synthesis.

Mutation: Classification of mutation; Types of mutagens and their effects; Detection of mutation; Mechanism and significance of gene mutation.

Chemical organisation of chromosomes.

Structural changes of chromosomes, their meiotic behaviour and cytogenetic consequences.

Numerical changes of chromosomes, their meiotic behavior and cytogenetic consequences.

Genome and individual chromosome identification using autoradiography, microspectrophotometry, banding and *in situ* hybridization.

Cytogenetics of wheat in relation to:

a. Origin and distribution of the polyploid wheat and related species.

b. Genomic relationship of the phylogenetically related species.

Teaching strategy

- Lecture
- Assignment
- Video clip
- Small group discussion

Assessment strategy

- MCQ
- Short question
- Essay type question

Books recommended

Gupta P.K. 1987. Genetics 2nd ed. Rastogi Publication Meerut, India

Gupta, P.K. 1995. Cytogenetics. 1st. ed. Rastogi, India.

Strickberger, M.W. 1990. Genetics. 3rd ed. Mucmillan Publishing Co. New York.

Verma, P.S. and V.K. Agarwal, 1998. Genetics. 8th ed. S. Chand and Co. Ltd. New Delhi

Course number	:	**GPB 3102**
Course title	:	**Genetics-Practical (Compulsory)**
Number of credits	:	**2**
Total marks	:	**100**

Rationale

The course focuses on the practical aspects of plant genetics for crop hybridization.

Objectives

- Provide knowledge to identify and maintain different generations of crop plants
- Explain the mechanisms of solving problems involve one, two and three pairs of genes controlling traits
- Demonostrate the goodness of fit of experimental data obtained from different breeding programs
- Construct a genetic map for linked genes

Learning outcome

- Identify the parents, F_1 and segregating generations
- Explain the pattern of inheritance & variations in segregating generations
- Test the fitness of field experiment results with Mendelian and Non Mendelian ratios
- Calculate the frequency of crossing over and construct a physical gene map

Course content

Introduction to practical genetics: Demonstration and maintenance of parents, F_1 and F_2 generation plants in the Genetics and Plant Breeding experimental farm.

Problems on monohybrid cross: Complete dominance, partial dominance and Co-dominance.

Problem on dihybrid cross: Complete dominance, partial dominance and co-dominance.

Problems on trihybrid cross : Complete dominance

Problems on gene interaction: Non-epistatic gene interaction and epistatic gene interaction.

Problems on quantitative inheritance: Collection of data from genetic populations such as P_1, P_2, F_1 and F_2 to study quantitative inheritance.

Problems on Chi-square test: Collecting F_2 data from GPB experimental farm to perform Chi-square test for goodness of fit to Mendelian and Non Mendelian ratios.

Problems on linkage and crossing over: Using two and three point test cross:

Teaching strategy

- Lecture
- Demonstration
- Field visit
- Group discussion

Assessment strategy

- Written examination
- Quiz
- Problem solving
- Data analysis & interpretation

Books recommended

Gupta P.K. 1987. Genetics 2nd ed. Rastogi Publication Meerut, India
Gupta, P.K. 1995. Cytogenetics. 1st. ed. Rastogi, India.
Strickberger, M.W. 1990. Genetics. 3rd ed. Mucmillan Publishing Co. New York.
Verma, P.S. and V.K. Agarwal, 1998. Genetics. 8th ed. S. Chand and Co. Ltd. New Delhi.

Course number	:	**GPB 4201**
Course title	:	**Plant Breeding-Theory (Compulsory)**
Number of credits	:	**3**
Total marks	:	**100**

Rationale

The course covers knowledge on principles and methods of plant breeding essential for crop improvement.

Objectives

- Provide knowledge on principles, methods and tools for plant breeding
- Explain population structures and selection responses in plant breeding
- Describe the ideas on plant breeding approaches and strategies
- Discuss plant tissue culture and genetic engineering techniques

Learning outcomes

- Explain the plant breeding principles
- Assess pollination behavior of crop plants
- Describe conservation and management of plant genetic resources
- Assess components of population genetics and their utilization
- Construct and modify need-based breeding strategies
- Explain and apply plant tissue culture and genetic engineering techniques
- Design variety release processes

Course content

Principle and basic topics: Scope and goal of plant breeding, mechanism of self and cross-pollinations, genetic significance of pollination methods. Male sterility and self-incompatibility phenomena and their causes. Evolution of crop plants, centers of origin and diversity, conservation and management of plant genetic resources.

Genetic basis of crop improvement: Population structure and gene frequency; effects of genes in quantitative inheritance; heritability and its role on genetic advance; hybrid vigour, inbreeding depression, **Heterosis breeding** – types and measurement of heterosis, commercial exploitation, techniques of hybrid seed production.

General plant breeding methods:

a) For self–pollinated crops – pedigree, single seed descent, bulk population and backcross methods.

b) For cross-pollinated crops – mass selection, recurrent selection, development of hybrid and synthetic varieties.

C) For vegetatively propagated crops – clonal selection after hybridization, mutation and polyploidization.

Special plant breeding methods:

a) Mutation breeding – induction and utilization of mutants in crop improvement.

b) Polyploid breeding – induction and use of auto and allopolyploids.

c) Resistance breeding – for disease and insect.

d) Stress breeding – for important stress factors.

Innovative methods: Application of biotechnology and genetic engineering in crop improvement:

a) Tissue culture – cellular totipotency, micropropagation, embryo culture, anther culture, pollen culture, somatic embryogenesis and somatic hybridization (protoplast fusion).

b) Recombinant DNA technology – cloning and selection of recombinants.

Variety release and seed production: Principles and practices relating to evaluation and release of new crop varieties, seed legislation, seed certification and seed testing.

Teaching strategy

- Lecture
- Video clips
- Discussion

Assessment strategy

- Written exam.
- Short and broad question
- Assignment
- Field trip report
- Group presentation

Books recommended

Old, R.W. and Primrose, S.B. 1994. Principles of Gene Manipulation - An introduction to Genetic Engineering. Blackwell Scientific Publications. London. 5th edition.

Poehlman,J. M. and Sleeper, D. A. 1995. Breeding Field crops. Panima Pub. Cor. , New Delhi.

Primrose, S. B. 1987. Modern Biotechnology. Backwell Scientific Pub. , London

Sharma, J. R. 1994. Principles and Practice of Plant Breeding. Tata McGraw - Hill Pub, New Delhi.

Singh , B. D. 1986. Plant Breeding. Kalyani Publishers, India.

Acquaah, G. 2007. Principles of Plant Genetics and Breeding (1st Ed.), Blackwell Publishing Ltd. USA

Course number	:	**GPB 4202**
Course title	:	**Plant Breeding-Practical (Compulsory)**
Number of credits	:	**2**
Total marks	:	**100**

Rationale

This course provides practical knowledge on principles and techniques of plant breeding

Objectives

- Demonstrate hybridization techniques in crop plants
- Explain the procedure to record, compile, analyze and interpret data from various plant breeding schemes
- Hands-on practice on plant tissue culture techniques

Learning outcomes

- Perform hybridization procedure of different crop plants
- Design and execute breeding schemes
- Compile and analyze field experimental data
- Execute different plant tissue culture techniques

Course content

Hybridization techniques:

Floral biology, pollination system and crossing techniques in crop plants, such as rice, wheat maize, tomato, beans, peas, groundnut, mustard and jute.

Demonstration of field experiments:

a) Demonstration of parental, hybrid and segregating populations and data collection.

b) Demonstration of breeding research activities in the GPB experimental farm.

Statistical analysis of plant breeding and genetic experiments:

a) Data analysis for variety testing and other experiments, using a RCB design-anova, test of significance and mean separation.

b) Plant characters association –correlation and regression analysis.

c) Estimation of heterosis, heritability and no. of genes controlling quantitative character

Tissue Culture: Preparation of tissue culture media, sterilization techniques and handling of equipment related to tissue culture, and demonstration of embryo culture.

Teaching strategy

- Lectures
- Assignment
- Demonstration
- Field experiment
- Data analysis

Assessment strategy

- Written exam.
- Quiz
- Short & broad question
- Field visit & report

Books recommended

Old, R.W. and Primrose, S.B. 1994. Principles of Gene Manipulation - An introduction to Genetic Engineering. Blackwell Scientific Publications. London. 5th edition.

Poehlman,J. M. and Sleeper, D. A. 1995. Breeding Field crops. Panima Pub. Cor. , New Delhi.

Primrose, S. B. 1987. Modern Biotechnology. Backwell Scientific Pub. , London

Sharma, J. R. 1994. Principles and Practice of Plant Breeding. Tata McGraw - Hill Pub, New Delhi.

Singh , B. D. 1986. Plant Breeding. Kalyani Publishers, India.

Course number	:	**GPB 4101**
Course title	:	**Plant Biotechnology and Genetic Engineering–Theory (Elective)**
Number of credits	:	**2**
Total marks	:	**100**

Rationale

This course is designed to provide knowledge on principles and techniques of plant tissue culture & recombinant DNA.

Objectives

- Familiarize the students with the fundamentals of plant tissue culture techniques and applications
- Impart comprehensive idea on basic techniques and applications of recombinant DNA technology
- Make the students know the regulations and management of transgenic plants

Learning outcomes

- Understand prerequisites of tissue culture
- Apply the use of tissue culture in creating genetic variation and crop improvement
- Explain the details of recombinant DNA technology including cloning and transformation
- Illustrate its potential application in agriculture

Course content

Concepts and basic techniques in tissue culture, prerequisites for cell and tissue culture, media preparation and sterilization techniques.

Anther culture: Production of haploids and double haploids and their application in agriculture.

Plant regeneration from callus & cell suspension cultures by somatic embryogenesis.

Somaclonal & gametoclonal variation: Concepts and practical application of variability in tissue cultures.

Protoplast isolation, fusion and culture: Somatic hybridization, selection system of hybrid and production of hybrids. Role of protoplast culture and somatic hybrids in the development of crop plants.

Basic principles of recombinant DNA technology

Cloning – concept and basic steps; application of bacteria and viruses in genetic engineering, cloning vectors, expression of cloned genes, selection of recombinants.

Restriction endonucleases and their nomenclature

Genetic transformation in crop plants: Concept, various methods of gene transfer, Agrobacterium – mediated transformation for disease resistance.

PCR-Concept and application in gene cloning

Application of recombinant technology in crop improvement

Teaching strategy

- Lecture
- Video show
- Small group discussion
- Reading assignments

Assessment strategy

- Quiz
- Short answer question
- Presentation
- Peer rating

Books recommended

Dixon, R. A. 1987. Plant cell culture: a practical approach IRL Press. Oxford, Washington DC. Razdan, M. K. 2000. An introduction to Plant tissue culture oxford and IBH Pub. Co. Pvt. Ltd. Newh Delhi.

Brown , T. A. 2002. Gene cloning and DNA analysis : An introduction 4th edition. Blackwell science

Gamborg, O. L. and Phillips , G. C. 1995. Plant cell, tissue and organ culture, Fundamental methods. Narosa Pub. House, New Delhi, Bombay, Loud, Madras, Calcutta.

Old. R.W. and Primrose, S.B. 1994. Principles of Gene Manipulation - An introduction to Genetic Engineering. Backwell Scientific Publications London. 5th edition.

Course number	:	**GPB 4102**
Course title	:	**Plant Biotechnology and Genetic Engineering –Practical (Elective)**
Number of credits	:	**2**
Total marks	:	**100**

Rationale

Provide practical knowledge on equipments, methods and techniques of plant tissue culture and recombinant DNA technology

Objectives

- Know the basic requirements to set up a tissue culture laboratory
- Conduct tissue culture techniques
- Conduct DNA isolation, PCR and gel-electrophoresis
- Carry out genetic transformation in plants

Learning outcomes

- Design a proper tissue culture laboratory
- Perform *in vitro* plant regeneration from living cell
- Carry out and compare various DNA isolation & electrophoresis techniques
- Perform genetic transformation in crop plants using Agrobacterium.

Course content

Prerequisites for an ideal tissue culture laboratory, Media preparation, Preparation of explants, Sterilization of media and explants

DNA extraction, Agarose gel electrophoresis, Polymerase Chain Reaction, Agrobacterium-mediated genetic transformation

Teaching strategy

- Lecture
- Video show
- Demonstration
- Hands on training
- Individual lab work
- Lab visit

Assessment strategy

- Quiz
- Short answer question
- Presentation
- Assignment
- Lab work assessment

Books recommended

Dixon, R. A. 1987. Plant cell culture: a practical approach IRL Press. Oxford, Washington DC. Razdan, M. K. 2000. An introduction to Plant tissue culture oxford and IBH Pub. Co. Pvt. Ltd. Newh Delhi.

Brown , T. A. 2002. Gene cloning and DNA analysis : An introduction 4th edition. Blackwell science

Gamborg, O. L. and Phillips , G. C. 1995. Plant cell, tissue and organ culture, Fundamental methods. Narosa Pub. House, New Delhi, Bombay, Loud, Madras, Calcutta.

Old. R.W. and Primrose, S.B. 1994. Principles of Gene Manipulation - An introduction to Genetic Engineering. Backwell Scientific Publications London. 5th edition.

Course number	:	**GPB 4203**
Course title	:	**Special Plant Breeding-Theory (Elective)**
Number of credits	:	**2**
Total marks	:	**100**

Rationale

The course provides knowledge on special plant breeding approaches and techniques to enhance varietal improvement of crops.

Objectives

- Describe the techniques of hybrid variety development
- Explain methods of creating genetic variation and their uses in plant breeding
- Illustrate the techniques of multiplication and maintenance of parental and breeder seeds
- Explain plant breeders' rights and roles

Learning outcomes

- Elaborate breeders' achievements in Bangladesh
- Explain the methods of pollination control to develop and maintain hybrid varieties
- Elucidate the methods of creating genetic variation and their uses in crop improvement
- Assess different seed classes, their production and maintenance
- Describe breeders' rights and outline the rules and regulations for keeping farmers' privileges

Course content

Status of breeding achievements of important field crops in Bangladesh: rice, wheat, maize, jute, sugarcane, mustard, groundnut, soybean, lentil, chickpea and tomato.

Breeding for hybrid variety in self –pollinated crops: System of pollination control. Development, selection, and maintenance of parental lines, production of single cross and double cross hybrids, significance and problems.

Mutation in crop improvement: Handling of mutagenized materials, factors influencing mutation spectrum, prospects and limitation of mutation breeding.

Polyploid in crop improvement: Polyploids in nature, artificial induction of polyploids, its application in crop improvement, prospects and limitations of polyploid breeding.

Haploidy in crop improvements: Haploids in nature, induction of haploids and doubled haploids, their application in crop improvement, prospects and limitations

Wide hybridization: Objectives, barriers, application in crop improvement-alien addition, alien substitution and transfer of segment of chromosomes, transfer of cytoplasm, prospects and limitations.

Apomixis: Origin induction and its application in crop improvement.

Quality seed: Classes, production practices and maintenance of breeders' seeds.

Plant Breeders' rights: Requirements, farmer's privilege, breeders' exemption, benefits and disadvantages from PBR.

Teaching strategy

- Lectures
- Video clips
- Field visit

Assessment strategy

- Written exams
- Assignments
- Field visit reports

Books recommended

Sharma, J.R. 1994. Principles and Practice of Plant Breeding. Tata McGraw-Hill Publishing Company, New Delhi, India.

Singh, B.D. 2012. Plant Breeding: Principles and Methods. 9th Edition, Kalyani Publishers, New Delhi, India.

Sleper D.A. and J.M. Poehlman. 2006. Breeding Field Crops. 5th Edition, Blackwell Publishing, Ames, Iowa, USA.

Van der Have, D.J. 1979. Plant Breeding Persectives. Centre for Agricultural Publishing and Documentation, Wageningen, The Netherlands.

Course number	:	**GPB 4204**
Course title	:	**Special Plant Breeding-Practical (Elective)**
Number of credits	:	**2**
Total marks	:	**100**

Rationale

The course provides practical knowledge on special plant breeding approaches and techniques to enhance varietal improvement of crops.

Objectives

- Demonstrate special breeding approaches to solve field oriented problems
- Explain advanced breeding approaches for inbred line development and hybrid seed production
- Describe wide hybridization techniques to improve yield and nutritional quality

Learning outcomes

- Identify, maintain and use different breeding materials
- Develop haploids, double haploids for enhancing breeding cycles
- Demonstrate hybridization method with distance species
- Utilize polyploids in appropriate breeding to improve crop yield
- Assess parental lines, identify suitable parents, their maintenance for hybrid seed production
- Explain breeding programs of National Research Institutions of the Country

Course content

Demonstration of mutants, polyploids and hybrids in research fields

Haploid production through anther culture and wide crossing

Interspecific hybridization

Polyploid production

Evaluation and maintenance of parental lines in hybrid seed production.

Study visit at different crop breeding stations followed by report.

Teaching strategy

- Lectures
- Field visit
- Lab works

Assessment strategy

- Written test
- Field visit reports
- Assignments
- Group presentation

Books recommended

Sharma, J.R. 1994. Principles and Practice of Plant Breeding. Tata McGraw-Hill Publishing Company, New Delhi, India.

Singh, B.D. 2012. Plant Breeding: Principles and Methods. 9th Edition, Kalyani Publishers, New Delhi, India.

