

## Soil, Water and Environment Discipline

Soil, Water and Environment Discipline has launched its academic activities in 1998-1999 introducing Undergraduate program that offers Bachelor of Science (Hons.) degree that includes 4 academic years and 8 semesters. It has its Graduate program that offers Master of Science Degree including 1 and ½ academic years (3 semesters) and PhD degree including 3 academic years.

The integration of three basic sciences i.e., Soil, Water and Environment are multidimensional and multidisciplinary subjects in itself. Courses are designed to provide its graduates a thorough knowledge in the field of Pedology, Soil Physics, Soil Chemistry, Soil Biochemistry, Soil Microbiology, Soil Ecology, Soil Mineralogy, Soil Survey, Land Evaluation, Soil Conservation, Sustainable Landuse, Watershed Management, Irrigation & Drainage Technology, Groundwater Hydrology, Agronomy, Soil Fertility and Plant Nutrition, Soil Management, Environmental Chemistry, Natural Resources Management, Environmental Impact Assessment and Monitoring, Application of GIS and Remote Sensing in soil Water and Environmental Sector, Geochemistry and Advanced Pedology and Soil and Land Quality Management.

Course curricula are designed aiming at fulfilling the regional, national and international demand and providing necessary knowledge to its graduates to be capable of carrying out diversified researches and their applications in the field of Soil Science, Agriculture, Environment as well as Water Management.

Soil, Water and Environment Discipline has linkage with SRDI (Soil Resource Development Institute), Department of Soil, Water and Environment, Dhaka University and Bangladesh – Australia Center for Environmental Research (BACER – DU), Dhaka University. This Discipline has carried out and currently conducting number of research activities jointly with SRDI and Dept. of Soil, Water and Environment, Dhaka University.

The discipline has four well-equipped labs (Soil Physics lab, Soil Chemistry lab, Soil Microbiology lab, Soil Mineralogy lab and Instrumentals Lab) and a sophisticated seminar library, rich with books, CDs, theses and journals.

Since the domain of this discipline are soil, water and environment, the irreplaceable resources of the earth, this discipline has a promise to produce competent graduates to face future challenges of utilization, conservation and management of these natural resources.

### 1. Program Name:

B.Sc. (Hons.) in Soil, Water and Environment Discipline

### 2. Course Structure:

- Program duration : 4 Years
- Number of terms : 8
- Term duration : 21 Weeks
- Total number of credit hours available : 204.0
- Minimum credit hours to be earned : 160.0

### 2.1 Summary of the total available credits (core and optional) from different areas of study:

Distributions of credits in different areas of study

Areas of Study	Theory		Sessional/Field Work		Total (Core/Optional)		Total	%
	Core	Optional	Core	Optional	Core	Optional		
Arts and Humanities and Social Science	0.0	21.0	0.0	0.0	0.0	21.0	<b>21.0</b>	<b>10.0</b>
Basic Science	9.0	3.0	3.0	1.5	12.0	4.5	<b>16.5</b>	<b>8.0</b>
Agriculture	3.0	6.0	1.5	1.5	4.5	7.5	<b>12.0</b>	<b>6.0</b>
Soil Science	51.0	3.0	30.0	1.5	81.0	4.5	<b>85.5</b>	<b>42.0</b>

Computer Science and Information Technology	0.0	3.0	3.0	1.5	3.0	4.5	<b>7.5</b>	<b>4.0</b>
Environmental Science	9.0	18.0	1.5	4.5	10.5	22.5	<b>33.0</b>	<b>16.0</b>
Water Science	12.0	9.0	6.0	1.5	18.0	10.5	<b>28.5</b>	<b>14.0</b>
<b>Total</b>	<b>84.0</b>	<b>63.0</b>	<b>45.0</b>	<b>12.0</b>	<b>129.0</b>	<b>75.0</b>	<b>204.0</b>	<b>100.0</b>

Year-wise distribution of credits

Year	Term	Theory		Sessional/Field Work		Total
		Core	Optional	Core	Optional	
First	First	12.0	9.0	4.5	0.0	<b>25.5</b>
	Second	12.0	6.0	6.0	1.5	<b>25.5</b>
Second	First	9.0	9.0	6.0	1.5	<b>25.5</b>
	Second	12.0	6.0	6.0	1.5	<b>25.5</b>
Third	First	12.0	6.0	6.0	1.5	<b>25.5</b>
	Second	9.0	9.0	4.5	3.0	<b>25.5</b>
Fourth	First	9.0	6.0	9.0	1.5	<b>25.5</b>
	Second	9.0	12.0	3.0	1.5	<b>25.5</b>
<b>Total</b>		<b>84.0</b>	<b>63.0</b>	<b>45.0</b>	<b>12.0</b>	<b>204.0</b>

2.2 Course Outline:

Term-wise course outline for the entire program

First Year First Term

Course No.	Course Title	Contact Hours per Week	Credit
SWE-1101	Introductory Soil Science	3-0	3.0
SWE-1102	Introductory Soil Science Sessional/Field Work	0-3	1.5
SWE-1103	Hydrology	3-0	3.0
SWE-1104	Hydrology Sessional/Field Work	0-3	1.5
SWE-1105	Introductory Environmental Science	3-0	3.0
Chem-1151	Chemistry	3-0	3.0
Chem-1152	Chemistry Sessional	0-3	1.5
*Eng-1155	Communicative English	3-0	3.0
*HRM-1157	Human Resource Management	3-0	3.0
*DS-1159	Introduction to Development Studies	3-0	3.0
<b>Total</b>	<b>7 Theory (4 Core + 3 Optional) and 3 Sessional (3 Core)</b>	<b>21-9</b>	<b>Total: 25.5 Core: 16.5 Optional: 9.0</b>

\*Indicates optional course

First Year Second Term

Course No.	Course Title	Contact Hours per Week	Credit
SWE-1201	Soil Chemistry I	3-0	3.0
SWE-1202	Soil Chemistry I Sessional	0-3	1.5
SWE-1203	Soil Physics I	3-0	3.0
SWE-1204	Soil Physics I Sessional/Field Work	0-3	1.5
*SWE-1205	Plant Diversity and Plant Physiology	3-0	3.0
*SWE-1206	Plant Diversity and Plant Physiology Sessional/Field Work	0-3	1.5
SWE-1207	Geology	3-0	3.0
SWE-1208	Geology Sessional/Field Work	0-3	1.5
*Soc-1253	Principles of Sociology	3-0	3.0
CSE-1254	Word Processing and Spread Sheet Analysis	0-3	1.5
Math-1267	Mathematics	3-0	3.0
<b>Total</b>	<b>6 Theory (4 Core + 2 Optional) and 5 Sessional (4 Core + 1 Optional)</b>	<b>18-15</b>	<b>Total: 25.5 Core: 18.0</b>

			<b>Optional: 7.5</b>
--	--	--	----------------------

**Second Year First Term**

<b>Course No.</b>	<b>Course Title</b>	<b>Contact Hours per Week</b>	<b>Credit</b>
SWE-2101	Soil Mineralogy	3-0	3.0
SWE-2102	Soil Mineralogy Sessional/Field Work	0-3	1.5
SWE-2103	Water Resources and Water Quality	3-0	3.0
SWE-2104	Water Resources and Water Quality Sessional/Field Work	0-3	1.5
*SWE-2105	Environmental Chemistry	3-0	3.0
*SWE-2106	Environmental Chemistry Sessional/Field Work	0-3	1.5
SWE-2107	Surface Chemistry	3-0	3.0
SWE-2108	Surface Chemistry Sessional	0-3	1.5
*SWE-2109	Fundamentals of Geography and Environment	3-0	3.0
CSE-2152	Database Systems Sessional	0-3	1.5
*Econ-2155	Economics	3-0	3.0
<b>Total</b>	<b>6 Theory (3 Core + 3 Optional) and 5 Sessional (4 Core + 1 Optional)</b>	<b>18-15</b>	<b>Total 25.5 Core 15.0 Optional 10.5</b>

\*Indicates optional course

**Second Year Second Term**

<b>Course No.</b>	<b>Course Title</b>	<b>Contact Hours per Week</b>	<b>Credit</b>
SWE-2201	Soil and Environmental Biochemistry	3-0	3.0
SWE-2202	Soil and Environmental Biochemistry Sessional	0-3	1.5
SWE-2203	Soil Physics-II	3-0	3.0
SWE-2204	Soil Physics-II Sessional/Field Work	0-3	1.5
*SWE-2205	Water and Soil Pollution	3-0	3.0
SWE-2207	Ecology and Ecosystems	3-0	3.0
SWE-2208	Ecology and Ecosystems Sessional/Field Work	0-3	1.5
SWE-2209	Agronomy and Integrated Agricultural Systems	3-0	3.0
SWE-2210	Agronomy and Integrated Agricultural Systems Sessional/Field Work	0-3	1.5
*SWE-2211	Atmospheric Science	3-0	3.0
*SWE-2212	Atmospheric Science Sessional/Field Work	0-3	1.5
<b>Total</b>	<b>6 Theory (4 Core +2 Optional) and 5 Sessional (4 Core +1 Optional)</b>	<b>18-15</b>	<b>Total 25.5 Core 18.0 Optional 7.5</b>

\*Indicates optional course

**Third Year First Term**

<b>Course No.</b>	<b>Course Name</b>	<b>Contact Hours per Week</b>	<b>Credit</b>
SWE-3101	Soil Genesis	3-0	3.0
SWE-3102	Soil Genesis Sessional/Field Work	0-3	1.5
SWE-3103	Watershed and Wetland Management	3-0	3.0
SWE-3104	Watershed and Wetland Management Sessional/Field Work	0-3	1.5
SWE-3105	Soil Fertility and Plant Nutrition	3-0	3.0
SWE-3106	Soil Fertility and Plant Nutrition Sessional/Fieldwork	0-3	1.5
*SWE-3107	Biostatistics	3-0	3.0
*SWE-3108	Biostatistics Sessional	0-3	1.5
SWE-3109	Soil and Environmental Microbiology	3-0	3.0
SWE-3110	Soil and Environmental Microbiology Sessional	0-3	1.5
*SWE-3111	Environmental Hazards and Disaster Management	3-0	3.0
<b>Total</b>	<b>6 Theory (4 Core + 2 Optional) and 5 Sessional (4 Core + 1 Optional)</b>	<b>18-15</b>	<b>Total 25.5 Core 18.0 Optional 7.5</b>

\*Indicates optional course

**Third Year Second Term**

<b>Course No.</b>	<b>Course Name</b>	<b>Contact Hours per Week</b>	<b>Credit</b>
SWE-3201	Soil Chemistry II	3-0	3.0
SWE-3202	Soil Chemistry II Sessional	0-3	1.5
SWE-3203	Soil Erosion and Conservation	3-0	3.0
SWE-3204	Soil Erosion and Conservation Field Work	0-3	1.5
SWE-3205	Research Methodology	3-0	3.0
SWE-3206	Research Methodology Sessional/Field Work	0-3	1.5
*SWE-3207	Water and Waste Water Treatment	3-0	3.0
*SWE-3208	Water and Waste Water Treatment Sessional/Field Work	0-3	1.5
*SWE-3209	Natural Resource Management	3-0	3.0
*URP-3261	Geographical Information System	3-0	3.0
*URP-3262	Geographical Information System Sessional	0-3	1.5
<b>Total</b>	<b>6 Theory (3 Core + 3 Optional) and 5 Sessional (3 Core + 2 Optional)</b>	<b>18-15</b>	<b>Total 25.5 Core 13.5 Optional 12.0</b>

\*Indicates optional course

**Fourth Year First Term**

<b>Course No.</b>	<b>Course Name</b>	<b>Contact Hours per Week</b>	<b>Credit</b>
SWE-4101	Soil Survey and Land Evaluation	3-0	3.0
SWE-4102	Soil Survey and Land Evaluation Field Work	0-3	1.5
SWE-4103	Environmental Soil Physics	3-0	3.0
SWE-4104	Environmental Soil Physics Sessional/Field Work	0-3	1.5
SWE-4105	Problem Soils of Bangladesh	3-0	3.0
SWE-4108	Thesis	0-12	6.0
*SWE-4109	Forest Soil Management	3-0	3.0
*SWE-4110	Forest Soil Management Sessional/Field Work	0-3	1.5
*Econ-4161	Natural Resource Economics	3-0	3.0
<b>Total</b>	<b>5 Theory (3 Core+ 2 Optional) and 4 Sessional (3 Core + 1 Optional)</b>	<b>15-21</b>	<b>Total 25.5 Core 18.0 Optional 7.5</b>

\*Indicates optional course

**Fourth Year Second Term**

<b>Course No.</b>	<b>Course Name</b>	<b>Contact Hours per Week</b>	<b>Credit</b>
SWE-4201	Soils classification and Soils of Bangladesh	3-0	3.0
SWE-4202	Soils Classification and Soils of Bangladesh Filed Work	0-3	1.5
SWE-4203	Irrigation and Drainage Management	3-0	3.0
SWE-4204	Irrigation and Drainage Management Sessional/Filed work	0-3	1.5
SWE-4205	Climate Change and Food Security	3-0	3.0
*SWE-4207	Waste Management	3-0	3.0
*SWE-4208	Waste Management Sessional/Fieldwork	0-3	1.5
*SWE-4209	River and Floodplain Management	3-0	3.0
*SWE-4211	Crops of Bangladesh	3-0	3.0
*Eng-4257	Professional English	3-0	3.0
<b>Total</b>	<b>7 Theory (3 Core + 4 Optional) and 3 Sessional (2 Core + 1 Optional)</b>	<b>21-9</b>	<b>Total 25.5 Core 12.0 Optional 13.5</b>

\*Indicates optional course

### 2.3 Course Profile:

Course: SWE-1101: Introductory Soil Science	Credit: 3.0	Year: First	Term: First
<p><b>Rationale:</b> This course is designed to provide preliminary ideas about weathering of soil minerals, soil formation, and interaction of soil phases, soil physical, chemical and biological properties that produce soil a suitable medium of plant growth.</p>			
<p><b>Course Objectives</b></p>			
<ul style="list-style-type: none"> <li>• Acquisition of preliminary ideas about soil as a medium of plant growth</li> <li>• Building knowledge on formation of soil and weathering processes and on soil properties that contribute to plant growth</li> </ul>			
Intended Learning Outcomes (ILOs)	Course Content		
<b>Section-A</b>			
<p>At the end of the course the students will be able to -</p> <ol style="list-style-type: none"> <li>1. describe the importance of soil to the crop production.</li> <li>2. identify the process of formation of soil profile</li> <li>3. explain agents weather rocks and minerals and form soil.</li> <li>4. illustrate solid, air, and water, interaction and its contribution to the soil-plant-atmosphere relation.</li> </ol>	<p><b>1. Introduction:</b> Concept of Soil; historical development of Soil Science; objectives of studying Soil Science as an independent discipline and branch of Biological Science.</p>		
	<p><b>2. Soil Formation:</b> Soil forming materials-rocks, minerals; factors influence soil formation; basic ideas on soil forming processes; development of soil horizons and soil profiles.</p>		
	<p><b>3. Weathering:</b> Weathering processes - physical, chemical and biological weathering, factors affecting weathering; products of weathering.</p>		
	<p><b>4. Soil Phases:</b> Soil as a three-phase disperse system; description of the three phases of soils; interaction of the phases.</p>		
<b>Section-B</b>			
<ol style="list-style-type: none"> <li>5. demonstrate the role of various soil properties that constitute soil characteristics.</li> </ol>	<p><b>5. Soil Properties:</b> Basic ideas about properties of soil – morphological, physical, chemical, physico-chemical, biological and mineralogical properties of soil.</p>		
<ol style="list-style-type: none"> <li>6. outline the influence of soil physical properties to function as a medium of plant growth.</li> </ol>	<p><b>6. Soil Physical Properties:</b> Physical nature of the soil separates: particles size distribution; soil textural classes; soil structure-classification and importance; soil colour - origin and importance; soil water-classification and importance; soil air-composition and importance.</p>		
<ol style="list-style-type: none"> <li>7. list soil nutrients.</li> </ol>			
<ol style="list-style-type: none"> <li>8. describe the influence of soil reaction and organic matter in nutrient release and availability.</li> </ol>	<p><b>7. Soil Chemical Properties:</b> soil nutrients; soil reaction - soil acidity, soil alkalinity; soil electrical conductivity; soil organic matter and humus.</p>		
<ol style="list-style-type: none"> <li>9. classify soil microorganism and their role in soil</li> </ol>	<p><b>8. Soil Biological Properties:</b> Basic idea about microbes in soils: bacteria, algae and fungi.</p>		

<b>Course: SWE-1102: Introductory Soil Science Sessional/Field Work</b>	<b>Credit: 1.5</b>	<b>Year: First</b>	<b>Term: First</b>
<b>Rationale:</b> This course is designed to provide practical knowledge and hand-on practice for determination of soil properties in the field and in the laboratory.			
<b>Course Objectives</b> <ul style="list-style-type: none"> <li>• Acquisition of basic knowledge on soil properties</li> <li>• Comprehension of the formation of soil</li> <li>• Conceptualization of properties and processes and adoption measures for improving condition</li> </ul>			
<b>Intended Learning Outcomes (ILOs)</b>	<b>Course Content</b>		
<p>At the end of the course the students will be able to -</p> <ol style="list-style-type: none"> <li>1. describe soil profile in field.</li> <li>2. identify master and transitional horizon</li> <li>3. collect soil, water and plant sample determine some basic soil properties in laboratory.</li> </ol>	1. Soil profile study in the field.	2. Sampling techniques for soil, water and plant.	3. Preparation of the samples for different kinds of analysis.
	4. Determination of some physical and chemical properties of soil.		

Course: SWE-1103: Hydrology	Credit : 3.0	Year: First	Term: First
<p><b>Rationale:</b> The course is designed to provide preliminary knowledge about hydrologic cycle, surface and groundwater hydrology, occurrence, distribution, and movement of water resource within the environment.</p>			
<p><b>Course Objectives</b></p> <ul style="list-style-type: none"> <li>• Acquire basic knowledge on hydrology and hydrologic cycle.</li> <li>• Comprehend the basic concepts of various hydrologic parameters and water balance in the environment.</li> <li>• Outline the surface and ground water storage and movement.</li> </ul>			
Intended Learning Outcomes (ILOs)	Course Content		
Section-A			
<p>At the end of the course the students will be able to -</p> <ol style="list-style-type: none"> <li>1. name the major components of hydrologic cycle</li> <li>2. classify precipitation,</li> <li>3. describe regional and global distribution of precipitation.</li> <li>4. acquire knowledge about measurement, distribution and pattern of precipitation.</li> <li>5. relate precipitation amount and intensity with flood and its impact.</li> </ol>	<p><b>1. Hydrology and hydrologic cycle:</b> Concept of hydrology, hydrologic cycle and the various stages of this cycle- evaporation, condensation, transportation, precipitation, interception, run-off, and infiltration, global distribution of water; watershed, water balance.</p>	<p><b>2. Precipitation:</b> Process and subsequent events, types of precipitation, measurement of rainfall intensity, duration, frequency relationship, global and regional patterns of precipitation, effects of excess precipitation and run-off.</p>	
	<p><b>3. Surface Hydrology:</b> Sources of stream flow, formation of streams, stream flow hydrographs, excess rain fall and runoff, drainage basin/watersheds, drainage divides, overland flows, rivers, lakes, wetlands, estuaries, oceans.</p>	<p><b>4. Floods and its control:</b> Definition, types, intensity, discharge, velocity and related measurements, factors controlling flood frequency, duration, and havoc; effects of flood in soil formation through erosion and deposition, flood control measures.</p>	
Section-B			
<ol style="list-style-type: none"> <li>6. define groundwater terminologies</li> <li>7. describe occurrences and movement of groundwater.</li> <li>8. compare ground water quality with standards</li> <li>9. identify major sources and types of groundwater pollution and contamination.</li> </ol>	<p><b>5. Introduction to Groundwater:</b> definition, types of aquifers: aquifers, aquitards, aquifuge, aquiclude confined and unconfined aquifer, perched aquifers, artesian well, groundwater table; properties of aquifers; formation of different aquifers; causes of drying of aquifers.</p>		
	<p><b>6. Movement of Groundwater:</b> vertical distribution of ground water, capillary fringe, movement of groundwater through different soil, rock properties affecting groundwater.</p>		
	<p><b>7. Groundwater Interaction:</b> Groundwater interaction, with streams and lakes, groundwater basins and springs, ground water recharge and discharge, salt water intrusion in aquifers</p>		
	<p><b>8. Groundwater and environmental influence:</b> Ground water chemistry, ground water quality, groundwater contamination, groundwater pollution surface-Groundwater interaction and ecosystem dependence. ,</p>		

<b>Course: SWE-1104: Hydrology Sessional / Field Work</b>	<b>Credit : 1.5</b>	<b>Year: First</b>	<b>Term: First</b>		
<b>Rationale:</b> This course is designed to recognize, understand, analyze and describe the hydrological processes.					
<b>Course Objectives</b> <ul style="list-style-type: none"> <li>• Comprehension of the interrelationship and functions of hydrological components.</li> <li>• Effectively link theory with practice and application.</li> <li>• Provide students hand-on experience of common techniques in labs and exposure to equipment and machines.</li> </ul>					
<b>Intended Learning Outcomes (ILOs)</b>	<b>Course Content</b>				
<p>At the end of the course the students will be able to -</p> <ol style="list-style-type: none"> <li>1. estimate different hydrologic components and their functions and data collection and their interpretation.</li> <li>2. construct hydrograph</li> <li>3. interpret hydrograph</li> <li>4. identify the level of subsurface and groundwater</li> </ol>	<ol style="list-style-type: none"> <li>1. Measurement of precipitation, runoff and infiltration.</li> </ol>	<ol style="list-style-type: none"> <li>2. Hydrologic data collection and field water balance interpretation.</li> </ol>	<ol style="list-style-type: none"> <li>3. Hydrograph construction and interpretation;</li> </ol>	<ol style="list-style-type: none"> <li>4. Field measurement of sediment transport and discharge.</li> </ol>	<ol style="list-style-type: none"> <li>5. Groundwater survey from different well installation data; seasonal fluctuation of subsurface and groundwater level.</li> </ol>

Course:SWE-1105: Introductory Environmental Science	Credit : 3.0	Year: First	Term: First
<p><b>Rationale:</b> This course is designed to provide preliminary ideas and concepts of environment and its components for global as well as local issues.</p>			
<p><b>Course Objectives</b></p> <ul style="list-style-type: none"> <li>• Acquisition of the fundamental knowledge on environmental component and processes</li> <li>• Comprehension about environmental threats and control measures</li> </ul>			
Intended Learning Outcomes (ILOs)	Course Content		
Section-A			
<p>At the end of the course the students will be able to -</p> <ol style="list-style-type: none"> <li>1. label and define the terminologies,</li> <li>2. match components with ecological functions,</li> <li>3. relate environment with its living organisms</li> </ol>	<p><b>1. Introduction to Environment :</b> Basic terminologies and concepts of environment, nature and organization of matter, energy flow, equilibrium and change, interior of the earth,</p>		
	<p><b>2. Components of environment:</b> Atmospheric sciences, Ecology, Environmental chemistry, Geosciences, The relationship among environmental components (Freshwater ecology, Marine ecology, Terrestrial ecology), The basis of the relationship,</p>		
	<p><b>3. Interactions among Components:</b> Interrelated scientific principles (matter, energy and environment), Interaction between environment and organisms.</p>		
Section-B			
<ol style="list-style-type: none"> <li>4. explain environmental ethics should be followed;</li> <li>5. describe global environmental issues,</li> <li>6. state the probable consequences of global environmental problems</li> </ol>	<p><b>4. Ethics and Issues:</b> Ethics and Issues of Environment, historic and modern environmental issues, issues related to epidemics., and related social and managerial issues),</p>		
	<p><b>5. Global warming:</b> Global warming, greenhouse effect, sea-level rise, ozone depletion, acid rain, El Nino and La Nino and human impact related issues</p>		
	<p><b>6. Study:</b>The methods of studying environmental issues.</p>		

Course: Chem-1151: Chemistry	Credit : 3.0	Year: First	Term: First
<p><b>Rationale:</b> The course is designed to provide students with the knowledge and practical skills required for careers in analytical chemistry and related subject areas.</p>			
<p><b>Course Objective:</b></p> <ul style="list-style-type: none"> <li>To provide students with a broad and balanced foundation of knowledge on chemistry and practical skill on application in various fields.</li> </ul>			
Intended Learning Outcomes (ILOs)	Course Content		
Section-A			
<p>At the end of the course the students will be able to-</p> <ol style="list-style-type: none"> <li>discuss about the nature and composition of matter</li> <li>explain the atomic structure and the periodic table</li> <li>analyze different chemical reactions</li> <li>evaluate analytical and colloidal phenomena of chemistry</li> </ol>	<p><b>1. Introduction to chemistry:</b> Definition and scope; the nature and composition of matter: the chemical structure of matter.</p>		
	<p><b>2. Atomic structure and the periodic table:</b> Early views, atomic spectra of hydrogen and the Bohr theory, Bohr-Sommerfield model, quantum number; wave mechanical approach; atomic orbital, build-up elements, the periodic table of the elements, atomic properties and the periodic table.</p>		
	<p><b>3. The structure of molecules:</b> The origin of bonding, types of bonding; covalent vs ionic bonding; bond polarity, bonding of some representative molecules and their chemical geometry.</p>		
	<p><b>4. Chemical reaction and stoichiometry:</b> Synthesis in chemistry, the stoichiometry of chemical reactions, precipitation reactions, acid-base reactions and oxidation reduction reactions: ion electron method for balancing redox reactions.</p>		
	<p><b>5. Introduction to analytical chemistry:</b> Chemical analysis, types of analysis, volumetric analysis: types of volumetric analysis, acid-base titration, oxidation-reduction titration, precipitation titration and complexometric titration, colorimetry and spectrophotometric analysis: Lambert and Beer's law and its application.</p>		
	<p><b>6. Colloids:</b> Colloids and crystalloid; classification of colloids; general methods of preparation of colloidal solution; properties of colloids; coagulation; peptisation and electrophoresis</p>		
Section-B			
<ol style="list-style-type: none"> <li>narrate various laws of thermodynamics</li> <li>explain physico-chemical equilibrium of chemical reactions</li> <li>discuss first and second order reactions</li> <li>conceptualize organic chemistry</li> </ol>	<p><b>7. Matter and energy:</b> Heat and work: the first law of thermodynamics, heat of reaction; enthalpies, the second law of thermodynamics; entropy, the third law; absolute entropies, a general criterion for spontaneous change; the Gibbs free energy</p>		
	<p><b>8. System in equilibrium:</b> Physical equilibrium; Raoult's law to dilute solution, non-ideal solution: Henry's laws, application of Raoult's law to dilute solution: colligative properties, chemical equilibrium, the law of mass action, equilibrium constant, Lechatelier principle, equilibria in ionic solutions, acid-base equilibria, concept of pH and buffer solution.</p>		
	<p><b>9. Chemical kinetics:</b> First and second order reactions and their simple treatment; determination of order of reaction; outline of Arrhenius and Collision theory.</p>		
	<p><b>10. Introduction to organic chemistry:</b> Aliphatic hydrocarbon, halogen derivatives of aliphatic hydrocarbon, alcohol, aldehyde, ketones, carboxylic acid, esters and amines; structure, properties and some representative reactions with special reference to functional groups, modern concepts of the structure of benzene and its derivatives.</p>		