Van der Have, D.J. 1979. Plant Breeding Persectives. Centre for Agricultural Publishing and Documentation, Wageningen, The Netherlands.

Department of Agricultural Extension Education

Course No	:	**AGEXT 2201**
Course Title	:	**Fundamentals of Extension, Leadership and Motivation-Theory (Compulsory)**
Number of Credits	:	**3**
Total Marks	:	**100**

Rationale

This course is intended to let the students learn about fundamental issues of extension education, leadership, and motivation.

Objectives

- Deliver the information about the concepts of extension, extension education extension teaching methods and aids
- Acquaint the students with learning process
- Provide ideas on different extension teaching methods and their use
- Offer fundamental ideas of leadership and motivation in extension work.

Learning outcomes

- Explain fundamental issues of extension education and extension work
- Describe the learning theories and laws of learning along with their implications in extension work
- Identify and explain extension teaching methods and aids along with their utilizations in extension work
- Justify the use of leadership skill in extension work
- Explain the issues related to motivation in extension work
- Apply need theories in extension work

Course content

Extension Education: Basic concepts of extension, education, and extension education; evolution of extension; philosophies, principles, scope and phases of extension work; history of agricultural extension in South and South-east Asia.

Learning process: Elements of the learning process; theories of learning; laws of learning and their implication in extension work; special features of adult learning.

Extension teaching methods and aids: Meaning and steps of extension teaching; guides to effective extension teaching; classification of extension teaching methods; different extension teaching methods; criteria/factors for selection and use of extension teaching methods. Purpose and classification of teaching aids; selection of appropriate teaching aid.

Leadership: Concept and types of leadership; importance of leadership in extension work, qualities of a good leader; duties and responsibilities of local and professional leaders; identifying local leaders; ways of recognizing and developing local leaders; opinion leadership in extension work; opinion leaders and their characteristics.

Fundamentals of motivation in extension: Concept of need and motivation; importance of motivation in extension work; ways of motivating extension workers and farmers.

Need theories: Concept of need; need theories of Maslow, Hertzberg and McGregor; implication of need theories in extension work.

Teaching strategy

- Lecture and discussion
- Self study
- Assignment

Assessment strategy

- Written examination
- Assignment
- Short question

Books recommended

Beal, G.M., J.M. Bholen and J.N. Roudabaugh. 1972. *Leadership and Dynamic Group Action.* Ames: The Iowa State University Press.

Bhuiya, M.H. 1988. *Krishi Samprasaran Parichiti*, Dhaka Jamuna Printers.

Bhuiya, M.H. and M. A. M. Miah. 1998. *Extension Psychology*, Dhaka: Colour line Printers.

Dahama, O.P. and O.P. Bhatnagar. 1980. *Education and Communication for Development.2nd. edn*. New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.

Kashem, M.A. 1992. *Samprasaran Bijnan* (Extension Science). Dhaka: The Bangladesh Packing Press.

Ray, G.L. 2010. *Extension Communication and Management.* 5nd edition, NayaProkash Publication, Calcutta, India.

Wilson, M.C. and G. Gallup. 1955. *Extension Teaching Methods.* Federal Extension Service, U.S. Dept. of Agriculture.

Course Number : **AGEXT 2202**
Course Title : **Extension Teaching Methods and Aids –Practical (Compulsory)**
Number of Credit : **2**
Total Marks : **100**

Rationale

The course is designed to make teaching effective through utilization of different extension teaching methods and aids

Objectives

- To provide information on various aspects on different extension teaching methods and aids
- To deliver instructions to prepare, present and practice the commonly used extension teaching methods and aids
- To guide the students to use group techniques in extension work

Learning outcomes

- Understand the basic concepts and procedure of demonstrations.
- Prepare various teaching aids and apply them during extension teaching.
- Prepare a presentation in projector.
- Understand group techniques and their application in extension work.
- Prepare a lecture script and present it as part of practice.

Course content

Demonstration: Conducting method and result demonstrations.

Teaching Aids: Introduction to teaching aids; preparation and use of poster, flash cards, leaflets, flip chart, charts & graphs

Projector: Introduction to projectors, types of projectors, working principles and components of projectors; preparation of slides; handling of projectors with practice sessions

Group techniques: Introduction, purposes and examples; procedure and practice of small group discussion, Phillips 66 method, brainstorming and role playing

Delivering a Talk (Lecturing): Concept of a lecture, prepare a lecture, common mistakes in a lecture, practice of delivering a talk on an assigned topic.

Teaching strategy

- Lecture
- Individual presentation
- Group discussion/ Group work
- Group presentation
- Video presentation practice

Assessment strategy

- Test and Assignment

Books recommend

Ray, G.L. 2010. Extension Communication and Management.5nd edition, NayaProkash Publication, Calcutta, India.
Anonymous. 2016. Practical Manual for Agricultural Extension Education, Department of Agricultural Extension Education, Bangladesh Agricultural University, Mymensingh.

Course number : **AGEXT 3101**
Course Title : **Extension Communication and Group Approaches-Theory (Compulsory)**
Number of credits : **2**
Total Marks : **100**

Rationale

This course is intended to give basic understanding of extension communication and dissemination of technologies along with application of knowledge of people's participation and group dynamics in extension work.

Objectives

- Provide information on communication process and its implication in extension work.
- Acquaint students with fundamental issues of diffusion of innovations.
- Introduce extension approaches followed by different extension agencies.
- Equip students with necessary knowledge on people`s participation and group dynamics in extension work.

Learning outcomes

- Describe communication process, its models and their implications in extension work.
- Explain innovation-decision process, use diffusion process and adopter categories in extension work.
- Apply different approaches and people's participation in extension work
- Recognize group dynamics and associate factors, and develop skills for working with groups.

Course content

Communication process: Concept of communication and communication process; importance of communication in extension work; functions of communication.

Models of communication process: Different models of communication and their elements; feedback in communication process; concept of noise and fidelity in communication process

Diffusion of Innovations: Concepts of innovation and diffusion; characteristics of innovations; innovation-decision process; adopter categories; diffusion process and its elements

Approaches to extension work: Meaning and elements of extension approaches; different approaches of extension work in Bangladesh and their critical analysis.

People's participation in agricultural extension programmes: Concept of people's participation in extension programme; factors of people's participation; major criteria of securing people's participation in extension programmes; examples showing evidences of people's participation in the programmes of GOs and NGOs.

Group dynamics: Concept of group and importance of group dynamics; internal and external forces acting in a group; principles of working with groups and their mobilization; roles of member in a group.

Working with group: Principles of working with a group; advantages and limitations in working with groups; skills of working with a group; group formation and skills necessary for forming and working with a new group

Teaching strategy

- Lecture and discussion
- Self-study
- Video clip
- Assignment

Assessment strategy

- Written examination
- MCQ
- Assignment

Books recommended

DAE. 2015. *Agricultural Extension Manual* (The Training and Visit System). Department of Agricultural Extension. Ministry of Agriculture. Govt. of the People's Republic of Bangladesh.

Kamath, M.C. (editor) 1961. *Extension Education in Community Development.* Directorate of Extension. New Delhi: Ministry of Food and Agriculture, Govt. of India.

Kashem, M.A. 1992. *Samprasaran Bigyan* . Dhaka: The Bangladesh Packing Press.

Ray, G.L. 2010. Extension Communication and Management. 5nd edition, NayaProkash Publication, Calcutta, India.

Samanta R.K. (ed). 1990. *Development Communication for Agriculture.* New Delhi: B.R. Publishing Corporation.

Wentling, T. 1993. *Planning for Effective Training.* Rome: FAO of the UN.

Course number : **AGEXT 3102**
Course Title : **Data Collection, Processing and Report Writing-Practical (Compulsory)**
Number of credits : **2**
Total Marks : **100**

Rationale

The course is designed to familiarize the students about data collection, analysis, report writing and presentation of report.

Objectives

- Acquaint students with various aspects of data collection methods, data analysis and processing.
- Develop skills to prepare research report based on empirical data.
- Develop presentation skills of the students.

Learning outcomes

- Describe different methods of data collection
- Prepare data collecting tools (interview schedule/questionnaire/checklist)
- Explain the process of farmers' interviewing and agricultural survey
- Process and analyze data
- Prepare and present a survey report

Course content

Methods of data collection: Concept and types of data, different methods of data collection: conventional methods and participatory methods; different tools of data collection.

Instruments of data collection: Concept of questionnaire; types of questionnaires; forms of questions; qualities of a good questionnaire; preparation of an interview schedule/questionnaire.

Interviewing: Meaning of interviewing; considering points for conducting an interview; steps of interviewing.

An agricultural survey: Meaning and purpose of survey; Areas usually to be covered during an agricultural survey; Qualities of a good surveyor.

Data processing and analysis: Transferring data from interview schedule/questionnaire; categorization, tabulation and interpretation of data; data analysis.

Preparation and presentation of report: Concept and format of a report; preparation of a research report; presentation of a survey report.

Teaching strategy

- Discussion
- Assignment
- Exercise
- Group Discussion
- Reporting

Assessment strategy

- Written examination
- Assignment

Books recommended

Ray, G.L. 2010. *Extension Communication and Management.* 5nd edition, Naya Prokash Publication, Calcutta, India.
Anonymous. 2016. Practical Manual for Agricultural Extension Education, Department of Agricultural Extension Education, Bangladesh Agricultural University, Mymensingh.

Course number : **AGEXT 4101**
Course title : **Extension Organization Management-Theory (Compulsory)**
Number of credits : **3**
Total marks : **100**

Rationale

This course provides understanding of various aspects of extension organization and human resource management as well as extension strategies for special interest groups

Objectives

● Conceptualize and describe various issues of extension organizations including their management, human resource development, and organizational decision making

● Describe the important aspects of extension programme planning, as well as monitoring and evaluation of extension programmes

● Explain extension programmes for special interest groups such as rural youth, rural women and landless farmers.

Learning outcomes

- Characterize different agricultural organizations and personnel involved in these.
- Illustrate the elements of management and associated problems and aspects of organizational decisions.
- Describe the basic concepts of HRM and HRD, and training needs of employees in extension organizations.
- Explain the important issues of an extension programme.
- Clarify basic concepts, importance and procedures of monitoring and evaluation in extension programmes.
- Describe suitable extension programmes for rural youth and rural women, their role in agriculture and extension programmes
- Characterize landless farmers and provide suitable interventions to them

Course content

Extension organization: Concept of organization and extension organization; objectives and features of an extension organization; organizations related to agricultural development in Bangladesh; introduction to DAE and personnel.

Management functions in organization: Concept of management; elements of management; management problems of an organization.

Decision-making process in extension organization: Concept of decision- making; steps in decision-making; factors.

Human resources development: Concept of human resource management (HRM) and human resource development (HRD); techniques of human resources development; training, its importance and types; methods of identification of training needs.

Extension programme planning: Concept of programme and extension programme planning; importance, principles and steps of extension programme planning.

Monitoring and evaluation of extension programme: Meaning and types of monitoring; importance of monitoring in extension programmes; meaning, types, principles and steps in evaluation of extension programmes.

Rural youth: Concept of youth, youth hood and rural youth; roles of youths; youth programmes in Bangladesh; rural youths in agricultural extension programmes and activities.

Rural women in agriculture: Role of rural women in agricultural activities; involvement of women in decision-making process in family; agricultural extension work for income generation and empowerment of women in Bangladesh.

Landless farmers: Concepts of landlessness and landless farmers; causes and consequences of landlessness; socio-economic situation of landless rural families; suitable agricultural activities and interest of landless families

Teaching strategy

- Lecture
- Discussion
- Self study

Assessment strategy

- Short questions
- Essay questions
- Assignment

Books recommend

Bhuiya, M.H. and M.A.M. Miah. 1998. *Samprasaron Monobiggan* (Extension Psychology). Dhaka: Krishi Lekhak Forum, Colourline Printers.

Bhuiya, M.H. 1999. *Extension Organization and Management.* Dhaka: Gulshan Publications.

Hassanullah, M. 1995. *Management Extension Services.* Dhaka: University Press Ltd.

Kashem, M.A. 1992. *Samprasaran Bijnan.* Dhaka: The Bangladesh Packing Press.

Kashem, M.A. 2004. *Fundamentals of Extension Education*. Mymensingh: Lima Printing Press.

Samanta R.K. (ed) 1993. *Extension Strategy for Agricultural Development.* New Delhi: MD Publications.

Samanta R.K. (ed) 1995. *Women in Homestead The South Asian Perspective.* New Delhi: MD Publications.

Swanson, B.E., R.P. Bentz and A.J. Sofranko (eds) 1997. *Improving Agricultural Extension.* a reference Manual. 3rd edn. Rome: Food and Agriculture Organization of the United Naitons.

Van den Ban, A.W. and H.S. Hawkins. 1996. *Agricultural Extension.* 2nd ed. London: Blackwell Science Ltd.

Course number : AGEXT 4102
Course title : Extension Programme Planning and Outreach Programmes- Practical (Compulsory)
Number of credits : 2
Total marks : 100

Rationale

This course focuses on need based extension programme planning, understanding execution of extension programmes, preparing training schedule and conducting group techniques

Objectives

- Hands-on preparing extension programme
- Develop training programmes
- Demonstrate functions of Upazila Parishad as a local government unit and its role for rural communities
- Describe assessment and analysis of socio-economic situation of farmers, diffusion of technologies and farm level problems

Learning outcomes

- Identify and explain farmers' problems using participatory methods
- Make appropriate problem tree and objective tree based on identified problems
- Identify and analyze alternatives and stakeholders of an extension programme
- Develop a logical framework in relation to an extension programme
- Prepare a plan of work and calendar of work of an extension programme
- Plan and design a training programme
- Describe the activities of different Nation Building Departments and technology transfer situations at upazila level

Course content

Introduction to programme planning: Concept of programme and extension programme planning, purpose and steps of extension programme planning

Problem identification: Identification of farmers' problems through using participatory methods; conduction of problem census for problem identification.

Problem and objective analysis: Concept and types of problems; concept of problem tree/chart and objective tree/chart; preparation of appropriate problem chart/tree and objective chart/tree.

Alternative and stakeholder analysis: Procedure for alternative analysis; preparation of alternative

analysis; concept of stakeholders and procedures of stakeholder analysis

Logical framework of an extension programme: Concept of Logical Framework and preparation of a logical

Plan of work and calendar of work: Concept of plan of work and calendar of work; preparation of a plan of work and a calendar of work.

Teaching strategy

- Discussion
- Exercise
- Field trip
- Reporting

Assessment strategy

- Written examination
- Assignment

Preparation of a training programme

Concept and types of training; essential elements and methods of training; preparation of a training schedule

Extension field trip

Conduction of a six-day long extension field trip at upazila level and submission of report (introduction to local government at upazila level, Nation Building Departments, understanding technology dissemination and farmers' problems)
Lecture/Presentation Group work Group presentation
Interactive discussion Group work Group presentation
Group discussion Village and farm visit Case study and survey Group Presentation Report Preparation

Books recommended

DAE. 1985. *Agricultural Extension Manual* (The Training and Visit System). Department of Agricultural Extension Ministry of Agriculture, Govt. of the People's Republic of Bangladesh.

Ray, G.L. 2010. *Extension Communication and Management.*5nd edition, NayaProkash Publication, Calcutta, India.

Anonymous. 2016. Practical Manual for Agricultural Extension Education, Department of Agricultural Extension Education, Bangladesh Agricultural University, Mymensingh.

Course number : **AGEXT 4103**
Course Title : **Extension for Sustainable Agricultural Development-Theory (Elective)**
Credit : **2**
Total Marks : **100**

Rationale

This course is intended to orient the students about need and application of sustainable agriculture and role of extension for its development at field level

Objectives

- Render information about present status of modern agriculture
- Acquaint the students with concept of sustainability in agriculture and need of different groups and institutions for sustainable agricultural development
- Provide basics on management and research activities for sustainable agricultural development

Learning outcomes

- Recognize the present status of modern agriculture and its effect on environment.
- Conceptualize the idea of sustainable agricultural development
- Identify and compare between different social groups and their functional procedure
- Assess different management practices for sustainable agricultural development
- Realize the issues of sustainable agriculture research and extension

Course content

Socio-economic Impact of Modern Agriculture: Effects of chemical fertilizer, pesticides and modern practices on environment, soil and water quality; ground water use and its impact on soil and human health; salinity, alkalinity and soil degradation.

Sustainable Agricultural Development: Concept, criteria and elements of sustainability in agriculture.

Local Groups and Institutions for Sustainable Agriculture: Local groups, and their socialempowerment and advocacy; formations of local groups; functions of different types of local groups towards sustainable farming and rural development

Managing Practices towards Environment Friendly and Sustainable Agricultural Development: i) Indigenous Technical Knowledge (ITK) (ii) Integrated Pest Management (IPM)Integrated Plant Nutrient Management (IPNM) (iii) Organic Farming (OF) (iv)Integrated Crop Management (ICM)
Facilitating Sustainable Agriculture: Research and extension agenda for sustainable agriculture

Teaching strategy

- Lecture and discussion
- Self study

Assessment strategy

- Short questions
- Essay questions
- Assignment

Books recommended

Chitamber, J.B. 1973. Introductory Rural Sociology (a synopsis of concepts & principles) New Delhi: Wiley Eastern Private Ltd.

Halim,Abdul and Kaida Yoshihiro. 2001. Agricultural Extension in South and Southeast Asia — A Comparative Historical Review; (Mimeo.).

Kamath, M.G. (ed.) 1961. Extension Education in Community.Development Directorate of Extension. New Delhi, Ministry of Food and Agriculture, Government of India,

Swanson, B. E., R.P. Bentz and A.J. Sofranko (eds) 1997. Improving Agricultural Extension.a reference Manual.3rdedn.Rome: Food and Agriculture Organization of the United Nations.

Updated Annual Reports and Publication of different GOs & NGOs as assigned by the class teacher. The organization should cover BRDB, DAE, LGED, BARD, RDA, BRAC, PROSHIKHA and other leading NGOs.

Course number : **AGEXT 4104**
Course Title : **Extension for Sustainable Agricultural Development (Practical)**
Credit : **2**
Total Marks : **100**

Rationale

The course is designed to give students opportunities to work closely with farmers

Objectives

- Equip students with necessary skills for surveying at farmers' field level issues of sustainable agriculture
- Acquaint student of the potential ways of achieving sustainable agricultural development

Learning outcomes

- Practice survey and other participatory approaches at farmers' field level
- Identify and explain different ITKs in rural community
- Observe the field level practice of organic farming by the farmers in rural areas
- Identify and describe the use of medicinal plants at farmer's field level

Course content

Identification of ITKs in the rural community: Farm and home visit, Focus Group Discussion (FGD), Observation, PRA, and Surveying through semi-structured interviewing.
Surveying the extent of use of ITKs in the farming community in respect to crops animals, fishes.
Surveying the extent of use of plant products as bio-pesticides by the farmers.
Identification and exploring the use of medicinal plants used by the farmer in human and animal health.

Teaching strategy

- Discussion
- Exercise
- Visit to farmers' field
- Reporting

Assessment strategy

- Written examination
- Assignment

Books recommended

Manion, A. M. 1995. Agriculture and Environmental Change: Temporal and Spatial Dimensions. New York: John Wiley & Sons.

Pretty, J. N. 1995. Regenerating Agriculture: Policies and Practice for Sustainability and Self-Reliance. London: Earthscan.

Reijntes, C., B. Haverkort and A. Waters-Bayer. 1992. Farming for the Future: An Introduction to Low-External-Input and Sustainable Agriculturlture. Leusden, Netherlands:Macmillan.

Röling, N. G. and M. A. E. Wagemakers. 1998. Facilitating Sustainable Agriculture: Participatory Learning and Adaptive Management in Times of Environmental Uncertainty. Cambridge: Cambridge University Press.

Vldhuizen, L.V., A. Waters-Bayer and H. D. Zeeuw. 1997. Developing Technology with

Farmers: A Trainer's Guide for Participatory Learning. London: ETC.

Course number : **AGEXT 4201**
Course title : **Community Participation-Theory (Elective)**
Number of credit : **2**
Total Marks : **100**

Rationale

This course is planned to orient students with community participation activities and its impact in agricultural and rural development.

Objectives

- Describe the role and functions of community based organizations (CBOs)
- Explain community participation activities of different CBOs
- Discuss comparative scenario of community participation between Bangladesh and South East Asian countries

Learning outcomes

- Identify and explain the role of different community based organizations in Bangladesh for community development
- Explain community development approaches of GOs and NGOs
- Elaborate the role of the field level workers in community development
- Compare community development programmes between Bangladesh and South East Asian countries

Course content

Community Participation- The on-going community based leading organizations in Bangladesh and their role and functions: BAUEC, BRDB, LGED, Gucchhagram, RDA, BARD, BRAC, CARE Bangladesh, PROSHIKA etc. The class teacher will select two/three suitable organizations in each semester for study/observation.

The present community development approaches of the selected GOs and NGOs in Bangladesh and their comparative advantages and disadvantages.

The role and functions of the field level workers of the above selected community-based organizations.

The history of comparative community development programme in Bangladesh and other Southeast Asian Countries: India, Thailand, Malaysia, Vietnam and Japan

Teaching strategy

- Lecture
- Reading assignment
- Video clips

Assessment strategy

- Test
- Assignment
- Group presentation

Books recommended

Kumar, S. 2002. Methods for Community Participation: A Complete Guide for Practitioners. ITDG Pub. Co. Ltd.

Ledwith, M. 2005. Community Development: A Critical Approach. Bristol: Policy Press.

Lewis, D. and Kanji, N. 2009. Non-Governmental Organizations and Development. London and New York: Routledge.

Malki, M. 2006. 'Community Development Approaches: A Concept Note', in Hamyaran (ed.) Community Empowerment for Sustainable Development in Iran, pp. 50–9. Beirut, Lebanon: Iran NGO Resource Centre.

Course number : **AGEXT 4202**
Course title : **Community Participation-Practical (Elective)**
Number of credit : **2**
Total Marks : **100**

Rationale

This course is designed to make students familiar with community-based organizations

Objectives

To conceptualize the practical experiences about the management of community-based organizations in Bangladesh

Learning outcomes

- Get exposure from different community -based organizations

Course content

Each student will be assigned to write term paper/essays on at least two community based organizations - one from GOs and other from NGOs

Teaching strategy

- Visit
- Study tour
- Case study
- Group Presentation

Assessment strategy

- Test and
- Report submission
- Group Presentation

Books recommended

DAE (2017). Agricultural Extension Manual. Ministry of Agriculture. Government of the Peoples Republic of Bangladesh.

Henry Sanoff (2000).*Community Participation Methods in Design and Planning*, Lohn Wiley & Sons. Inc. New Work.

Department of Agricultural Chemistry

Course number	:	**ACHEM 1101**
Course title	:	**Agroanalytical, Physical and Organic Chemistry-Theory (Compulsory)**
Number of credits	:	**3**
Total marks:	:	**100**

Rationale

This course is designed to impart knowledge and skills on analytical, physical and organic chemistry.

Objectives

- Provide knowledge on analytical methods to apply in different fields of agriculture.
- Acquaint students with theoretical and applied knowledge on physical and organic chemistry.
- Explain the chemistry, extraction, isolation and purification technologies of natural products.

Learning outcomes

- Describe solubility products and solve electrochemical problems.
- Explain pH, EC, buffer solutions, units of concentration and standard solutions.
- List properties of solution and colloids, and solve relevant problems.
- Explain nature, formation and mechanisms of chemical bonding and chemical reactions in organic compounds.
- Illustrate stereochemistry, optical activity, racemic modification, and specific rotation.
- Explain aromaticity of heterocyclic and polynuclear organic compounds.
- Identify the sources and explain purification methods for natural products.

Course content

Electrochemistry: Electrolytes and non-electrolytes, electrolytic dissociation and conductance, ionic equilibrium, solubility product, principles of precipitation, common ion effect.

pH and buffer solution.

Chemical equilibrium: Law of mass action and its application in homogenous and heterogeneous reactions, Le-chateliar principle.

Properties of solution: Colligative properties, elevation of boiling point, depression of freezing point, osmosis and Raoult's law.

Colloids: Preparation, properties, types and application of colloids.

Analytical chemistry: Introduction to analytical chemistry, units of concentrations, preparation of standard solutions.

Volumetric analysis: Acid-base and redox titrations, indicators - selection and theories, errors in chemical analysis.

Chemical bonding: Bonding in organic compounds, polarity, formation and cleavage of covalent bonds.

Reaction mechanism: Electrophilic and nucleophilic additions and substitutions, Cannizzaro reactions, aldol and Parkin condensation.

Stereochemistry: Configuration and confirmation, optical and geometrical isomerism, cause of optical activity, racemic modification and specific rotation. Ring structure, mutarotation, epimer, anomer, inversion and conformation of organic compounds.

Chemistry of aromatic, heterocyclic, organometallic and polynuclear compounds: Sources, properties, chemical nature, reactions and applications.

Carboxylic acid and their derivatives: Properties, preparations, reactions and their applications.

Chemistry of natural products: Sources, classification, biosynthesis, isolation and purification of alkaloids, carotenoids and terpenoids.

Teaching strategy

- Lecture
- Video clip
- Discussion

Assessment strategy

- Short question
- MCQ
- Essay type question
- Assignment

Books recommended

Bahl, B. S.; Tuli, G. D. and Bahl, A. 2010. Essentials of Physical Chemistry. S. Chand & Company Ltd., New Delhi. India.

Bansal, R. K. 2016. A Textbook of Organic Chemistry. Revised 6thedn., New Age International (P) Ltd., New Delhi. India.

Christian G.D.; Dasgupta, P.K. and Schug, K.A. 2014. Analytical Chemistry 7th edn., John Wiley & Sons, Inc.

Morison, R. T. and Boyd, R. N. 2014. A Text Book of Organic Chemistry. 7thedn., Dorling Kindersley (India) Pvt. Ltd., New Delhi, India.

Skoog, D.A.; West, D.M.; Holler, F. J. and Crouch S.R. 2014. Fundamentals of Analytical Chemistry. 9thedn., Harcourt Asia Pvt. Ltd., Singapore.

Stanforth, S. 2006. Natural Product Chemistry at a Glance. Blackwell Publishers, USA.

Vollhardt, K.P.C. and Schore, N.E. 2014. Organic Chemistry: Structure and Function 7 thedn., W.H. Freeman and Company. New York.

Course number	**:**	**ACHEM 1102**
Course title	**:**	**Agroanalytical, Physical and Organic Chemistry-Practical (Compulsory)**
Number of credits	**:**	**2**
Total marks:	**:**	**100**

Rationale

This course covers the aspects of laboratory safety, agrochemical handling and analyzing different inorganic and organic compounds.

Objectives

- Acquaint the students with knowledge on different aspects of lab apparatus/glassware, chemicals and their safety.
- Develop skills on qualitative and quantitative chemical analyses of organic and inorganic compounds.

Learning outcomes

- Choose suitable chemicals and apparatus for analysis.
- Prepare buffer and standard solutions.
- Perform titrametric analysis.
- Identify organic compounds.
- Extract, purify and isolate natural products.

Course content

General instructions: Directions for the use of laboratory chemicals, filter papers and glassware with their safety measures.

Preparation of standard solution: Primary and secondary standard compounds and standard series, standardization of solution of secondary standard substances, preparation of buffer solutions.

Acid-base titration: Strong acid-strong base, strong acid-weak base and weak acid-strong base titrations

Qualitative analysis of organic compounds: Formic, acetic, oxalic, tartaric and citric acids; formaldehyde, acetaldehyde, acetone, glucose, fructose, urea and thiourea, determination of melting and boiling points of organic compounds.

Natural products: Extraction and purification of natural products.

Teaching strategy

- Lecture
- Demonstration
- Experiment

Assessment strategy

- Short question
- MCQ
- Experiment
- Assignment

Books recommended

Chopra, L. S. and Kanwar, J. S. 2012. Analytical Agricultural Chemistry. Kalyani Publishers, Ludhiana, New Delhi. India.

Christian G.D.; Dasgupta, P.K. and Schug, K.A. 2014. Analytical Chemistry. 7th edn., John Wiley & Sons, Inc.

Clarke.H.T. 2007. A Handbook of Organic Analysis: Qualitative and Quantitative, 4th edn., CBS Publishers & Distributors.

Mendham, J.; Denney, R.C.; Barnes, J.D.; Thomas, M. and Sivasankar, B. 2009. Vogel's Textbook of Quantitative Chemical Analysis. 6th edn., Pearson Education Pte. Ltd., New Delhi, India.

Furniss, B. S.; Hannaford, A. J.; Rogers, V.; Smith, P. W. G. and Tatchell, A. R. 1978. Vogel's Text Book of Practical Organic Chemistry. 4thedn. Longman Scientific & Technical, England.

Skoog, D.A.; West, D.M.; Holler, F. J. and Crouch S.R. 2014. Fundamentals of Analytical Chemistry. 9thedn., Harcourt Asia Pvt. Ltd., Singapore.

Course number	:	**ACHEM 2201**
Course title	:	**Agroindustrial and Nuclear Chemistry-Theory (Compulsory)**
Number of credits	:	**2**
Total marks:	:	**100**

Rationale

This course deals with the chemistry and technology of different agroindustrial crops and the application and safety of radioisotopes through nuclear techniques.

Objectives

- Acquaint the students with the theoretical and applied knowledge on manufacturing, processing, quality control, storage and use of different agroindustrial crops.
- Explain the chemistry, manufacturing technologies and quality of fertilizers.
- Provide basic knowledge on nuclear chemistry to apply radioisotopes in different fields of agriculture.
- Describe the suitability of water for different usage.

Learning outcomes

- Explain manufacturing, processing, quality control, storage and use of different industrial crops.
- Enumerate the chemistry, quality and compatibility of fertilizers.
- Describe the production technology of fertilizers.
- Explain nuclear reactions, properties, safety and absorption of radiations.
- Identify suitable radiation detection techniques and justify radioisotope applications in different fields of agricultural research.
- Categorize water based on quality parameters to recommend water for different usage.

Course content

Rubber: Tapping system; composition and processing of natural rubber; properties and synthesis of synthetic rubber

Sugar: Condition and quality of sugarcane, manufacture of plantation white sugar, industrial utilization of sugar mill by products

Tea: Manufacturing processes and change of chemical composition in tea leaves, aroma, tea infusion and liquoring quality of tea

Chemistry and technology of fertilizer: Choice and purification of feedstocks; manufacturing technology of urea, SSP, TSP, DAP and MOP; secondary and micronutrient fertilizers; mixed, compound, liquid and controlled release fertilizers; properties of fertilizers; quality control, specifications, compatibility and comparison of commonly used fertilizers.

Nuclear chemistry: Nuclear reactions and stability; properties and absorption of radionuclide radiations; radioactive decay and half-life, radiocarbon dating; radiation detection, radiation safety, selection of isotopes for radiotracer assay; radiotracer methodology - isotopic dilution and plant injection techniques; application of radioisotopes in soil, crop, plant protection, irrigated agriculture and irradiation studies.

Water chemistry: Sources of water, quality assessment and criteria for drinking, irrigation, poultry, livestock, aquaculture and agroindustrial usage of water, ionic toxicity and plant tolerance, water pollution and treatment.

Teaching strategy

- Lecture
- Video clip
- Field trip

Assessment strategy

- Short question
- MCQ
- Assignment

Books recommended

Ayers, R.S. and Westcot, D.W. 1985. Water Quality for Agriculture. FAO Irrigation and Drainage Paper 29 Rev. Rome, Italy.

Dhingra, K.C. 1984. Hand Book on Rubber and Rubber Goods Industries. Small Industry Research Institute, New Delhi.

Jain, N.K. (ed.). 1999. Global Advances in Tea Science. Aravali Books International Pvt. Ltd., New Delhi, India.

Lieser, K H. 2001. Nuclear and Radiochemistry: Fundamentals and Applications. 2nd Edition. WILEY-VCH Verlag GmbH, D-69469 Weinheim, Germany

Mathur, R.B.L. 1987. Hand Book of Cane Sugar Technology. Oxford and IBH Publishing Co. Calcutta, India.

UNIDO and IFDC (eds.) 1998. Fertilizer Manual. Kluwer Academic Publishers. Dordrecht, The Netherlands

Vose, P.B. 1980. Introduction to Nuclear Techniques in Agronomy and Plant Biology. Pergamon Press Ltd., Oxford, England.

Course number	:	**ACHEM 2202**
Course title	:	**Agroindustrial and Nuclear Chemistry-Practical (Compulsory)**
Number of credits	:	**2**
Total marks:	:	**100**

Rationale

This course covers the aspects of sophisticated analytical instruments and their calibration techniques to analyze fertilizers and water samples.

Objectives

- Calibration and operation of analytical and nuclear equipments.
- Develop skills on sampling and analyses of fertilizers to identify commonly used fertilizers and their adulterations.
- Categorize water on the basis of physical and chemical properties.
- Acquaint with radioisotopes applications in institutional installations.

Learning outcomes

- Operate and calibrate laboratory equipments.
- Collect and process water, plant and fertilizer samples.
- Analyze manures and fertilizers for quality control.
- Determine water quality parameters for different usage.
- Apply radioisotopes in agricultural research.

Course content

Operation and calibration of laboratory equipments: Analytical/electronic balance; pH meter; Conductivity meter; Colorimeter/Spectrophotometer; Flame photometer and Atomic absorption spectrophotometer.

Sampling: Principles and procedures for collection and preparation of water, plant and fertilizer samples.

Manure and fertilizer analysis: Moisture and nutrient contents in cow dung, FYM, poultry manure, compost, urea, SSP, TSP, DAP, MOP, gypsum, zinc sulphate, borax, copper sulphate and ferrous sulphate

Water analysis: Analysis of water for pH, EC, TDS and different ionic constituents including toxic metals like As, Cd, Cr, Pb & Hg.

Radio chemistry: Basic techniques of radiotracer assay in agriculture.

Teaching strategy

- Lecture
- Demonstration
- Experiment
- Field trip

Assessment strategy

- Short question
- MCQ
- Experiment
- Assignment

Books recommended

APHA (American Public Health Association). 2012. Standard Methods for the Examination of Water and Wastewater. 22nd edn., AWWA and WEF, Washington, USA.

Ayers, R.S. and Westcot, D.W. 1985. Water Quality for Agriculture. FAO Irrigation and Drainage Paper 29 Rev. Rome, Italy.

FRG. 2012. Fertilizer Recommendation Guide. Bangladesh Agricultural Research Council (BARC), Farmgate, Dhaka-1215. 274p.