Course: Chem-1152: Chemistry Sessional	Credit : 1.5	Year: First	Term:First
<p><b>Rationale:</b> The course is designed to serve students practical skills required in analytical chemistry and related subject areas.</p>			
<p><b>Objectives:</b></p> <ul style="list-style-type: none"> <li>• To develop the ability of students to apply their chemical knowledge and skills to the solution of theoretical and practical chemical problems.</li> </ul>			
Intended Learning Outcomes (ILOs)	Course Content		
<p>At the end of the course the students will be able to -</p> <ol style="list-style-type: none"> <li>1. prepare different types of chemical solutions</li> <li>2. determine strength of acids and bases</li> <li>3. use different methods of titration</li> <li>4. determine salinity of water sample</li> <li>5. estimate Ca and Mg from water samples</li> </ol>	<ol style="list-style-type: none"> <li>1. Preparation of standard solutions.</li> <li>2. Volumetric analysis: Acid-base titration; determination of the strength of acid/base by using standard base/acid solution respectively.               <ol style="list-style-type: none"> <li>i) Oxidation-reduction titration: determination of the amount of iron (in grams per litre) of the given ferrous sulphate solution by standard potassium permanganate solution;</li> <li>ii) Iodometric titration: determination of the amount of copper (in grams per litre) of a given copper sulphate solution by using standard sodium thiosulphate solution.</li> <li>iii) Precipitation titration: determination of salinity of a water sample</li> <li>iv) Complexometric titration: determination of Ca and Mg from water sample.</li> </ol> </li> </ol>		

Done Course:Eng-1155: Communicative English		Credit : 3.0	Year: First	Term: First
<b>Rationale:</b> Competence in language skills is essential for effective communication. The course offers the students an opportunity to know the skills of English Language and their proper uses.				
<b>Objective:</b> This course is designed to -				
<ul style="list-style-type: none"> <li>• help students learn about the major skills of English language and their proper applications in everyday life</li> <li>• develop students' communicative competence</li> </ul>				
Intended Learning Outcomes (ILOs)		Course Content		
<b>Section-A</b>				
<p>At the end of the course the students will be able to-</p> <ol style="list-style-type: none"> <li>1. apply how to transform one part of speech into another part</li> <li>2. differentiate between clauses and phrases</li> <li>3. frame W/H questions</li> <li>4. explicate the elements of reading</li> <li>5. elucidate the process of note-taking</li> </ol>	<ol style="list-style-type: none"> <li>1. <b>Development of Vocabulary:</b> Processes of word formation and Transformation; proper use of parts of speech.</li> </ol>			
	<ol style="list-style-type: none"> <li>2. <b>Sentence Structure:</b> Structures of basic sentences, identification of clauses and phrases, joining sentences, transformation of sentences, framing W/H questions.</li> </ol>			
	<ol style="list-style-type: none"> <li>3. <b>Reading and Understanding:</b> Perspectives on reading comprehension; elements of reading: vocabulary, syntax and meaning; Reading strategies: intensive and extensive reading; scanning and skimming; prediction and inference; reader's expectation and interpretation; contextual understanding and understanding the whole text; effective note-taking.</li> </ol>			
<b>Section-B</b>				
<ol style="list-style-type: none"> <li>6. implement the notions of speaking</li> <li>7. explain the mechanics in writing</li> <li>8. perform the role of ideal listeners</li> </ol>	<ol style="list-style-type: none"> <li>4. <b>Development of Speaking skills:</b> Art of Good Speaking, Notions and Functions, Speaker-listener Rapport, Intonation and Stress</li> </ol>			
	<ol style="list-style-type: none"> <li>5. <b>Development of Writing Skills:</b> Process of writing, Understanding Academic Writing: features and elements, Mechanics in Writing: Capitalization and Punctuation; Generating ideas for a writing task; Drafting and Supporting ideas with evidence; Integrating data and graphics in texts; Modes of writing, Writing tasks: Paragraph, Essay, Summary, Précis, Report, Abstract, Letter of Application, Assignment, Examination Paper</li> </ol>			
	<ol style="list-style-type: none"> <li>6. <b>Development of Listening Skills:</b> Guide Lines for Developing Listening Skills, Role of a Good Listener, Listening Comprehension.</li> </ol>			

<b>Course: HRM-1157: Fundamentals of Management</b>	<b>Credit : 3.0</b>	<b>Year: First</b>	<b>Term: First</b>
<b>Rationale:</b> Fundamentals of Management course is designed to discuss management theories, functions, concepts, techniques, and practices in the context of complex, dynamic, changing and globalizing business world.			
<b>Course Objectives:</b>			
<ul style="list-style-type: none"> <li>Acquire knowledge of key principles of management and able to critically apply this knowledge to the analysis of a complex case study.</li> <li>Understand and apply a selected management topic to a real organizational setting</li> <li>Have a reflection of contemporary trends in management.</li> <li>Have a strong practical focus and covering latest research studies in the field.</li> </ul>			
<b>Intended Learning Outcomes (ILOs)</b>	<b>Course Content</b>		
<b>Section-A</b>			
At the end of the course the student will be able to -	<b>1. Introduction:</b> Definition, scope, purpose and functions of management; Management Process; Characteristics of a good manager; Kinds of managers; Managerial roles, Managerial skills; The organization's environment.		
<ol style="list-style-type: none"> <li>define management, explain management process, discuss managerial roles, managerial skills.</li> <li>Outline the importance of history and theory, the classical management perspective, the classical management perspective, the behavioral management perspective</li> <li>describe contemporary management issues and challenges.</li> <li>explain management planning and decision making, steps of planning process, rational decisional process.</li> <li>conceptualize objective, management by objectives, describe process of MBO.</li> </ol>	<b>2. Management Theory and Thought:</b> Importance of theory and history; Precursors to management theory; The Classical Management Perspective-Scientific management; Administrative management; The classical management perspective today; The Behavioral Management Perspective- The Hawthorne studies, The Human Relations Movement; The Behavioral Management perspective today, Integrating Perspectives for Managers, The Systems perspective; The contingency perspective, An Integrating Framework; Contemporary Management Issues and Challenges.		
	<b>3. Management Planning and Decision Making:</b> Purposes and goals; Planning process; Organizational plans; Types of strategic alternatives; Barriers of goal setting and planning process; Overcoming the barriers; Types of decision making; Decision making condition; Rational decision making process; Group and Team decision making in the organization.		
	<b>4. Objectives:</b> Nature of objectives-Management by objectives; Process of MBO-Setting objectives; Benefits and weakness of MBO.		
<b>Section-B</b>			
<ol style="list-style-type: none"> <li>define organizing, discuss authority and responsibility, and explain delegation of authority.</li> <li>explain Maslow's hierarchy of needs, ERG theory, two-factor theory, theory of individual human needs, equity theory, reinforcement theory, goal-setting theory, mccllland's theory of need.</li> <li>conceptualize leadership, leadership theory-Michigan studies, Ohio state studies; situational approaches to leadership-LPC theory, path-goal theory.</li> <li>describe controlling, types of control, steps in control process.</li> </ol>	<b>5. Organizing:</b> Designing Jobs, Grouping Jobs: Departmentalization; Establishing reporting relationships; Distributing authority; Coordinating activity; differentiating between positions; Line and staff position.		
	<b>6. Motivation:</b> Definition, Importance, Maslow's hierarchy of needs; ERG theory; Two-factor theory; Theory of individual human needs; Equity theory; Reinforcement theory; Goal-setting theory; McClelland's theory of need.		
	<b>7. Leadership:</b> Definition, Leadership vs. management; Power and leadership; Leadership theory-Michigan studies, Ohio State studies; Situational approaches to leadership-LPC theory; Path-goal theory; Charismatic leadership; Transformational leadership.		
	<b>8. Controlling:</b> Meaning and purpose of control; Types of control; Steps in control process; Characteristics of effective control; Resistance to control; Overcoming resistance to control.		

<b>Course: DS-1159: Introduction to Development Studies</b>	<b>Credit : 3.0</b>	<b>Year: First</b>	<b>Term: First</b>
<p><b>Rationale:</b> This course intends to provide an introduction to the field of development studies by orienting students towards the main debates around the meanings of development, as well as through some of the most exciting new approaches to the development process.</p>			
<p><b>Course Objectives:</b></p> <ul style="list-style-type: none"> <li>• To provide with the knowledge on development and development studies</li> <li>• To orient the students with the theoretical underpinnings on different development issues in Bangladesh</li> <li>• To prepare students develop skills so that they can assess the dynamics of development in Bangladesh</li> <li>• To help students demonstrate applications of major theories of development</li> </ul>			
<b>Intended Learning Outcomes (ILOs)</b>	<b>Course Content</b>		
<b>Section-A</b>			
<p>At the end of the course the students will be able to -</p> <ol style="list-style-type: none"> <li>1. interpret the changing definitions of development over time and space</li> <li>2. critically examine the evolution of development theories</li> <li>3. explain the reasons for vast inequalities which exist in the world today</li> </ol>	<p><b>1. Meaning of Development:</b> Definitions, Dimensions and Interpretations of Development; Key Aspects of Development</p>		
	<p><b>2. Development Studies as a Discipline:</b> Origin and Evolution; Nature, Scope and Focus</p>		
	<p><b>3. History of Development Thought:</b> Ideas and Evolution of Development Thinking; Modern Critics of Development Thinking</p>		
	<p><b>4. Measuring Development:</b> Development Indicators and Uses; Example of Development Indicator- Human development Index; Challenges to Measure Development</p>		
<b>Section-B</b>			
<ol style="list-style-type: none"> <li>4. assess the main components of development in the global South with particular reference to economic, social and environmental processes and issues</li> <li>5. internalize the different roles of development actors and the debates about their role and impact</li> <li>6. assemble different approaches from the macro level of international development agencies to the micro-level of grassroots organizations</li> </ol>	<p><b>5. Issues in Development:</b> Globalization; Poverty and Inequality; Health and Education; Gender; Environment, Sustainability and Climate Change</p>		
	<p><b>6. Global Initiatives for Development:</b> Millennium Development Goals (MDGs); Sustainable Development Goals (SDGs); North-South Cooperation; South-South Cooperation</p>		
	<p><b>7. Civil Society and NGOs for Development:</b> Role of Local and International NGOs; Civil Society and Social Movements; Grassroots Development</p>		
	<p><b>8. Development Aid and International Financial Institutions:</b> Bilateral and Multilateral Donor Agencies and Financial Institutions- DFID, USAID, AusAid, UNDP, ADB, World Bank, IDB, IMF.</p>		

Course: SWE-1201: Soil Chemistry I	Credit : 3.0	Year: First	Term: Second
<p><b>Rationale:</b> This course is designed to provide the basic concepts on chemistry and chemical processes of soil directly and indirectly involved in soil environment nourishing plant growth.</p>			
<p><b>Course Objectives:</b></p> <ul style="list-style-type: none"> <li>To introduce students with the soil components take part in soil chemical phenomena</li> <li>To build the student's knowledge on chemistry of the soil</li> <li>To teach how knowledge of chemistry helps to explain soil functions</li> </ul>			
Intended Learning Outcomes (ILOs)	Course Content		
<b>Section-A</b>			
<p>At the end of the course the students will be able to -</p> <ol style="list-style-type: none"> <li>understand the importance of soil chemistry in the study of soil</li> <li>recognize the importance soil organic matter and humus in relation to the release and retention of plant nutrients</li> <li>define and conceptualize the role of the solution phase of the soil and the chemical processes involved</li> <li>identify the sources of ions that determine pH and explain the pH as a major determinant in soil plant relationship.</li> </ol>	<p><b>1. Introduction:</b> Definition and concept of soil chemistry. Importance of soil chemistry in relation to other soil properties. Scope of soil chemistry in soil science and other subjects. Chemical composition of soil.</p>		
	<p><b>2. Soil organic matter:</b> Definition, sources, and composition of organic matter. Importance of soil organic matter. Humus and its role in agriculture. Carbon and nitrogen in soil organic matter. Factors influencing organic matter status of soil.</p>		
	<p><b>3. Soil solution:</b> Composition and concentration of soil solution and factors controlling them, dynamic equilibria in soil solution, importance of soil solution, movement of salts in soil.</p>		
	<p><b>4. Soil reaction and buffering:</b> Concept of soil pH and pH scale. Sources of H<sup>+</sup> and OH<sup>-</sup> ions in soil. Factors affecting soil pH. Soil pH and agricultural crops. Concept of buffering; soil as a buffer; importance of soil buffering.</p>		
<b>Section-B</b>			
<ol style="list-style-type: none"> <li>explain how size hence surface area of the soil particles contributes in adsorption of water and ions. Describe the degree and strength of ion adsorption and their importance in ion exchange</li> <li>define the basic physicochemical properties of soil indicative to soil conditions</li> <li>name the major cations and anions and mention the estimates of the significant fraction of the elements, and their rates of cycling through the environment</li> </ol>	<p><b>5. Chemical principles:</b> Chemical units, ion-water interactions, solute-solute interactions, activity, ion activity coefficients, complex ions and ion pairs, ionic strength, solubility product, soil reaction coefficients, Thermodynamics, the laws of thermodynamics, free energy, irreversible thermodynamics, kinetics, reaction order and rate constants.</p>		
	<p><b>6. Important Ions:</b> Major cations and anions found in soil solution, various forms of ions, oxidized and reduced state of ions and their importance, interaction of ions, radicals and their significance</p>		
	<p><b>7. Ion exchange phenomenon:</b> Concept of soil colloid and adsorption, definition and types of ion exchange, fundamentals of ion exchange reactions, principles regulating ion exchange phenomena in soil, Cation exchange capacity (CEC) and Anion Exchange Capacity (AEC) of soil colloids and its importance, factors affecting ion exchange reactions in soil. Problems</p>		
	<p><b>8. EC and Eh of soil:</b> Definition and soil properties influencing EC and Eh. Importance of EC and Eh for crop production. Status of EC and Eh of Bangladesh soil</p>		

Course: SWE-1202: Soil Chemistry I Sessional	Credit : 1.5	Year: First	Term: Second
<p><b>Rationale:</b> This course is designed to make students capable of detecting and measuring important soil chemical and physico-chemical parameters.</p>			
<p><b>Course Objectives:</b></p> <ul style="list-style-type: none"> <li>• Teach students to comprehend soil acidity and procedures of their measurement</li> <li>• To teach to measure soil physico-chemical properties</li> <li>• To determine soil organic carbon and proper interpretation for SOC.</li> </ul>			
Intended Learning Outcomes (ILOs)	Course Content		
<p>At the end of the course the students will be able to-</p> <ol style="list-style-type: none"> <li>1. determine and assess soil acidity in various soils and evaluate the importance of soil acidity in agricultural production.</li> <li>2. determine soil EC and Eh in various soils and rank EC and Eh for agricultural production.</li> <li>3. determine and evaluate soil organic carbon in various soils and interpret its meaning.</li> <li>4. determine and identify colloid charges on the basis of soil pH.</li> </ol>	1. Determination of soil acidity		
	2. Determination of EC and Eh of soil		
	3. Determination of organic carbon and organic matter in soil		
	4. The use of $\Delta$ pH in the determination of negative or positive charges of soil		

Course: SWE-1203: Soil Physics I	Credit : 3.0	Year: First	Term: Second
<p><b>Rationale:</b> This course is designed to provide concepts and skills on soil physics and physical properties of soil to evaluate its physical conditions and to manage soil surface to make it suitable for plant growth and increasing productivity potential.</p>			
<p><b>Course Objectives:</b></p> <ul style="list-style-type: none"> <li>• Acquisition of basic knowledge on soil physical properties and their importance to agriculture</li> <li>• Understanding the role of soil physical properties in regulating soil air, soil temperature, soil moisture and their exchange between soil and atmosphere</li> <li>• Understanding and identification of what went wrong about anthropogenic activities and agronomic practices caused damaged to soil physical health and environment.</li> <li>• Application of theoretical knowledge in improvement of soil physical properties that contribute to plant growth.</li> </ul>			
Intended Learning Outcomes (ILOs)	Course Content		
Section-A			
<p>At the end of the course the students will be able to -</p> <ol style="list-style-type: none"> <li>1. explain the role soil physics can play in increasing its agricultural potential.</li> <li>2. Illustrate the interactions among the soil phases</li> <li>3. define soil separates, explain soil textural class, and characterize soil textural classes</li> <li>4. label type of soil structure, express the status of aggregation, relate it with agricultural condition</li> <li>5. list the components of soil color,</li> <li>6. use munsel color book to study soil color in the field,</li> <li>7. relate soil color of the field with moisture regime and drainage condition of the soil.</li> </ol>	<p><b>1. Introduction:</b> Concepts on soil physics, importance of soil physics, role of soil physics - in soil functions (fertility, productivity, filtering, buffering, moisture retention, soil and water pollution, biodiversity, climate change, environmental balance).</p>	<p><b>2. Soil Phases:</b> Definition, measurement and practical relevance of the proportions of the three phases: MaSWE-volume relationship of phases. Problems of bulk density, particle density, porosity, moisture content, mass of soil, volume of soil, degree of saturation, void ratio.</p>	
	<p><b>3. Particle Size Analysis:</b> Definition of soil separates (primary particles), origin and role of soil separates, size distribution of particle in different texture, textural class determination, Stoke's law, textural classification, characteristics of textural groups, effects of texture on other soil properties and soil usage, specific surface of soil.</p>	<p><b>4. Soil Structure (aggregate):</b> Definition, classification, formation, factors affecting aggregate formation and destruction, cultural practices favor aggregate formation and stability, methods of evaluation of aggregate stability, agricultural and environmental significance of soil aggregation and structural stability, consequences of structural degradation.</p>	
	<p><b>5. Soil Color:</b> Definition, components of soil color, factors and conditions that contribute soil color, Munshel color chart, protocol of field study of soil color, significance of soil color study, soil color –soil drainage relationships.</p>		
Section-B			
<ol style="list-style-type: none"> <li>8. compare gravimetric and potential concept of soil water,</li> <li>9. explain importance of soil water.</li> <li>10. classify soil consistency; explain consistency-workability of soil to favor tillage and other cultural operation.</li> <li>11. compare the composition of soil air with atmospheric air;</li> <li>12. explain the process of renewal of soil air (aeration)</li> <li>13. describe the effects of soil temperature on plant growth; ways to modify soil temperature of surface soil.</li> </ol>	<p><b>6. The soil liquid phase:</b> Molecular properties of water, water retention in soil, energy state of water in soil, properties of water near particle surfaces, soil water constants - definition and measurement, surface tension and capillarity, physical, chemical and biological significance of soil water to aggregate stability, erosion and plant growth.</p>	<p><b>7. Soil Consistency:</b> Definition, Atterberg's constants and practical significance of liquid limit, plastic limit, shrinkage limit and plasticity index to tillage and soil mechanics.</p>	
	<p><b>8. The gaseous phase:</b> Composition of soil air and atmospheric air, gaseous exchange-the renewal of soil air, aeration condition and crop growth relationship, importance of aeration, management practices for improvement in aeration, movement of gases, and measurement of soil aeration</p>	<p><b>9. Soil temperature:</b> Factors affecting soil temperature; soil-temperature fluctuations; effects of soil temperature on plant growth, thermal properties of soil: heat capacity, thermal conductivity and diffusivity of soil; measurement of thermal conductivity.</p>	

Course: SWE-1204: Soil Physics I Sessional/Field Work	Credit : 1.5	Year: First	Term: Second
<b>Rationale:</b> This course is designed to deal with determination, interpretation, reasoning, and routing ways of improvement in soil physical environment in soil and the rhizosphere.			
<b>Course Objectives:</b> <ul style="list-style-type: none"> <li>• Acquisition of basic knowledge on soil physical properties and their importance to agriculture</li> <li>• Understanding the role of soil physical properties in regulating soil air, soil temperature, soil moisture and their exchange between soil and atmosphere</li> <li>• Identifying anthropogenic activities and agronomic practices deleterious to soil physical health and environment</li> </ul>			
Intended Learning Outcomes (ILOs)	Course Content		
<p>At the end of the course the students will be able to -</p> <ol style="list-style-type: none"> <li>1. determine the moisture content and infer needs of water supply</li> <li>2. estimate bulk density and rank it as per textural class for root growth in the rhizosphere</li> <li>3. determine textural class by hand-feel and hydrometer method</li> <li>4. construct summation percentage curve</li> <li>5. estimate different aggregation indices</li> <li>6. interpret soil color in filed</li> </ol>	1. Determination of moisture content by gravimetric and tensiometer methods.	2. Determination of bulk density of soil.	3. Determination of particle density of soil.
	4. Determination of textural class in field and laboratory analysis.	5. Determination of particle size distribution.	6. Determination micro-aggregate analysis by dry sieving and wet sieving method.
	7. Field study of soil color.		

Course: SWE-1205: Plant Diversity and Plant Physiology	Credit : 3.0	Year: First	Term: Second
<b>Rationale:</b> The course is designed to provide fundamental and applied knowledge on systematic botany, physiological processes and diversity of plants, and stresses that affect the plants.			
<b>Course Objectives:</b> <ul style="list-style-type: none"> <li>• The course is designed to gather knowledge on systematic botany, behavior of different plants under different conditions.</li> </ul>			
Intended Learning Outcomes (ILOs)	Course Contents		
Section-A			
<p>At the end of the chapter the students will be able to -</p> <ol style="list-style-type: none"> <li>1. explain ways of conservation of plant diversity.</li> <li>2. list the types of plant tissues and tissue systems, characterize them</li> <li>3. state structures, functions and distribution of tissue.</li> <li>4. identify dicot and monocot plants on the basis of their internal structure.</li> <li>5. describe the adaptation strategies of different types of plants under different climatic conditions.</li> <li>6. describe plant succession with their stages.</li> <li>7. identify diseases and their causes and control different plant diseases.</li> </ol>	<b>1. Introduction to Plant Diversity:</b> Definition, causes of plant diversity, role of plant diversity: ecological, economic, scientific, importance of plant diversity in agriculture, types of plant diversity: genetic diversity, species diversity, ecosystem or ecological diversity, functional diversity, threats of plant diversity, consequences of plant diversity declines, conservation of biological diversity.	<b>2. Tissue and Tissue Systems:</b> Definition and classification, characteristics, structures, functions and distribution of different types of plant tissues and tissue systems, origin and development of apical meristem, internal structure of stem, root and leaf of dicot and monocot plants.	<b>3. Adaptation to the Environment:</b> Study of ecological factors in relation to the development of vegetation with particular reference to Bangladesh, adaptations and characteristics of hydrophytes, mesophytes, halophytes and xerophytes, plant succession: definition, causes, types, theories.
	<b>4. Study of Plant Diseases:</b> Definition of plant disease; causes of plant diseases; how do plant pathogens cause disease in plants; plant disease control through cultural and chemical methods; study (causal organisms, symptoms and control) of some common diseases of some economically important crops (rice, wheat, jute, potato, sugarcane) in Bangladesh.		
Section-B			
<ol style="list-style-type: none"> <li>8. define water potential, diffusion, osmosis, plasmolysis and imbibition.</li> <li>9. explain different physiological processes of plants.</li> <li>10. state the mechanism of water and mineral absorption and translocation.</li> <li>11. illustrate the use of growth regulators in the growth and development of plants.</li> <li>12. define and classify stress.</li> <li>13. explain the effects of different stresses on crop production with their mitigation.</li> <li>14. describe photoperiodism and vernalization.</li> <li>15. classify plants on the basis of photoperiod.</li> </ol>	<b>5. Plant Physiological Processes:</b> Photosynthesis: definition, importance, factors of photosynthesis; respiration: definition, mechanism of aerobic and anaerobic respiration; transpiration: definition, types and factors affecting transpiration, significance of transpiration; translocation: definition, role of translocation in plant.	<b>6. Absorption and Translocation of Water and Mineral Nutrients:</b> Water relations-water potential, diffusion, osmosis, plasmolysis and imbibition; concept and related theories of water absorption; ascent of sap-concept and related theories; theories of absorption of mineral nutrients-mechanism.	
	<b>7. Plant Growth Regulators:</b> Concept, characteristics and classification of plant growth regulators, examples and physiological effects of plant growth regulators, importance of growth regulators in the growth and development of plants and plant parts; uses of plant growth regulators in Bangladesh.		
	<b>8. Responses of Plants to Environmental Stresses:</b> Concept of stress and stressful environments, crop production under different stresses; effects of different stresses on plant physiology with mitigation.		
	<b>9. Photoperiodism and Vernalization:</b> concept, critical photoperiod, photoperiodic classification of plants; mechanism of flowering and its role; concept, processes and factors of vernalization, its application in agriculture.		