Jones, U.S. 1979. Fertilizers and Soil Fertility. Reston Publishing Com., Reston, Virginia, USA.

Kalra, Y.P. 1998. Handbook of reference methods for plant analysis. CRC Press Taylor & Francis Group, Broken Sound Parkway, NW

Tandon, H.L.S. (ed.). 2013. 2nd edn., Methods of Analysis of Soils, Plants, Waters, Fertilizers and Organic Manures. Fertilizer Development and Consultation Organization, New Delhi, India.

UNIDO and IFDC (eds.) 1998. Fertilizer Manual. Kluwer Academic Publishers. Dordrecht, The Netherlands.

Course number	:	**ACHEM 3101**
Course title	:	**Plant Nutrition, Pesticide and Environmental Chemistry-Theory (Compulsory)**
Number of credits	:	**3**
Total marks:	:	**100**

Rationale

This course is intended to impart knowledge on chemistry and management of plant nutrients, pesticides and agrowastes for sustainable crop production, renewable energy generation and green environment.

Objectives

- Explain uptake mechanisms and utilization of plant nutrients
- Provide knowledge on chemistry and formulation of pesticides and their mode of action.
- Acquaint with instrumental analytical techniques and their applications.
- Provide concept on pollutants and foods adulterants, their impact on health and environment and their management.
- Deliver concept on sustainable bioenergy generation.

Learning outcomes

- Explain uptake and utilization of plant nutrients and analyze the budget of applied nutrients
- Identify and refer pesticide formulations and explain their chemistry and mode of action for efficient use
- Explain the quality control and regulations of pesticides
- State working principles of major analytical instruments and select suitable techniques for chemical analyses
- Describe the sources, transport, effects, fates and management of pollutants in the environment.
- Illustrate the ways of food adulteration; justify the quality control and safety regulations for food products
- Select the agrowastes for bioenergy generation and solve related problems.

Course content

Colloids and plant nutrition: Role of colloids in plant nutrition; phytochemistry and its application, classification, role and principal form of essential and beneficial nutrient elements; translocation of nutrients from soils to plant roots; nutrient uptake mechanisms; interactions of nutrient ions in soil-plant system and adsorption isotherms.

Pesticide formulations: Chemistry and utilization of auxiliary materials for insecticide, fungicide and herbicide formulations; Dust, wettable powder, granule, emulsifiable concentrates, fumigant, aerosol and microencapsulation.

Pesticide chemistry: Preparation, properties, mode of action and uses of commonly used pesticides: Natural organic compounds, organochlorinated hydrocarbons, organophosphorus, organocarbamate and synthetic pyrethroid insecticides, synthetic fungicides, herbicides and acaricides; Compatibility of pesticides with agrochemicals. Environmental fate of pesticides in soil, plant and aquatic systems; adverse effects of pesticides and their remediation; pesticide ordinance and rules.

Instrumental methods of analysis: Principle, instrumentation and application of colorimetry and spectrophotometry, flame emission and atomic absorption spectrophotometry, mass spectrometry, fluorimetry, differential thermal analysis (DTA) and chromatography.

Environmental chemistry: Concept of environmental compartments; toxicological chemistry of chemical substances; biochemical effects of contaminants; environmental fate of inorganic and organic contaminants; adverse effects of contaminants on soil, plant and aquatic ecosystems; hazardous wastes and its impact on the environment; remediation of the polluted environments; food adulteration and its management.

Bioenergy: Concept, scope and application of bioenergy; bioconversion process - biomass conversion to ethanol and methane; biogas generation and utilization of effluents; biodiesel production and its blend. Renewable energy.

Teaching strategy

- Lecture
- Video clip
- Group discussion

Assessment strategy

- MCQ
- Short questions
- Essay type questions
- Assignment

Books recommended

Fageria, N. K.; Baligar, V. C. and Jones, C. A. 2011. 3rd edn., Growth and Mineral Nutrition of Field Crops CRC Press, Taylor & Francis Group.

Manahan, S. E. 2010. Environmental Chemistry. 9th edn., CRC Press LLC, Boca Raton, Florida, USA.

Marschner, H. 2012. Mineral Nutrition of Higher Plants. 3rd edn., Academic Press. Harcourt Brace & Company, Publishers.

Ramulu, U. S. S. 1995. Chemistry of Insecticides and Fungicides. Oxford and IBH Pub. New Delhi India.

Skoog, D.A.; West, D.M.; Holler, F. J. and Crouch S.R. 2014. Fundamentals of Analytical Chemistry. 9thedn., Harcourt Asia Pvt. Ltd., Singapore.

Val Deublein, D. and Steinhauser, A. 2008. Biogas from Waste and Renewable Resources: An Introduction. WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim.

Yu, S. J. 2015. The Toxicology and Biochemistry of Insecticides. 2nd edn., CRC Press, Taylor & Francis Group.

Course number : **ACHEM 3102**
Course title : **Plant Nutrition, Pesticide and Environmental Chemistry-Practical (Compulsory)**
Number of credits : **2**
Total marks: : **100**

Rationale

This course covers the instrumental skills on plant nutrients and agrochemicals analyses, and bioenergy generation from agrowastes.

Objectives

- Develop instrumental analytical skills to determine plant nutrients, agrochemicals and their residues.
- Familiarize with sustainable bioenergy generation plant.
- Acquaint with on-site operational practices in pesticide formulation plants.

Learning outcomes

- Operate various analytical instruments.
- Collect and process plant, pesticides and waste samples for analyses.
- Analyze mineral elements and pesticide residues from different samples.
- Design/ sketch bioenergy generation plant.

Course content

Analytical techniques of titrimetry, colorimetry/ spectrophotometry, flame emission and atomic absorption spectrophotometry.

Preparation of plant extracts for the analysis of different nutrients.

Analysis of plant for essential nutrient elements. Field study of pesticide formulation techniques.

Analysis of pesticide residue by different chromatographic techniques.

Generation of bioenergy from different agrowastes.

Teaching strategy

- Lecture
- Experiment
- Field trip

Assessment strategy

- Short question
- MCQ
- Experiment
- Assignment

Books recommended

Chopra, L. S. and Kanwar, J. S. 2012. Analytical Agricultural Chemistry. Kalyani Publishers, Ludhiana, New Delhi. India.

Christian G.D.; Dasgupta, P.K. and Schug, K.A. 2014. Analytical Chemistry. 7th edn., John Wiley & Sons, Inc.

FRG. 2012. Fertilizer Recommendation Guide. Bangladesh Agricultural Research Council (BARC), Farmgate, Dhaka-1215. 274p.

Kalra, Y.P. 1998. Handbook of reference methods for plant analysis. CRC Press Taylor & Francis Group, Broken Sound Parkway, NW

Mendham, J.; Denney, R.C.; Barnes, J.D.; Thomas, M. and Sivasankar, B. 2009. Vogel's Textbook of Quantitative Chemical Analysis. 6th edn., Pearson Education Pte. Ltd., New Delhi, India.

Sparks, D. L. (ed.), 2009. Methods of Soil Analysis. Part 3. Chemical Methods- SSSA Book Series No. 5, Soil Science Society of America and American Society of Agronomy, Inc., Madison, USA.

Tandon, H.L.S. (ed.). 2013. 2nd edn., Methods of Analysis of Soils, Plants, Waters, Fertilizers and Organic Manures. Fertilizer Development and Consultation Organization, New Delhi, India.

Course number	:	**ACHEM 4101**
Course title	:	**Bioenergy - Principles and Practices-Theory (Elective)**
Number of credits	:	**2**
Total marks:	:	**100**

Rationale

This course is intended to impart knowledge on efficient management of biomass resources, bioremediation and utilization of different wastes for sustainable and ecofriendly energy generation**.**

Objectives

- Provide knowledge on scope and importance of bioenergy and bioremediation.
- Familiarize suitable biogas and biodiesel generation plants.
- Justify strategies for the generation of bioenergy from different biomass resources**.**

Learning outcomes

- Explain the scope and importance of bioenergy.
- Enlist and classify biomass resources.
- Explain and compare bioconversion processes.
- Compute energy economics of biomass.
- State and compare different sources of renewable energy.
- Describe bioremediation technologies and their applications**.**

Course content

Introduction to bioenergy: Concept, scope and importance of bioenergy; energy from biomass - past and present perspectives of bioenergy.

Biomass resources: Biomass wastes; energy crops and aquatic sources.

Energy profiles: Producer gas, biogas, biodiesel, hydrogen, ethanol, methanol, vegetable oil and solid fuels.

Bioconversion processes: Microbial conversion; thermal conversion; fuels and co-products. Biogas: Anaerobic digestion process, digester design, primary products and by-products of biogas; utilization of biogas and biogas effluents.

Role of wood in energy production: Prospect and retrospect; description of the process and requirements for agricultural applications. Energy, economics and environment: Energy analysis and economics of biomass; environmental and sociological issues.

Renewable resources of energy: Concept, scope and importance; comparative feasibility of renewable energy against bioenergy.

Bioremediation technology: Scope and importance of bioremediation; bioremediation treatment technologies; bioremediation organisms, bioavailability of compounds and biological process requirements.

Teaching strategy

- Lecture
- Discussion
- Video clips
- Field trip

Assessment strategy

- Essay/Short type question
- MCQ
- Assignment

Books recommended

Alexander, M. 1999. Biodegradation and Bioremediation. 2nd ed., Academic Press, California, USA.

Deublein, D. and Steinhauser, A. 2008. Biogas from Waste and Renewable Resources: An Introduction. WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim.

Hou, C.T. and Shaw, J.F. 2008. Biocatalysis and Bioenergy. John Wiley and Sons, Inc., Hoboken, New Jersey.

Manahan, S.E. 2010. Environmental Chemistry. 9th ed., CRC Press LLC, Boca Raton, Florida, USA.

Mital, K.M. 1997. Biogas System - Policies, Progress and Prospects. Taylor & Francis, New York, USA.

Olguin, E.J., Sanchez, G. and Hernandez, E. (eds.) 2000. Environmental Biotechnology and Cleaner Bioprocesses. Taylor & Francis Inc., London.

Stevens, C.V. and Verhe, R. 2004. Renewable Bioresources: Scope and Modification for Non-food Applications. John Wiley and Sons, UK.

Course number : ACHEM 4102
Course title : Bioenergy - Principles and Practices-Practical (Elective)
Number of credits : 2
Total marks: : 100

Rationale

This course provides practical knowledge on different waste analyses and management, and skills to design biofuel plant for renewable and ecofriendly energy generation.

Objectives

- Develop analytical skills for agrowastes.
- Apply and formulate techniques for bioenergy generation.
- Design suitable bioenergy generation plant.
- Acquaint with practical experience of on-field waste management practices for bioenergy generation.

Learning outcomes

- Collect and process different biomass for physico-chemical analyses.
- Construct and manage biogas plant.
- Analyze nutrients and heavy metals from different wastes and bioslurries.
- Demonstrate and apply the bioslurry as organic fertilizer.

Course content

Collection and preparation of different wastes.

Production of biogas from different agrowastes.

Field study of renewable energy (solar and bioenergy) from different agencies.

Analysis of cowdung and bioslurry.

Analysis of domestic, municipal and industrial wastes.

Application of bioslurry on field crops.

Teaching strategy

- Lecture
- Demonstration
- Experiment
- Field trip

Assessment strategy

- Short question
- MCQ
- Experiment
- Viva-voce
- Assignment

Books recommended

Gupta, I.C., Yaduvanshi, N.P.S. and Gupta, S.K. 2012. Standard Methods for Analysis of Soil Plant and Water. Scientific Publishers, Jodhpur, India.

Gupta, P.K. 2013. Soil, Plant, Water and Fertilizer Analysis. 2nd ed., Agrobios Jodhpur, India.

Singh, D., Chhonker, P.K. and Pandey, R.N. 1999. Soil Plant Water Analysis: A Methods Manual. Indian Agricultural Research Institure, New Delhi, India.

Sparks, D.L. (ed.). 2009. Methods of Soil Analysis. Part 3. Chemical Methods- SSSA Book Series No. 5, Soil Science Society of America and American Society of Agronomy, Inc., Madison, USA.

Tandon, H.L.S. (ed.). 2013. Methods of Analysis of Soils, Plants, Waters, Fertilizers and Organic Manures. Fertilizer Development and Consultation Organization, New Delhi, India.

Course number	:	**ACHEM 4201**
Course title	:	**Micronutrients in Agriculture-Theory (Elective)**
Number of credits	:	**2**
Total marks:	:	**100**

Rationale

This course imparts knowledge on sources, interactions, biochemical functions, metabolism and bioavailability of micronutrients in plants.

Objectives

- Describe sources, interactions, biochemical functions, metabolism and bioavailability of micronutrients
- Explain deficiencies and toxicities of micronutrients in crops
- Formulate fertilizer recommendation for overcoming micronutrient deficiencies

Learning outcomes

- Describe the geographical distribution and importance of micronutrients in Bangladesh agriculture
- State the functions, uptake mechanisms and interaction of micronutrients
- Explain the micronutrient deficiencies and disease prevalence
- Describe biotic and abiotic factors influencing deficiencies of micronutrients
- Recommend micronutrient fertilizers

Course content

Micronutrients in soils, plants and animals. Geographic patterns of trace element problems and distribution of problematic areas. Sorption mechanisms and reactions of individual micronutrients in soils.

Function and interactions of micronutrients in soils and plants. Critical limit of micronutrients in soils and plants.

Mechanisms of micronutrient uptake and translocation in plants.

Micronutrients and disease resistance and tolerance in plants.

Environmental and soil factors affecting micronutrient deficiencies and toxicities.

Micronutrient fertilizer technology. Fertilizer applications for correcting micronutrient deficiencies.

Teaching strategy

- Lecture
- Video clips
- Field visit

Assessment strategy

- Short question
- MCQ
- Assignment

Books recommended

Bennett, W. F. (ed.). 1994. Nutrient Deficiencies & Toxicities in Crop Plants. APS Press, Minnesota, USA.

Fageria, N. K.; Baligar, V. C. and Jones, C. A. 2011. 3rd edn., Growth and Mineral Nutrition of Field Crops CRC Press, Taylor & Francis Group.

Havlin, J. L.; Tisdale, S.L.; Tisdale, S. L. and Nelson, W. L. Beaton, J. D. 2013. Soil Fertility and Fertilizers, 8thedn., Prentice-Hall Inc., New Jersey, USA.

Kabata-Pendias, A. and Pendias, H. 1994. Trace Elements in Soils and Plants. CRC Press, Inc.

Marschner, H. 2012. Mineral Nutrition of Higher Plants. 3rd edn., Academic Press. Harcourt Brace & Company, Publishers.

Mortvedt, J. J.; Cox, F. R.; Shuman, L. M. and Welch, R. M. 1991. Micronutrients in Agriculture. 2ndedn., Soil Science Society of America Inc., Madison, Wisconsin, USA.

Sharma, C. P. 2006. Plant micronutrients : roles, responses, and amelioration of deficiencies. Science Publishers. Enfield, New Hampshire, USA.

Course number : **ACHEM 4202**
Course title : **Micronutrients in Agriculture-Practical (Elective)**
Number of credits : **2**
Total marks: : **100**

Rationale

This course focuses on analytical skills to diagnose deficiencies and toxicities of micronutrients.

Objectives

- Demonstrate diagnostic methods of analyzing micronutrients and interpreting the results
- Explain micronutrient deficiencies and toxicities in crops.
- Hands-on field management practices for micronutrient deficient crops.

Learning outcomes

- Perform collection and processing of samples for micronutrient analysis
- Extract and analyze different fractions of micronutrients
- Correlate soil test values of micronutrients with crop yield
- Design and recommend micronutrient management practices

Course content

Analysis of available and total micronutrients (Zn, Fe, Cu, Mn, B, Mo & Co) in soil and plant.

Analysis of micronutrient (Zn, Fe, Cu, Mn, B, Mo & Co) fractions in soil.

Assessment of the fate of applied micronutrients in soil.

Interpretation of soil test values with crop yield, micronutrient concentration and uptake of plant.

Field visit for survey and identification of micronutrient deficiency symptoms in field and horticultural crops.

Teaching strategy

- Lecture
- Demonstration
- Lab work
- Field visit

Assessment strategy

- Short question
- MCQ
- Experiment
- Assignment

Books recommended

Chopra, L. S. and Kanwar, J. S. 2012. Analytical Agricultural Chemistry. Kalyani Publishers, Ludhiana, New Delhi. India.
Christian G.D.; Dasgupta, P.K. and Schug, K.A. 2014. Analytical Chemistry. 7th edn., John Wiley & Sons, Inc.
Kalra, Y.P. 1998. Handbook of reference methods for plant analysis. CRC Press Taylor & Francis Group, Broken Sound Parkway, NW
Mendham, J.; Denney, R.C.; Barnes, J.D.; Thomas, M. and Sivasankar, B. 2009. Vogel's Textbook of Quantitative Chemical Analysis. 6th edn., Pearson Education Pte. Ltd., New Delhi, India.
Sparks, D. L. (ed.), 2009. Methods of Soil Analysis. Part 3. Chemical Methods- SSSA Book Series No. 5, Soil Science Society of America and American Society of Agronomy, Inc., Madison, USA.
Tandon, H.L.S. (ed.). 2013. 2nd edn., Methods of Analysis of Soils, Plants, Waters, Fertilizers and Organic Manures. Fertilizer Development and Consultation Organization, New Delhi, India.
Westerman, R. L. (ed.). 1990. Soil Testing and Plant Analysis, 3rd edn. Soil Science Society of America, Inc. Madison, Wisconsin, USA

Department of Biochemistry & Molecular Biology

Course number : **BMB1201**
Course title : **Chemistry of Biomolecules-Theory (Compulsory)**
Number of credits : **2**
Total marks : **100**

Rationale

The students need to have a proper knowledge on the physical and chemical aspects of biomolecules for understanding of physiological phenomena of plants, and their improvement.