<b>Course: SWE-1206: Plant Diversity and Plant Physiology Sessional/Field Work</b>	<b>Credit : 1.5</b>	<b>Year: First</b>	<b>Term: Second</b>
<b>Rationale:</b> The course is designed to gain the practical knowledge on plant diversity in nature through field trip and microscopic observation of internal structure as well as physiological processes of some selected plant species.			
<b>Course Objectives:</b> <ul style="list-style-type: none"> <li>• The course is designed to gather knowledge on plant diversity in nature and anatomy of different plants.</li> </ul>			
<b>Intended Learning Outcomes (ILOs)</b>	<b>Course Contents</b>		
<p>At the end of the course the students will be able to -</p> <ol style="list-style-type: none"> <li>1. identify different types of plants on the basis of anatomical structure.</li> <li>2. estimate plant diversity with their types.</li> <li>3. measure chlorophyll pigments and transpiration.</li> <li>4. recognize symptoms of particular plant disease.</li> </ol>	<ol style="list-style-type: none"> <li>1. Study of internal structures of stem, root and leaf of dicot and monocot plants as well as hydrophytes, mesophytes, halophytes and xerophytes.</li> <li>2. Field trip to observe plants adapted to different habitats and identify herbs, shrubs, trees, climbers, epiphytes, sub aerial, terrestrial, aquatic plants, etc. and the seasonal variations in nature in the plant kingdom and submission of reports.</li> <li>3. Study of plant diseases covered in the theory course causing damage to food stuff.</li> <li>4. Determination of chlorophyll pigments by using spectrophotometer.</li> <li>5. Measurements of transpiration.</li> </ol>		

Course: SWE-1207: Geology	Credit : 3.0	Year: First	Term: Second
<p><b>Rationale:</b> The main goal of this course is to expose students to the wonderful world of the geological sciences and to demonstrate the impact of Geology on everyday life. This course is designed to provide preliminary ideas and concepts of earth crust with the general knowledge of minerals, parent rocks, geological processes dynamics in Earth crust and regional geology of Bangladesh.</p>			
<p><b>Course Objectives:</b></p> <ul style="list-style-type: none"> <li>• The student will gain familiarity with the more common minerals and rocks, learn the principles of classification and methods of identification, and will be able to identify them both in hand-specimen and under the microscope.</li> <li>• The student will gain practice in the systematic description of rocks and minerals and appreciate the importance of practical work in geology. To develop the basic recording skills required for mineral and rock description and identification.</li> </ul>			
<b>Intended Learning Outcomes (ILOs)</b>		<b>Course Content</b>	
<b>Section-A</b>			
<p>On successful completion of this module students should be able to -</p> <ol style="list-style-type: none"> <li>1. explain the creation of universe and processes</li> <li>2. describe the common minerals and rocks</li> <li>3. outline the principles of rock and mineral classification</li> <li>4. demonstrate the ability to use both hand-lens and petrological microscope</li> <li>5. develop skills to systematically describe rocks and minerals</li> <li>6. demonstrate knowledge of the importance of practical work in geology</li> </ol>	<ol style="list-style-type: none"> <li>1. <b>Introduction to Geology:</b> Scope of geology, geology and soil formation, creation of the universe, an introductory study of the earth's composition, structure, and internal and external processes; origin of different spheres, continental drift, seismic waves, their characteristics &amp; application.</li> </ol>		
	<ol style="list-style-type: none"> <li>2. <b>Mineralogy:</b> Elements of crystal chemistry and aspects of crystal structures; minerals: definition and classification, physical and chemical composition of common rock-forming minerals; hand specimen identification of both silicate and non-silicate minerals.</li> </ol>		
	<ol style="list-style-type: none"> <li>3. <b>Petrology:</b> Rock types, the rock cycle, igneous rocks; definition, classification, characteristics of intrusive &amp; extrusive igneous rocks, various forms of igneous rocks, structure &amp; texture of igneous rocks, common igneous rocks.</li> </ol>		
	<ol style="list-style-type: none"> <li>4. <b>Sedimentary rocks:</b> Sedimentary Processes: Introduction to basic concepts: description and classification of sedimentary rocks, sedimentary environments, common sedimentary rocks; sedimentary texture, sedimentary structures.</li> </ol>		
	<ol style="list-style-type: none"> <li>5. <b>Metamorphic rocks:</b> Metamorphism, agents of metamorphism, kinds of metamorphism, depth of metamorphism, facies and grades of metamorphism, texture and structure of metamorphic minerals, classification &amp; nomenclature of metamorphic rocks.</li> </ol>		
<b>Section-B</b>			
<ol style="list-style-type: none"> <li>7. conceptualize relative and numerical age of rocks.</li> <li>8. correlate rocks with their time formation</li> <li>9. explain different types of formations of structural geology: joint, fold and faults</li> <li>10. define supercontinent and various forms of natural disasters worldwide</li> </ol>	<ol style="list-style-type: none"> <li>6. <b>Geologic Principles:</b> Uniformitarianism, major branches of Geology, numerical age (radiometric decay, dating technique, choice of isotopic system, C-14 dating), physical principles used to determine relative age.</li> </ol>		
	<ol style="list-style-type: none"> <li>7. <b>Paleontology:</b> Various types of contacts, types of unconformity, correlations, fossils (rock type, preservation), and geologic time scale.</li> </ol>		
	<ol style="list-style-type: none"> <li>8. <b>Structural Geology:</b> Mechanical principles (stress and strain), fold (definition, attribute of beds, strike, deep, parts of a fold, nomenclature of folds, causes of folding), joint, fault.</li> </ol>		
	<ol style="list-style-type: none"> <li>9. <b>Geologic Maps:</b> Introduction to topographic maps, geologic maps and satellite imagery: maps, projections, scale, location system (longitude &amp; latitude), world time, GMT and international date line, remote sensing, radar imaging.</li> </ol>		
	<ol style="list-style-type: none"> <li>10. <b>Disasters:</b> Supercontinent and various natural disasters.</li> </ol>		

<b>Course: SWE-1208: Geology Sessional/Field Work</b>	<b>Credit : 1.5</b>	<b>Year: First</b>	<b>Term: Second</b>
<b>Rationale:</b> This course is introduced to study and recognition of common minerals and rocks in hand specimen.			
<b>Course Objectives:</b> <ul style="list-style-type: none"> <li>• To teach students to identify igneous, sedimentary and metamorphic rocks, and to characterize the major differences between rock types</li> <li>• To teach students about key properties of minerals and use them for mineral identification.</li> </ul>			
<b>Intended Learning Outcomes (ILOs)</b>	<b>Course Contents</b>		
<p>At the end of the course a student should be able to -</p> <ol style="list-style-type: none"> <li>1. explain the causes of the principal physical properties of minerals</li> <li>2. identify and characterize common igneous, sedimentary and metamorphic rocks</li> <li>3. identify and characterize common minerals</li> <li>4. give an account of the basic structure and composition of the most important rock-forming minerals</li> </ol>	<ol style="list-style-type: none"> <li>1. Minerals differ from each other in chemical composition and architecture, and these factors produce distinctive physical properties that enable minerals to be identified.</li> </ol>	<ol style="list-style-type: none"> <li>2. Physical Properties: Color, luster, streak, hardness, cleavage, fracture, and crystal form are the most useful physical properties for identifying most minerals. Other properties-such as reaction with acid, magnetism, specific gravity, tenacity, taste, odor, feel, and presence of striations are helpful in identifying certain minerals</li> </ol>	
	<ol style="list-style-type: none"> <li>3. Identification of igneous, sedimentary and metamorphic rocks</li> </ol>	<ol style="list-style-type: none"> <li>4. Field observations of minerals and rocks of Bangladesh.</li> </ol>	

Course: Soc-1253: Principles of Sociology	Credit Hour: 3.0	Year: First	Term: Second
<p><b>Rationale:</b> The course is designed to introduce students to the basic concepts, theories and methods of Sociology. This course will pay attention to the meaning of ‘think sociologically’ and how this differs from other ways of observing the world around us. It will focus on the systematic understanding of social relations, social interaction, social structure, social organization, social institution, culture and social change. This course will also introduce students to key issues addressed by contemporary sociologists; i.e. social class, social stratification and inequality, deviance and crime, economy and work, politics, mass media, population, health, environment and so on.</p>			
<p><b>Course Objective:</b></p> <ul style="list-style-type: none"> <li>• To acquaint with the students with the overview of Sociology as distinct Discipline within the social sciences, the basic concepts, theories and methods that sociologists use</li> <li>• To develop a concept of social structures, social forces and individual circumstances to link their own lives and significant relationships are shaped by larger social forces</li> <li>• To increase awareness among students on the social world and to reply sociological knowledge to their personal and social life</li> </ul>			
Intended Learning Outcomes (ILOs)	Course Content		
Section-A			
<p>At the end of the course the students will be able to -</p> <ol style="list-style-type: none"> <li>1. define and describe the sociology and its nature and importance</li> <li>2. differentiate among society, group, community, association and institution.</li> <li>3. define culture and civilization and related theories; compare between culture and civilization,</li> <li>4. explain the theories and agents of socialization</li> <li>5. define family and explain function and position of family in Bangladesh.</li> <li>6. differentiate between horizontal and vertical mobility.</li> </ol>	<p><b>1. Understanding Sociology:</b> Definition, Nature and Scope of Sociology, Development of Sociology, Major Theoretical perspectives of Sociology, Research in Sociology, Necessity of Sociology.</p>		
	<p><b>2. Basic concepts:</b> society; community; association; institution; group; norms; values and Social process.</p>		
	<p><b>3. Culture and Social Structure:</b> Meaning and Elements of Culture, Development of culture around the World, culture and civilization, definition and Elements of Social Structure, Social Structure in global perspective.</p>		
	<p><b>4. Socialization and Institutions:</b> Meaning, Theories and Agents of Socialization, Major Institutions- Family, Marriage, kinship, Property, Division of Labor, Religion, Education and State.</p>		
	<p><b>5. Social stratification and Inequality:</b> Definition and Theories of Social stratification, Determinants and Forms of Social stratification; Meaning, Determinants and Dimensions of Social Inequality; Social Mobility.</p>		
Section-B			
<ol style="list-style-type: none"> <li>7. define social change and identify its causes and results/consequences</li> <li>8. describe social control and explain the roles of agencies in social control.</li> <li>9. interpret importance of mass media communication technology in social life</li> <li>10. interpret crime, juvenile delinquency, unemployment and illiteracy problem.</li> <li>11. explain different theories of population describe adverse effect on environment.</li> <li>12. differentiate social structure of different era of Bangladesh and describe changing political systems and social problems of Bangladesh</li> </ol>	<p><b>6. Changing World:</b> Types of Society; Social Change; Theories of Social Change, Resistance to Social Change, Technology and Social Change, Urbanization, Industrialization and Social Change.</p>		
	<p><b>7. Mass Media, Communication and Collective Behavior:</b> Meaning and Sociological perspectives of Mass Media and Communication; Forms and Theories of Collective Behavior, New Communication Technology and Collective Behavior.</p>		
	<p><b>8. Deviance, Crime and Social Control:</b> Meaning and Theories of Deviance and Crime; Juvenile Delinquency; definition and Agents of Social Control.</p>		
	<p><b>9. Population and Environment:</b> Theories on Population; Basic Demographic Process; Population and Environment.</p> <p><b>10. Changing Society of Bangladesh:</b> Social Structure of Colonial Bangladesh; neo-Colonialism and the Emergence of Bangladesh; Changing Political system and Social Problems of Bangladesh.</p>		

<b>Course: CSE-1254: Word Processing and Spread Sheet Analysis</b>	<b>Credit : 1.5</b>	<b>First: Year</b>	<b>Term: Second</b>
<b>Rationale:</b> This course is designed to provide basic knowledge on computer, Microsoft office and spread sheet package.			
<b>Objectives:</b> <ul style="list-style-type: none"> <li>• To acquaint students with the basic principles and fundamental applications of computer.</li> </ul>			
<b>Intended Learning Outcomes(ILOs)</b>	<b>Contents</b>		
At the end of the course the students will be able to - 1. apply the principles of word processing and spread sheet analysis	1. Introduction to computer.		
	2. Detailed practice of word processing using contemporary word processing packages.		
	3. Spread sheet analysis using contemporary spread sheet packages.		

Course: Math-1267: Mathematics	Credit -3.0	Year-First	Term-Second
<b>Rationale:</b> The course is designed to serve students practical skills related to higher mathematics.			
<b>Objectives:</b>			
<ul style="list-style-type: none"> <li>To develop the ability of students to apply their practical knowledge and skills to the solution of theoretical and practical problems of mathematics.</li> </ul>			
Intended Learning Outcomes (ILOs)	Course Content		
Section-A			
<p>At the end of the course the students will be able to -</p> <ol style="list-style-type: none"> <li>various types of arrangements will be made by permutation and combination.</li> <li>introduce addition, subtraction, multiplication and inverse of matrices to solve the algebraic equations.</li> <li>interpret variables, functions and their graphs.</li> <li>plotting limit, continuity properly and differentiate the nature of the functions.</li> <li>differentiae various types of functions.</li> <li>apply differentiation.</li> </ol>	<b>Differential calculus</b>		
	1. Functions- Understanding the geometric behavior of elementary functions and families of curves-		
	2. $y = mx + c, y = x^n, y = \frac{1}{x^n}, \log x, \ln x, e^x$ .		
	3. Basics concepts of limit and continuity		
	4. Differentiation of different types of functions e.g. parametric and explicit etc. differentials, differentiability and physical meaning of differentiation; application of differentiation.		
	5. Basics of Successive and partial differentiation		
	6. Maxima and minima		
Section-B			
<ol style="list-style-type: none"> <li>conceptualize of integration and its nature.</li> <li>measure length of something by definite integral</li> <li>calculate area and volume of some surfaces.</li> <li>elaborate concepts of geometry on positioning an object, perpendicularity and parallel conditions.</li> <li>shift axes and origin in various ways of positioning</li> </ol>	<b>Integral calculus:</b>		
	7. Basics of integration: definite and indefinite, proper and improper integrals, antiderivative physical meaning of integration.		
	8. Integration by method of substitution		
	9. Integration by parts		
	10. Definite integrals; properties of definite integrals.		

Course: SWE-2101: Soil Mineralogy	Credit: 3.0	Year: Second	Term: First
<p><b>Rationale:</b> This course presents the fundamental concepts of soil and clay mineralogy that are important to agriculture, environment, geology, toxicology and engineering applications and problems.</p>			
<p><b>Course Objectives:</b></p> <ul style="list-style-type: none"> <li>To become familiar with the structure of common soil minerals and their chemical and physical properties</li> <li>To develop an understanding of the general distribution of minerals in soils/sediments and how it is influenced by environmental conditions</li> <li>To learn some of the basic techniques and procedures used for mineralogical characterization of soils and sediments.</li> </ul>			
Intended Learning Outcomes ( ILOs)	Course content		
Section-A			
<p>At the end of the course the students will be able to -</p> <ol style="list-style-type: none"> <li>gather knowledge about minerals and their behavior in soils.</li> <li>demonstrate the composition of clay minerals and their behavior in natural environment.</li> <li>explain the importance of clay minerals in agriculture, environment and engineering applications.</li> </ol>	<p><b>1. An Introduction to Mineralogy:</b> Scope of soil minerals; some crystallographic concepts; chemical and structural classification of minerals; phyllosilicate minerals in soils; aluminosilicate minerals with short range order.</p>		
	<p><b>2. Surface Chemistry of Soil Minerals:</b> Nature of mineral surfaces; processes at mineral Surface.</p>		
	<p><b>3. Kaoline Minerals:</b> Structural properties of kaolin Minerals; morphological characteristics of kaolinite and halloysite; formation of kaolin; occurrence of kaolin minerals in soils; chemical properties of kaolinite; identification of kaolinite and halloysite.</p>		
	<p><b>4. Smectite Minerals (expandable and non-expandable):</b> Structural properties and mineral identification of smectites, vermiculites and micas; their weathering and synthesis relationships, natural occurrence, chemical and physical properties; distribution in soils; identification of smectites, vermiculites and micas.</p>		
	<p><b>5. Carbonate, Halide, Sulfate and Sulfide Minerals:</b> Natural occurrence, crystallography, formation and stability; identification and impact on soils.</p>		
Section-B			
<ol style="list-style-type: none"> <li>distinguish chlorite and interlayered vermiculite and smectite as well as make a comparison about their environmental condition.</li> <li>explain the role of highly weatherable aluminium and iron oxides minerals in soils.</li> <li>illustrate feldspars, olivines, pyroxenes and amphiboles.</li> <li>apply the principles of common soil mineral analysis methods and instruments.</li> </ol>	<p><b>6. Chlorites and Hydroxy-Interlayered Vermiculite and Smectite:</b> Origin and source of chlorite; structural properties and mineral identification of chlorite; weathering of chlorite minerals; structural properties and mineral identification of hydroxy-interlayered vermiculite and (HIV) and smectites (HIS).</p>		
	<p><b>7. Interstratification in Layer Silicates:</b> Formation of interstratified minerals; mica-vermiculite; mica-smectite; mechanism of regular interstratifications; regular interstratifications; random stratification.</p>		
	<p><b>8. Aluminium Oxides, Oxyhydroxides and Iron Oxides:</b> Nomenclature and structural properties; mechanism of formation; gibbsite, goethite and hematite in soils; reactions in soils, methods of identification and determination.</p>		
	<p><b>9. Feldspars, Olivines, Pyroxenes, and Amphiboles:</b> Structural properties and mineral identification; natural occurrence, physicochemical properties, quantitative determination.</p>		
<p><b>10. Identification Clay Minerals:</b> Principle and application of XRD; FTIR; thermal analysis; optical microscopy and chemical analysis for the identification of soil clay minerals.</p>			

<b>Course: SWE-2102: Soil Mineralogy Sessional/Field Work</b>	<b>Credit: 1.5</b>	<b>Year: Second</b>	<b>Term: First</b>
<b>Rationale:</b> This course focuses on identification, quantification, and characterization of the soil minerals. State-of-the-art instruments including a XRD, FTIR and SEM will be used for the analysis with chemical characterization.			
<b>Course Objectives:</b> <ul style="list-style-type: none"> <li>• Use of analytical methods such as XRD, FTIR for identifying well-crystallized phases and electron microscopy, SEM for studying the morphology of soil minerals, their crystallinity and their chemical composition.</li> </ul>			
<b>Intended Learning Outcomes (ILOs)</b>		<b>Course content</b>	
At the end of the course the students will be able to - <ol style="list-style-type: none"> <li>1. identify and quantify common soil minerals in soils, clays and sediments.</li> <li>2. apply the principles of common soil mineral analysis methods and instruments, know the advantages and limitations of each method and instrument.</li> </ol>		<b>1. Preparation of Soil Samples for Identification:</b> Removal of cementing agents, SOM and calcium carbonate; Sand, Silt and Clay fractionation for minerals identification.	
		<b>2. XRD analysis:</b> Ca/Mg and K saturation of clay fractions for XRD analysis along with silt and sand fractions.	
		<b>3. FTIR:</b> FTIR analysis of clay fractions.	
		<b>4. SEM:</b> Scanning electron microscope observation of soil samples for the identification of soil minerals.	

<b>Course: SWE-2103: Water Resources and Water Quality</b>	<b>Credit: 3.0</b>	<b>Year: Second</b>	<b>Term: First</b>
<b>Rationale:</b> This course is designed to provide ideas about water resources and its quality for different uses.			
<b>Course Objectives:</b>			
<ul style="list-style-type: none"> <li>To understand the students about the sources of water, water quality, uses, water policy and water quality challenges and impacts.</li> </ul>			
<b>Intended Learning Outcomes (ILOs)</b>	<b>Course content</b>		
<b>Section A</b>			
<p>At the end of the course the students will able to-</p> <ol style="list-style-type: none"> <li>classify the different sources of water.</li> <li>explain the groundwater situation and problems in ground water development.</li> <li>calculate water quantity.</li> <li>identify the water quality impacts.</li> <li>assess the water quality standards.</li> </ol>	<b>1. Sources of Water:</b> Introduction; hydrological cycle; surface water; groundwater: ground water aquifer, flow towards wells; groundwater in Bangladesh: problems in ground water development.		
	<b>2. Water Quantity and Water Quality:</b> Water quantity: population projection, per capita water consumption; Water quality: impurities and their effects, sources and significance of selected water quality parameters, water quality standards; Bangladesh national drinking water quality; groundwater quality of Bangladesh.		
	<b>3. National Water Policy:</b> Objectives, planning and management; river basin management; economic and financial management; research and information management; stakeholder participation; institutional policy.		
	<b>4. Water Quality Challenges and Impacts:</b> Sources of pollution; strategies to negotiate water quality problems; restoration and protection of water body and ecosystems; clean water for today and tomorrow.		
<b>Section B</b>			
<ol style="list-style-type: none"> <li>demonstrate the importance of water supply, sources and collection systems.</li> <li>use different water supply technologies, its construction and maintenance.</li> <li>construct water resource projects.</li> <li>analyze the concept of water quality monitoring in global scale as well as Bangladesh perspective.</li> </ol>	<b>5. Introduction to Water Supply:</b> History and development of water supply (both national and global scale); objectives of water supply; Importance of water supply; elements of water supply; sources of supply, collection system, treatment, distribution system.		
	<b>6. Water Supply Technologies:</b> Technological options; dug well; tube-well, shallow tube-well; deep tube-wells; alternative water supply technologies: shallow and very shallow tube-well, pond sand filter, household filters, infiltration well/gallery, rainwater harvesting, solar desalination.		
	<b>7. Water Resource Projects:</b> Introduction; physical factors; economic considerations; environmental effects; adverse effects of dams and reservoirs on environment; pre-construction investigations; choice of dams; planning of reservoirs.		
	<b>8. Water Quality Monitoring:</b> Introduction; concept; monitoring in relation to use; components of a monitoring program; quality assurance and control; water quality monitoring in developing countries and global scale.		

<b>Course: SWE-2104: Water Resources and Water Quality Sessional/Field Work</b>	<b>Credit : 1.5</b>	<b>Year: Second</b>	<b>Term: First</b>
<b>Rationale:</b> This course is designed to provide analytical knowledge on water quality.			
<b>Course Objectives:</b>			
<ul style="list-style-type: none"> <li>To analyze water quality parameters and interpret the results.</li> </ul>			
<b>Intended Learning Outcomes (ILOs)</b>	<b>Course content</b>		
<b>Section A</b>			
At the end of the course the students will able to - <ol style="list-style-type: none"> <li>1. collect and preserve water sample for laboratory analysis.</li> <li>2. calculate the quantity of water for a particular region.</li> <li>3. grade water based on different water quality parameters.</li> </ol>	1. Water sample collection and preservation		
	2. Calculation of water quality.		
	3. Analysis of water quality: Laboratory analysis of different parameters of water sample and grading		
	4. Water quality monitoring		

Course: SWE-2105: Environmental Chemistry	Credit: 3.0	Year: Second	Term: First
<b>Rationale:</b> This course involves a study of soil, water and atmospheric chemistry as well as the associated air, water and soil pollution.			
<b>Course Objectives:</b> <ul style="list-style-type: none"> <li>• To acquire knowledge on soil, water and atmosphere as an environmental component and their chemistry</li> <li>• To understand the mechanisms which pollutants can affect the quality of soil, air and water</li> </ul>			
Intended Learning Outcomes(ILOs)	Course content		
Section-A			
<p>At the end of the course the students will be able to -</p> <ol style="list-style-type: none"> <li>1. generalize the concept of environmental chemistry and its relation with different components of environment.</li> <li>2. explain basic concepts of geosphere and its interaction with air, water, and human</li> <li>3. demonstrate basic concepts of water chemistry and water pollution</li> </ol>	<ol style="list-style-type: none"> <li>1. <b>Concept and Introduction of Environmental Chemistry:</b> Concept of environmental chemistry, environmental science, environmental biochemistry; environmental chemistry and its interactions among water, air, earth, life and the atmosphere; concept of ecology and the biosphere; energy and cycles of energy; matter and cycles of matter; human impact and pollution; Technology: the problems it poses and the solution it offers.</li> <li>2. <b>The Geosphere and Geochemistry:</b> The nature of solids in the geosphere; physical form of the geosphere; clays and geochemistry; environmental aspects of the geosphere; surface earth movement; phenomena at the land/ocean interface; phenomena at the land/atmosphere interface; effects of human activities; air and water pollution and the geosphere; waste pollution and the geosphere.</li> <li>3. <b>Atmospheric Chemistry and Air Pollution:</b> Composition of atmosphere, important physical and chemical properties of the atmosphere, biological and non-biological forces affecting the atmosphere, stratospheric chemistry – the ozone layer, the ozone holes, the chemistry of ground level air pollution, sources of air pollution, the environmental and health consequences of polluted air – outdoors and indoors.</li> <li>4. <b>Water Chemistry and Water Pollution:</b> Chemical and physical properties of water; important natural water reservoirs; sources, classes and reactions of pollutants in water; remediation of polluted water; wastewater and drinking water treatment: monitoring, assessment, and regulation of water quality.</li> </ol>		
Section-B			
<ol style="list-style-type: none"> <li>4. describe the greenhouse effect, climate change; distinguish between fossil fuels and renewable energy technologies.</li> <li>5. identify hazardous wastes and explain their effect on the environment and remediation technologies.</li> <li>6. develop an understanding of green chemistry and its effect on the environment.</li> <li>7. discuss on the different sources of soil pollution as well as different types of pollutants and identify the different types of soil remediation methods, their application fundamentals and their major advantages and constraints.</li> </ol>	<ol style="list-style-type: none"> <li>5. <b>The Greenhouse Effect, Climate Change, Fossil Fuels and CO<sub>2</sub>:</b> The greenhouse effect; energy use, fossil fuels, CO<sub>2</sub> emissions, and global climate change; biofuels and other alternative fuels; renewable energy technologies: hydroelectric, wind, solar, geothermal, and marine energy, and their storage; radioactivity, radon, and nuclear energy.</li> <li>6. <b>Environmental Chemistry of Hazardous Wastes:</b> Sources of waste; classification of hazardous substances and wastes; reactive, corrosive and toxic substances; physical and chemical properties of hazardous wastes; hazardous wastes in the geosphere, hydrosphere, atmosphere, and biosphere; processes for waste minimization, utilization and treatment – chemical treatment, thermal treatment, biodegradation, land treatment and composting.</li> <li>7. <b>Green Chemistry:</b> Concept of green chemistry; principle of green chemistry; components of green chemistry; application of green chemistry for waste minimization, utilization and treatment.</li> <li>8. <b>Toxic elements and compounds:</b> Toxic heavy metals; pesticides; dioxins, furans, and PCBs; other toxic compounds of environmental.</li> <li>9. <b>Soil Pollution and Remediation:</b> Soil pollution; pollutants and contaminants, classification and effects; transport mechanisms of pollution through soil; control of soil pollution–different remediation technologies like physical, chemical and biological.</li> </ol>		

<b>Course: SWE-2106: Environmental Chemistry Sessional/Field Work</b>	<b>Credit: 1.5</b>	<b>Year: Second</b>	<b>Term: First</b>
<b>Rationale:</b> This course involves a study of sampling, quantitative detection and data analysis soil, water and atmospheric samples. More specifically this course highlights a study of the soil, water and air pollution and their remediation process.			
<b>Course Objectives:</b>			
<ul style="list-style-type: none"> <li>• To acquire practical knowledge on the sampling and lab techniques for soil, water and atmospheric samples.</li> <li>• To understand how anthropogenic activities affect their chemistry on planet earth and</li> </ul>			
<b>Intended Learning Outcomes (ILOs)</b>		<b>Course content</b>	
At the end of the course the students will be able to -		<b>1. Water quality:</b> Collection of water samples from industrial sites, lakes, rivers, and tube wells and make a comparison where relevant.	
1. demonstrate sampling process of soil, water and air samples for laboratory as well as research purposes.		<b>2. Soil Quality:</b> Collection of soil samples from agricultural fields (far and adjacent near highway), industrial sites and near brick fields; prepare soil samples and analysis, particularly highlight the heavy metals and toxic compounds in soils.	
2. associate the data from different sources and make a conclusion/recommendation		<b>3. Air Quality:</b> Determine the air quality in different sites (Urban, rural and industrial areas).	
3. represent the methodology for the analysis of soil, water and air samples		<b>4. Acid rain:</b> Make a laboratory experiment to find out the effect of acid rain on soil and aquatic system.	
4. generalize the effect of anthropogenic activities on different environmental components.			

Course: SWE-2107: Surface Chemistry	Credit: 3.0	Year: Second	Term: First
<p><b>Rationale:</b> This course is designed to provide preliminary ideas and concepts of surface chemistry.</p>			
<p><b>Course Objectives:</b></p>			
<ul style="list-style-type: none"> <li>• To acquire basic knowledge on surface chemistry.</li> <li>• To understand the various processes of surface chemistry taking place in soil environment.</li> <li>• To apply surface chemistry for the development of soil productivity.</li> </ul>			
<p><b>Intended Learning Outcomes (ILOs)</b></p>		<p><b>Course content</b></p>	
<p><b>Section-A</b></p>			
<p>At the end of the course the students will be able to -</p> <ol style="list-style-type: none"> <li>1. define the basic terminologies in surface chemistry.</li> <li>2. explain the charge development processes and various colloidal characteristics.</li> <li>3. apply surface chemistry knowledge for different purposes.</li> </ol>	<p><b>1. Properties of Colloids:</b> Colloidal characteristics: size, shape, surface area, adsorption; tyndall effects, hydration, swelling, plasticity, adhesion; cohesion, shrinkage and movement.</p>		
	<p><b>2. Formation and Stability of sols:</b> Condensation, dispersion, purification of sols; definition, stabilization of sols; coagulation (precipitation) of sols, precipitation, coagulation methods</p> <p><b>3. Development of charges on Colloids:</b> i) adsorption of ions from medium, ii) ionization of surface groups (pH dependant charge), iii) isomorphous substitution.</p>		
	<p><b>4. Electrophoresis (cataphoresis):</b> Principle, procedure and application of electrophoresis and electro-osmosis in colloid chemistry, comparison of pure colloidal system and soil colloidal system.</p>		
	<p><b>Section-B</b></p>		
<ol style="list-style-type: none"> <li>4. describe the diffuse double layer of soil colloids.</li> <li>5. classify the adsorption phenomena and describe the adsorption equations.</li> <li>6. demonstrate the mechanisms of adsorption by different forces and by different soil components by soil colloids.</li> </ol>	<p><b>5. Surface Chemistry:</b> Definition, properties and classification of colloids: i) on the basis of the deformation of colloidal particles, ii) the state of aggregation, iii) the affinity of sol particles for the medium;</p>		
	<p><b>6. Surface behavior of colloids:</b> Adsorption; types of adsorption; adsorption characteristics; forces of adsorption; adsorption isotherms-Freundlich equation; Langmuir equation, Brunauer, Emmett and Teller equation, Gibbs Equation.</p>		
	<p><b>7. Adsorption of water and ions:</b> Organic compounds by soil colloids, interparticle attraction, adsorption of cations and anions by soil colloids.</p>		
	<p><b>8. Double layer theory:</b> Introduction to double layer and triple layer theories of soil colloids; function and importance of double layer.</p>		

Course: SWE-2108: Surface Chemistry Sessional	Credit : 1.5	Year: Second	Term: First
<b>Rationale:</b> This course is designed to provide preliminary ideas and concepts of soil as a functional medium of plant growth.			
<b>Course Objectives:</b> <ul style="list-style-type: none"> <li>• To acquire basic knowledge on colloidal behavior of soil.</li> <li>• To understand the various colloidal system and their practical implication.</li> <li>• To conceptualize the impact of various soil colloids on plant growth.</li> </ul>			
Intended Learning Outcomes (ILOs)	Course content		
At the end of the course the students will be able to - <ol style="list-style-type: none"> <li>1. determine the ion exchange phenomena and specific surface area.</li> <li>2. measure the influence of lyotropic series on ion exchange.</li> <li>3. identify clay types.</li> <li>4. determine and calculate CEC, PBS, ESP, SAR and their application in soil.</li> </ol>	<ol style="list-style-type: none"> <li>1. Demonstrating surface area and ion exchange phenomenon,</li> </ol>	<ol style="list-style-type: none"> <li>2. Effect of lyotropic series on ion exchange,</li> <li>3. Behavior of different types of clays,</li> </ol>	<ol style="list-style-type: none"> <li>4. Cation exchange capacity, percent base saturation, sodium adsorption ratio, and exchangeable sodium percentage.</li> </ol>

<b>Course: SS -2109: Fundamentals of Geography and Environment</b>	<b>Credit: 3.0</b>	<b>Year: Second</b>	<b>Term: First</b>
<b>Rationale:</b> This course is designed to provide the basic knowledge on physical geography, solar system, atmosphere, pollution, global warming and environmental laws.			
<b>Course Objectives:</b>			
<ul style="list-style-type: none"> <li>• To strengthen the students understanding of physical geography.</li> <li>• To teach students about solar and atmospheric system.</li> <li>• To understand the environmental pollution and its management.</li> </ul>			
<b>Intended Learning Outcomes (ILOs)</b>	<b>Course content</b>		
<b>Section-A</b>			
<p>At the end of the course the students will be able to -</p> <ol style="list-style-type: none"> <li>1. define and explain solar system.</li> <li>2. demonstrate the universe and its components.</li> <li>3. explain earthquake, its cause and effects.</li> </ol>	<b>1. Introduction:</b> Introduction to geography. solar system: sun, mercury, venus, earth, mars, jupiter, saturn, moon, uranus, neptune, pluto, asteroids.		
	<b>2. Introduction to Galaxy:</b> Galaxy, milky way, comet, nebula, star. equator, longitude, latitude, international date line, local time, GMT.		
	<b>3. Earthquake:</b> Volcano, dormant volcano, dead volcano, tsunami, mountain, plateau, plains.		
	<b>4. Introduction to atmosphere:</b> Atmosphere, troposphere, stratosphere, mesosphere, thermosphere		
	<b>5. Wind:</b> Trade wind, antitrade wind, polar wind, periodical wind, sea breeze, land breeze, monsoon, sand dunes. cyclone, typhoon, tornado, hurricane, tide, ebb, hot surface current, cold under current, convention current.		
<b>Section-B</b>			
<ol style="list-style-type: none"> <li>4. explain the effects of greenhouse gases, global warming and its effects.</li> <li>5. demonstrate the management of environment, policy and law.</li> </ol>	<b>6. Introduction and concept of Environment:</b> Greenhouse gases, CFCs, sources and sinks of greenhouse gases.		
	<b>7. Global Warming:</b> Ozone layer destruction, methane flux, effects of deforestation, acid rains-their impact on soil, plant, water and air.		
	<b>8. Introduction to pollution:</b> Pollution of soil, water and air, sewage sludge, industrial effluents, city wastes, agrochemicals, fossil fuels, radioactive materials, arsenic pollution-severity of arsenic pollution in Bangladesh.		
	<b>9. Environmental management:</b> Bioremediation, phytoremediation and biotechnological approach in environmental management. environmental laws, policy and decision-making.		

<b>Course: CSE-2152: Database Systems Sessional</b>	<b>Credit: 1.5</b>	<b>Year: Second</b>	<b>Term: First</b>
<b>Rationale:</b> This course is designed to provide basic knowledge on database, input and output designs, data query and analysis of data using statistical package.			
<b>Course objectives:</b>			
<ul style="list-style-type: none"> <li>To acquaint students with the basic principles and fundamental applications database, input and output designs, data query and analysis of data using statistical package.</li> </ul>			
<b>Intended Learning Outcomes (ILOs)</b>	<b>Course content</b>		
At the end of the course the students will be able to -  <b>1.</b> apply the principles of data base and statistical Package	<b>1.</b> Concept on database		
	<b>2.</b> Input and output designs		
	<b>3.</b> Data query		
	<b>4.</b> Analysis of data using statistical packages		

Course: Econ-2155: Economics	Credit: 3.0	Year: Second	Term: First
<b>Rationale:</b> The course is designed to provide knowledge on basics of basic and agricultural Economics, demand-supply, consumer behavior, agricultural Finance, farm management, agricultural Marketing and land tenure system.			
<b>Course Objectives:</b> <ul style="list-style-type: none"> <li>To teach the students about basics of agricultural Economics, demand-supply, consumer behavior, agricultural Finance, farm management, agricultural Marketing and land tenure system so that they can realize accurate the demand supply situation, consumers' behavior, mode of agri. financing, manage farm effectively, identify the market constraints etc.</li> </ul>			
Intended Learning Outcomes (ILOs)	Course content		
<b>Section-A</b>			
<p>At the end of the course the students will be able to -</p> <ol style="list-style-type: none"> <li>define agricultural economics, its scope, basic concepts and tools.</li> <li>explain demand-supply equilibrium, determinants, curves and their application.</li> <li>apply the theory of consumer behavior.</li> <li>apply the theory of production and firm.</li> <li>define international trade and its classical theory and gains from international trade.</li> </ol>	<ol style="list-style-type: none"> <li><b>1. Introduction:</b> Definition and scope of economics and agricultural economics; concept of- scarcity, commodity, production, distribution, consumption; solution of basic economic problems; production Possibility Curve (PPC).</li> <li><b>2. Demand and supply:</b> Concept of demand and supply, law of demand and supply, determinants of demand and supply; demand and supply functions, equations, schedules and curves; market equilibrium.</li> <li><b>3. Theory of production:</b> Factors of production; production function; stages of production; returns to scale; iso-quant and iso-cost curve; producer's equilibrium; cost and revenue; market structure.</li> <li><b>4. Introduction to macroeconomics and Bangladesh economy:</b> Basic macroeconomic concepts-GNP, GDP, NNP, NI, PI, DI; methods of measuring national income; overview of the economy of Bangladesh; major sectors of the economy and their contributing to national income.</li> </ol>		
<b>Section-B</b>			
<ol style="list-style-type: none"> <li>define agricultural finance and banking and related issues.</li> <li>identify the sources, nature and role of rural money market, impact of informal credit system on agriculture.</li> <li>explain the functions of different types of banking in Bangladesh.</li> <li>identify the role of agriculture in economic development, characteristics of agriculture and problems of agricultural development in Bangladesh.</li> <li>explain the role of land tenure in agriculture; owner operator, sharecropper; land reforms in Bangladesh</li> <li>describe market structure; agricultural marketing-cost, margin, efficiency, intelligence, grading, integration; imperfections in agricultural marketing in LDC's.</li> </ol>	<ol style="list-style-type: none"> <li><b>5. Agricultural finance:</b> Definition of money, value of money and inflation, sources of capital and credit; nature and role of rural money market; impact of informal credit system on agriculture; indebtedness and rural poverty in Bangladesh; central bank, commercial banks and specialized banks and their functions.</li> <li><b>6. Agriculture and economic development:</b> Role of agriculture in the economic development of Bangladesh; characteristics of Bangladesh agriculture; problems of agricultural development in Bangladesh; traditional agriculture and modern agriculture; farmer's role as a decision-maker.</li> <li><b>7. Farm and farm size:</b> Subsistence, commercial, specialized and diversified farms; private, cooperative and collective farms</li> <li><b>8. Land tenure and land reform:</b> Role of land tenure in agriculture; owner operator, sharecropper; land reforms in Bangladesh</li> <li><b>9. Agricultural marketing:</b> Market structure; agricultural marketing-cost, margin, efficiency, intelligence, grading, integration; imperfections in agricultural marketing in LDC's.</li> </ol>		

Course: SWE-2201: Soil and Environmental Biochemistry	Credit: 3.0	Year: Second	Term: Second
<b>Rationale:</b> This course is designed to provide preliminary ideas about basic Biochemistry and Soil Biochemistry.			
<b>Course Objectives:</b>			
<ul style="list-style-type: none"> <li>• To acquire basic knowledge on biochemistry and especially on soil biochemistry.</li> <li>• To understand the construction of macromolecules in nature and their behavior and how these macromolecules function within living cell to make life possible.</li> </ul>			
Intended Learning Outcomes (ILOs)	Course content		
Section-A			
<p>At the end of the course the students will be able to -</p> <ol style="list-style-type: none"> <li>1. apply biochemistry and the basic concepts of carbohydrate.</li> <li>2. gather knowledge about the various aspects of nucleic acids.</li> <li>3. demonstrate lipids and lignin along with its properties, structure and functions in nature.</li> </ol>	<p><b>1. Introduction:</b> Basic biochemistry and application of biochemistry in soil, water and environment, concepts of macromolecules, their monomers (building blocks). <b>Carbohydrates:</b> Definition, classification, monosaccharides, isomerism, cyclization, important polysaccharides, their composition and function in nature, detail study of cellulose.</p>		
	<p><b>2. Nucleic acids:</b> Composition of nucleotides, esterification of nucleotides, classification, and composition of DNA, genetic role of DNA, DNA replication and its characteristics, different forms of DNA, classification of RNA molecules, structure of t-RNA, difference between DNA and RNA, functions of nucleic acid, relationship between cell, nuclei, chromosomes, DNA and genes.</p>		
	<p><b>3. Lipids:</b> Definitions, functions, classification, fatty acids (saturated and unsaturated fatty acids, physical properties and chemical reactions), glycerides (neutral glycerides and phosphoglycerides).</p>		
	<p><b>4. Lignin:</b> Natural occurrence, importance, composition, lignification and wood quality.</p>		
Section-B			
<ol style="list-style-type: none"> <li>4. explain protein, enzyme and its functions.</li> <li>5. summarize the overall metabolism of carbohydrate, protein and lipid.</li> </ol>	<ol style="list-style-type: none"> <li><b>5. Proteins:</b> The <math>\alpha</math>-amino acids and their classification, condensation of amino acids, structure of proteins and their significance, synthesis of protein in cell (transcription and translation), genetic code, cellular functions of proteins.</li> <li><b>6. Enzymes:</b> Characteristics and functions of enzymes, nomenclature and classification, mechanism of enzyme functions, Michaelis-Menten equation and significance of <math>K_m</math>, exoenzyme, endoenzyme, factors affecting enzyme activity, regulation of enzyme activity, coenzyme and cofactor, inhibition of enzyme activity and its significance.</li> <li><b>7. Overview of catabolic processes:</b> Common catabolism of carbohydrate, protein and lipid, ATP-the cellular energy currency, chemical bond energy and heat energy, structure of ATP and its significance in cellular energetic, high energy bonds, energy comparison of several phosphorylated compounds.</li> <li><b>8. Antibiotics:</b> Concepts of immunology, specific and nonspecific immunity, structure of immunogens (antigens), structure of immunoglobulin (antibody), classification of IgG, mechanisms of antibody-antigen reaction.</li> <li><b>9. Vitamin and minerals:</b> Definitions, role in catabolism, major groups of vitamins, solubility of vitamins and their significance in nutrition.</li> </ol>		

<b>Course: SWE-2202: Soil and Environmental Biochemistry Sessional</b>	<b>Credit : 1.5</b>	<b>Year: Second</b>	<b>Term: Second</b>
<b>Rationale:</b> This course is designed to provide basic practical knowledge on biochemistry.			
<b>Course Objectives:</b> <ul style="list-style-type: none"> <li>• To understand some basic biochemical processes in nature.</li> </ul>			
<b>Intended Learning Outcomes (ILOs)</b> At the end of the course the students will be able to - <ol style="list-style-type: none"> <li>1. categorize reducing and non-reducing sugar.</li> <li>2. determine the crude protein content of a sample.</li> <li>3. isolate genomic DNA</li> </ol>	<b>Course content</b> <ol style="list-style-type: none"> <li>1. Reduced sugar determination by Fehling method.</li> <li>2. Determination of crude protein content of a sample.</li> <li>3. Genomic DNA isolation by centrifugation method.</li> </ol>		

<b>Course: SWE-2203: Soil Physics II</b>	<b>Credit: 3.0</b>	<b>Year: Second</b>	<b>Term: Second</b>
<b>Rationale:</b> This course is designed to provide concepts on soil water retention characteristics, loss movement and plant availability in different soils.			
<b>Course Objectives:</b>			
<ul style="list-style-type: none"> <li>• To acquire knowledge for better dealing with soil-water-plant relationships</li> <li>• To familiarize with water retention and movement pattern in soils</li> <li>• To build concepts on soil moisture-suction relationship</li> <li>• To understanding the role of soil physical properties in regulating soil moisture availability to plants</li> </ul>			
<b>Intended Learning Outcomes (ILOs)</b>	<b>Course content</b>		
<b>Section-A</b>			
<p>At the end of the course the students will be able to -</p> <ol style="list-style-type: none"> <li>1. define the soil-water energy, <i>i.e.</i>, soil water potential concept for the assessment of soil moisture status and availability.</li> <li>2. demonstrate the need of soil moisture characteristic curve and realize the role of texture and structure in soil water retention.</li> <li>3. apply Daracy's Law.</li> <li>4. find reason the movement of water in unsaturated soil and compare the significance of unsaturated water movement in soil-plant relationships over saturated water movement.</li> <li>5. state the influence of viscosity of fluid and soil wall friction (drag force) in water movement in soil pores of varying size.</li> </ol>	<ol style="list-style-type: none"> <li>1. <b>Equilibrium physical state of water:</b> Energy concept of water, soil water potentials- osmotic potential, gravitational potential, metric potential, pressure potential, pneumatic potential, total soil water potential concepts and measurement, potential profile in a homogeneous and heterogeneous soil, problems.</li> </ol>		
	<ol style="list-style-type: none"> <li>2. <b>Pore geometry and water retention:</b> Water retention characteristics, effect of texture and structure on soil moisture retention; Hysteresis- definition, factors affecting hysteresis.</li> </ol>		
	<ol style="list-style-type: none"> <li>3. <b>Water flow in saturated soil:</b> Discharge, flux, flux density, Darcy velocity, Darcy's law, assumption, limitation, and validity of Darcy's law, applications of Darcy's law, measurement of saturated hydraulic conductivity, problems.</li> </ol>		
	<ol style="list-style-type: none"> <li>4. <b>Water flow in unsaturated soil:</b> Driving force of water movement in unsaturated soil; downward movement as affected by soil layers of different textures; contrast between saturated and unsaturated water movement; methods of measuring unsaturated hydraulic conductivity.</li> </ol>		
	<ol style="list-style-type: none"> <li>5. <b>Water movement in soil:</b> Capillarity, water flow in capillary tubes, effect of viscosity and friction on the capillary movement of water, Poiseuille's law, assumption and limitation of Poiseuille's law, problems of capillary movement of water.</li> </ol>		
<b>Section-B</b>			
<ol style="list-style-type: none"> <li>6. define the concepts, basic principles and applications on energy and heat, solar and terrestrial radiation, and energy balance in soils.</li> <li>7. explain transpiration, evaporation and evapotranspiration and determine their rates.</li> <li>8. demonstrate the factors that affect evapotranspiration.</li> <li>9. express how application rate affects infiltration rate and wetted pattern for different soil types and textures.</li> <li>10. define soil erosion, list the factors causing erosion and describe how those factors cause erosion.</li> </ol>	<ol style="list-style-type: none"> <li>6. <b>Atmospheric Energy Balance:</b> Solar radiation; Stefan-Boltzmann radiation flux; solar constant – Kirchoff's law, Planck's law, Wein's law; shortwave and longwave radiation; processes modify the solar radiation passing through atmosphere; atmospheric interactions; radiation balance; albedo distribution and solar radiation; measurement of solar radiation; soil surface energy balance; energy balance for wet and dry surfaces.</li> </ol>		
	<ol style="list-style-type: none"> <li>7. <b>Evaporation and Evapotranspiration:</b> Evapotranspiration and water balance; estimation of evapotranspiration, transpiration coefficients; method for transpiration measurement; bare soil evaporation; steady evaporation from a shallow water table; evaporation in the absence of a water table; stages of drying; evaporation from irregular surfaces and shrinkage cracks, reduction of evaporation from bare soils.</li> </ol>		
	<ol style="list-style-type: none"> <li>8. <b>Infiltration:</b> Infiltration; factors affecting infiltration; empirical infiltration equations; physically based infiltration equations – the Green-Ampt equation, Philip's equation; Ponding time; infiltration rate; the wetting profile during infiltration; measurement of infiltration.</li> </ol>		
	<ol style="list-style-type: none"> <li>9. <b>Soil Erosion:</b> Physical principles underlying soil erosion; kinetic energy of water and wind to cause erosion, terminal velocity of raindrop, raindrop impact energy as determined by the size of the raindrop (mass and radius), problems.</li> </ol>		

<b>Course:SWE-2204: Soil Physics II Sessional/Fieldwork</b>	<b>Credit :1.5</b>	<b>Year: Second</b>	<b>Term: Second</b>
<b>Rationale:</b> This course is designed to provide skills in analyzing soil physical properties to yield results to explain soil water retention, movement, loss and availability.			
<b>Course Objectives:</b> <ul style="list-style-type: none"> <li>• To acquire skill in operating instruments for determining some soil physical properties</li> <li>• To obtain skill for using data and analytical skill for interpreting data derived from tensiometer, infiltrometer, and evaporimeter.</li> <li>• To gather the real-life experience of water and suction distribution after a precipitation or irrigation</li> </ul>			
<b>Intended Learning Outcomes (ILOs)</b>	<b>Course content</b>		
<p>At the end of the course the students will be able to -</p> <ol style="list-style-type: none"> <li>1. install tensiometer in soil; determine soil moisture potential; and to interpret soil tensiometer data.</li> <li>2. plot suction and moisture content data (primary or secondary) to construct soil-moisture characteristic curve.</li> <li>3. analyze curves for aggregated soil and compact soil of same texture to understand the importance of aggregates in retention of PAW.</li> <li>4. determine infiltration and evaporation from applying US pan evaporimeter and double ring infiltrometer method.</li> <li>5. conduct a field experiment to investigate in situ pattern of water distribution in layered soil of varying texture and that in a homogenous soil.</li> </ol>	<ol style="list-style-type: none"> <li>1. Determination of moisture content by gravimetric and tensiometer method.</li> <li>2. Determination of saturated hydraulic conductivity by constant head method.</li> <li>3. Determination of unsaturated hydraulic conductivity by falling head method.</li> <li>4. Construction of soil-moisture characteristic curve for different texture by primary and secondary data.</li> <li>5. Compare soil moisture retention curves for an aggregated and a compacted soil having same texture</li> <li>6. Field demonstration of water infiltration through layered and homogenous soils.</li> </ol>		

Course: SWE-2205: Water and Soil Pollution	Credit: 3.0	Year: Second	Term: Second
<b>Rationale:</b> This course is designed to provide knowledge of water and soil pollution and to build up awareness regarding the impact of water and soil pollution to the environment and on human health.			
<b>Course Objectives:</b> <ul style="list-style-type: none"> <li>The aim of this course is to teach the students regarding the water and soil pollution and impact on soil and human health.</li> </ul>			
Intended Learning Outcomes (ILOs)	Course content		
Section-A			
<p>At the end of the course the students will be able to -</p> <ol style="list-style-type: none"> <li>explain the nature and types of water pollutants and understand the parameters required for evaluation of water quality.</li> <li>demonstrate the water quality for drinking water, irrigation water and water for livestock.</li> <li>gather knowledge about the source and occurrence of arsenic, severity of As pollution and its effect on soil, plant and human health.</li> <li>apply different remedial measures of As in soil and drinking water.</li> </ol>	<ol style="list-style-type: none"> <li><b>Water Pollution:</b> Nature and types of water pollutants, elemental pollutants, heavy metals, metalloids, organically bound metals and metalloids, inorganic species, algal nutrients and eutrophication, acidity, alkalinity and salinity, oxygen, oxidants and reductants, organic pollutants, pesticides in water, radionuclides.</li> </ol>		
	<ol style="list-style-type: none"> <li><b>Water Quality Standards:</b> Parameters for evaluation of water quality; water quality for drinking purpose, irrigation; for livestock; quality of treated wastewater for irrigation; Bangladesh national water policy, Bangladesh national drinking water quality.</li> </ol>		
	<ol style="list-style-type: none"> <li><b>Arsenic in Water and Soil Environment:</b> Sources and occurrence of arsenic in the environment; environmental levels and human exposure; arsenic contamination of irrigation water, soil and crops in Bangladesh; Remedial measures for arsenic in soil and drinking water.</li> </ol>		
	<ol style="list-style-type: none"> <li><b>Remediation of Pollutants:</b> Selection of remediation procedure; factors involved in selection of procedure; modes of treatment application; classification of techniques; physical, chemical, thermal and biological methods of removal of pollutants.</li> </ol>		
Section-B			
<ol style="list-style-type: none"> <li>classify sources and types of pollutant in soil; causes, effect and control of soil pollutants.</li> <li>Use different types of bioremediation techniques for removal of pollutants.</li> </ol>	<ol style="list-style-type: none"> <li><b>Soil Pollution:</b> Introduction; pollutants in soil; types of soil pollution; causes of soil pollution; effects and control of soil pollution; contaminants and contaminated sites; classification of contaminated sites.</li> </ol>		
	<ol style="list-style-type: none"> <li><b>Heavy Metals in Soils:</b> Sources of heavy metals in contaminated soils; basic soil chemistry and potential risks of heavy metals; soil concentration ranges and regulatory guidelines for some heavy metals; remediation of heavy metal contaminated soils.</li> </ol>		
	<ol style="list-style-type: none"> <li><b>Bioremediation of Contaminated Sites:</b> Concept of bioremediation; different types of bioremediation techniques used for removal of pollutants.</li> </ol>		
	<ol style="list-style-type: none"> <li><b>Biochar and Soil Additives for Remediation:</b> Biochar as a tool for revegetation, Biochar and the sorption of heavy metals, Biochar and the sorption of pesticides and other organic molecules, Biochar and hydrocarbon contamination.</li> </ol>		

Course: SWE-2207: Soil Ecology and Ecosystems	Credit: 3.0	Year: Second	Term: Second
<b>Rationale:</b> This course is designed to provide fundamental concepts on soil ecology and ecosystems.			
<b>Course Objectives:</b> <ul style="list-style-type: none"> <li>The course contains information of major ecosystems and ecology of soil. This will make the students to understand different ecological processes and interaction that function in soil.</li> </ul>			
Intended Learning Outcomes (ILOs)	Course content		
Section-A			
<p>At the end of the course the students will be able to -</p> <ol style="list-style-type: none"> <li>define ecology and functional attributes of ecosystem; get the information of structure of community and population.</li> <li>describe all the components of an ecosystem.</li> <li>identify the pollutant that adversely affect the soil ecology and know the effect of radioactive elements on soil ecosystem.</li> </ol>	<b>1. Organism and Environmental Complex:</b> Scope of ecology; stress and strain; adaptation; habitat and niche; functional attributes of ecosystem- energy flow, food chain and soil food webs: energy exchange in ecosystem, energy available for food chains and webs; hierarchical approach to organisms in soils.		
	<b>2. Community and Population Ecology:</b> Concept and basic terms, structure, composition and stratification; community function; population fluctuations and interactions; basic techniques in ecology.		
	<b>3. Ecosystems:</b> Definition, structure, different components, biome; terrestrial, fresh water and marine ecosystems.		
	<b>4. Forest Ecology and its Conservations:</b> Forest vegetation, structure and environment; acid rains – their impact on soil and plant. salt marsh soils-their nature and importance in ecology.		
	<b>5. Ecology of Polluted Soils:</b> Ecology of soils polluted from acid deposition, Ecology of soils polluted with radio nuclides.		
Section-B			
<ol style="list-style-type: none"> <li>recognize the major interactions of soil biota that play a significant role in soil system and understand the relationship between biodiversity and different soil processes within the ecosystem.</li> <li>explain the nutrient cycling with particular reference to N, P and S and know the changes of major nutrients in soil due to human activities.</li> <li>demonstrate the carbon dynamics in soil and the possible mechanisms for evolution of the fitness of the soil environment.</li> </ol>	<b>6. Ecological Interactions:</b> Relationship among organisms, plant microbial interactions; animal/microbial interactions; plant-animal interactions; animal/animal interactions; microbe-microbe interactions.		
	<b>7. Soil Biodiversity and Linkages to Soil Processes:</b> Biodiversity in soils and its impacts on terrestrial ecosystem function; heterogeneity of carbon substrates and effects on soil biodiversity; impacts of species richness on ecosystem function; models, microcosms, and soil biodiversity; experimental additions and deletions in soil biodiversity studies; problems of concern in soil biodiversity studies; why is soil diversity so high? biogeographical trends in diversity of soil organisms.		
	<b>8. Terrestrial Nutrient Cycling:</b> Introduction; nitrogen inputs to ecosystems; biological nitrogen fixation; nitrogen deposition; internal cycling of nitrogen; overview of mineralization; production and fate of dissolved organic nitrogen; production and fate of ammonium; production and fate of nitrate; temporal and spatial variability; pathways of nitrogen loss; gaseous losses of nitrogen; ecological controls; solution losses; other element cycles- phosphorus, sulfur; essential cations; nonessential elements; interactions among element cycles.		
	<b>9. Global Biogeochemical Cycles:</b> Introduction; the global carbon cycle; long-term change in atmospheric CO <sub>2</sub> ; anthropogenic changes in the carbon cycle; terrestrial sinks for CO <sub>2</sub> ; the global methane budget; the global nitrogen cycle; anthropogenic changes in the nitrogen cycle; the global phosphorus cycle; anthropogenic changes in the phosphorus cycle; the global sulfur cycle;		
	<b>10. Future Developments in Soil Ecology:</b> Introduction; roles of soils in carbon sequestration; roles of soils in the global carbon cycle; problems in modeling soil carbon dynamics; biological interactions in soils and global change; ecology of invasive species in soil systems: an increasing problem in soil ecology; possible mechanisms for evolution of the fitness of the soil environment; soil ecology in the third millennium.		