Objectives

- Provide knowledge on sources and classification of biomolecules
- Explain properties and biochemical functions of biomolecules
- Construct structure of biomolecules

Learning outcomes

- Classify different biomolecules
- List the sources and biological function of different biomolecules
- Describe the physical and chemical properties of biomolecules
- Compare and contrast among various biomolecules
- Determine the structure of unknown biomolecules
- Construct Oligomeric-/polymeric forms of various biomolecules

Course content

Important organic constituents of plants and animals.

Carbohydrates: Occurrence, definition, classification, physical and chemical properties. Stereochemistry. Chemistry of monosaccharides and disaccharides. Composition and chemical linkages of polysaccharides with special reference to starch, cellulose and cell wall polysaccharides.

Proteins: Definition, classification, physical and chemical properties. Amino acid composition of peptides and proteins. Hydrolysis of proteins, Reactions of amino acids. Amino acids as ampholytes. Isoelectric point. Protein structure. Plant proteins - leaf, seed and cereal proteins.

Lipids: Definition, classification, chemical and physical properties. Fatty acid composition of fats. Chemical reactions of fatty acids. Edible oils and their characteristics fatty acid composition. characterization of fats, oils and waxes. Phospholipids with special reference to lecithin and cephalin. Phospholipids and glycolipids as membrane components.

Nucleic acids: Occurrence, composition, classification and structural features. Chemical and physical properties. Important functions of nucleic acids.

Enzymes: Definition, classification and chemical nature of enzymes. Concept of coenzymes and prosthetic groups. Mode of action of enzymes. Factors affecting enzymatic reaction. Enzyme specificity and inhibition with special reference to plant proteolytic enzymes. Concept of active center. Principle of enzyme assay.

Vitamins: Classification and biochemical functions.

Plant Hormones: Classification and biochemical functions.

Teaching strategy

- Lecture
- Group discussion
- Exercise
- Assignment
- Video clip

Assessment strategy

- Gap filling
- Multiple choice
- Short question
- Essay type question
- Assignment

Books recommended

Conn, E.E. and Stumpf, P. K. 1987. Outlines of Biochemistry. 5th edition. John Wiley and Sons, New York.

Devlin, T.M. 2002. Textbook of Biochemistry. 5th edition. John Wiley and Sons, Inc. USA.

Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H. and Martin, K.C. 2016. Molecular Cell Biology. 8th edition. W. H. freeman and company. New York.

Murray, R.K. 2002. Harper's Biochemistry. 25th edition. McGraw Hill. Printed in Singapore.

Nelson, D.L. and Michael, M.M. 2017. Lehninger Principles of Biochemistry. 7th edition. W. H. freeman and company. New York.

Stryer, L. 1995. Biochemistry. 4th edition. W. H. freeman and company. New York.

Voet, D and Voet, J.G. 1995. Biochemistry. 2nd edition, John Wiley and Sons, New York.

Course number : **BMB1202**
Course title : **Chemistry of Biomolecules-Practical (Compulsory)**
Number of credits : **2**
Total marks : **100**

Rationale

The students need to develop practical skills on identification and quantification of various biomolecules.

Objectives

- Prepare common laboratory solutions
- Identify and quantify various biomolecules
- Analyze enzymatic activity

Learning outcomes

- Prepare various types of solutions
- Determine the pH of a solution
- Identify unknown biomolecules in plant sample
- Test the solubility of fats in various solvents
- Assess the activity of enzymes on their substrates
- Quantify various biomolecules and nutrients in plant samples

Course content

Preparation of buffer solutions and determination of pH

Determination of pKa value

Colour tests of carbohydrates

Colour tests of proteins

Preparation of esters and solubility tests for fats

Preparation of starch and detection of amylase activity

Determination of vitamin C

Proximate analysis: Moisture, fat, protein, crude fibre and ash

Teaching strategy

- Lecture
- Demonstration
- Practice
- Assignment

Assessment strategy

- Quiz
- Experiment
- Assignment

Books recommended

Chaykin, S. 1970. Biochemistry Laboratory Techniques. Wiley Eastern Private Limited, New Delhi.

Davit, T. 1995. An introduction to practical Biochemistry. Tata McGraw-Hill Publishing Company Limited, New Delhi.

Litwack, G. 1960. Experimental Biochemistry. A Laboratory Manual. John Liley and Sons. Inc, New York.

Official Methods of Analysis. 1990. Association of Official Analytical Chemists (AOAC), Washington D.C.

Segel, I. H. 1968. Biochemical Calculations. How to Solve Mathematical Problem in General Biochemistry. John Wiley and Sons, Inc. New York.

Strong, F.M. 1965. Biochemistry Laboratory Manual. WM.C. Brown Company Publishers, USA.

Course Number : **BMB 2101**
Course title : **Metabolism and Human Nutrition –Theory (Compulsory)**
Number of credits : **3**
Total marks : **100**

Rationale

This course covers the mechanism of metabolic processes and their impact on human nutrition under normal and adverse condition.

Objectives

- Describe digestion, absorption and various metabolic processes of fuel molecules
- Provide knowledge on bioenergetics and food intake as per RDA
- Explain the interrelation among various metabolic processes
- Impart knowledge on various diseases/disorders due to nutrient deficiency & metabolic abnormalities

Learning outcomes

- Describe various metabolic processes (pathways/cycles).
- Compare and contrast between/among different metabolic processes
- Construct relationship among the various metabolic processes
- Interpret the biochemical function and deficiency symptoms of vitamin and minerals
- Calculate the energetic of different biomolecules in different stages
- Evaluate the food protein quality
- Calculate BMR, BMI, RQ and SDA according to age, sex and weight.

Course content

Bioenergetics: Free energy, entropy and enthalpy. Exergonic and endergonic reaction, ADP-ATP cycle. ATP as universal currency of energy in biological systems. Anabolism and catabolism.

Digestion and absorption: Food in human

Carbohydrate Metabolism: Glycolysis and alcoholic fermentation. Krebs cycle. Electron transport chain. Shuttle systems. Pentose phosphate pathway. Gluconeogenesis, Biosynthesis of sucrose and starch.

Nucleic acid metabolism: Replication and transcription of genetic code.

Protein metabolism: Transamination, deamination, decarboxylation, deamidation. Assimilation of ammonia in plants. Nitrogen cycle. Urea cycle. Protein synthesis – translation of genetic message.

Fat Metabolism: Beta, alpha and omega oxidation of fatty acids. Glyoxalate Pathway. Fatty acid biosynthesis.

Vitamins and minerals: Occurrence, biochemical functions and deficiency symptoms, RDA

Food protein quality evaluation: Biological value, PER, NPU etc.

Nutrient contents and availability: Basic food groups; Cereals, legumes, oil seeds, fruits, vegetables etc. Antinutritional factors, Dietary fibre.

Energy: Requirement according to age, sex and weight. Basal metabolic rate, respiratory quotient, balanced diet.

Nutrition and agriculture: National nutritional policy. Crop diversification in relation to human nutrition.

Teaching strategy

- Lecture
- Group discussion
- Video clip

Assessment strategy

- MCQ
- Short answer
- Essay type question
- Assignment

Books recommended

Conn, E.E. and Stumpf, P. K. 1987. Outlines of Biochemistry. 5th edition. John Wiley and Sons, New York.

Devlin, T.M. 2002. Textbook of Biochemistry. 5th edition. John Wiley and Sons, Inc. USA.

Nelson, D.L. and Michael, M.M. 2017. Lehninger Principles of Biochemistry. 7th edition. W. H. freeman and company. New York.

Stryer, L. 1995. Biochemistry. 4th edition. W. H. freeman and company. New York.

Swaminathan, M. 1977. Hand Book of Food and Nutrition. Ganesh and Company, Madras, India.

Voet, D and Voet, J.G. 1995. Biochemistry. 2nd edition, John Wiley and Sons, New York.

Walker, F.A. 1990. Applied Human Nutrition. Ellis Horwood Limited, West Sussex, England.

Course Number : **BMB 2102**
Course title : **Metabolism and Human Nutrition-Practical (Compulsory)**
Number of credits : **2**
Total marks : **100**

Rationale

This course covers methods and techniques to facilitate acquiring skills for carrying out various biochemical analyses.

Objectives

- Demonstrate various methods and techniques used for different biochemical analyses.
- Explain the mechanism of reactions involved in different steps in the procedure of various analyses.
- Explain separation, extraction, isolation and purification of compounds from various samples.

Learning outcomes

- Describe the methods and techniques used for various biochemical analyses
- Determine the pI value of ampholytes
- Determine saponification number, acid- and iodine value of fat/oil samples
- Extract and estimate plant pigments, protein, glucose and DNA from different plant and animal samples
- Separate amino acids from various plant samples

Course content

Determination of isoelectric pH

Biuret method of protein estimation

Fehling's and Folin-Wu methods of glucose estimation.

Determination of saponification value, iodine value and acid value of fats.

Extraction and estimation of DNA

Separation of amino acids by paper chromatography.

Separation of sugar by TLC

Extraction of albumin and globulin from plant sample

Extraction and estimation of plant pigments.

Assay of glucose oxidase.

Teaching strategy

- Lecture
- Experiment
- Group discussion

Assessment strategy

- MCQ
- Short questions
- Essay type question
- Experiment
- Assignment

Books recommended

Chaykin, S. 1970. Biochemistry Laboratory Techniques. Wiley Eastern Private Limited, New Delhi.

Davit, T. 1995. An introduction to practical Biochemistry. Tata McGraw-Hill Publishing Company Limited, New Delhi.

Litwack, G. 1960. Experimental Biochemistry. A Laboratory Manual. John Liley and Sons. Inc, New York.

Official Methods of Analysis. 1990. Association of Official Analytical Chemists (AOAC), Washington D.C.

Segel, I. H. 1968. Biochemical Calculations. How to Solve Mathematical Problem in General Biochemistry. John Wiley and Sons, Inc. New York.

Strong, F.M. 1965. Biochemistry Laboratory Manual. WM.C. Brown Company Publishers, USA.

Course Number	:	**BMB 4101**
Course Title	:	**Fundamentals of Molecular Biochemistry and Biotechnology-Theory (Elective)**
Number of credits	:	**2**
Total Marks	:	**100**

Rationale

This course provides knowledge on genetic materials and their manipulation for synthesizing new enzymes and proteins.

Objectives

- Illustrate biochemical aspects of genetic materials and their replication and transcription
- Explain protein biosynthesis and regulation
- Provide knowledge on enzyme isolation, purification, kinetics, inhibition and immobilization
- Explain structure and function of immunoglobulins
- Discuss types and functions of restriction enzymes
- Describe the procedure of gene manipulation and transformation

Learning outcomes

- Explain the findings of experiments elucidating DNA/RNA as genetic materials
- Describe different processes of central dogma of molecular biology
- Explain the mechanism of enzyme isolation, purification and characterization
- Analyze enzyme kinetics related mathematical problems
- Describe the procedure for gene constructing, sequencing and transformation

Course content

Nucleic acid as genetic material. DNA replication and transcription.

Protein biosynthesis and regulation, Genetic code.

Biochemistry of viruses.

Immunoglobulins.

Enzyme isolation, purification, mechanism of action, kinetics, regulation and immobilization.

Regulation of carbohydrate and lipid and their accumulation in storage tissue of plant.

Recombinant DNA and concept of biotechnology.

Teaching strategy

- Lecture
- Group discussion
- Video clips

Assessment strategy

- MCQ
- Short answer
- Essay type question
- Assignment

Books recommended

Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H. and Martin, K.C. 2016. Molecular Cell Biology. 8th edition. W. H. freeman and company. New York.

Nelson, D.L. and Michael, M.M. 2017. Lehninger Principles of Biochemistry. 7th edition. W. H. freeman and company. New York.

Voet, D and Voet, J.G. 1995. Biochemistry. 2nd edition, John Wiley and Sons, New York.

Names, D. and Watson, W.A. 1987. Molecular Biology of Gene. 3rd Edition. Bengamin, Inc.

Elliot, W.H. and Elliot, D.C. 1997. Biochemistry and Molecular Biology, Oxford University Press.

Brown, T.A. 2002. Molecular Cloning: DNA Analysis. 4th Edition.

Devlin, T.M. 2002. Textbook of Biochemistry. 5th edition. John Wiley and Sons, Inc. USA.

Course Number : **BMB 4102**
Course Title : **Fundamentals of Molecular Biochemistry and Biotechnology-Practical (Elective)**
Number of credits : **2**
Total Marks : **100**

Rationale

This course covers biochemical methods and techniques for conducting experiments on enzyme kinetics and immobilization, gene manipulation and transformation.

Objectives

- Demonstrate experiments on enzyme kinetics and inhibition
- Describe enzyme immobilization techniques
- Illustrate biochemical techniques for gene manipulation and transformation

Learning outcomes

- Conduct experiments on enzyme kinetics and inhibition
- Analyze data on enzyme kinetics and inhibition
- Explain the mechanism of enzyme immobilization
- Perform various techniques for gene manipulation and transformation

Course content

Determination of Km and Vmax
Effect of inhibitors on Km and Vmax
Enzyme immobilization
Gene manipulation and transformation
Electrophoresis
Chromatography with special reference to HPLC
Autoradiography
Field visit for gathering knowledge on on-going biotechnological approaches at research institutes

Teaching strategy

- Lecture
- Group discussion
- Video clips
- Field visit

Assessment strategy

- MCQ
- Short answer
- Essay type question
- Assignment

Books recommended

Brown, T.A. 2002. Molecular cloning: DNA Analysis. 4th Edition.
Cooper, T.G. 1977. The Tools of Biochemistry. John Willey and sons, Inc. New York.
Davit, T. 1995. An introduction to practical Biochemistry. Tata McGraw-Hill Publishing Company Limited, New Delhi.
Oliver, R.W.A. 1991. HPLC of macromolecules a practical approach. IRL press. Walton Street Oxford.
Strong, F.M. 1965. Biochemistry Laboratory Manual. WM.C. Brown Company Publishers, USA.
Wilson, K. and Walker, J. Practical Biochemistry (Principles and Technique). 4th Edition. Cambridge University Press, U.K.
Woodward, J. 1985. Immobilized cells and enzymes a practical approach. IRL press. Oxford, Washington DC.

Department of Languages

Course Number	:	**LAN 1001**
Course Title	:	**English Language-Theory (Optional)**
Number of Credits	:	**2**
Total Marks	:	**100**

Rationale

This course focuses on developing students' English communication skills of reading, writing, listening & speaking.

Objectives

- Provide knowledge of vocabulary and their usage
- Describe different reading and writing techniques
- Demonstrate learner's speaking fluency and accuracy in both written and oral presentations
- Facilitate students to prepare a formal cover letter and CV

Learning outcomes

- Apply multifarious grammatical rules and their usage
- Describe mechanics of writing and their applications
- Perform better oral presentation
- Prepare a standard professional job application and CV

Course content

Grammar: Sentence making according to tense, Question making, Subject-verb agreement rules, use of capitalization & punctuation, application of articles & prepositions, transformation of sentences (voice change; simple, complex & compound; assertive, interrogative, imperative, optative & exclamatory; positive, comparative & superlative)

Reading Tasks: Skimming & scanning exercises**,** reading comprehension passages and other texts (Wh-Questions, antonyms & synonyms, sentence making, fill-in-the blanks, summarizing, column matching)

Writing Exercises: Paragraph writing (Types of paragraph & their examples; writing topic, supporting & concluding sentences; organizing a paragraph with cohesive devices), summary/abstract & précis writing, letter writing (Job application, application for scholarship, other formal letters), email writing, preparing CV/Resume

Speaking Activities: Introducing oneself and others, making dialogues, delivering presentations

Teaching strategy

- Lecture
- Demonstrations
- Simulation & role play
- Video clips

Assessment strategy

- MCQ
- Short and essay type questions
- Assignment

Books recommended

Speaking Naturally (Audio CD) Communication Skills in American English by Bruce Tillitt and Mary Newton Bruder, 2005. CUP

Speaking Effectively - Developing Speaking Skills For Business English, Comfort Rogerson Stott & Utley, 1994 CUP

Accelerator (An Effective English Language Workbook), by Karim and Arifeen, 2016, Madhorse, Shahbag, Dhaka.

High School English Grammar and Composition, by Wren and Martin. 1980. S. Chand & Company, India.

A communicative Grammar in English, by Leech, G. and Svartvik, J. 1995. 2nd edition, Longman, London and NY.

Guide to Patterns and Usage in English, by Hornby A. S. 1998. 2nd edition, Oxford University Press, Delhi.

Writing Skills Handbook, by Wiener, B. 1988, 4th edition, Houghton Miffin Company, Boston and New York, USA.