<b>Course: SWE-2208: Soil Ecology and Ecosystems Sessional/Field Work</b>	<b>Credit: 1.5</b>	<b>Year: Second</b>	<b>Term: Second</b>
<b>Rationale:</b> This course is designed to gather practical experiences on soil ecology and ecosystems.			
<b>Course Objectives:</b>			
<ul style="list-style-type: none"> <li>The course will provide practical knowledge on major ecosystems in Bangladesh and analytical abilities about community description.</li> </ul>			
<b>Intended Learning Outcomes (ILOs)</b>	<b>Course content</b>		
At the end of the course the students will be able to -	<b>1.</b> Study of major ecosystems in Bangladesh including the Sundarbans.		
<b>1.</b> get the practical idea about major ecosystems of Bangladesh.	<b>2.</b> Diversity measurements of an ecosystem.		
<b>2.</b> calculate the index of diversity and dominance of a community.	<b>3.</b> Community analysis of a particular ecosystem.		
<b>3.</b> analyze community on the basis of quantitative data.	<b>4.</b> Estimation of biomass of carbon, nitrogen and phosphorus.		
<b>4.</b> measure biomass C, N and P.			

Course: SWE-2209: Agronomy and Integrated Agricultural Systems	Credit: 3.0	Year: Second	Term: Second
<b>Rationale:</b> This course is designed to provide fundamental concepts of agronomy, different aspects of cropping systems and practices involved in crop production.			
<b>Course Objectives:</b> <ul style="list-style-type: none"> <li>• To conceptualize agriculture and agronomy</li> <li>• To acquire knowledge on weather and climate</li> <li>• To gather knowledge of seeds, weeds and crops</li> <li>• To provide knowledge on cropping systems of Bangladesh and ways of its improvement</li> </ul>			
Intended Learning Outcomes (ILOs)	Course content		
Section-A			
<p>At the end of the course the students will be able to -</p> <ol style="list-style-type: none"> <li>1. depict various aspects of agriculture and agronomy.</li> <li>2. explain the weather and climate and their influence on crops.</li> <li>3. describe the seed, its germination, quality and dormancy.</li> <li>4. acquire knowledge of weeds and their control.</li> </ol>	<b>1. Introduction:</b> Concept, importance and scope of agriculture and agronomy; history of agriculture; chronology of Bangladesh agriculture; basic principles of agronomy; agricultural research institutes of Bangladesh.		
	<b>2. Weather and Climate:</b> Definition of weather and climate; differences between weather and climate; weather elements and their role on the growth and development of crops; climatological equipment.		
	<b>3. Crops:</b> Definition of crop, classification of crops and cropping seasons of Bangladesh.		
	<b>4. Seeds:</b> Definition, importance of seeds, classification of seeds, seed germination, precautions and mechanism of seed germination, factors affecting seed germination, seed rate, plant population, plant density, seed law, yield gap, seed dormancy with its importance, seed quality.		
	<b>5. Weeds:</b> Definition, characteristics and types of weeds, crop weed association, beneficial and harmful effects of weeds, mechanical, chemical and biological methods of weed control.		
Section-B			
<ol style="list-style-type: none"> <li>5. describe cropping systems, existing cropping patterns of Bangladesh and provide necessary suggestions for improvement.</li> <li>6. explain the basic issues of multiple cropping and crop rotation.</li> <li>7. produce some crops.</li> </ol>	<b>6. Cropping systems:</b> Concept, types and determinants.		
	<b>7. Cropping pattern:</b> Concept; factors affecting cropping pattern; basic information about the major cropping patterns of Bangladesh and ways of their improvement; efficiency in cropping system, interaction in intercropping and sequential cropping, prerequisites and potentials; sequential cropping and intercropping with their advantages and disadvantages; criteria for selection of intercrop components; land equivalent ratio (LER); relative yield total (RYT), crop equivalent yield (CEY), multiple cropping index (MCI).		
	<b>8. Crop rotation:</b> Objectives, principles; advantages and limitations		
	<b>9. Production technology of crops:</b> Origin, soil, climate, varieties, land preparation, fertilizer application, planting, harvesting and post-harvest operations of jute, cotton, rice, sugarcane, rubber, oilseeds, wheat and tea		

Course: SWE-2210: Agronomy and Integrated Agricultural Systems Sessional/Field Work	Credit : 1.5	Year: Second	Term: Second
<p><b>Rationale:</b> The course is oriented to provide applied knowledge on morphology of different crops with their economic importance and different aspects of land utilization, crop statistics, crop cultivation, planning and agricultural farm management, weed control, seed germination, morphological and physiological attributes of crops.</p>			
<p><b>Course Objective:</b></p> <ul style="list-style-type: none"> <li>• The course is designed to apply the acquired knowledge of microscopy as well as external and internal morphology of different crops in their practical life.</li> </ul>			
Intended Learning Outcomes (ILOs)	Course content		
<p>At the end of the course the students will be able to -</p> <ol style="list-style-type: none"> <li>1. demonstrate external morphological features of different crops and identify them.</li> <li>2. identify different seeds and weeds</li> <li>3. determine percent seed germination and purity of seeds</li> <li>4. recognize fake fertilizers and suggest to farmers</li> <li>5. confirm weather conditions for crop cultivation</li> </ol>	<ol style="list-style-type: none"> <li>1. Study of the external morphology of the following crops - rice, wheat, jute; familiarize with agricultural tools.</li> </ol>	<ol style="list-style-type: none"> <li>2. Graphical representation of land utilization and crop statistics in Bangladesh</li> </ol>	<ol style="list-style-type: none"> <li>3. Morphological and physiological attributes of crops , preparation of crop rotation schedules</li> </ol>
	<ol style="list-style-type: none"> <li>4. Recording local rainfall, temperature, and humidity; Measurement of precipitation by rain gauge.</li> </ol>	<ol style="list-style-type: none"> <li>5. Identification of seeds, seed germination, seed rate, purity of seed, real value of seed and collection of different weeds.</li> </ol>	

Course: SWE-2211: Atmospheric Science	Credit: 3.0	Year: Second	Term: Second
<b>Rationale:</b> This course is designed to provide ideas and concepts of atmosphere focused on various atmospheric phenomena.			
<b>Course Objectives:</b> <ul style="list-style-type: none"> <li>• To understand the structure and characteristics of the atmosphere.</li> <li>• To acquire knowledge on atmospheric circulations as represented by the wind, temperature, pressure and humidity.</li> <li>• To comprehend atmospheric chemistry.</li> </ul>			
Intended Learning Outcomes (ILOs)	Course content		
Section-A			
<p>At the end of the course the students will be able to -</p> <ol style="list-style-type: none"> <li>1. explain the basic characteristics of the atmosphere- structure, composition and layering of atmosphere.</li> <li>2. demonstrate the Earth- sun relationships and their application to the concepts of climate and energy budgets.</li> <li>3. discuss humidity, basic cloud-forming processes, and the mechanisms that initiate the movement of air.</li> </ol>	<b>1. Introduction, composition and structure of the atmosphere:</b> Composition of the atmosphere; variation of atmospheric composition with height, latitude and season; mixing ratio, number density and partial pressure of atmospheric composition; mass of the atmosphere; layering of the atmosphere		
	<b>2. Climate, Solar radiation and the global energy budget:</b> Definition, physical factors of climate, earth-sun relationship, rotation of the earth, seasons, climatic controls. radiation climatology of the earth's atmosphere, geographical and seasonal distribution of incoming solar radiation, outgoing radiation, net radiation, terrestrial heat balance. vertical distribution of temperature and winds. upper air climatology during winter and summer.		
	<b>3. Atmospheric moisture budget:</b> Atmospheric components of global hydrological cycles; changes of state of water; humidity, evaporation and condensation; cloud types, formation of cloud and precipitation, air stability and instability,		
	<b>4. Atmospheric motion:</b> Air pressure and winds; causes of wind formation; forces affecting winds; horizontal and vertical transport of winds; wind classification, global air circulation pattern, regional and local atmospheric circulation.		
Section-B			
<ol style="list-style-type: none"> <li>4. acquire knowledge on Chemical and photochemical reactions in the atmosphere.</li> <li>5. discuss the importance of the following atmospheric components: green house gases, sinks of gases and ozone.</li> </ol>	<b>5. Atmospheric chemistry related to atmospheric processes:</b> Introduction to atmospheric chemistry, effects of atmospheric motions on atmospheric chemistry; half-life, residence time and renewal time of chemicals in the atmosphere; chemical and photochemical reactions in the atmosphere.		
	<b>6. Atmospheric aerosols:</b> Concentration and size, sources and transformation, chemical composition, transport and sinks, residence times of aerosols, geographical distribution and atmospheric effects. cloud morphology, growth of cloud droplets by collision and coalescence.		
	<b>7. Atmospheric Pollution, Greenhouse Effect, Ozone Layer Depletion:</b> Air pollution, transformation, transport and sinks of gases in the troposphere, green house gases, human contributions, heating of the atmosphere, evolution of the ozone layer, CFC's and chlorine chain reaction in the stratosphere. effects of ozone in the troposphere and the stratosphere, ozone layer depletion, acid deposition, acid rain.		

<b>Course: SWE-2212: Atmospheric Science Sessional/Field Work</b>	<b>Credit: 1.5</b>	<b>Year: Second</b>	<b>Term: Second</b>
<b>Rationale:</b> This course is designed to recognize, understand and analyze the atmospheric functioning.			
<b>Course Objectives:</b> <ul style="list-style-type: none"> <li>• To understand the interrelationship and functions of atmospheric components</li> <li>• To effectively link theory with practice and application.</li> <li>• To provide students hand-on experience of common techniques in labs and exposure to equipment and machines.</li> </ul>			
<b>Intended Learning Outcomes (ILOs)</b>	<b>Course content</b>		
At the end of the course the students will be able to -  1. recognize and estimate atmospheric components and their functions.	1. Measurement of physical parameters of atmosphere.		
	2. Collection of air sample from different locations and determination of nature and concentration of pollutants.		
	3. Construction a model containing different spheres of atmosphere.		

Course: SWE-3101: Soil Genesis	Credit: 3	Year: Third	Term: First
<p><b>Rationale:</b> The course is designed to deal with formation of soil systems, their environments from the perspective of adoption of necessary management practices.</p>			
<p><b>Course Objectives:</b></p> <ul style="list-style-type: none"> <li>• Become familiar with conceptual issues involved in the study of soils at landscape scales.</li> <li>• Understand process involved in soil development.</li> <li>• Understanding how soils are affected by parent material, vegetation, landscape, climate and time.</li> </ul>			
Intended Learning Outcomes (ILOs)	Content		
Section-A			
<p>At the end of the course the students will be able to -</p> <ol style="list-style-type: none"> <li>1. describe, using proper terminology, the morphological characteristics of soils as they are found in their natural setting.</li> <li>2. understand the basic principles of weathering and relationships between soils and weathering process.</li> <li>3. discuss how soil forming factors influence the rate and intensity of soil formation and explain how soil forming processes and factors interact resulting in a catena.</li> <li>4. interpret soil behavior and understand proper soil use and management based on soils morphology and landscape setting.</li> <li>5. describe the major categories of soil forming processes.</li> </ol>	<ol style="list-style-type: none"> <li>1. <b>Pedological Concepts and Definition:</b> Pedological and Edaphological approaches in the study of soil; Pedon and Polypedon; Scope of Pedology; Concept of soil as a natural system; Introduction to soil components, organics and minerals.</li> <li>2. <b>Weathering and Soil Formation:</b> Physical and Chemical weathering process; Mineral weathering reactions and sequences; Environmental factors of soil formation: Parent material, time, relief, climate and organisms.</li> <li>3. <b>Soil Morphology:</b> Soil horizon designations: surface horizon (epipedon) and subsurface horizon (endopedon); Master horizons and layers; Transitional and mixed horizons; Properties used in describing soil layers; Pedofeatures: Fabric, Nodules, Cutans.</li> <li>4. <b>Soil Forming Processes:</b> Additions, Losses, Translocation and Transformations; Important soil forming processes in Bangladesh: Ripening, Homogenization, Reduction, Ferrollysis, Calcification and Decalcification, Flood coating, Ploughpan, Mottles, Alkalization, Salinization, Acidification, Clay migration.</li> </ol>		
Section-B			
<ol style="list-style-type: none"> <li>6. describe, using proper terminology, the morphological characteristics of soils as they are found in their natural setting.</li> <li>7. understand basic principles of landscape development and relationships between soils and landscape features.</li> <li>8. able to interpret soil behavior and understand proper soil use and management based on a soils morphology, landscape setting, and classification.</li> </ol>	<ol style="list-style-type: none"> <li>5. <b>Overview of Soil Genesis:</b> Introduction; Summarizing the history of key concepts of pedology, including soil forming processes and factors.</li> <li>6. <b>Soils in relation to landscape:</b> Catena concept; Soil profile, relief features and their relation to structure; Soil-Landscape relationship.</li> <li>7. <b>Zonality concept in soils:</b> Zonal, Intrazonal and Azonal soils</li> <li>8. <b>Soil Orders:</b> Environmental settings, genetic processes, properties and uses of twelve soil orders. Outline of the orders of Entisols ; Inceptisols ; Histosols ; Aridisols ; Ultisols; Vertisols; Spodosols; Oxisols; Gelisols; Andisols; Alfisols; Mollisols.</li> </ol>		

<b>Course: SWE-3102: Soil Genesis Sessional/Field Work</b>	<b>Credit: 1.5</b>	<b>Year: Third</b>	<b>Term: First</b>
<b>Rationale:</b> This course focuses on observing and describing soils in the field and interpreting soil suitability for various uses.			
<b>Course Objectives:</b> <ul style="list-style-type: none"> <li>• Learn to interpret and classify soils from soil descriptions.</li> </ul>			
<b>Intended Learning Outcomes(ILOs)</b>		<b>Content</b>	
<p>At the end of the course the students will be able to -</p> <ol style="list-style-type: none"> <li>1. make a thorough and technically accurate description of a soil in the field.</li> <li>2. make some reasonable estimates of soil chemical and physical properties from field observations.</li> <li>3. have a working knowledge of soil taxonomy.</li> </ol>		<ol style="list-style-type: none"> <li>1. <b>Soil Morphology: descriptions and interpretation of soils:</b> Demonstration of standard equipment and techniques; Practice in the field description and interpretation.</li> <li>2. <b>Examining soil-landscape-vegetation relationships:</b> Genetic interpretation; Land-use interpretation.</li> </ol>	

<b>Course: SWE-3103: Watershed and Wetland Management</b>	<b>Credit: 3</b>	<b>Year: Third</b>	<b>Term: First</b>
<b>Rationale:</b> This course is designed to provide concepts of watershed, benefits of watershed based survey, monitoring and management.			
<b>Course Objectives:</b>			
<ul style="list-style-type: none"> <li>• Introduce students to watershed processes and functions and to the principles underpinning watershed management and decision making.</li> <li>• Examine strategies for planning and management of watershed resources in general, and in the particular contexts of developing countries.</li> <li>• Introduce students to wetland functions and benefits to the diversity, water availability and quality and climate resilience.</li> </ul>			
<b>Intended Learning Outcomes (ILOs)</b>	<b>Course Content</b>		
<b>Section-A</b>			
<p>At the end of the course the students will be able to -</p> <ol style="list-style-type: none"> <li>1. define, classify recognize benefits of studying watershed management.</li> <li>2. understand the sources and sinks of the hydrologic cycle and the effects of land-use practices on them.</li> <li>3. conduct a survey to describe watershed condition, watershed problems, analyze problem related data and to assess the extent of the problem.</li> <li>4. develop a core set of ‘walk-around’ knowledge for adopting multidisciplinary approach for dealing with watershed management issues.</li> </ol>	<ol style="list-style-type: none"> <li>1. <b>Introduction to Watershed :</b> Definitions, classification of watershed; watershed boundary; watershed resources; causes and consequences of watershed deterioration; principles and objectives of watershed management.</li> </ol>		
	<ol style="list-style-type: none"> <li>2. <b>Watershed Hydrology:</b> Hydrologic cycle: precipitation, interception, infiltration, runoff, evaporation and transpiration; Surface, subsurface and groundwater; basic hydrologic processes within watershed boundary; land use impact on watershed hydrology.</li> </ol>		
	<ol style="list-style-type: none"> <li>3. <b>Watershed Survey and Planning:</b> Objectives, The need for watershed survey and planning; Identification of watershed problems; Survey and planning mechanisms; Some survey techniques and examples; Survey data reporting and analysis; Recommendations for improvement.</li> </ol>		
	<ol style="list-style-type: none"> <li>4. <b>Integrated Watershed Management (IWM):</b> Principles of IWM; Multidisciplinary approach to watershed management; Parameters of watershed; Organizations involvement needed; Participatory watershed management; Watershed Management in different Asian countries and Bangladesh.</li> </ol>		
<b>Section-B</b>			
<ol style="list-style-type: none"> <li>5. acquire knowledge on sediment production, sediment transport and deposition and consequences of excess sedimentation in water reservoirs.</li> <li>6. conceptualize the significance land capability class, importance of forest to site productivity, water yield, and water quality.</li> <li>7. realize the function and importance of wetland to biodiversity, surface water and groundwater quality and recharge, flood mitigation, , carbon sequestration and climate moderation.</li> <li>8. know the causes of wetland deterioration and state the wetland condition and needs of wetland restoration in Bangladesh.</li> </ol>	<ol style="list-style-type: none"> <li>5. <b>Sedimentation:</b> types of sediment, sediments in a water body, fluid velocity-sediment concentration interaction, sediment transport, sediment production, sedimentation process, factors affecting movement of sediments, sediment deposition, reservoir sedimentation.</li> </ol>		
	<ol style="list-style-type: none"> <li>6. <b>Hill Soil and watershed management:</b> concepts on hill soils, soils in watershed hydrology, effects of land use and land capability, soil management in watershed program, forests and erosion, human activities in forests and their impacts on erosion, forest and water availability.</li> </ol>		
	<ol style="list-style-type: none"> <li>7. <b>Wetland and global climate change:</b> Definition, types of wetland; wetland –ecosystem interaction; Ramsar Convention -1971; wetland and biodiversity; wetland and groundwater recharge; wetland and surface water flow; wetland and flood; wetlands and climate change; wetland habitat responses to climate change and the implications for restoration, restoring degraded wetland soils, the carbon sink function.</li> </ol>		
	<ol style="list-style-type: none"> <li>8. <b>Wetland Restoration:</b> Wetlands in Bangladesh: past, present and future; wetland deterioration: causes and consequences; wetland biodiversity; needs of wetland restoration, wetland and water security in future.</li> </ol>		

<b>Course: SWE-3104: Watershed and Wetland Management Fieldwork</b>	<b>Credit: 1.5</b>	<b>Year: Third</b>	<b>Term: First</b>
<b>Rationale:</b> This course is designed to provide skills in characterizing watershed, watershed survey and monitoring and prioritizing needs for improvement in the optimization of watershed health.			
<b>Course Objectives:</b> <ul style="list-style-type: none"> <li>• Provide an opportunity for practical teamwork in the characterization and thus figuring out the areas or components needs to be focused for optimization.</li> <li>• Characterizing watershed and interpretation of data</li> <li>• Figuring out areas need improvement.</li> </ul>			
<b>Intended Learning Outcomes (ILOs)</b>	<b>Course Content</b>		
<b>Section – A</b>			
<p>At the end of the course the students will be able to -</p> <ol style="list-style-type: none"> <li>1. operate a survey and measure different watershed parameters to indicate its condition.</li> <li>2. detect the problematic area and sketch the degree and delineate the extent of the problem.</li> <li>3. calculate stream velocity and graph the sediment load of the reservoir across the depth and the distance.</li> <li>4. sketch the watershed hydrology and indicate the future dos and don'ts for water resource management.</li> <li>5. partitioning of rainwater into infiltration and runoff.</li> </ol>	1. Conduct a field visit and survey to hill and plain land watershed.	2. Characterization of the given watershed by conducting a survey.	3. Determination of stream velocity and estimation of sediment load of a reservoir.
	4. Analysis of watershed hydrology: surface water and groundwater sources, volume of surface and groundwater storage recharge, drainage density, stream ordering.	5. Computation of storage capacity of the reservoirs and runoff water volume in watershed area for a given precipitation or for a specific period like month or year.	

<b>Course: SWE-3105: Soil Fertility and Plant Nutrition</b>	<b>Credit: 3</b>	<b>Year: Third</b>	<b>Term: First</b>
<b>Rationale:</b> This course is designed to provide knowledge for the improvement in crop production, increase in the ecological efficiency, and incorporation of progressive nutrient management strategies for production agricultural systems.			
<b>Course Objectives:</b>			
<ul style="list-style-type: none"> <li>• Introduce students to soil fertility and soil productivity concept in an ecological context</li> <li>• Teach the function of each essential plant nutrient in crops and soils</li> <li>• Teach how each nutrient cycles through the soils, plant, animal, and atmosphere</li> <li>• Teach how to read a soil test report, develop appropriate soil fertility recommendations</li> <li>• To examine current issues in soil fertility and nutrient management</li> </ul>			
<b>Intended Learning Outcomes (ILOs)</b>	<b>Course Content</b>		
<b>Section – A</b>			
<p>At the end of the course the students will be able to -</p> <ol style="list-style-type: none"> <li>1. list all essential elements for plants, their available forms and their role in the process of plant growth, development, and reproduction.</li> <li>2. describe how soil properties and environmental conditions affect nutrient availability and plant growth; illustrate different growth curves.</li> <li>3. appraise fertility status; recognize deficient or toxic nutrient</li> <li>4. utilize different fertilizer recommendation options for estimating the amount of fertilizers needed to apply for specific soil fertility level and crop in question.</li> </ol>	<p><b>1. Introduction to Soil Fertility and Productivity:</b> Concept of soil fertility and productivity; Past and recent advances in soil fertility and plant nutrition research; Essential nutrients; Functions of essential elements; modern concept of fertility.</p>		
	<p><b>2. Nutrients and Plant growth:</b> Available forms taken up by plants; Factors affecting availability and plant growth; Mathematical approaches to express plant growth and the various growth equations; Growth curves.</p>		
	<p><b>3. Soil Fertility Evaluation:</b> Needs for soil fertility evaluation; diagnosis of fertilizer needs – different approaches to diagnosis; visual symptoms (for nutrient deficiency or toxicity in major crops of Bangladesh); soil and plant analysis, biological methods and laboratory; greenhouse and field experimentation; fertility (nutrient) status of Bangladesh soils; Factors responsible for declining fertility level.</p>		
	<p><b>4. Fertilizer Recommendation Service in Bangladesh:</b> Fertilizer research in Bangladesh; Fertilizer recommendation services; Fertilizer recommendation - in Fertilizer Recommendation Guide (FRG), Land and Soil Utilization Guide, Online Fertilizer Recommendation System (OFRS).</p>		
<b>Section – B</b>			
<ol style="list-style-type: none"> <li>5. describe the process of manufacture and methods of application of inorganic and organic fertilizers and state their demand in Bangladesh.</li> <li>6. calculate the amounts of fertilizers need and categorize nutrients that have synergistic and antagonistic relation.</li> <li>7. select and combine practices to design for sustainable fertility and productivity of soils.</li> </ol>	<p><b>5. Fertilizer Materials:</b> Terminologies: single, compound and mixed fertilizer; fertilizer grades, and fertilizer ratios; sources and manufacture of major fertilizer materials; organic fertilizer and bio-fertilizers; compost and composting; inorganic versus organic fertilizers; fertilizer use and demand in Bangladesh; fertilizer law.</p>		
	<p><b>6. Application of Fertilizer:</b> Common fertilizers; Estimation of the amount of recommended fertilizer; methods of fertilizer application; reasons and rationale of various methods; fertilizer movement in soil; fate of added nutrient in soil; residual effects of fertilizers; salt index of fertilizers; balanced fertilization; impact of fertilizer application on soil quality and environment.</p>		
	<p><b>7. Fertilizer Response:</b> Nutrient interaction; antagonistic – synergistic activity among the fertilizer nutrient; fertilizer response in plants; mathematical models to express fertilizer response; various equations and curves; calculation of fertilizer need of soil; nutrient mobility in soils- mobile, immobile nutrients; factors affecting movements of nutrients.</p>		
	<p><b>8. Fertility Management:</b> Nutrient management, nutrient index level, meaning of index level for crop, nutrient management planning, practices for nutrient management harmful effects of inorganic fertilizer to soil physical, chemical and biological properties and to human health and environment.</p>		

<b>Course: SWE-3106: Soil Fertility and Plant Nutrition Sessional/Fieldwork</b>	<b>Credit : 1.5</b>	<b>Year: Third</b>	<b>Term: First</b>
<b>Rationale:</b> This course is designed to provide skills for evaluation of soil fertility status and setting management requirements for the target improvement.			
<b>Course Objectives:</b> <ul style="list-style-type: none"> <li>• Equip students with knowledge to analyze soil for evaluation of soil fertility status</li> <li>• Capacitate students to analyze fertilizers (inorganic and organic) to determine nutrient content in the soil and fertilizers to take appropriate measures to improve soil condition.</li> </ul>			
<b>Intended Learning Outcomes (ILOs)</b>	<b>Course Content</b>		
<p>At the end of the course the students will be able to -</p> <ol style="list-style-type: none"> <li>1. apply appropriate techniques/methods for soil and plant sampling and soil and plant sample extraction.</li> <li>2. prepare compost.</li> <li>3. test purity of fertilizers.</li> <li>4. assess fertility status and recommend fertilizer need.</li> <li>5. explain the procedures followed for manufacturing, refining, packaging and labeling fertilizer in the visited factory.</li> </ol>	1. Sampling techniques for soil nutrient analysis or soil fertility evaluation.	2. Preparation of compost fertilizer.	3. Quick methods for testing purity of fertilizers usually used by the farmers.
	4. Determination of lime requirement.	5. Visual symptom analysis in the field for identifying nutrient element responsible either for toxicity or for deficiency.	6. Extraction and determination of N, P, K, and micro nutrients in soils and plants.

Course: SWE-3107: Biostatistics	Credit : 3	Year: Third	Term: First
<b>Rationale:</b> This course is intended to provide with a general understanding of when and how to conduct various statistical analyses on biological data.			
<b>Course Objectives:</b> At the end of the course, students will understand the theory and practice of statistical analysis well enough that he/she will be able to design and analyze his/her own biological studies.			
Intended Learning Outcomes (ILOs)	Course Contents		
<b>Section A</b>			
<p>At the end of the course the students will be able to -</p> <ol style="list-style-type: none"> <li>1. define statistics and know the importance of statistics in biological sciences.</li> <li>2. distinguish between descriptive and inferential statistics, sample and population, statistic and parameters.</li> <li>3. know about data and variables their collection, classification, tabulation and scales of measurement.</li> <li>4. get the idea about measures of central tendency and measures of dispersion.</li> <li>5. calculate, interpret, and apply correlation and regression analysis</li> </ol>	<p><b>1. Introduction and Statistical Terminologies:</b> Definition of statistics; importance of statistics in biological/agricultural sciences; population and sample; data, variables (qualitative, quantitative, discrete and continuous), descriptive statistics; inferential statistics; collection of statistical data, types of statistical data.</p>		
	<p><b>2. Processing and Presentation of Statistical Data:</b> Classification of data; tabulation of data; frequency distribution; relative frequency distribution; presentation of data.</p>		
	<p><b>3. Measures of Central Tendency and Dispersion:</b> Basic concept; different measures of central tendency; various measures of dispersion; measures of position (z-score, percentiles, deciles, quartiles); standard error; coefficient of variation; computing standard deviation, standard error and coefficient of variation from grouped and ungrouped data; comparative study of different measure of central tendency and dispersion.</p>		
	<p><b>4. Correlation and Regression Analysis:</b> Basic concepts of correlation and regression coefficients; strength of the linear correlation; simple and multiple correlation and regression; application of correlation and regression in biological research; interpretation of correlation and regression coefficients; misuses of correlation and regression analysis in biological research.</p>		
<b>Section B</b>			
<ol style="list-style-type: none"> <li>6. define probability and know the rules and use of probability.</li> <li>7. construct a sampling distribution of a statistic.</li> <li>8. learn the importance and basic principles of estimation.</li> <li>9. understand the basic properties and uses of the t distribution.</li> <li>10. calculate and interpret z, t, f, and chi-square test and state the inference.</li> <li>11. know about time series analysis: its need and application.</li> </ol>	<p><b>5. Probability and Forms of Distribution:</b> Concept of probability; definition of probability; rules of probability: conditional probability; probability distribution; Bayes' rule, sampling distribution.</p>		
	<p><b>6. Estimation:</b> Introduction, estimating a population proportion; point estimate, confidence interval, interpreting a confidence interval, determining sample size, estimating a population mean;</p>		
	<p><b>7. Tests of Hypothesis:</b> Characteristics of hypothesis, procedure for hypothesis testing, important parametric tests; chi-square distribution:</p>		
	<p><b>8. Sampling Design:</b> Census and sample survey; implications of a sample design; steps in sampling design; criteria of selecting a sampling procedure; characteristics of a good sample design; different types of sample designs; selection of a random sample; random sample from an infinite universe; complex random sampling designs.</p>		
<p><b>9. Time Series Analysis:</b> Concept of time series; different components of a time series: secular trend, seasonal variation, cyclical fluctuation, and irregular variation; measurement of trend; determination of seasonal variation; uses and importance of time series analysis in soil and agriculture.</p>			

Course: SWE-3108: Biostatistics Sessional	Credit : 1.5	Year: Third	Term: First
<p><b>Rationale:</b> This course is introduced to familiarize students with practical knowledge about biostatistics and computer packages as statistical tools.</p>			
<p><b>Course Objectives:</b></p> <ul style="list-style-type: none"> <li>• Capacity building in students about practical application of the biostatistical theories.</li> </ul>			
Intended Learning Outcomes (ILOs)	Course Contents		
<p>At the end of the course the students will be able to -</p> <ol style="list-style-type: none"> <li>1. construct frequency table and present data graphically.</li> <li>2. measure central tendency and dispersion</li> <li>3. calculate the correlation coefficient, regression coefficient and regression equations</li> <li>4. compute the mean differences and test of hypotheses</li> <li>5. draw sample from population under study.</li> <li>6. use computer built-in software packages.</li> </ol>	<ol style="list-style-type: none"> <li>1. Formation of frequency distributions; diagrammatic and graphical presentations of statistical data.</li> </ol>	<ol style="list-style-type: none"> <li>2. Computation of different measures of central tendency and dispersion; coefficient of variation.</li> </ol>	<ol style="list-style-type: none"> <li>3. Computation of simple, multiple and partial correlation coefficient; computation of regression coefficient and regression equations; fitting of linear regression models for prediction.</li> </ol>
	<ol style="list-style-type: none"> <li>4. Computation of tests of significance based on t, <math>\chi^2</math> and F distributions; hypothesis testing for differences between means, test for a fixed-ratio hypothesis; test for homogeneity of ratio, test for homogeneity of variance, test for goodness of fit.</li> </ol>	<ol style="list-style-type: none"> <li>5. Sampling from experimental and farmers' field.</li> </ol>	

Course: SWE-3109: Soil and Environmental Microbiology	Credit : 3	Year: Third	Term: First
<b>Rationale:</b> This course is designed to provide preliminary ideas and concepts of basic Environmental Microbiology.			
<b>Course Objectives:</b> <ul style="list-style-type: none"> <li>• Acquire basic knowledge on Environmental Microbiology.</li> <li>• Understand the various microbial transformations in soil and their role to plant growth and environment</li> <li>• Understand organic matter decomposition &amp; their consequences in soil and environment</li> </ul>			
<b>Intended Learning Outcomes (ILOs)</b>		<b>Course content</b>	
<b>Section – A</b>			
<p>At the end of the course the students will be able to-</p> <ol style="list-style-type: none"> <li>1. recognize the origin of life, interconnection between organisms and their basic nutrient requirements.</li> <li>2. describe various processes to sterilize.</li> <li>3. explain how absence of oxygen transformation in the microbial processes.</li> <li>4. understand various types of staining, mutations, interaction of organisms and c:n ratio.</li> </ol>	<b>1. Introduction:</b> Origin of life in earth (Spontaneous generation theory, creation theory, comparison between these two theories), place of microorganisms in the living world (Haeckel’s protist, five kingdom classification and three domain classification), nutritional requirements of organisms (list of nutritional requirements, classification of organisms on the basis of their nutrition).		
	<b>2. Control of microorganisms:</b> Sterilization, objectives of sterilization, general modes of action of different methods, quality of suitable chemical antimicrobial agent, quality of antibiotics, concept of antibiotics, chemotherapy and chemotherapeutic agent, various methods of sterilization.		
	<b>3. Microbial processes:</b> List of terminal electron acceptors in absence of O <sub>2</sub> and the related processes, pyruvic acid-the key metabolite in life (relation of pyruvic acid in the link between catabolic & anabolic processes), concept of fermentation, different fermentative products formed from pyruvic acid and their importance.		
<b>Section – B</b>			
<ol style="list-style-type: none"> <li>5. understand the diversification of microbial habitat in soil &amp; environment.</li> <li>6. describe the decomposition of major organic compounds and their consequences.</li> <li>7. understand biofertilizer, their variety &amp; application in agriculture.</li> <li>8. describe sulfur transformation and its consequence to soil and environment.</li> </ol>	<b>5. Soil habitat:</b> Soil as a diversified microbial habitat, factors affecting the habitat of microorganisms, inorganic, organic and living biomass as sources of nutrients.		
	<b>6. Microbial decomposition:</b> Natural occurrence, composition, biochemistry of decomposition, enzymes, decomposing microorganisms and factors governing the decomposition of cellulose, hemicellulose, lignin, starch, pectic substances, inulin and chitin.		
	<b>7. Biofertilizers:</b> BNF: classification of BNF, composition of nitrogenase, mechanism and processes of Legume- <i>Rhizobium</i> association, cross inoculation groups, factors affecting nodulation, Classification of <i>Rhizobia</i> on different basis, characteristics of <i>Rhizobium</i> , ARA test and its significance, <b>Mycorrhiza:</b> general features, classification and benefits, <i>Cyanobacteria:</i> general features, ecological significance, Azolla: general features, <i>Azolla-Anabaena</i> symbiosis, their ecological significance, Phosphate solubilizing microorganisms.		
<b>8. Transformations of S:</b> Forms of soil S, organic S mineralization, oxidation of inorganic S, organisms involved in S transformations, reduction of inorganic S compounds, volatile S compounds.			

Course: SWE-3110: Soil and Environmental Microbiology Sessional	Credit : 1.5	Year: Third	Term: First
<p><b>Rationale:</b> This course is designed to isolate microorganisms from soil, their characteristics study and to determine the various microbial mediated processes.</p>			
<p><b>Course Objectives:</b></p> <ul style="list-style-type: none"> <li>• Acquire basic knowledge on soil microbial habitat</li> <li>• Determination of various microbial transformations in soil and their role to plant growth and environment</li> <li>• Determination of organic matter decomposition &amp; their consequences in soil and environment</li> </ul>			
Intended Learning Outcomes (ILOs)	Course Content		
<p>At the end of the course the students will be able to -</p> <ol style="list-style-type: none"> <li>1. operate most of the microscopes and get knowledge of common microscopic procedures.</li> <li>2. learn how to isolate bacteria and study them scientifically.</li> <li>3. understand the diversified microbial habitat.</li> <li>4. learn about biofertilizers and their benefit in agriculture.</li> </ol>	1. Use of bright field, dark field, phase contrast and trinocular microscopy.	2. Isolation, purification and preservation of soil bacteria, Identification of bacteria through their colony characteristics, microscopic examination and biochemical tests.	
	3. Study of various soil parameters that regulate soil microbial activity.	4. Study the influence of biofertilizers and their composition.	
	5. Performing all kinds of staining.	6. Determine C: N ratio of soil and organic matter.	

<b>Course: SWE-3111: Environmental Hazards and Disaster Management</b>	<b>Credit : 3</b>	<b>Year: Third</b>	<b>Term: First</b>
<b>Rationale:</b> This course is designed to apply knowledge and understanding of environmental hazards and disaster to mitigate these calamities.			
<b>Course Objectives:</b>			
<ul style="list-style-type: none"> <li>• Acquire fundamental knowledge on environmental hazards and disaster</li> <li>• Understand and apply different monitoring techniques and mitigation processes.</li> </ul>			
<b>Intended Learning Outcomes (ILOs)</b>	<b>Course Content</b>		
<b>Section – A</b>			
<p>At the end of the course the students will be able to-</p> <ol style="list-style-type: none"> <li>1. understand the natural processes that can lead to hazards.</li> <li>2. illustrate the concepts of risks, vulnerability and the influence of global changes on the impact of hazards.</li> </ol>	1. Definition of hazards and disaster, risk, and vulnerability		
	2. Climate hazards: floods, storms, drought		
	3. Geohazards: Earthquakes, landslides and volcanic hazards		
	4. Other hazards: natural, semi-natural and man-made hazards		
<b>Section – B</b>			
<ol style="list-style-type: none"> <li>3. illustrate the importance of monitoring techniques, preparation of hazard maps and the implementation of mitigation measures.</li> <li>4. learn to differentiate the phases of a crisis, to identify the actors involved and to analyze the best practices before, during and after a crisis to avoid that a natural hazard turns into a human disaster.</li> </ol>	5. Assessment of vulnerability by using different indices		
	6. Monitoring and modeling hazards; impact and mitigation measures.		
	7. Risk assessment and the crisis management cycle, Disaster risk reduction strategies.		

<b>Course: SWE-3201:Soil Chemistry II</b>	<b>Credit : 3.0</b>	<b>Year: Third</b>	<b>Term: Second</b>
<b>Rationale:</b> This course is designed to provide soil chemistry as functional property for the understanding and application of theories to soil environment for plant growth.			
<b>Course Objectives:</b>			
<ul style="list-style-type: none"> <li>• The student's will understand the application of cation and anion exchange reactions of soil.</li> <li>• Teach students how soil colloids and organic fractions act as fixing sites for plant nutrients.</li> <li>• To build the knowledge of soil nutrient fractionation, waterlogged soil and isotopes in soil-plant study.</li> </ul>			
<b>Intended Learning Outcomes (ILOs)</b>	<b>Course Content</b>		
<b>Section – A</b>			
<p>At the end of the course the students will be able to-</p> <ol style="list-style-type: none"> <li>1. apply the theories and formulate the cation and anion exchange in soil application.</li> <li>2. measure the fixing capacity of soil for particular nutrient and propose for better rate of application.</li> <li>3. describe the role of chelation and complex cation in soil fertility and detoxification of contaminants.</li> <li>4. signify the role of buffering capacity and evaluate soil in relation to its capacity to buffer.</li> </ol>	<b>1. Cation exchange and Anion exchange in soil:</b> Adsorption of cations by soil colloids, cation exchange reactions, CEC, empirical equations of cation exchange, sources of positive charges on soil colloid, adsorption of anions by soil colloids (nonspecific adsorption negative and positive adsorption), specific adsorption, prediction of anion concentration.		
	<b>2. Fixation of nutrients in inorganic way:</b> Non-biological fixation of N factors affecting non-biological fixation of N in soil, non-biological fixation of P: fixation of P, factors affecting non-biological fixation of P in soil, P fixation capacity of soils, theories of K fixation (lattice hole theory), release of fixed K, factors affecting K fixation in soil,		
	<b>3. Chelation and complexation/ Chemistry of soil-organic matter interaction:</b> Complex formation and chelation: importance of chelation, effectiveness of organic acids in chelation, stability constants, clay – organic compound complexes, complex formation and soil fertility: effect of complex formation on soil physical, chemical and biological properties, mode of nutrient uptake by plants in chelated forms.		
	<b>4. Buffering:</b> Definition, buffering action and buffer solution soil as a buffer, importance of buffering in agriculture, base saturation percentage.		
<b>Section – B</b>			
<ol style="list-style-type: none"> <li>5. characterize humic substances and understand theories of humus formation.</li> <li>6. illustrate and compare different schemes of nutrient fractionation and assess the significance of each fraction in crop production.</li> <li>7. analyze electrochemical changes and nutrient transformations in submerged soil.</li> <li>8. apply tracer techniques in soil plant study.</li> </ol>	<b>9. Humus/Colloidal chemistry of humus:</b> The colloidal system, the organic components: soil humus, humic matter, humic substances: definitions and terminology, extraction and isolation of humic substances from soils and water, fractionation, chemical characterization and composition of humic substances, spectral characteristics of humic substances, structural chemistry of humic substances, agricultural, industrial and environmental importance of humic acids.		
	<b>10. Fractionation and characterization of nutrients:</b> Fractionation and characterization of N, P, K and S as major nutrients and some micronutrients in soil, factors controlling the fractions, significance of individual fractions in crop production.		
	<b>11. Chemistry of submerged soil:</b> Definition and characterization of different waterlogged soil, electrochemical changes due to soil reduction, transformation and availability of N and P in submerged soil, organic matter decomposition in submerged soil.		
	<b>12. Isotopes and Radiation:</b> Definition, stable and radioisotopes, their properties, characteristics of radiation, radiation detection and measurement, principles of trace methodology, use of isotopes in soil fertility study and soil organic matter research.		

<b>Course: SWE-3202: Soil Chemistry II Sessional</b>	<b>Credit : 1.5</b>	<b>Year: Third</b>	<b>Term: Second</b>
<b>Rationale:</b> This course is designed to handle practically the soil chemical phenomenon and familiar to use in the agricultural field			
<b>Course Objectives:</b>			
<ul style="list-style-type: none"> <li>• The student's will understand the cation and anion exchange behavior of soil colloid.</li> <li>• Teach students how soil colloids behave as adsorptive sites for substances</li> <li>• Demonstrate the chemical knowledge of soil nutrient fixation and their combination in soil system.</li> </ul>			
<b>Intended Learning Outcomes (ILOs)</b>	<b>Course Content</b>		
At the end of the course the students will be able to-	<b>1.</b> Determination of ion exchange: cation and anion exchange in soil.		
1. design ion exchange reaction for different soil system.	<b>2.</b> Determination of nutrient fixing capacity of soil: N, P, K – fixation in different soils		
2. formulate and compare nutrient fixing capacity of soil and estimate optimum quantity of nutrients for better plant yield.	<b>3.</b> Fractionation of humic substances in soil: isolation and fractionation of humic acid, fulvic acid and humin in different soil under varying conditions		
3. compare humic substances in soil and asses the soil on the basis of humic substances present.			

Course: SWE-3203: Soil Erosion and Conservation	Credit : 3.0	Year: Third	Term: Second
<b>Rationale:</b> This course is designed to provide concepts and skills soil erosion and soil degradation; their impacts on environment and measures of controls.			
<b>Course Objectives:</b> <ul style="list-style-type: none"> <li>• Acquaint students with importance of soil-water-vegetation system for sound survival of humankind.</li> <li>• Teach and help students understand erosion and degradation that can jeopardize soil functions.</li> <li>• Equip students with knowledge on soil conservation practice options.</li> </ul>			
Intended Learning Outcomes (ILOs)	Course Content		
Section – A			
<p>At the end of the course the students will be able to-</p> <ol style="list-style-type: none"> <li>1. summarize the value of soil to support mankind.</li> <li>2. discover reasons for wind erosion and measures to control wind erosion.</li> <li>3. recognize the types of water erosion measure kinetic energy of rain and apply erosivity indices to quantify the impact of water erosion.</li> <li>4. use technology to check erosion that may lead to degradation.</li> <li>5. relate land abuse and overexploitation with types of degradation.</li> <li>6. assess land degradation types and causes and explain their impact in Bangladesh.</li> </ol>	<ol style="list-style-type: none"> <li>1. <b>Introduction to soil Erosion and conservation:</b> Soil as a basic and irreplaceable resource, soil as an endangered ecosystem, population versus resource base of the world and Bangladesh, history of soil erosion and conservation in different civilizations, soil erosion in modern times, harmful effects of soil erosion (on-site and off-site).</li> </ol>		
	<ol style="list-style-type: none"> <li>2. <b>Wind Erosion:</b> Classification of soil erosion, mechanism of particle movement in wind erosion, factors affecting water erosion and wind erosion, wind erosion hazard, factors affecting wind erosion, wind erosion model, practices for controlling wind erosion.</li> </ol>		
	<ol style="list-style-type: none"> <li>3. <b>Water Erosion:</b> Terminologies; erosivity and erodibility, classification of soil erosion, types of water erosion, physical factors affecting water erosion, rainfall erosivity indices, soil erodibility indices, quantifying the impact of water erosion, practices controlling water erosion.</li> </ol>		
	<ol style="list-style-type: none"> <li>4. <b>Soil Degradation:</b> Concept of soil degradation; Soil erosion versus degradation; Processes and types and of soil degradation; harmful effects of different types of degradation; Degree and extent of different types of degradation worldwide; Assessment of land degradation; impact of land degradation in Bangladesh.</li> </ol>		
Section – B			
<ol style="list-style-type: none"> <li>7. recognize areas need adoption of conservation practices and identify problems in implementation.</li> <li>8. select suitable agronomic and mechanical conservation practices that suit to economic condition and severity of the hazard.</li> <li>9. explain the ways to identify and locate vulnerable site to slope failure or landslide and suggest measures to protect and stabilize slope or at the least to minimize damage.</li> <li>10. paraphrase the term ‘sustainability’, appreciate the value of obtaining sustainability, and manage soil sustainably.</li> </ol>	<ol style="list-style-type: none"> <li>5. <b>Soil Conservation:</b> Conservation viewpoint, needs of soil conservation, obstacles to conservation, problems of implementing soil conservation practices in the field, socio-economic aspects of soil conservation, conservation techniques, choosing conservation practices, low-cost methods of soil conservation.</li> </ol>		
	<ol style="list-style-type: none"> <li>6. <b>Agronomic and Mechanical Methods of Soil Conservation:</b> Agronomic practices – land use, crop management, conservation tillage, agro-forestry, mulching, and use of soil conditioners, Mechanical practices – contouring, contour strip cropping, contour bunding, terracing, hillside ditches, and safe waterways.</li> </ol>		
	<ol style="list-style-type: none"> <li>7. <b>Sloping land and Erosion:</b> Land use in hilly areas triggers erosion, slope and soil vulnerability, landslides- types, identification and mitigation of landslide hazard, guidelines for people at risky areas.</li> </ol>		
	<ol style="list-style-type: none"> <li>8. <b>Sustainable Land Use:</b> Concept of sustainability and soil resilience, measurement of sustainability, organic matter as an attribute for sustainability assessment, sustainable land use system and soil resilience, land use, soil management and sustainability relationship, technological options for sustainable land use.</li> </ol>		

<b>Course: SWE-3204: Soil Erosion and Conservation Sessional/ Fieldwork</b>	<b>Credit:1.5</b>	<b>Year: Third</b>	<b>Term: Second</b>
<b>Rationale:</b> Assessment of soil erosion and degradation of soil for maintaining its sustainable use.			
<b>Course Objectives:</b>			
<ul style="list-style-type: none"> <li>• Estimation of erosion on sloping land</li> <li>• Adopt agronomic and mechanical measures of controlling loss of soil from top soil</li> </ul>			
<b>Intended Learning Outcomes (ILOs)</b>	<b>Course Content</b>		
At the end of the course the students will be able to -	1. Estimation of soil erodibility with nomograph and multi-slot divisor.		
1. estimate amount of water erosion and soil erodibility.	2. Measurement of slope.		
2. determine slope gradient and classify sloping land according to slope steepness.	3. Contour line formation by A-frame.		
3. design and construct contour line for bench terrace construction (inward and outward type).	4. Construction of inward and outward bench terrace.		
4. select ways or paths for safe water construction and for its stabilization.	5. Constructing of gabion dam for the protection of gully erosion.		
5. identify vulnerable areas to specific type of erosion, mention reasons for it.	6. Area selection for safe-water ways and stabilization by stone pitching.		
6. figure out problems of jhum cultivation and suggest ways of improvement.	7. Conduct a mini survey on areas to identify the vulnerable areas to gully erosion, mass wasting and landslides.		
	8. Conduct a survey on Jhum cultivations - its advantages and limitations and drawing suggestions for improvement.		