Department of Agroforesty

Course number	:	**AGROF 3101**
Course title	:	**Principles of Agroforestry-Theory (Compulsory)**
Number of credits	:	**3**
Total Marks	:	**100**

Rationale

This course covers the areas of agroforestry technologies for sustainable farm production, combating the adverse climatic situations and conserving natural resources.

Objectives

- Acquaint students with the concepts, components and attributes of agroforestry.
- Distinguish conventional forestry, social forestry and agroforestry.
- Understand the integrated production systems with multiple components.
- Realize the significant role of trees towards soil and water conservation.
- Analyze cost-benefit and economic aspects of different agroforestry systems.
- Develop skills to design appropriate agroforestry model for rural development and nature conservation.

Learning outcomes

- Explain agroforestry, forestry and social forestry with their characteristics, benefits and attributes.
- Categorize agroforestry practices; suggest appropriate agroforestry practices for different land types with suitable MPTS.
- Demonstrate tree management techniques
- Determine tree-crop interaction effect and Land Equivalent Ratio (LER)
- Design agroforestry practices for erosion control and reclaiming degraded soil
- Analyze marketing channel and cost-benefit of agroforest products

Course content

Introduction: Concept, scope and benefits of agroforestry, the present status of forests resources in Bangladesh; possible improvement of present land use system through sustainable agroforestry practices.

Classification of Agroforestry System: Components and structures of agroforestry and social forestry systems, their classification and interlinkages with other farming systems.

Agroforestry species and their compatibility: Woody (trees and shrubs) and non-woody (annual crops) species suitable for agroforestry systems, characteristics of agroforestry species, species compatibility and adaptability in different agro-ecological zones with special reference to salinity, drought, marshy and degraded lands.

Agroforestry management techniques: Various regeneration systems and nursery management, plantation and replanting systems, development of wastelands and establishment of trees through agroforestry systems, management of trees and other components.

Tree-crop interaction, soil fertility and productivity in agroforestry: concepts and types of tree-crop interaction, resource sharing and minimizing competition for maximum production and economic

return; soil and water conservation, land reclamation and byproduct processing, utilization and nutrient recycling in agroforestry.

Agroforestry Production Techniques: Introduction to agrisilvicultural, silvopastoral, agrosilvopastoral and multi-storied tree production systems, hill cultivation-SALT practice and its different models.

Harvesting, processing, marketing, use of agroforestry products and economics of agroforestry **Systems:** Regular harvesting methods of fuel, fodder, timber and crops; processing and preservation of agroforestry products; marketing systems and remodeling of short-term component combinations based on market demands, economic analysis of agroforestry systems using PRA techniques.

Teaching strategy

- Lecture
- Video clip
- Assignment
- Field visit

Assessment strategy

- Short question
- MCQ
- Essay
- Project

Books recommended

Bandyopadhyay, A.K. 1997. A textbook of Agroforestry with Applications. Vikas Publishing House Pvt. Ltd, New Delhi.

Dwivedi, A.P. 1992. Agroforestry- Principles and Practices. Oxford and IBH Pub. Co., New Delhi.

Jha, L.K. 1995. Advances in Agroforestry. APH Publishing Corporation, New Delhi.

Nair, P.K.R. 1993. An Introduction to Agroforestry. ICRAF, Nairobi.

Haque, M.A. (ed.) 1996. Agroforestry in Bangladesh. VFFP, BAU, Mymensingh and SDC, Dhaka.

Ong, C.K. and P.A. Huxley. 1999. Tree-crop Interactions: A Physiological Approach. CABI Publishing.

Young, A. 2000. Agroforestry for Soil Management. 2nd Edition, CABI Publishing.

Course number	:	**AGROF 3102**
Course title	:	**Principles of Agroforestry-Practical (Compulsory)**
Number of credits	:	**2**
Total Marks		**100**

Rationale

The course is designed to cover the aspects of agroforestry components, land-use systems and characterize socioeconomic conditions related to sustainable agroforestry models.

Objectives

- Identify and describe common Multipurpose Trees and Shrubs (MPTS) used in Agroforestry in the tropics and subtropics.
- Demonstrate above and below ground tree-crop interactions.
- Design an ideal agroforestry nursery and seedlings/saplings growing techniques.
- Determine and analyze the growth and biomass yield of trees.
- Assess and interpret land use problems and socioeconomic conditions when designing different agroforestry practices.

Learning outcomes

- Identify multipurpose trees and shrubs (MPTS) in different categories, their diversified uses and mode of propagation.
- Describe the possible tree-crop interactions and their effect measurement in integrated farming system
- Design and calculate the required material for an ideal forest nursery to raise tree seedlings/saplings.
- Describe tree management techniques for maximizing the farm productivity.
- Determine tree growth and calculate its tentative timber volume and price.
- Develop agroforestry model for the different land category.
- Categorize conventional forestry, agroforestry and social forestry activities

Course content

Identification of MPTs and their plant parts.

Demonstration of tree crop interactions and their combined productivity.

Preparation of nursery for raising saplings of different trees.

Plantation under different systems shoots and root management of trees and shrubs under agroforestry systems.

Study of root spread and root mass of trees in crop fields.

Determination of growth and biomass yields of trees and other components.

D & D planning, data collection and economic analysis of agroforestry systems.

Field visit Madhupur Sal forest area to observe agroforestry, social forestry and forestry activities and preparation of reports individually.

Teaching strategy

- Lecture
- Field visit
- Demonstration
- Video clip

Assessment strategy

- Identification
- Observation
- MCQ
- Assignment
- Experiment

Books recommended

Chundawat, B.S. and S.K. Gautam.1993. Textbook of Agroforestry. Oxford and IBH Pub. Co., New Delhi.

Dwivedi, A.P. 1992. Agroforestry- Principles and Practices. Oxford and IBH Pub. Co., New Delhi.

Jha, L.K. 1995. Advances in Agroforestry. APH Publishing Corporation, New Delhi.

Nair, P.K.R. 1993. An Introduction to Agroforestry. ICRAF, Nairobi.

Huxley, P.A. 1999. Tropical Agroforestry. Blackwell Sciences.

Ong, C.K. and P.A. Huxley. 1999. Tree-crop Interactions: A Physiological Approach. CABI Publishing.

Young, A. 2000. Agroforestry for Soil Management. 2nd Edition, CABI Publishing.

Department of Biotechnology

Course Number : **BTECH 1201**
Course Title : **Basic Biotechnology-Theory (Elective)**
Number of credits : **2**
Total Marks : **100**

Rationale

This course aims to equip the students with elementary knowledge about different aspects of biotechnology.

Objectives

- Provide basic knowledge on biotechnology approaches
- Explain different cell and tissue culture techniques
- Provide basic knowledge on recombinant DNA Technology

Learning outcomes

- Describe basics of biotechnology
- Explain rDNA technology
- Apply biotechnological knowledge in practice

Course content

Introduction: Concept, importance, scope, limitations and branches of biotechnology.

Basic requirements: Media composition, aseptic manipulation and *in vitro* microenvironment.

Cells: Composition, cellular classification, cell cycle

Cell and Tissue Culture Techniques:

Nodal culture, meristem culture and embryo culture.

Protoplast isolation, culture, and somatic hybridization.

Haploid production through anther, pollen, ovary and ovule culture.

In vitro somaclonal and gametoclonal variations, ploypoidization.

Plant regeneration from callus and cell suspension cultures through somatic embryogenesis.

Animal and fish cell technology, embryo transfer technology (ETT), multiple ovulation embryo transfer (MOET).

In vitro production of secondary metabolites.

DNA Structure: Modern concept of gene, Watson and Crick model of DNA.

Genetic Engineering: Vectors, restriction endonuclease, ligase, cDNA. Methods of genetic engineering. Promoter, marker and reporter genes.

Teaching strategy

- Lecture
- Assignment
- Demonstration
- Video clip
- Discussion

Assessment strategy

- MCQ
- Short and essay type questions
- Assignment

Books recommended

Alcamo, I. E. 2004. Schaum's Outlines: Microbilogy. The McGraw-Hill Companies, Inc., New York.

Brown, T. A. 1998. Recombinant DNA. Academic Press, London.

Elrod, S. and W. Stanasfield. 2003. Schaum's Outlines: Genetics. 4th Edition. Tata McGraw-Hill Publishing Comp., Germany.

Freifelder, D. 2004. Molecular Bilogy. 2nd Edition. Jones and Bartlett Pub., Inc., USA.

Primrose, S. B., R. M. Twyman and R. W. Old. 2003. Principles of Gene Manipulation. 6th Edition. Blackwell Pub. Com., Germany.

Purohit, S. S, and S. K. Mathur. 1996. Biotechnology. Agro's Botanical Pub., India.

Razdan, M. K. 2003. An Introduction to Plant Tissue Culture. Oxford & IBH Pub. Co., Pvt. Ltd., New Delhi.

Course Number : **BTECH 1202**
Course Title : **Basic Biotechnology-Practical (Elective)**
Number of credits : **2**
Total Marks : **100**

Rationale

The aim of this course is to provide hands-on practice on different primary aspects of biotechnology.

Objectives

- Provide basic knowledge on biotechnology approaches
- Explain different cell and tissue culture techniques for crop improvement
- Acquint the students with basic understanding of recombinant DNA technology

Learning outcomes

- Lay out a biotechnology laboratory
- Prepare media, buffers, explants for tissue culture
- Regenerate plants using different *in vitro* regeneration techniques
- Extract DNA from different organisms
- Separate DNA, RNA and protein using gel electrophoresis
- Construct recombinant DNA

Course content

Biotechnology Laboratory design and requirements.

Media and buffer preparation, aseptic manipulation, explants preparation.

Node, meristem, embryo, pollen, anther, ovule, protoplast, cell and callus culture.

Isolation of genomic DNA from plant, fish and animal tissues; isolation of plasmid DNA.

DNA, RNA and protein electrophoreses.

Digestion, ligation, competent cell preparation, transformation in *Escherichia coli.*

Teaching strategy

- Lecture
- Assignment
- Experiment
- Video clip

Assessment strategy

- MCQ
- Short and essay type questions
- Experiment
- Assignment

Books recommended

Brown, T. A. 2002. Gene Cloning and DNA Analysis. 4th Edition. Blackwell Pub., London.

Glover, D. M. and B. D. Hames. 1995. DNA Cloning-1 Core Techniques: A Practical Approach. Oxford University Press, UK.

Sambrook, J., E. F. Fritsch and T. Manniatis. 1999. Molecular Cloning. Vol. 1, 2, 3. Cold Spring Harbor Press, USA.

Gamborg. O. L. and G. S. Phillips. 1995. Plant Cell Tissue and Organ Culture. Fundamental Methods, Narosa Pub. House, New Delhi.

Jane, K. S. and H. Alexander. 1982. Genetics engineering. Principles and methods Plenum Press, New York.

Raymond, L. R. and C. T. Robert. 1983. Recombinant DNA Techniques. An Introduction. The Benjamin Cumming Pub., Co., London

Course Number : **BTECH 4001**
Course Title : **Genetic Engineering and Biotechnology-Theory (Elective)**
Number of credits : **2**
Total Marks : **100**

Rationale

This course covers advanced knowledge about different aspects of modern biotechnology and genetic engineering.

Objectives:

- Provide advanced knowledge on genetic engineering approaches
- Explain different molecular techniques commonly used in Recombinant DNA Technology
- Provide basic knowledge on Genetically Modified Organisms and GM Crops
- Discuss biosafety issues and ethics of modern biotechnology and genetic engineering

Learning outcomes

- Describe different tools and techniques of genetic engineering
- Identify, analyze and validate transgenes in GMOs using different molecular techniques
- Explain gene expression and regulation
- Apply genetic engineering technology in different branches of agriculture
- Evaluate biosafety issues of GMOs.
- Retrieve and analyze genome sequencing data

Course content

Introduction: Concept, scope and importance of Genetic Engineering.

Gene Manipulation: Recombinant DNA technology, vectors, methods for gene delivery, selection of recombinants, site specific recombination/mutagenesis.

Molecular Techniques: Nucleic acid and protein purification, Electrophoresis, PCR, Southern, Northern and Western blotting; DNA sequencing, cDNA library.

Gene Expression: Regulation of transcription in prokaryotes and eukaryotes, promoter, terminator, splicing and processing of RNAs, translation, Operon concept.

Application of Genetic Engineering:

Plants: Pest resistance, herbicide tolerance, resistance to fungi, bacteria and virus. Oxidative, salt, drought and submergence tolerance.

Nutritional quality improvement: Provitamin A, iron, protein etc. Genetic manipulation for flower pigmentation, nitrogen fixation, photosynthesis, male sterility, fruit ripening, senescence tolerance. Edible vaccines in food products.

Fish and Animals: Production of transgenic animal and fish; feed quality improvement; dairy products and milk quality, recombinant protein

Medicine and Industry: Commercial synthesis of hormones, vaccines, gene therapy, disease diagnosis, monoclonal antibodies, biomining, biogas, bioengineering. genome mapping, DNA fingerprinting, forensic medicine; enzymology, immunotechnology.

Biosafety and GMO: Biosafety and environmental issues. Biosafety guidelines & regulations. Ethics and issues regarding GM organisms. Religious and social acceptance of GMOs.

Bioinformatics: Model for Sequence related information, usage of IT in biotechnology, internet browsing for retrieval and dissemination of biological information.

Teaching strategy

- Lecture
- Video clip
- Discussion

Assessment strategy

- MCQ
- Short and essay type questions
- Assignment

Books recommended

Baxevanis, A. D. and B. F. F. Ouellette. 2002. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. 2nd Edition. Gopsons Papers Ltd., India.

Primrose, S. B., R. M. Twyman and R. W. Old. 2003. Principles of Gene Manipulation. 6th Edition. Blackwell Pub. Com., Germany.

Traynor, P. L., R. J. Frederick and M. Koch. 2002. Biosafety and Risk Assessment in Agricultural Biotech.

Watson, J. D., T. A. Baker, S. P. Bell, A. Gann, M. Levine, R. Losick. 2004. Molecular Biology of the Gene. 5th Edition. Pearson Education Pte. Ltd., New Dilhi, India.

Westhead, D. R., J. H. Parish and R. M. Twyman. 2003. Instant Notes: Bioinformatics. 1st Edition. Bios. Scientific Pub. Ltd., Oxford, UK.

Winnacker, E. L. 2003. From Genes to Clones: Introduction to Gene Technology. Panima Publishing Corporation, New Delhi.

Course Number : **BTECH 4002**
Course Title : **Genetic Engineering and Biotechnology-Practical (Elective)**
Number of credits : **2**
Total Marks : **100**

Rationale

Agriculture graduates wishing to be employed in the field of agriculture will need to have thorough understanding about biotechnology for its improvement. The aim of this course is to provide hands on knowledge on different advanced aspects of biotechnology.

Objectives

- Provide advanced knowledge on genetic engineering approaches
- Teach different molecular techniques commonly used in Recombinant DNA Technology
- Provide basic knowledge on GMO
- Teach about long time preservation of plant, animal and microbial cell

Learning outcomes

- Manipulate gene and develop GM plants
- *In vitro* amplification of DNAs
- Apply molecular markers in estimation of genetic variation in plants
- Detect specific genes in GMO
- Describe labeling DNAs with radioisotopes and techniques of chromatography
- Preserve plant or animal samples for long time
- conserve biodiversity

Course content

Agrobacterium-mediated transformation techniques; co-cultivation of explants.

Polymerase Chain Reaction (PCR), Restriction Fragment Length Polymorphism (RFLP), Amplified Fragment Length Polymorphism (AFLP), Randomly Amplified Polymorphic DNA (RAPD); Southern, Northern and Western blotting; bioassay tests.

Radioisotopes, their uses and monitoring concept, counting efficiency; autoradiography.

Applications and types of chromatography.

Applications of UV and visible spectrophotometry

Cryopreservation and conservation of seed, plant sample, semen, embryo, revival of frozen germplasm.

Teaching strategy

- Lecture
- Demonstration
- Assignment
- video clip

Assessment strategy

- True/False
- Multiple Choice Questions
- Short and essay type questions
- discussion
- Report writing
- Presentation
- Viva-voce

Books recommended

Ansubel, F. M., R. Brent, R. E. Kingston, D. D. Moore, J. A. Sidman, J. A. Smith and K. Struhl. 1993. Current Protocols in Molecular Biology. Wiley Pub., UK.

Baxevanis, A. D. and B. F. F. Ouellette. 2002. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. 2nd Edition. Gopsons Papers Ltd., India.

Brown, T. A. 2002. Gene Cloning and DNA Analysis. 4th Edition. Blackwell Pub., London.

Glover, D. M. and B. D. Hames. 1995. DNA Cloning-1 Core Techniques: A Practical Approach. Oxford University Press, UK.

Jane, K. S. and H. Alexander. 1982. Genetics engineering. Principles and methods Plenum Press, New York.

Kjellssion, G., V. Simonsen, and K. Ammann. 1997. Methods for Risk Assessment of Transgenic Plants. Birkhauser Verlag, Germany.

Raymond, L. R. and C. T. Robert. 1983. Recombinant DNA Techniques. An introduction. The Benjamin Cumming Publishing Co., London.

Robert, J. 1987. Tissue Culture of Selected Tropical Fruit Plants; a handbook on the application of tissue culture of plant propagation. FAO, Rome.

Sambrook, J., E.F. Fritsch and T. Manniatis. 1999. Molecular Cloning. Cold Spring Harbor Press, USA.