<b>Course: SWE-3205: Research Methodology</b>	<b>Credit: 3.0</b>	<b>Year: Third</b>	<b>Term: Second</b>
<b>Rationale:</b> This course is designed to provide an introduction to research and research methodology in biological sciences. The course also provides different experimental designs and how to analyze the statistical data with a valid procedure.			
<b>Course Objectives:</b> At the end of the course the students will gain insights into how scientific research is conducted as well as learn to test the significance, validity and reliability of the research results.			
<b>Intended Learning Outcomes (ILOs)</b>	<b>Course Contents</b>		
<b>Section A</b>			
<p>At the end of the course the students will be able to-</p> <ol style="list-style-type: none"> <li>1. define the meaning of research.</li> <li>2. choose different types of research.</li> <li>3. list the problems encountered by researchers in Bangladesh.</li> <li>4. discover how scientific research is conducted.</li> <li>5. formulate the research problem.</li> <li>6. analyze critical review of literature, develop a hypothesis</li> <li>7. develop a research proposal.</li> <li>8. build a research report as well as a scientific article.</li> </ol>	<p><b>1. Perception of Research:</b> Meaning of research, general characteristics of research; functions of research, objectives of research, motivation in research, ethics in research, types of research, characteristics of researcher, research approaches, research methods versus methodology, research and scientific method, importance of knowing how research is done, criteria of good research, problems encountered by researchers in Bangladesh.</p>		
	<p><b>2. Research Process:</b> Formulating the research problem, extensive literature survey, developing the hypothesis, preparing the research design, determining sample design, collecting the data, steps involved in designing questionnaire, execution of the project, analysis of data, hypothesis testing; generalizations and interpretation, preparation of the report or presentation of the results.</p>		
	<p><b>3. Research Proposal and Report Writing:</b> Developing research proposal or synopsis, significance of report writing, different steps in writing report, layout of the research report, types of reports, oral presentation, mechanics of writing a research report, writing research abstract, writing research papers, precautions for writing research reports.</p>		
	<p><b>4. Data Analysis and Presentation of Research Results:</b> Single-factor experiment, two-factor experiments, discrete treatments, quantitative treatments, line graph, factorial experiment, tabular form, bar chart, line graph, more-than-one set of data, measurement over time, multi-character data, SWOT analysis.</p>		
<b>Section B</b>			
<ol style="list-style-type: none"> <li>9. analyze experimental design and its purposes.</li> <li>10. define different terminologies about experimental design.</li> <li>11. apply commonly used experimental designs in agricultural sciences.</li> <li>12. choose the analysis of variance and covariance.</li> <li>13. describe the techniques used in the one-factor and two-factor ANOVA with equal or unequal observations.</li> <li>14. test the significance, validity and reliability of the research results.</li> <li>15. identify the different types of errors and how to minimize it.</li> </ol>	<p><b>5. Elements of Experimentation:</b> Valid experimental design, needs and purpose of experimental design, terms in experimental designs: experiment, treatment, experimental unit, factor, yield, block, experimental error and precision, elements of experimentation-estimate of error: replication, randomization, control of error: blocking, proper plot technique, data analysis, proper interpretation of results.</p>		
	<p><b>6. Experimental Designs:</b> Completely randomized design: randomization and layout, randomized complete block design: blocking technique, randomization and layout, block efficiency, latin square design: randomization and layout, efficiencies of row- and column-blockings, interaction between two factors, factorial experiment, complete block design, split-plot design: randomization and layout, analysis of variance.</p>		
	<p><b>7. Analysis of Variance and Covariance:</b> Definition, the basic principles of ANOVA, ANOVA technique, setting up analysis of variance (ANOVA) table, short-cut method for one-way ANOVA, two-way ANOVA, ANOVA in LS design, analysis of co-variance (ANOCOVA), ANOCOVA technique, assumptions in ANOCOVA.</p>		
	<p><b>8. Comparison Between Treatment Means:</b> Least significant difference test (LSD), Duncan's multiple range test (DMRT).</p>		
<p><b>9. Reliability and Validity in Measurements:</b> Limitation of analytical methods, classification of errors, measurement of error, accuracy, precision, minimization of systematic errors, reliability and its measurements, standard error of measurement, validity and its measurements.</p>			

<b>Course: SWE-3206: Research Methodology Sessional/Field Work</b>	<b>Credit: 1.5</b>	<b>Year: Third</b>	<b>Term: Second</b>
<p><b>Rationale:</b> This course is introduced to make the student familiar with practical aspects of research methodology in biological sciences.</p>			
<p><b>Course Objectives:</b></p> <p>At the end of the course the students will be able to design and layout different field experiments. They will be able to prepare research proposal, scientific article as well as will be introduced different statistical software for data analysis.</p>			
<b>Intended Learning Outcomes (ILOs)</b>		<b>Course Contents</b>	
<p>After studying this chapter, the student will be able to-</p> <ol style="list-style-type: none"> <li>1. prepare questionnaire and research proposal/thesis/report/scientific article.</li> <li>2. create blocks in the field condition to make a desirable experimental design.</li> <li>3. analyze both one way and two way variance and covariance by using computer built-in statistical software packages.</li> <li>4. compare several populations in terms of their means and variances.</li> <li>5. use computer packages for data analysis.</li> <li>6. present his/her research results.</li> </ol>		1. Preparation of questionnaire; research proposal development and scientific papers writing.	
		2. Formation of plots and blocks, randomization and layout of CRD, CRBD and LS design; analysis of data obtained from CRD, CRBD, LS design.	
		3. Analysis of variance, covariance and comparison between treatment means.	
		4. Analysis of data using computer packages and presentation of research results.	

<b>Course: SWE-3207: Water and Waste Water Treatment</b>	<b>Credit: 3.0</b>	<b>Year: Third</b>	<b>Term: Second</b>
<b>Rationale:</b> This course is designed to expose students about water resources, water quality and water management in Bangladesh, as well as provide ideas and concepts of water treatments and waste water re-use in Bangladesh.			
<b>Course Objectives:</b>			
<ul style="list-style-type: none"> <li>• Acquire basic knowledge on water resources</li> <li>• Understand the water quality and water management</li> <li>• Gather ideas on water treatments and waste water re-use</li> </ul>			
<b>Intended Learning Outcomes (ILOs)</b>	<b>Course Content</b>		
<b>Section – A</b>			
<p>At the end of the course the students will be able to-</p> <ol style="list-style-type: none"> <li>1. familiar about the water resource of Bangladesh.</li> <li>2. interpret water quality and describe the common water quality parameters.</li> <li>3. make use of water resource management in Bangladesh.</li> </ol>	<b>1. Water Resource:</b> Types and sources of water resource, factors affecting water stress in the world, surface water hydrology, classification of watershed, watershed management for poverty alleviation and rural development, lake: Ecological zones and classification of lakes on the basis of nutrition, thermal cycles of lakes, comparison of surface and ground water.		
	<b>2. Water Quality:</b> Importance of water quality, water quality parameters for drinking and irrigation, eutrophication, types, effect and control of eutrophication, effects of heavy metals, acid rain and climate change on water quality.		
	<b>3. Water resource management:</b> Water resource management in Bangladesh, aspect of water management, water management in rural and urban areas of Bangladesh, world water distribution, sharing of Ganges water treaties.		
<b>Section – B</b>			
<ol style="list-style-type: none"> <li>4. Outline the principles of water treatment technologies.</li> <li>5. describe basic techniques of waste water treatment</li> <li>6. Demonstrate waste water re-use.</li> </ol>	<b>6. Water Treatment:</b> Water treatment, importance of water treatment, impurities of water.		
	<b>7. Techniques of water treatment:</b> Primary and secondary treatment of waste water, techniques for removal of dissolved gases, odor and color from waste water, soda-lime process to remove Ca and Mg, removal of Fe and Mn, radioactive materials and dissolve organics from waste water, chlorination as disinfectants, coagulation and its types, activated sludge/biological treatment, reverse osmosis, aerated lagoons and oxidation ponds.		
	<b>8. Waste water Re-use:</b> Definition and types of waste water re-use, water quality requirements, sludge dewatering and disposal.		

<b>Course: SWE-3208: Water and Waste Water Treatment Sessional</b>	<b>Credit: 1.5</b>	<b>Year: Third</b>	<b>Term: Second</b>
<p><b>Rationale:</b>The course is designed to provide applied knowledge on physical, chemical and biological water quality parameters.</p> <p><b>Course Objectives:</b></p> <ul style="list-style-type: none"> <li>The course is designed to apply the acquired knowledge of water and waste water quality for various uses.</li> </ul>			
<p><b>Intended Learning Outcomes (ILOs)</b></p> <p>At the end of the course the students will be able to-</p> <ol style="list-style-type: none"> <li>assess the quality levels of water and waste water from any source and suggest fit or unfit for different uses.</li> <li>determine different water quality parameters.</li> </ol>	<p><b>Course Content</b></p> <ol style="list-style-type: none"> <li>Collection and preparation of water, waste water and effluents samples.</li> <li>Visit of different water sources including industries releasing effluents.</li> <li>Determination of pH, EC, TDS, TSS, turbidity, temperature, <math>\text{CO}_3^-</math>, <math>\text{HCO}_3^-</math>, <math>\text{Cl}^-</math>, hardness, <math>\text{Ca}^{2+}</math>, <math>\text{Mg}^{2+}</math>, <math>\text{Na}^+</math>, <math>\text{K}^+</math>, <math>\text{NH}_4^+</math>, BOD, COD, color, odor, DO, <math>\text{SO}_4^{2-}</math>, <math>\text{PO}_4^{3-}</math>, <math>\text{NO}_3^-</math> in water and waste water and industrial effluents.</li> </ol>		

<b>Course: SWE-3209: Natural Resource Management</b>	<b>Credit: 3.0</b>	<b>Year: Third</b>	<b>Term: Second</b>
<b>Rationale:</b> This course is designed to provide ideas and concepts of interdisciplinary ecology and social-ecological systems applied to sustainable natural resource management in a time of rapid global change.			
<b>Course Objectives:</b>			
<ul style="list-style-type: none"> <li>• Understand principles and concepts of Natural Resources and sustainability.</li> <li>• Develop concepts and skills to manage natural resources in a sustainable way.</li> <li>• Integrated understanding of ecological, economic and social aspects of natural resources including their use, misuse and management.</li> </ul>			
<b>Intended Learning Outcomes (ILOs)</b>	<b>Course Content</b>		
<b>Section – A</b>			
<p>At the end of the course the students will be able to-</p> <ol style="list-style-type: none"> <li>1. justify sustainability and its ultimate goal.</li> <li>2. acquire knowledge on natural resources and its ecological, social and economic aspect.</li> <li>3. describe land and energy resources and their sustainable management.</li> </ol>	<ol style="list-style-type: none"> <li>1. <b>Concept of Sustainability:</b> Principles and concept, components of sustainability, history, criteria and indicators, measurements, sustainable development goal.</li> </ol>		
	<ol style="list-style-type: none"> <li>2. <b>Introduction to Natural Resource Bases:</b> Definition and concepts, classification of natural resources, distribution and uses, interrelationships among different types of natural resources, exploitation of natural resources, resource conflicts, ecological, social and economic dimension of resource management.</li> </ol>		
	<ol style="list-style-type: none"> <li>3. <b>Sustainable Land Management:</b> Concept and progress, land as a resource, land use change and degradation, integrated land use management, sustainable land use and food security, agro-ecosystem, parameters of agro-ecosystem and sustainability, land tenure, land administration.</li> </ol>		
	<ol style="list-style-type: none"> <li>4. <b>Energy resources:</b> Growing energy needs, renewable and nonrenewable energy sources, use of alternative renewable energy sources.</li> </ol>		
<b>Section – B</b>			
<ol style="list-style-type: none"> <li>4. describe forest resources status over exploitation and management.</li> <li>5. achieve knowledge on the utilization and the management of the water from different sources.</li> <li>6. comprehend common international resources and management.</li> </ol>	<ol style="list-style-type: none"> <li>5. <b>Sustainable forest management:</b> Forest Principles, status and distribution, Use and over-exploitation, ecological forestry and natural resource management, wildlife considerations, protected area management, agro-forestry, forest governance, public input and awareness.</li> </ol>		
	<ol style="list-style-type: none"> <li>6. <b>Water resources management:</b> Use and over-utilization of surface and ground water, conflicts over water, dams-benefits and problems, water conservation at domestic, industrial and agricultural sectors, flood control, drought management, rain, water harvesting and recharge wells, water ecology and management.</li> </ol>		
	<ol style="list-style-type: none"> <li>8. <b>Mineral resources:</b> Use and exploitation, environmental effects of extracting and using mineral resources and using mineral resources.</li> </ol>		

<b>Course: SWE-3261: Geographical Information System</b>	<b>Credit: 3.0</b>	<b>Year: Third</b>	<b>Term: Second</b>
<p><b>Rationale:</b> Students of this course are expected to learn and understand the basic concept and techniques associated with geographic information science and technology. It is assumed that the students have familiarity with desktop computers, operating system of Windows XP/Vista/7, basics of web browsing and some software like MS Office suits, SPSS. It emphasizes the understanding and implementation of geographic information system theories including map projection and coordinate system, vector and raster data models, spatial data management and queries, and spatial data analysis.</p>			
<p><b>Course Objectives:</b> This course aims at providing -</p> <ul style="list-style-type: none"> <li>• in-depth understanding about digital map preparation,</li> <li>• integration of different kinds of data with the map and</li> <li>• extracts relevant information using different spatial analytical tools.</li> </ul>			
<b>Intended Learning Outcomes (ILOs)</b>	<b>Course Content</b>		
<b>Section – A</b>			
At the end of this course, the student will be able to -	1. <b>Introduction to GIS:</b> Definition, History of GIS development, component, Applications of GIS.		
1. define GIS and describe its scope	2. <b>Coordinate System and Map projection:</b> geographic coordinate system, projected coordinate system, Spheroid, Datum, false easting and northing, scale factor Map Projections, Error Issues in map projection;		
2. describe scale, projection, and coordinate systems and explain importance of each of these components in GIS	3. <b>Geographical Data types and methods of representation:</b> Spatial databases (Databases concepts, point, line, arc, and continuous surface). <b>Spatial Database Development:</b> Data input methods, GIS data editing and correction implementation;		
3. differentiate between vector, raster, and object-oriented data structures and explain the appropriate use of each of these data structures	4. <b>GIS Data Structure:</b> nature of geographical data, spatial data models, raster data models (simple raster array, hierarchical raster structures), vector data model (whole polygon structure, arc-node structure, and relational structure), comparison, format conversion, topology.		
4. describe various types of GIS data capture and storage,			
<b>Section – B</b>			
5. differentiate between attribute analysis and spatial analysis and describe the appropriate use of each type of analysis,	5. <b>Preprocessing:</b> Data reduction and generalization, Error detecting editing, Merging, Edge Matching, Rectification and Registration, Coordinate systems and geo-referencing, geometric transformation, spatial data accuracy.		
6. demonstrate proficiency with primary level of spatial statistics	6. <b>Manipulation, Analysis and Spatial Modeling:</b> Attribute data management, vector data analysis (buffering, overlay, distance management, pattern analysis), raster data analysis (Reclassification and aggregation (attribute operations, spatial aggregation, connectivity operations, neighborhood operations)		
	7. <b>Overlay Operations:</b> Topological overlay (Union, Identity, Intersect,Clip). <b>Interpolation:</b> Definition, purpose, applications. Surface creating, Hill shade, slope, aspect. IDW, Kriging.		
	8. <b>GPS:</b> Basic concept of GPS, <b>Structure:</b> Space segment, Control segment and User segment, <b>GPS Applications, Error source and Analysis. Differential GPS (DGPS), Assisted GPS (AGPS)</b>		

<b>Course: SWE-3262: Geographical Information System Sessional</b>	<b>Credit: 1.5</b>	<b>Year: Third</b>	<b>Term: Second</b>
<p><b>Rationale:</b> This is a practical, hands-on course fully supported by its theoretical concept. This course is designed to provide skill on meaningful application GIS software to produce maps of analytical results.</p>			
<p><b>Course Objectives:</b></p> <ul style="list-style-type: none"> <li>To make the students of this course proficient in solving complex spatially integrated problems using different GIS related software and explains the same using theoretical knowledge acquired from course URP 3261.</li> </ul>			
<b>Intended Learning Outcomes (ILOs)</b>	<b>Course Content</b>		
<p>At the end of the course the students will be able to-</p> <ol style="list-style-type: none"> <li>demonstrate proficiency in GIS software</li> <li>produce effective maps of analytical results which adhere to established cartographic standards</li> <li>gain proficiency in spatial data analysis and 3D data analysis</li> </ol>	<p><b>1. Developing spatial database:</b> Digitizing; Digitizing Considerations: format, ID, error reduction in digitizing; Topology creation and map correction, Error identification and editing. Coordinate System and map projection.</p>		
	<p><b>2. GIS Map and Database:</b> joining database with map. <b>Query:</b> attribute and spatial query, summarization. <b>Table Manipulations, Overlay Techniques, Model Builder.</b></p>		
	<p><b>3. Spatial analysis:</b> Interpolation, Hill shade, slope, aspect. IDW, Kriging, spline. <b>3D Analysis:</b> Creating and managing 3D GIS data. 3D Data Visualization, <b>DEM</b>, 3D Terrain and Surface Analysis,</p>		
	<p><b>4. Watershed Analysis:</b> Flow Direction, Accumulation and Sink.</p>		

Course: SWE-4101: Soil Survey and Land Evaluation	Credit : 3.0	Year: Fourth	Term: First
<p><b>Rationale:</b> This course is designed to expose students about soil survey and land evaluation.</p>			
<p><b>Course Objectives:</b></p>			
<ul style="list-style-type: none"> <li>• To give students basic knowledge and skills on soil survey for land evaluation purposes</li> <li>• To enable students learn how to integrate soil survey and land evaluation into land use planning</li> </ul>			
Intended Learning Outcomes (ILOs)	Course Content		
Section-A			
<p>At the end of the course the students will be able to-</p> <ol style="list-style-type: none"> <li>1. familiar about soil survey, its importance and uses.</li> <li>2. outline the types and techniques of soil survey.</li> <li>3. make use of base materials and aerial photographs.</li> <li>4. demonstrate knowledge of remote sensing.</li> </ol>	<p><b>1. Definition and importance of soil survey.</b> Agricultural and non-agricultural uses of survey data.</p>	<p><b>2. Types of soil Survey.</b> Techniques of reconnaissance and detailed soil survey.</p>	
	<p><b>3. Principal types of base material:</b> Base material and their scale, merits and demerits. Interpretation and uses of base materials especially aerial photograph and aerial mosaics, soil survey work plan.</p>	<p><b>4. Remote sensing:</b> Use of remote sensing data for soil survey.</p>	
Section-B			
<ol style="list-style-type: none"> <li>5. make use of soil maps, units and legend.</li> <li>6. interpret plotting of soil boundaries</li> <li>7. achieve idea of land use and land evaluation</li> </ol>	<p><b>5. Soil Maps:</b> Unit of soil classification and mapping, soil mapping legend.</p>	<p><b>6. Plotting of soil boundaries:</b> Soil correlation and interpretation, soil grouping on the map.</p>	
	<p><b>7. Land use and land use planning:</b> Definition, land use type, major types of rural land use, land use in Bangladesh, and use regulation, national land use policy.</p>	<p><b>8. Land evaluation:</b> Definition, land capability and land cover classification, principles of land evaluation, land evaluation procedure, approaches of land evaluation, scale of land evaluation survey.</p>	

<b>Course: SWE-4102: Soil Survey and Land Evaluation Sessional/Field Work</b>	<b>Credit : 1.5</b>	<b>Year: Fourth</b>	<b>Term: First</b>
<b>Rationale:</b> The course is designed to provide applied knowledge on soil survey, land uses, land evaluation and remote sensing.			
<b>Course Objective:</b> <ul style="list-style-type: none"> <li>• To apply the acquired knowledge of soil survey, land uses, land evaluation and remote sensing</li> </ul>			
<b>Intended Learning Outcomes( ILOs)</b>	<b>Course Content</b>		
<p>At the end of the course the students will be able to -</p> <ol style="list-style-type: none"> <li>1. conduct a soil survey on land uses,</li> <li>2. demonstrate differences in soil series along catena</li> <li>3. appraise land quality for complete evaluation for agronomic and other purposes</li> <li>4. interpret remote sensing data for land mapping, mapping legend</li> </ol>	<ol style="list-style-type: none"> <li>1. Examination and description of soils in the field.</li> <li>2. Collection of soil samples.</li> <li>3. Soil survey report, soil survey interpretation for agricultural uses.</li> <li>4. Study and interpret aerial photographs.</li> </ol>		

Course: SWE-4103: Environmental Soil Physics	Credit : 3.0	Year: Fourth	Term: First
<b>Rationale:</b> This course is designed to provide the students the engineering or mechanical aspect of soil along with rice field physics and water balance.			
<b>Course Objectives:</b> <ul style="list-style-type: none"> <li>• To acquaint students with the soil mechanics and provide the basics of geotechnical engineering.</li> <li>• To determine soil compaction and consolidation and apply knowledge for achieving good tilth.</li> <li>• To study the effects of puddling and water balance in rice field.</li> </ul>			
Intended Learning Outcomes (ILOs)	Course Content		
Section-A			
<p>At the end of the course the students will be able to-</p> <ol style="list-style-type: none"> <li>1. define and use the basic concepts of soil mechanics</li> <li>2. sketch the distribution of stress in soil mass due to external and internal loads and calculate these stresses.</li> <li>3. recognize how settlement occurs in soil and calculate settlement based on soil conditions and variable loading</li> <li>4. compare and contrast between compaction and consolidation; explain the factors and processes of compaction</li> <li>5. explain how strength is classified and quantified in soils</li> <li>6. analyze slopes with respect to stability</li> </ol>	<b>1. Basic Principle of Soil Mechanics:</b> Soil description and classification for engineering purpose; their significance – index properties of soils; basic forms of geotechnical structure; introduction of geotechnical engineering; fundamentals of mechanics.		
	<b>2. Stress and Strain in Soils:</b> Modulus of elasticity; Poission’s ratio; Stress at point, equilibrium equation and stress distribution in soil; Boussinesq theory; pressure stress diagrams; components of settlement; Terzaghi’s consolidation theory; pore pressure, effective stress and drainage; streSWE-strain relationship of soil.		
	<b>3. Soil Compaction and Consolidation:</b> consolidation and compaction; process of compaction; relationship between void ratio/porosity and pressure of compaction; effect of water content on compactability of soil; compression and expansion curve, co-efficient of compressibility and volume change; consolidation test.		
	<b>4. Shear strength of soil:</b> Definition; factors affecting soil strength; Mohr’s cycle; Mohr-Coulomb failure theory; laboratory determination of soil strength; direct shear – triaxial compression.		
	<b>5. Slope stability:</b> Slope failure mechanisms; types; total stress analysis for saturated clay- Fellenius method, friction circle method; use of stability number; slope protection measures.		
Section-B			
<ol style="list-style-type: none"> <li>7. practice for rice-based cropping soil management.</li> <li>8. describe as well as evaluate the effects of puddling.</li> <li>9. understand the importance of water balance study and design water balance in rice field.</li> <li>10. detect the impacts of long-term rice cultivation on soil structure and hypothesize consequences.</li> </ol>	<b>6. Physical aspects of soil management for rice-based cropping systems:</b> tillage management (tillage implements, weather forecasting, moisture condition).		
	<b>7. Rice and puddling:</b> Definition, objectives, advantages and disadvantages of puddling; soil’s suitability to puddling, mechanism of puddling; evaluation of degree of puddling; effects of puddling, management of puddling.		
	<b>8. Water balance:</b> Water balance in upland crop field and in rice paddy fields; drainage of rice fields, soil texture and plant available water capacity (PAW); least limiting water range (LLWR); drainage of rice field.		
	<b>9. Manifestation of soil structure in rice field:</b> Crusting and sealing; mechanism of crusting and surface seal formation in rice field (including saline soil); properties of crust, characterization of crust; model for surface crust development; crust management; hardsetting and cracking in rice field.		
<b>10. Swelling and Salt affected rice field:</b> Swelling soils, nature of swelling clay soils, models for swelling, stages of swelling, flow in swelling soils, measurement of swelling, effect of salinity on water movement, soil water repellency.			

<b>Course: SWE-4104: Environmental Soil Physics Sessional/Fieldwork</b>	<b>Credit : 1.5</b>	<b>Year: Fourth</b>	<b>Term: First</b>
<b>Rationale:</b> This course is designed to provide students with knowledge on soil mechanical properties and physical properties of rice field to enhance physical conditions of soil.			
<b>Course Objectives:</b> <ul style="list-style-type: none"> <li>• To determine soil mechanical properties and their importance to agriculture</li> <li>• To analyze water balance in the rice field</li> <li>• To evaluate soil physical condition the rice field.</li> </ul>			
<b>Intended Learning Outcomes (ILOs)</b>	<b>Course Content</b>		
<p>At the end of the course students will be able to-</p> <ol style="list-style-type: none"> <li>1. analyze the shearing strength, mechanical properties, settlement characteristics and compaction behavior in soils.</li> <li>2. determine the soil compaction.</li> <li>3. determine proctor limit of the soil.</li> <li>4. identify ideal soil texture- moisture condition to avoid compaction.</li> <li>5. estimate soil Atterberg's limits.</li> <li>6. analyze the effect of puddling on soil physical properties.</li> </ol>	<ol style="list-style-type: none"> <li>1. Determination of soil compaction in field.</li> <li>2. Direct shear test for shear strength properties of soils</li> <li>3. Tri-axial compression test to measure the mechanical properties of soils and</li> <li>4. Construction of soil moisture–compaction curve.</li> <li>5. Yielding of bulk density- compaction curve.</li> <li>6. Determination of soil liquid limit (LL), plastic limit (PL) and plasticity index (PI).</li> <li>7. Evaluation of soil puddling- structure, bulk density, porosity.</li> </ol>		

Course: SWE-4105: Problem Soils of Bangladesh	Credit : 3.0	Year: Fourth	Term: First
<b>Rationale:</b> This course is designed to introduce and manage the problem soils of Bangladesh.			
<b>Course Objectives:</b> <ul style="list-style-type: none"> <li>To know the extent of Bangladesh problem soils, their impacts on soil and crop growth and how to manage them.</li> </ul>			
Intended Learning Outcomes (ILOs)	Course Contents		
Section-A			
<p>At the end of the chapter the students will be able to-</p> <ol style="list-style-type: none"> <li>classify salt affected soils, understand the properties, extent, and major agricultural constraints of salt affected soils, take the steps to reclaim and manage salt affected soils.</li> <li>manage hill soils, deeply flooded soils, soils with plough pan</li> </ol>	<b>1. Salt Affected Soils:</b> Introduction; classification; properties; extent; major agricultural constraints; reclamation and management of salt affected soils.	<b>2. Acid Sulphate Soils:</b> Introduction; types; characteristics; extent; constraints; management.	
	<b>3. Hill Soils:</b> Introduction; classification; major problems in the hills; management of hill soils.	<b>4. Deeply Flooded Soil/Very Poorly Drained Soil:</b> Introduction; beel, jheel, haor, baor; problems related to deeply flooded soil; management of deeply flooded soil.	
	<b>5. Soils with Plough Pan:</b> Introduction; causes; problems; management.		
6. Section-B			
<ol style="list-style-type: none"> <li>solve the problems related to peat soil and its management.</li> <li>get the idea about the maintenance of organic matter content in soil</li> <li>identify charland, drought prone soils, coarse textured soils, nutrient deficient soils and their management approaches.</li> </ol>	<b>6. Peat Soils (Organic Soils):</b> Introduction; types; distribution; problems related to crop production; management.		
	<b>7. Organic Matter Deficient Soil:</b> Introduction; classification; organic matter status in Bangladesh soils; effect of OM on the physical condition and plant-nutrient supply of soils; causes of organic matter depletion; maintenance of organic matter content in soil.		
	<b>8. Charland Soil:</b> Introduction; soil related problems; distribution; char forming process and agents; soils of charland; agricultural developments potentials.		
	<b>9. Drought Prone Soil:</b> Introduction; types; causes of drought; location and extent; problems; management.		
	<b>10. Coarse Textured Soils:</b> Introduction; location and extent; characteristics; problems; management.		
	<b>11. Nutrient Deficient Soil (Sulphur and Zinc):</b> Introduction; classification; problems; recognition; causes; types, management.		