Singh, B. P., U. Srivastava. 2004. Plant Genetic Resources in Indian Perspective: Theory and Practices. Directorate of Information and Publications of Agriculture. Indian Council of Agricultural Research, New Delhi.

Slater, R.J. 1990. Radioisotopes in Biology- A Practical Approach. Oxford University Press, UK.

Department of Environmental Science

Course number : **ENVSC 1201**
Course title : **Introductory Environmental Science-Theory (Elective)**
Number of credits : **2**
Total marks :**100**

Rationale

This course provides students with an understanding of the interactions between environmental components, environmental problems and their associated solutions

Objectives

- Describe environmental components and their interactions, terrestrial, aquatic and animal ecosystems
- Understanding of distribution of flora and fauna, mechanism of solar system
- Explain greenhouse effects, climate change and environmental sustainability
- Analyze environmental issues and human impact on environment

Learning outcomes

- Describe the influence of matter and energy on environment
- Categorize solar system, flora and fauna
- Explain the mechanisms of climate change and predict its consequences
- List the components and factors affecting terrestrial, aquatic and animal ecosystems
- Identify and analyze environmental issues and their effective management

Course content

Introduction: Concept and historical development of the subject of Environmental Science. Environment, components and their relationship, inter-related scientific principles: matter, energy and environment, interaction between environments and organisms. Environmental policy, law and planning.

Geography: Introduction, location of a place on the earth's surface: Latitude, longitude. Solar system, the sun-earth geometry. Distribution of major flora and fauna in different geographical positions.

Climatology: Introduction to climatology and micrometeorology, global climate change and its consequences, Global warming; Concept, local and global emission, impact on various habitats.

Terrestrial environment: Components of plain, hill, homestead and farm environment and agro-ecosystem, effects of agriculture on the environment, crop-waste management. Human population as an environmental problem, impact of human activities on the degradation of terrestrial environment.

Aquatic environment: Fresh water, coastal and marine environments and importance of their maintenance. Impact of agricultural and industrial activities on water quality, aquatic flora and fauna.

Animal ecology and environment: Effect of climate on adaptation and acclimatization of animals. Environmental requirements for farm animals and poultry, animal waste management practices.

Bangladesh environment: Environment of Bangladesh, its degradation and management. Agricultural practices for environmental sustainability.

Environmental issues: The background and nature of the development of environmental issues, a brief outline of the historic and modern environmental issues, human impact on the natural environment, how to react with the environmental issues as an environmental scientist. Case studies: oil pollution, pest control, over population, Chernobyl, Bhopal.

Teaching strategy

- Lecture
- Discussion
- Demonstration
- Field trip

Assessment strategy

- Examination
- Case study
- Report writing
- Assignment

Books recommended

Botkin, D. B. and Keller, E. A. 2000. Environmental Science – Earth as a Living Planet. Third Edition. John & Wiley Sons, Inc. New York.

Cunningham, W.P., Cunningham, M.A. and Saigo, B.W. 2003. Environmental Science--A Global Concern. Seventh Edition. The McGrew-Hill Companies, Inc. New York, USA.

Miller, Jr., G. T. 2001. Living in the Environment – An Introduction to Environmental Science. Eighth Edition. Wadsworth Publishing Company.

Course number	**: ENVSC 1202**
Course title	**: Introductory Environmental Science-Practical (Elective)**
Number of credits	**: 2**
Total marks	**:100**

Rationale

This course provides opportunities for students to acquire fundamental knowledge and skills on components/systems involved in several ecosystems.

Objectives

- Differentiate various types of ecosystems and their components
- Describe micro-meteorological instruments and their uses
- Identify species diversity in terrestrial and aquatic habitat

Learning outcomes

- Identify the components of different ecosystems
- Describe the major types of interactions between species
- Identify and use of meteorological instruments
- Calculate energy budget and biodiversity index

Course content

Study of agro-ecosystem, forest-ecosystem, aquatic-ecosystem and animal-ecosystem.

Identification and use of different micro-meteorological instruments/sensors.

Study of species diversity (Flora & Fauna) indices in terrestrial and aquatic habitat.

Teaching strategy

- Lecture
- Discussion
- Field visit
- Demonstration

Assessment strategy

- MCQ
- Written examination
- Assignment

Books recommended

Jackson, I.J. 1982. Climate, Water and Agriculture in Tropics, Longman, London.

Oke, T. R. 1987. Boundary Layer Climate, Second Edition. Routledge, University Press, Cambridge.

Rosenberg, N.J., Blad, B.L. and Verma, S.B. 1983. Microclimate - The Biological Environment. John Wiley & Sons. New York.

Course number	**: ENVSC 4001**
Course title	**: Management of Environment-Theory (Elective)**
Number of credits	**: 2**
Total marks	**:100**

Rationale

This course is designed to provide knowledge on managing natural resources, disaster events and environment degradation properly for safe and sustainable ecosystem productivity.

Objectives

- Provide knowledge on natural resources, biodiversity, wetlands and their management strategy
- Explain ideas and application of appropriate waste management techniques
- Describe disasters and environmental degradation and their effective management

Learning outcomes

- Select and apply sustainable environment and resource conservation techniques
- Classify wetlands, importance and strategies for development
- Describe the benefits and stresses of rural and urban environment
- Classify and explain waste and waste management strategies
- Analyze risk and benefit on resources and services
- Design the mitigation strategies
- Explain cause and effects, & manage disaster related hazards

Course content

Natural resources: Introduction to Soil, water, vegetation, animals (including fishes, livestock and wildlife), food, minerals and energy as natural resources and their use and management for environmental sustainability.

Biodiversity: Classification and conservation for environmental sustainability. Concept and components of Eco-park. Convention of biodiversity.

Wetlands of Bangladesh: Introduction, classification, socio-economic values, management and strategies for sustainable development.

Rural and urban environment: Components and management of rural and urban environment, population and environment.

Waste management: Importance of waste management. Types, sources and disposal of wastes. Collection, storage and transport of farm waste: livestock and poultry. Waste water treatment. Wasting resources, reuse, recycling, detoxifying, burning, burying, exporting wastes; hazardous-waste regulation.

Environmental degradation: Concepts of degradation and pollution, degradation of atmosphere, hydrosphere and lithosphere, causes and impacts on Bangladesh environment and their management. Environmental pollution models.

Disaster management: Concept, classification, management of untimely rainfall, drought, river erosion, flood, cyclone and earthquake.

Environmental economics: Concept, utilization of resources, economics of natural resource, risk-benefit analysis.

Teaching strategy

- Lecture
- Discussion
- Field trip

Assessment strategy

- MCQ
- Assignment
- Short and essay question
- Case study

Books recommended

Botkin, D. B. and Keller, E. A. 2000. Environmental Science – Earth as a Living Planet. Third Edition. John & Wiley Sons, Inc. New York.

Brammer, H. 1999. Agricultural Disaster Management in Bangladesh. The Univ. Press, Dhaka.

Miller, Jr., G. T. 2001. Living in the Environment – An Introduction to Environmental Science. Eighth Edition. Wadsworth Publishing Company.

Course number	**: ENVSC 4002**
Course title	**: Management of Environment-Practical (Elective)**
Number of credits	**: 2**
Total marks	**:100**

Rationale

This course covers the practical skills on environmental analysis for overall environmental safety and sustainable ecosystem productivity.

Objectives

- Demonstrate analytical skills for air, water, and soil pollution
- Describe the characteristics of slums, traffic system, and prepare PRA tools
- Explain the methods for collection and analysis of wastes from different sources
- Discuss measurement of biodiversity indices

Learning outcomes

- Identify and categorize water pollutants
- Determine heavy metals and chemical residues in environment
- Prepare and practice PRA tools
- Develop environment friendly waste management practices
- Design tools for slum and traffic system study
- Examine biodiversity status in a particular area
- Develop suitable strategies for biodiversity preservation and conservation

Course content

Analysis of water for pollution studies.

Analysis of heavy metals of soils.

Analysis of residual effect of pesticides of soil, water and crop.

PRA exercise and reporting on environmental related issues.

Waste management activities in crop, livestock and poultry farms.

Survey of lifestyle of slum people.

Survey of a city traffic system.

Studies on biodiversity of a particular village.

Studies on biodiversity preservation and conservation for environmental sustainability.

Teaching strategy

- Experiment
- Field trip
- Group discussion

Assessment strategy

- MCQ
- Experiment
- Assignment
- Case study

Books recommended

Drechsel, P. and Kunze, D. 2006. Waste Composting for Urban and Peri-urban Agriculture: Closing the Rural-Urban Nutrient Cycle in Sub-Saharan Africa (Edited). International Water Management Institute, FAO of the United Nations, CABI Publishing, UK.

Energy and the Environment: Sources, Technologies, and Impacts, Reza Toossi, VerVe Publishers, 2008.

Department of Agricultural Economics

Course number	:	**AE 1103**
Course title	:	**Agricultural Economics-Theory (Compulsory)**
Number of credits	:	**3**
Total Marks	:	**100**

Rationale

This course aims at studying basic and introductory economic concepts on diverse set of issues of individual's and firms' decision making.

Objectives

- Understand the basic concepts of economics and agricultural economics
- Explain the fundamentals of consumer's and producer's behavior
- Discuss techniques to solve basic economic theory and their application

Learning outcomes

- Explain the nature and scope of agricultural economics
- Determine consumer's choices, preferences and behavior
- Describe the factors and theories of production
- Discuss theory of farms and markets
- Evaluate different cost and revenue concepts
- Explain different dimensions of money and banking
- Evaluate different concepts of international trade, measurement of national income, economic growth & development, and land tenure system in Bangladesh

Course content

Nature and Scope of Agricultural Economics: Definitions, Branches of economics and scope of economics and agricultural economics.

Utility Analysis of Demand: Meaning of utility, Total utility, and marginal utility, Law of diminishing marginal utility, Relationship between total utility and marginal utility.

Demand, Supply and Equilibrium of the Farm: Demand and law of demand, demand schedule, Demand curve, Exceptions to the law of demand, Reasons for downward sloping demand curve, Extension and contraction of demand, increase and decrease in demand. State supply and law of supply, Supply schedule and Supply curve, Explain factors affecting shift in and change in the demand and supply curves, Determine market equilibrium with the help of demand & supply curve.

Elasticity of Demand: Definition of elasticity and it's classification, Different types of price elasticity of demand, Geometric measurement of elasticity, Problems and solutions.

Indifference Curve Analysis: Indifference curve, map, Marginal rate of substitution (MRS), Budget line, Explain consumer's equilibrium, Iso-product curve, Marginal rate of technical substitution (MRTS), Iso-cost line, Producer's equilibrium and optimum factor combination.

Factors of Production and How These Work in Agriculture: Production, Factors of production, Land, Characteristics of land, Labour, Characteristics of labour, Labour productivity, Factors determining the efficiency of labour, Division of labour, Advantages and disadvantages of labour, Capital, Importance of capital, Capital formation, Organization or Enterprise, Concepts of production and production function, Stages of production and evaluate the rationale zone of production.

Theory of Farms & Market: Definition and classification of market**,** Market equilibrium under perfect competition, Agricultural marketing, Characteristics of agricultural products, Problems in agricultural marketing.

Cost & Revenue Concepts: Different cost and revenue concepts, Relationship of different cost curves (AC & MC), Equilibrium of the farm with the help of total revenue & total cost curve.

Money & Banking: Concept and functions of money, Concept of bank and banking, Functions of central, commercial and specialized (Grameen Bank) banks in Bangladesh.

National Income and International Trade: Concepts of international trade, Classical theory of international trade, The gains from international trade (comparative advantage theory), concepts of national income (NI), measurement of NI, difficulties of measuring NI.

Economic Growth and Development: Meaning of growth & development, Explain the characteristics of developing countries, Concept of food security, Definition of poverty, different methods of measuring poverty, Role of agriculture in economic development of Bangladesh.

Land Tenure Systems in Bangladesh: Farm size classification in Bangladesh, The different land tenure arrangements in Bangladesh, Inefficiency of share tenancy in Bangladesh.

Teaching strategy

- Lecture
- Group discussion
- e -learning

Assessment strategy

- MCQ
- Short question
- Assignment

Books recommended

Ahuja, H. L. (1977). Advanced Economic Theory, S. Chand & Company Ltd., Ram Nagar, New Delhi-110055.

Chandler, L. V: Economics of Money & Banking, Harner and Row, London.

Dewett, K. K. (2005). Modern Economic Theory, S. Chand & Company Ltd., Ram Nagar, New Delhi-110055.

Ferguson, C. E., and Gould, J. P. (1975). Microeconomic Theory, Fourth Edition, Richard D. Irwin Inc. Illinois.

Hirshleifer, J. (1976). Price Theory and Applications, Prentice/Hall International, London.

Mankiw, N. G. (2004). Principles of economics (3rd ed., Mason OH: Thomson / South-Western,). ISBN: 0-324-20309-8.

Samuelson. P. A. and Nordhaus, W. D. (1989). Economics, 13th Edition, McGraw Hill International Edition, Singapore.

Department of Agricultural Statistics

Course number : **Stat 1201**
Course title : **Agricultural Statistics-Theory (Compulsory)**
Number of credits : **3**
Total marks : **100**

Rationale

This course covers basic statistical knowledge for designing and executing experimentation

Objectives

- Explain the techniques of data collection
- Describe statistical methods for analyzing experimental and survey data
- Explain uncertainty in making correct decision about agricultural products and their production

Learning outcomes

- Describe different types of variables and draw the appropriate graphs.
- Measure the location, dispersion and shape characteristics of a frequency distribution.
- Explain the laws and distributions of probability.
- Measure linear relationship between two variables.
- Test hypotheses regarding the parameters of the population.
- Explain appropriate experimental design and analysis of variance

Course content

Definition, scope and limitations of Agricultural Statistics. Different types of variables. Frequency distribution: construction and graphical representation. Measures of location and variation and shape characteristics of frequency curves.

Random experiment, outcome, sample space, events, mutually exclusive, equally likely, independent and dependent events. Mathematical and statistical definitions of probability, compound and conditional probability. Additive and multiplicative laws of probability. Random variable, probability distribution. Probability function. Binomial, Poisson and Normal distributions.

Simple correlation and regression: Scatter diagram, the Pearson's correlation coefficient with its properties, least squares method for fitting regression line. Properties of regression coefficients.

Population and sample. Hypothesis, null and alternative hypotheses, type I error, type II error, level of significance. Basic steps for testing hypothesis. Statistical tests: a population mean is equal to a specified value, equality of two population means (independent & correlated), significance of correlation and regression coefficients, independence of attributes.

Experimental design: Basic concepts and principles. Completely randomized design (CRD), randomized block design (RBD) Latin square designs and Split plot design.

Teaching strategy

- Lecture
- Problem-based learning
- Interactive learning

Assessment strategy

- Creative questions
- MCQ
- Written test
- Oral test
- Assignment

Books recommended

Islam, M. N. (2011). *An Introduction to Statistics and Probability*, 3rd edition, Mullick & Brothers, Dhaka.

Mood, A. M., F. A. Graybill, and D. C. Boes, (1974). *Introduction to the Theory of Statistics*, 3rd edition. McGraw-Hill.

Rangaswamy, R. (2013). *A Textbook of Agricultural Statistics*, 2nd edition, New Age International (P) Limited, Publishers, India.

Ahmed A. R., M. A. A. Bhuiyan, Z. A. Reza and M. Z. Hossain (2007). *Methods of Statistics*. 6th edition, S. Ahmed & Associates, Manikgonj.

Montogomery, D. C. (2012). *Design and Analysis of Experiments*, 8th Edition, John Wiley & Sons.

Steel, R. G. D. and J. H. Torrie (1980). *Principles and Procedures of Statistics*, McGraw-Hill International Book Company, New York.

Gomez, A. K. & A. A. Gomez (2010). *Statistical Procedures for Agricultural Research*. 2nd edition. Wiley-India.

Course number : **Stat 1202**
Course title : **Agricultural Statistics-Practical (Compulsory)**
Number of credits : **2**
Total marks : **100**

Rationale

This course deals with different statistical tools and techniques and their application in experimental design and survey data

Objectives

- Explain the techniques of data collection
- Demonstrate statistical methods for analyzing experimental and survey data
- Explain uncertainty in making correct decision about agricultural products and their production

Learning outcomes

- Construct frequency distribution and select appropriate graphs.
- Measure the location, dispersion and shape characteristics of a frequency distribution.
- Assess the laws and distributions of probability.
- Measure linear relationship between two variables.
- Test hypotheses regarding the parameters of the population.
- Perform appropriate experimental design and analysis of variance

Course content

Construction of frequency tables and their graphical representation. Measures of location and variation. Measures of moments, skewness and kurtosis.

Pearson's correlation coefficient. Fitting linear regression to observed data by the method of least squares.

Statistical tests: A population mean is equal to a specified value, equality of two population means (for both independent & correlated samples), a population proportion is equal to a specified value, equality of two population proportions, independence of attributes, significance of correlation and regression coefficients.

Analysis of variance for completely randomized design (CRD), randomized block design (RBD), latin square design (LSD) and split plot design. Multiple comparison tests (using lsd and DMRT).

Teaching strategy

- Lecture
- Problem-based learning
- Interactive learning

Assessment strategy

- Creative questions
- MCQ
- Written test
- Oral test
- Assignment

Books recommended

Islam, M. N. (2011). *An Introduction to Statistics and Probability*, 3rd edition, Mullick & Brothers, Dhaka.

Mood, A. M., Graybill, F. A. and D. C. Boes (1974). *Introduction to the Theory of Statistics*, 3rd edition. McGraw-Hill.

Rangaswamy, R. (2013). A Textbook of Agricultural Statistics, 2nd edition, New Age International (P) Limited, Publishers, India.

Montogomery, D. C. (2012). *Design and Analysis of Experiments*, 8th Edition, John Wiley & Sons.

Steel, R. G. D. and J. H. Torrie (1980). *Principles and Procedures of Statistics*, McGraw-Hill International Book Company, New York.

Gomez, A. K. and A. A. Gomez (2010). *Statistical Procedures for Agricultural Research.* 2nd edition. Wiley-India.

Zaman, S. M. H., K. Rahim and M. Howlader (1982). Simple Lessons from Biometry. Joydebpur, Dacca, Bangladesh.

Department of Farm power and Machinery

Course Number : FPM 1101
Course Title : Farm Mechanics-Theory (Compulsory)
Number of Credits : 2
Total Marks : 100

Rationale

This course covers basic knowledge on farm mechanization for sustainable agricultural production

Objectives

- Provide knowledge on heat engine, agricultural machineries, and pumps
- Explain and analyze the field and economic performances of engine, agricultural machineries, and pumps
- Describe estimation of small construction cost in the field of agriculture.

Learning outcomes

- Identify status, benefits and constraints of agricultural mechanization in Bangladesh.
- Explain different types of engine, their systems and troubleshooting.
- Illustrate different tillage implements, crop establishment, harvesting, threshing & drying machineries.
- Evaluate field and economic performance of different types of agricultural machineries.
- Describe irrigation methods, irrigation efficiency, pump selection and cost analysis.
- Estimate material and cost of a simple agricultural construction

Course content

Farm mechanization: Definition of mechanization; benefits of mechanization; present status and constraints of agricultural mechanization in Bangladesh.

Introduction to engine: Definition of engine; classification of engine; working principle of different systems of engines; engine terminology and computing different parameters of engine.

Farm machinery: Introduction to different tillage implements, crop establishments, harvesting, threshing & drying machineries.

Field & Economic performance of agricultural machinery: Definition of field & economic performance; computing drawber power, field efficiency and annual cost of agril. machineries.

Irrigation: Definition of irrigation; methods of irrigation; centrifugal pump; irrigation efficiency; and cost calculation for irrigation.

Drying of agricultural crops: Definition of drying, importance of drying, methods of drying and cost calculation for drying.

Building materials and cost estimation: Different building materials (brick, sand, cement and wood) and estimation of material and cost for simple farm structure.

Teaching Strategy

- Lectures
- Discussion
- Demonstration by video
- Question & answer
- Self Study
- Case Studies
- Practice & Group Studies

Assessment Strategy

- Question & answer
- Assignment
- Quiz
- Observation

Books recommended

M. Michael and T. P. Ojha (1978). Principles of Agricultural Engineering (Vol. I & II). Jain Brothers (New Delhi).

Donnel Hunt (1983). Farm Power and Machinery Management. Iowa State University Press, Iowa.

S. C. Jain and C. R. RAI. (1980). Tractor Engine Maintenance and Repair. Tata McGraw Hill Publishing Company limited, New Delhi.

V. E. Hansen, O.W. Israelsen and G. E. Stringham (1993). Irrigation Principles and Practice. John Wiley & Sons.

M. A. Aziz (1967). A Text Book of Estimating and Costing. Zohri Pub,. Dhaka.

Course Number : FPM 1102
Course Title : Farm Mechanics-Practical (Compulsory)
Number of Credits : 2
Total Marks : 100

Rationale

This course covers practical skills on different agricultural power & machinery for sustainable agricultural production.

Objectives

- Demonstrate different types of heat engine, agricultural machineries, and pumps.
- Impart knowledge and skills to select, repair and maintenances of engine, agricultural machineries, and pumps.

Learning outcomes

- Identify different engines, agricultural machineries and pumps.
- Differentiate various systems of engines, engine's parts, and address troubleshooting
- Demonstrate different tillage implements, crop establishment and harvesting machine.
- Explain irrigation pumps and its maintenance procedure.

Course content

Hand-on experiment to disassemble and assemble different engines (2-stroke & 4-stroke cycle engine) systems (fuel system, spark ignition system, cooling system, lubrication system). Starting and operation of power triller and tractor. Hand-on experiment on mold board plough, disk plough, transplanter, thresher, combine harvester and centrifugal pump.

Teaching strategy

- Lectures
- Discussion
- Demonstration
- Demonstration by video
- Question & answer
- Self Study
- Case Studies
- Practice & Group Studies
- Assignment

Assessment strategy

- Question & answer
- Assignment
- Quiz
- Observation

Books recommended

A. M. Michael and T. P. Ojha (1978). Principles of Agricultural Engineering (Vol. I & II). Jain Brothers (New Delhi).

Department of Rural Sociology

Course Number : **RS 1201**

Course Title : **Rural Sociology-Theory (Elective)**

Number of Credits : **2**

Total Marks : **100**

Rationale

The course provides knowledge on sociological way of thinking about agrarian society, rural community and rural development.

Objectives

- Provide knowledge on various features of the society, culture, and social institutions in agrarian settings
- Describe the implications of rural social stratification, social inequality and rural power structure
- Discuss the patterns, causes and consequences of social change,social problem and rural development
- Explain gender roles in agriculture and rural development
- Familiarize students with social research process

Learning outcomes

- Explain basic features of rural society and rural sociology
- Analyze the implications of rural sociology in agriculture and rural development
- Identify and explain different elements of culture
- Analyze social differentiation, stratification, social classand social inequality
- Explain rural social change, agrarian transformation and rural development
- Comprehend the conduction of social research

Course content

Introduction: Definition of Sociology and Rural Sociology, Origin and Development of Rural Sociology, Scope and Importance of Rural Sociology, Implication of Rural Sociology in Agricultural Society, Role of Rural Sociologists and Agriculturists in Agricultural and Rural Development.

Culture and Society: Meaning of Culture, Rural Culture and Agrarian Culture, Characteristic and Function of Culture, Elements of Culture, Culture Variability and Diversity, Value Degradation, Cultural Adaptability in terms of Globalization, Drivers of Cultural Change, Rural Social Institutions, Ethics and Education.

Social Differentiation and Stratification: Social Differentiation and Stratification, Social Inequality, Principles of Social Stratification, Characteristic of Social Stratification, Form of Social Stratification, Theoretical Perspectives on Social Stratification, Rural Social Stratification in Bangladesh with Reference to Agrarian Stratification, Gender Stratification.

Social Change and Agrarian Transformation: Definition, Characteristics, and Causes of Social Change, Rural Social Change, Technological Change and Transformation of Agriculture, Impact of Technology on Social Order, Contemporary Social Problems.

Rural Development: Concepts and Definition, Pro-poor Development, Role of Agriculture in Rural Development, GO and NGO Initiatives for Rural DevelopmentSustainable Livelihood Framework, Sustainable Development Goals.

Feminization of Agriculture: Concepts on Sex and Gender, Sex and Gender Roles, Women Empowermentand Development Agencies, Gender Role in Agriculture, Women Entrepreneurship, Gender Analytical Framework.

Research Methods and Technique: Meaning of Research and Social Research, Types of Social Research, Purposes of Social Research, Ethical Issues in Social Research, Research Process, Sampling, Methods of Data Collection, PRA Tools and its Implications, Ethical Community Engagement.

Teaching strategy

- Lecture
- Group Discussion
- Field Visit
- Video clip

Assessment strategy

- Written Test
- Assignment
- Presentation

Books recommended

Chambers, R. (1983). *Rural Development: Putting the Last First*.Prentice Hall:Harlow.

Chittambar, J.B. (2015). Introductory Rural Sociology. New Age Int: New Delhi.

Green, G. P. (Ed.). (2013). Handbook of Rural Development. Edward Elgar Publishing.

Hillyard, S. (2011). The Sociology of Rural Life. Berg Publishers: Oxford.

IFAD (2009). Gender in agriculture Sourcebook. The World Bank.

Rogers, E.M. et al.(1988).Social Change in Rural Societies: An Introduction to Rural Sociology.Prentice-Hall:NJ.

Shaefer, Richard T. 2011. Sociology (9th edition), McGraw Hill, New York.

Department of Computer Science & Mathematics

Course number	:	**CSM 1207**
Course title	:	**Computer Science-Theory (Elective)**
Number of credits	:	**2**
Total marks	:	**100**

Rationale

This course covers fundamental concepts of computers, hardware and software, digital circuits, number system, programming languages and data structures.

Objectives

- Understand computer and its basic parts, different hardware devices, programming languages and data structures
- Describe advantage and disadvantage of current programming languages and also make them familiar with data structures
- Discuss different application and system software for document preparation, presentation and spreadsheet analysis
- Explain programming language to solve simple problems

Learning outcomes

- Describe history of computers, computer hardware and software.
- Explain the usage of number systems and their conversions and applications.
- Illustrate logic gates, digital circuits and their design
- Apply programming language to solve basic problems
- Analyze different data structure for efficient programming

Course content

Introduction to Computers: From a Key Press to Display, Hardware, Software, Operating System, Microprocessor, Memory Overview, File and File System. Input-Output Devices.

Computer Hardware and Software: Hardware – Types – Working methods, Introduction to Computer Memory – RAM, ROM, Storage Types, Cache, Register. Software – System software and application software – Basic Text Editor (gedit, Notepad), Document Processing, Spreadsheet, Presentation, Database, Mathematical Analysis, Simulation, Image and Video Editing, Games etc.

Number System: Concept of Bit, Electronic Representation of Bits. Bit- Array: Byte, Word, Double Word. Binary – to- Decimal Conversion, Binary Arithmetic, Bit- Shifting, Logic Representation (1-Bit, Bit- Array). Hexadecimal Arithmetic up to 32- Bit Array Representation. Conversion between Binary, Hexadecimal and Octal Numbers. Representation of Characters by Bit- Array: ASCII and UTF-8. Character Arithmetic: Case and Language Mapping and Changing. Information coding.

Introduction to Digital Circuits: Boolean algebra; Primary and secondary logic gates and their truth tables; Encoders and decoders.

Introduction to Programming: Different types of programming languages, programming designing tools, different types of errors in programming, system modeling and flow chart. Control structures, variable modifiers, pointer variables; functions; arrays; characters and strings; structures; recursive functions; disc I/Os.

Introduction to Data Structures: Array, stack, sorting and searching. Link list and queue.

Teaching strategy

- Lecture
- Group discussion
- e-Learning

Assessment strategy

- MCQ
- Short question
- Assignment

Books recommended

Peter Norton (2000): Introduction to Computers, 6 edition or later. Glencoe/McGraw-Hill.

Yale Patt and Sanjay Patel (2003): Introduction to computing systems. McGraw-Hill Higher Education.

Paul Wang and Sanda Katila (2004): An Introduction to Web Design and Programming. Thomson/Brooks/Cole.

George Spooner and Richard Mentzer (1968): Introduction to number systems. Prentice-Hall.

Anita Goel (2010): Computer Fundamentals. Pearson.

Course number	:	**CSM 1208**
Course title	:	**Computer Science-Practical (Elective)**
Number of credits	:	**2**
Total marks	:	**100**

Rationale

This course provides practical knowledge and hands-on practice in relation to CSM1207.

Objectives

- Demonstrate computer and its basic parts, different hardware devices, programming languages and data structures
- Discuss the advantage and disadvantage of current programming languages and also make them familiar with data structures
- Explain different application and system software for document preparation, presentation and spreadsheet analysis
- Demonstrate programming language to solve simple problems

Learning outcomes

- Describe basic parts of computer hardware and software
- Apply number systems and their conversions and applications.
- Design using logic gates and digital circuits
- Apply programming language to solve basic problems
- Analyze different data structure for efficient programming

Course content

Introduction to Computers: From a Key Press to Display, Hardware, Software, Operating System, Microprocessor, Memory Overview, File and File System. Input-Output Devices.

Computer Hardware and Software: Hardware – Types – Working methods, Introduction to Computer Memory – RAM, ROM, Storage Types, Cache, Register. Software – System software and application software – Basic Text Editor (gedit, Notepad), Document Processing, Spreadsheet, Presentation, Database, Mathematical Analysis, Simulation, Image and Video Editing, Games etc.

Number System: Concept of Bit, Electronic Representation of Bits. Bit- Array: Byte, Word, Double Word. Binary – to- Decimal Conversion, Binary Arithmetic, Bit- Shifting, Logic Representation (1-Bit, Bit- Array). Hexadecimal Arithmetic up to 32- Bit Array Representation. Conversion between Binary, Hexadecimal and Octal Numbers. Representation of Characters by Bit- Array: ASCII and UTF-8. Character Arithmetic: Case and Language Mapping and Changing. Information coding.

Introduction to Digital Circuits: Boolean algebra; Primary and secondary logic gates and their truth tables; Encoders and decoders.

Introduction to Programming: Different types of programming languages, programming designing tools, different types of errors in programming, system modeling and flow chart. Control structures, variable modifiers, pointer variables; functions; arrays; characters and strings; structures; recursive functions; disc I/Os.

Introduction to Data Structures: Array, stack, sorting and searching. Link list and queue.

Teaching strategy

- Lecture
- Demonstration
- Group discussion

Assessment strategy

- MCQ
- Short question
- Assignment

Books recommended

Peter Norton (2000): Introduction to Computers, 6 edition or later. Glencoe/McGraw-Hill.

Yale Patt and Sanjay Patel (2003): Introduction to computing systems. McGraw-Hill Higher Education.

Paul Wang and Sanda Katila (2004): An Introduction to Web Design and Programming. Thomson/Brooks/Cole.

George Spooner and Richard Mentzer (1968): Introduction to number systems. Prentice-Hall.

Anita Goel (2010): Computer Fundamentals. Pearson.

Department of Animal Science

Course number	:	**AS 1201**
Course title	:	**Animal Science-Theory (Elective)**
Number of credits	:	**2**
Total marks	:	**100**

Rationale

This course provides knowledge of livestock and poultry

Objectives

- Provide knowledge about development of animal enterprises/industries.
- Impart knowledge about animal farm management

Learning outcomes

- Identify livestock species & breeds, terminology related to livestock, analyze the animal behavior in livestock farming
- Conduct housing and feeding of livestock
- Conduct judging of livestock and poultry
- Analyze the factors involved in safe production of meat, milk, egg and other products and by products
- Conduct animal waste treatment

Course content

Scope and Importance, history of domestication of different livestock species; Breeds of cattle, sheep, goat, poultry, horse and swine; terminology related to livestock; Animal behavior: types of animal behavior, factors affecting animal behavior, vices of animals; Livestock housing, types of houses for different animals, feedstuffs and their composition, livestock feeding practices; Judging livestock, quality of a livestock judge, judging draught animals; Composition and quality of meat, milk and eggs; Aerobic and anaerobic treatment of livestock manures.

Teaching strategy

- Lecture
- Question & answer
- Exercise
- Group discussion
- Demonstration by video

Assessment strategy

- Test
- Assignment
- Presentation
- Demonstration
- Quiz and Observation

Books recommended

Blakely and Blade, The Science of Animal Husbandry, current edition.

Ensminger, Animal Science, current edition

Taylor and Field, Scientific Farm Animal Production, current edition

Leland S. Shapiro,“ Introduction to Animal Science”,2000

W. Stephen Damron, “Introduction to Animal Science: Global, Biological, Social and Industry Perspectives”, 4th edition, 2008

G.C. Banarjee, A Textbook of Animal Husbandry 9th 2006

Course number	:	**AS 1202**
Course title	:	**Animal Science-Practical (Elective)**
Number of credits	:	**2**
Total marks	:	**100**

Rationale

This course focuses on practical knowledge of livestock and poultry

Objectives

- Provide practical knowledge about development of animal enterprises/industries.
- Demonstrate how to manage animal farm

Learning outcomes

- Identify livestock species & breeds
- Demonstrate farm management practices such as approaching and handling, external points of animals, weighing, restraining, casting, grooming, marking, record keeping, dentition & ageing, castration, training of draught animals
- Demonstrate housing and feeding of livestock
- Conduct judging of livestock (draught and beef cattle) and poultry
- Conduct animal waste treatment experiments (compost and biogas from manure)

Course content

Identification of different livestock species and breeds; Animal behavior and vices; Animal management such as approaching and handling, external points of animals, weighing, restraining, casting, grooming, marking, record keeping, dentition & ageing, castration, training of draught animals; Livestock housing; Feedstuffs and their composition; Livestock judging practices; Feeding practices; Livestock wastes and their treatment procedure.

Teaching strategy

- Lecture
- Question & answer
- Exercise
- Group discussion
- Demonstration by video

Assessment strategy

- Test
- Assignment
- Presentation
- Demonstration
- Quiz and Observation

Books recommended

Blakely and Blade, The Science of Animal Husbandry, current edition.

Ensminger, Animal Science, current edition

Taylor and Field, Scientific Farm Animal Production, current edition

Leland S. Shapiro,“ Introduction to Animal Science”, 2000

W. Stephen Damron, “Introduction to Animal Science: Global, Biological, Social and Industry Perspectives”, 4th edition, 2008

G.C. Banarjee, A Textbook of Animal Husbandry 9th edition, 2006