Course: SWE-4108: Thesis	Credit : 6.0	Year: Fourth	Term: First
<p><b>Rationale:</b> Graduates having this qualification are eligible to be employed in all types of GOs, Research organizations and NGOs. There they need some sort of learning experiences in research also. To provide research experiences this course is included in the curriculum.</p>			
<p><b>Course Objective:</b></p> <ul style="list-style-type: none"> <li>• to enable the students to take a research project and conduct research under a supervisor</li> </ul>			
<p><b>Intended Learning Outcomes:</b></p>		<p><b>Course Content</b></p>	
<p>At the end of the course the students will be able to-</p> <ol style="list-style-type: none"> <li>1. complete a research work under a supervisor</li> <li>2. collect and assemble the data</li> <li>3. analyze the data using statistical computer program</li> <li>4. organize the analyzed data for interpretation</li> <li>5. interpret the results and discuss under guidance</li> </ol>		<p>It is open for the students. Under a supervisor a student can undertake any sort of research project that can be completed, presented in a dissertation and defended.</p>	

<b>Course: SWE-4109: Forest Soil Management</b>	<b>Credit : 3.0</b>	<b>Year: Fourth</b>	<b>Term: First</b>
<b>Rationale:</b> This course is designed to provide the basic knowledge on forest soil, their composition, and environment, nutrition of forest, chemistry and dynamics of forest soils.			
<b>Course Objectives:</b>			
<ul style="list-style-type: none"> <li>• To examine forest soils, environment and their composition</li> <li>• To analyze mineral nutrition, water relations and chemistry of forest soils</li> <li>• To evaluate nutrient dynamics in forest soils</li> </ul>			
<b>Intended Learning Outcomes (ILOs)</b>		<b>Course Content</b>	
<b>Section-A</b>			
At the end of the course the students will be able to		<b>1. Introduction to Forest Soils:</b> History of forest soil, science and management, global patterns in forest soils.	
<b>1.</b> recognize about definition and global pattern of forest soil.		<b>2. Forest Environment:</b> Site factors, classification of site factors, interrelations between site factors, effects of forest vegetation on site factors.	
<b>2.</b> analyze about the forest environment and site factors.		<b>3. Composition of forest soils:</b> Soil formation and minerals; soil organic matter; water, pore space and soil structure.	
<b>3.</b> asses the composition of forest soils.		<b>4. Mineral Nutrition of Forests:</b> Nutrient uptake; mycorrhiza and nutrient uptake; nutrient return; rainfall and nutrient input; litter fall and nutrient return, soil organisms; decomposition of organic matter; nutrient loss.	
<b>4.</b> compare the mineral nutrition of forest.			
<b>Section-B</b>			
<b>5.</b> distinguish soil water, water retention in forest soil.		<b>5. Water Relations in Forests:</b> Soil water and air; water retention in the soil; evapotranspiration in forest; rainfall and forest.	
<b>6.</b> simplify the biogeochemistry of forest soil.		<b>6. Life and chemistry in Forest soils:</b> Life in forest soils; forest biogeochemistry; chemistry of soil surface and solutions.	
<b>7.</b> demonstrate the basic techniques in sampling of forest soil.		<b>7. Measuring Forest Soils:</b> Sampling soils across space and time; common approaches to measuring soils.	
<b>8.</b> explain the dynamic properties of forest soil.		<b>8. Dynamics of Forest Soils:</b> Influence of tree species, soil management-harvesting, site preparation, conversion, and drainage, fire influences, nutrition management, managing forest soils for carbon sequestration.	

<b>Course: SWE-4110: Forest Soil Management Sessional/Field Work</b>	<b>Credit : 1.5</b>	<b>Year: Fourth</b>	<b>Term: First</b>
<b>Rationale:</b> This course is designed to provide knowledge on forest soil, their composition, different types of forest in Bangladesh			
<b>Course Objectives:</b> <ul style="list-style-type: none"> <li>• To teach students about the forest soil and vegetation.</li> <li>• To demonstrate the collection of forest soil and forest tree species.</li> <li>• To build concept on different forest types of Bangladesh.</li> </ul>			
<b>Intended Learning Outcomes (ILOs)</b>	<b>Course Content</b>		
<p>At the end of the course the students will be able to-</p> <ol style="list-style-type: none"> <li>1. collect soil sample and forest tree samples for the field.</li> <li>2. visit different forest types of Bangladesh to enrich their knowledge on different types of vegetation.</li> </ol>	<ol style="list-style-type: none"> <li>1. Sample collection and analysis of forest vegetation and soil.</li> <li>2. Field visit of different types of forest in Bangladesh (tropical moist semi evergreen forest, tropical moist deciduous forest, freshwater swamp forest, and tidal swamp forest and mangrove forest of Bangladesh).</li> </ol>		

Course: Econ-4161 : Natural Resource Economics	Credit : 3.0	Year: Fourth	Term: First
<p><b>Rationale:</b> Global resources are depleting day by day. Presently, near about 7,500 million people are living in this globe. To fulfill their day to day requirement people use resources. As Bangladesh is a developing country and there is a huge burden of population; hence, it is very much essential for a student to study resource economics to understand the reality of supply-demand mismatch in this respect.</p>			
<p><b>Course Objectives:</b></p> <ul style="list-style-type: none"> <li>• Provide basic knowledge about resource consciousness and functional aspects of resources.</li> <li>• Make students aware about measuring and mitigating natural resource scarcity.</li> <li>• Build up consciousness regarding existing resources of Bangladesh and its preservation and conservation.</li> </ul>			
Intended Learning Outcomes (ILOs)	Course Content		
Section-A			
<p>At the end of this course students will be able to-</p> <ol style="list-style-type: none"> <li>1. demonstrate all types of global resources and their proper use.</li> <li>2. categorize resources on the basis of degree of economic importance.</li> <li>3. use measurement techniques to estimate natural resource scarcity.</li> </ol>	<p><b>1. Concept of Natural Resources:</b> Definition; evolution of resource consciousness; wealth and resource; functional aspects of resources; various types of resources; economic categories of resources; relation between economics and ecology; steady-state economics; scarcity of resources; mitigating scarcity of factors; pricing of valuable factors; categories of resources on the basis of degree of economic importance and discovery.</p>		
	<p><b>2. Renewable Resources:</b> Basic concept on renewable resources; growth curves; rate of exploitation; costs and revenues; a model with time dimension; fundamental rule of renewable resource exploitation; problem of extinction; open and restricted access for resource harvest; profit maximization and extinction.</p>		
	<p><b>3. Exhaustible Resources:</b> Basic concepts on exhaustible resources; Hotelling's rule; fundamental principle of exhaustible resource use; diagrammatic exposition of optimal resource use; resource price and backstop technology; optimal use and depletion rules.</p>		
	<p><b>4. Measuring and Mitigating Natural Resource Scarcity:</b> Malthusian and Ricardian scarcity recognition; resource price path patterns; scarcity and price/cost index, geochemical and stock pollution constraints on resource exploitation; resource scarcity mitigation: recycling and mitigation.</p>		
Section-B			
<ol style="list-style-type: none"> <li>4. learn how to mitigate natural resource scarcity.</li> <li>5. appraise strategies aimed at resource preservation and conservation.</li> </ol>	<p><b>5. Economics of Fisheries:</b> Types on the basis of water body; freshwater, marine water and culture fisheries stock; fisheries enhancement by stocking; stocking strategies; impact of stocking on biodiversity; economic importance; harvesting and maximum sustained yield;</p>		
<ol style="list-style-type: none"> <li>6. prescribe policy issues in the way of preservation and conservation of natural resources.</li> </ol>	<p><b>6. Economics of Forestry:</b> Spatial distribution; Major forests based on different land types of Bangladesh; degradation; management strategies; social forestry – definition, objectives, scope, economic benefit and constraints; volume function and mean annual increment; optimal single rotation.</p>		
	<p><b>7. Economics of Wetlands:</b> Characteristics of wetland; social inefficiency and wetland resource use; total economic value of wetlands; inefficiency sources in wetland resource use – market and intervention failure; mechanisms for social cost internalization.</p>		
	<p><b>8. Development, Preservation and Conservation:</b> Conservation and preservation methods; development and total economic value; safe minimum standards; irreversibility and sustainability.</p>		
	<p><b>9. Natural Resources and Government Policies:</b> An overall view of government policies with conflicting results.</p>		

<b>Course: SWE-4201: Soil Classification and Soils of Bangladesh</b>	<b>Credit: 3.0</b>	<b>Year: Fourth</b>	<b>Term: Second</b>
<b>Rationale:</b> The course deals with soil systems and its environments from the perspective of soil classification.			
<b>Course Objectives:</b>			
<ul style="list-style-type: none"> <li>• Develop knowledge among graduates about different classification systems and structure of Soil Taxonomy, FAO-UNESCO, and WRB and be able to classify soils using the systems.</li> <li>• Augment analytical ability and environmental conditions of Bangladesh to discuss the AEZs of Bangladesh.</li> </ul>			
<b>Intended Learning Outcomes( ILOs)</b>	<b>Course content</b>		
<b>Section-A</b>			
At the end of the course the students will be able to - 1. propose the need and importance of soil classification systems. 2. summarize the history of soil classification systems. 3. classify soil profiles using the US, FAO-UNESCO and WRB system of soil classification. 4. arrange a correlation between all the classification systems.	1. <b>Introduction:</b> Definition of classification, need for soil classification, kinds of soil classification. 2. <b>Historical development of soil classification:</b> Ancient era, early scientific era, founding of pedology, the US great soil group system of classification: zonality concept. 3. <b>Modern System of Soil Classification:</b> Detail study of US soil taxonomic system, FAO-UNESCO soil classification system, the World Reference Base (WRB) soil classification system, a comparison of these classification systems.		
<b>Section-B</b>			
5. utilize soil and different environmental conditions in Bangladesh. 6. describes AEZs of Bangladesh emphasizing land topography, properties of soil and land utilization pattern.	4. <b>Soil Classification in Bangladesh:</b> General soil type in Bangladesh, classify Bangladesh soils on the basis of US, FAO-UNESCO and WRB classification systems, correlation of general soil types with other systems. 5. <b>Agro-Ecological Zone (AEZ):</b> Concept and classification, locations, extent, land topographic units and the crops growth therein, management and land utilization pattern in different AEZs of Bangladesh.		

<b>Course: SWE-4202: Soil Classification and Soils of Bangladesh Field Work</b>	<b>Credit : 1.5</b>	<b>Year: Fourth</b>	<b>Term: Second</b>
<b>Rationale:</b> This course focuses on identifying soils in the field and classifying soils in different classification systems for various uses.			
<b>Course Objectives:</b> <ul style="list-style-type: none"> <li>• Learn to interpret and classify soils from soil descriptions.</li> </ul>			
<b>Intended Learning Outcomes( ILOs)</b>	<b>Course content</b>		
<p>At the end of the course the students will be able to –</p> <p><i>The learning outcome associated with soil classification used for this study was as follows: Students should be able to use Soil Taxonomy to classify soils to the family level and be able to compare Soil Taxonomy to other soil classification systems, specifically the Simplified Guide to Soil Taxonomy.</i></p> <ol style="list-style-type: none"> <li>1. classify soils and make a correlation among all the classification systems.</li> <li>2. identify the potentiality and limitations of soils for different purposes.</li> <li>3. classify Bangladesh soils in different classification systems and identify the potentiality and limitations of Bangladesh soils.</li> </ol>	<ol style="list-style-type: none"> <li>1. <b>Soil Classification:</b> Mini pit description, identification of diagnostic horizons, physical and chemical analysis and classify soils on the basis of US Taxonomy, FAO-UNSCO and WRB classification systems.</li> <li>2. <b>Field trips:</b> Field trip in different floodplain, terrace and hilly areas, observe and record landform, land use, crop diversity and soil characteristics in field.</li> </ol>		

Course: SWE-4203: Irrigation and Drainage Management	Credit: 3.0	Year: Fourth	Term: Second
<p><b>Rationale:</b> This course is designed to provide the knowledge on ongoing irrigation and drainage practices and technologies for maximizing the economic benefits of irrigated agriculture to meet the challenge for ever increasing demand for irrigation water.</p>			
<p><b>Course Objectives:</b></p> <ul style="list-style-type: none"> <li>• Acquisition of basic knowledge on soil and crop specific irrigation techniques</li> <li>• Capacity building for adoption of measures for reduction of over and under irrigation and conservation of irrigation water.</li> </ul>			
Intended Learning Outcomes (ILOs)	Course content		
Section – A			
<p>At the end of the course the students will be able to -</p> <ol style="list-style-type: none"> <li>1. plan the scope of irrigation in Bangladesh and extrapolate for its future possibilities.</li> <li>2. infer the time for irrigation and estimate the amount of water to be irrigated.</li> <li>3. differentiate among the irrigation methods and modify and solve the challenges with land for making it suitable for particular irrigation method.</li> <li>4. prescribe time and amount of irrigation needed for major crops of Bangladesh.</li> <li>5. analyze water samples to evaluate usability as irrigation water.</li> <li>6. design structures for storing, conveyance and calculate amount of flow in channel.</li> </ol>	<p>1. <b>Introduction to Irrigation:</b> Definition and types of irrigation, extent and growth of irrigation, scope of irrigation with reference to Bangladesh, selection of land for irrigation; factors affecting irrigation needs, amount and frequency of irrigation; irrigation and food security.</p>		
	<p>2. <b>Diagnosis of Irrigation Need:</b> Soil and plant-water parameters for determining irrigation needs, estimation of irrigation water, irrigation frequency, irrigation scheduling (when to irrigate – how much water to supply), irrigation efficiency, effects of irrigation on soil properties.</p>		
	<p>3. <b>Methods of Irrigation:</b> Selection of irrigation methods, factors affecting the selection of surface irrigation methods, designing different surface irrigation methods, reasons and rationale for designing irrigation methods, advantages and disadvantages of different methods, conservation irrigation practices, distribution of irrigation water.</p>		
	<p>4. <b>Irrigation in Bangladesh:</b> Modes of Irrigation, irrigation systems and irrigation projects of Bangladesh, irrigation water requirement and withdrawal, irrigation needs of major crops of Bangladesh, sources and storage of irrigation water, surface and groundwater reservoirs, recharging and safe yields from groundwater reservoirs, feasibility of groundwater development, groundwater abstraction for irrigation, consequences of groundwater irrigation.</p>		
	<p>5. <b>Irrigation Water Quality:</b> Standard for irrigation water, typical analyses of irrigation waters, evaluation of irrigation water, saline water for irrigation.</p>		
	<p>6. <b>Irrigation Engineering:</b> Basic terms and calculations, irrigation implements and structures, conveyance of irrigation and drainage water, measurement of water flow, wells for irrigation water, pumping water for irrigation and drainage.</p>		
Section – B			
<ol style="list-style-type: none"> <li>7. comprehend land drainage, drainage requirements and benefits.</li> <li>8. acquire knowledge and skills to initiate drainage planning.</li> <li>9. design and implement drainage systems.</li> <li>10. calculate drain spacing, drain depth to install drain pipe.</li> </ol>	<p>7. <b>Land drainage:</b> Introduction to drainage in natural and agricultural environments, historical and world perspective of drainage, sources of excess water, benefits and problems of drainage, drainage requirements.</p>		
	<p>8. <b>Drainage Systems:</b> Filtration area and filtration flow– calculating schemes, filtration area characteristics, surface drainage: construction and design of drains, contour open channels, dikes, typical structures, open trench systematic drainage, open channel transfer network. sub-surface drainage: types, drainage design, drain capacity, slope and size, installation, interceptor drains, closed tube systematic drainage – main parameters, regulating and transfer networks.</p>		
	<p>9. <b>Groundwater drainage systems:</b> pipe drain systems, construction and maintenance of pipe drain systems, design of pipe drainage systems - drain spacing formula, flow patterns, Hooghoudt formula, non-steady state drainage formulae, basic design criteria, field drainage base depth, determination of the required diameter of a pipe drain, ditch systems.</p>		
	<p>10. <b>Drainage of irrigated land:</b> Pipe drainage system well drainage, main drainage systems and outlet.</p>		

<b>Course: SWE-4204: Irrigation and Drainage Management Sessional:</b>	<b>Credit: 1.5</b>	<b>Year: Fourth</b>	<b>Term: Second</b>
<b>Rationale:</b> This course is designed to provide skill to select methods, prepare land and adopt measures for each method to save water and yield maximum benefit per unit of water used.			
<b>Course Objectives:</b> <ul style="list-style-type: none"> <li>• Teach students to test irrigation water quality</li> <li>• Equip students with practical knowledge on determining the time, frequency and amount of irrigation water.</li> <li>• Train students in estimating irrigation efficiency to save time, labor and currency.</li> </ul>			
<b>Intended Learning Outcomes (ILOs)</b>	<b>Course content</b>		
<p>At the end of the course the students will be able to</p> <ol style="list-style-type: none"> <li>1. analyze and grade irrigation water quality.</li> <li>2. quantify the impact of irrigation water management.</li> <li>3. prepare ad irrigation scheduling for specific soil and other conditions.</li> <li>4. adopt conservation irrigation techniques to save water.</li> <li>5. measure irrigation efficiency.</li> </ol>	1. Analysis of water sample for determining irrigation water quality.	2. Estimation of amount of irrigation water	3. Determination of time and frequency of irrigation
	4. Ensuring equal infiltration opportunity time over the crop field.	5. Application of cut-off ratio, paired row and alternate row and other measures during irrigation.	
	6. Estimation of the different components of irrigation efficiency.		
	7. Designing drainage options for reuse of drainage water for irrigation.		

Course: SWE-4205: Climate Change and Food Security	Credit: 3.0	Year: Fourth	Term: Second
<b>Rationale:</b> This course is designed to evaluate the impacts of climate change and be aware and ensure food security as well.			
<b>Course Objectives:</b> <ul style="list-style-type: none"> <li>• Acquire fundamental knowledge on climate change and food security</li> <li>• Understand and analyze environmental processes contributing climate change</li> <li>• Evaluate environmental process that contribute to climate change and food security</li> <li>• Compare the strengths and limitations of existing food security measures</li> </ul>			
Intended Learning Outcomes (ILOs)	Course content		
Section – A			
<p>At the end of the course the students will be able to</p> <ol style="list-style-type: none"> <li>1. analyze the various physical phenomena forming background of weather mechanisms and weather formation.</li> <li>2. realize and illustrate the climate distribution over the Earth and climate change as well as the role of climate in environmental problems.</li> </ol>	<ol style="list-style-type: none"> <li>1. <b>Atmosphere of the earth:</b> Compositions of the atmosphere, thermal and chemical layering of the atmosphere, introduction to weather and climate, energy, temperature and heat, radiation, energy balance.</li> <li>2. <b>Temperature, humidity and clouds:</b> Seasonal and daily temperature variation, temperature controls, air temperature data, atmospheric moisture, dew, fog and clouds, stable, unstable and neutral atmospheric conditions, cloud development, precipitation processes..</li> <li>3. <b>Pressure, winds and general circulation:</b> Atmospheric pressure, forces, geostrophic wind, gradient winds, surface winds, small scale and local wind systems, global wind systems, atmosphere-ocean interactions, including El Niño and Southern oscillation, air masses and fronts, middle latitude cyclones (polar front theory), weather forecasting.</li> <li>4. <b>Global Climate and Climate Change:</b> The Köppen classifications principles, overview of the different climates, geographic climate distribution, possible causes of climate change, feedback effects, atmospheric greenhouse effects, anthropogenic and natural climate change.</li> <li>5. <b>Weather and climate modeling:</b> Meteorological phenomena leading to weather formation, meteorological sensors, weather maps, prediction of the weather based on a weather map, global climate and circulation patterns, ecosystem energy balances, cloud types, solar elevation and day length, physical phenomena forming the background of weather mechanisms and weather formation, interpretation of weather station data and weather maps, calculation; global warming , green house effects and sea level rise, toxicity of Salinity and coastal climate impact.</li> </ol>		
Section – B			
<ol style="list-style-type: none"> <li>3. explore the history, causes and consequences of hunger and food insecurity.</li> <li>4. compare the strengths and limitations of emergency food programs, federal food and nutrition assistance, and the community food security movement.</li> </ol>	<ol style="list-style-type: none"> <li>6. <b>Hunger and Food Security:</b> History, crisis, world summit on food security, pillars of food security: availability, access, utilization, stability, stunting and chronic nutritional deficiencies.</li> <li>7. <b>Challenges to achieving food security:</b> Global water crisis, land degradation, climate change, agricultural diseases, dictatorship and kleptocracy, food sovereignty.</li> <li>8. <b>Risks to food security:</b> Population growth, fossil fuel dependence, hybridization, genetic engineering, and loss of biodiversity, price setting, land use change, global catastrophic risks.</li> <li>9. <b>Community food security movement:</b> Children and food security, gender and food security, approaches by the United Nations: Food and Agriculture Organization, World Food Programme, global partnerships to achieve food security and end hunger, agricultural productivity to benefit the rural poor, producing food without agriculture, large-scale food stockpiling, agricultural insurances.</li> <li>10. <b>Food security in the Bangladesh</b></li> </ol>		

Course: SWE-4207: Waste Management	Credit: 3.0	Year: Fourth	Term: Second
<p><b>Rationale:</b> This course is designed to provide a foundation about waste and waste management systems.</p>			
<p><b>Course Objectives:</b></p> <ul style="list-style-type: none"> <li>The students will gather knowledge about waste, different types of waste, its collection and transportation, resource recovery and recycling.</li> </ul>			
Intended Learning Outcomes (ILOs)	Course contents		
<b>Section-A</b>			
<p>At the end of the chapter the students will be able to -</p> <ol style="list-style-type: none"> <li>discover waste and waste related terminologies.</li> <li>categorize different types of waste and problem associated with it.</li> <li>plan to collect and store waste.</li> <li>design transportation system for collected waste.</li> <li>realize the necessity of waste disposal.</li> <li>design waste processing, resource recovery and recycling.</li> </ol>	<p><b>1. Wastes:</b> Introduction, terminologies, composition, classification of waste, problems of wastes.</p>		
	<p><b>2. Collection and Storage of Waste:</b> Introduction, terminologies, collection and storage: on site handling and storage, methods of collection, collection routes, storage and collection of solid waste in Bangladesh, transportation: vehicles for transportation, vehicle maintenance, programing and scheduling.</p>		
	<p><b>3. Disposal of Waste:</b> Open dumps, landfills, sanitary landfill, landfill site selection, land filling methods and operations, design of landfill, leachate and gas in landfills, factor affecting landfill operations.</p>		
	<p><b>4. Waste Processing, Resource Recovery and Recycling:</b> Introduction, handling and processing, managing non-biodegradable solid waste, waste recycling and reuse, role of municipal corporations, GO's and NGOs for waste management, waste utilization at source, the role of rag pickers, resource recovery from solid waste, recycling process in Bangladesh, composting from waste with special reference to Bangladesh.</p>		
<b>Section-B</b>			
<ol style="list-style-type: none"> <li>model the processing of human waste treatment.</li> <li>able to know recycle the waste and biogas generation.</li> <li>list hazardous wastes and their effects on environment.</li> <li>design the regulation of hazardous wastes.</li> <li>realize the problems and limitations regarding the waste management.</li> <li>measure the status of waste management practices in different locations of Bangladesh.</li> </ol>	<p><b>5. Treatment of Human Waste:</b> Introduction, composition, objectives, principles: aerobic oxidation process, anaerobic digestion process, onsite waste treatment: pathogen removal, effluent disposal, biogas recovery: process of biogas generation, factors, biogas digesters, environmental aspects of biogas generation, Bangladesh perspectives.</p>		
	<p><b>6. Hazardous Waste:</b> Introduction, classification, Basel convention, nature and quantities of hazardous wastes, hazard identification, list, household hazardous wastes management.</p>		
	<p><b>7. Problems and Limitations of Waste Management:</b> Introduction, organizational problems, human resources and capabilities, land availability and congestion, technological capabilities, Financial aspects, law, legislation and enforcement, public awareness and motivation.</p>		
	<p><b>8. Solid waste management scenario in Bangladesh:</b> Case studies of waste management regional as well as national basis.</p>		

<b>Course: SWE-4208: Waste Management Sessional/Field Work</b>	<b>Credit: 1.5</b>	<b>Year: Fourth</b>	<b>Term: Second</b>
<b>Rationale:</b> This course is designed to get practical experiences about waste classification, disposal, resource generation and case studies on waste management.			
<b>Course Objectives:</b> <ul style="list-style-type: none"> <li>The course aims to motivate the student about the problems of waste as well as waste as a source of resource.</li> </ul>			
<b>Intended Learning Outcomes (ILOs)</b>		<b>Course contents</b>	
At the end of the course the students will be able to - <ol style="list-style-type: none"> <li>classify wastes.</li> <li>apply to dispose waste.</li> <li>generate resources from waste.</li> <li>perform case studies on waste management in different locations in Bangladesh.</li> </ol>		<b>1. Waste classification.</b>	
		<b>2. Methods of waste disposal.</b>	
		<b>3. Resource generation from waste and its uses.</b>	
		<b>4. Case study.</b>	

<b>Course: SWE-4209: Rivers and Floodplain Management</b>	<b>Credit: 3.0</b>	<b>Year: Fourth</b>	<b>Term: Second</b>
<b>Rationale:</b> This course is oriented to expose students about rivers, flood plains and their management.			
<b>Course Objectives:</b>			
<ul style="list-style-type: none"> <li>• Acquire basic knowledge on river system, water flow, and sediment transport and river bank erosion.</li> <li>• Gather ideas on flood plain, fossil deposits and management of flood plains.</li> </ul>			
<b>Intended Learning Outcomes (ILOs)</b>	<b>Course Content</b>		
<b>Section-A</b>			
<p>At the end of the course the students will be able to-</p> <ol style="list-style-type: none"> <li>1. familiar about river system and water flow in rivers.</li> <li>2. explain sediment transport.</li> <li>3. model river bed formation.</li> <li>4. apply the management of river bank erosion.</li> </ol>	<b>1. Introduction:</b> Overview of river systems in South-East Asia and Bangladesh.		
	<b>2. Fundamentals of Water Flow:</b> Velocity of flow, seasonal flow variation, measurement of river velocity, floods and flooding, depth of flooding, river flow, groundwater recharge extent around river flow.		
	<b>3. Fundamentals of Sediment Transport:</b> Types of sediment, sediment characteristics, sediment load estimation, velocity-depth-sediment load interaction, and sediment discharge.		
	<b>5. Alluvial Channels:</b> Bed forms and sedimentary structures, nature of alluvial channel, sand bar and charland formation, alluvial fans, suitability of sandbars and charland for agricultural use.		
	<b>6. River Bank Erosion:</b> Types of river bank erosion, factors triggering river bank failure, indices to measure vulnerability of river bank dynamics of the different riverbank erosion; impact of riverbank erosion, management of river bank erosion, river bank stabilization.		
<b>Section – B</b>			
<ol style="list-style-type: none"> <li>5. make use of flood plains and channel-belt movement.</li> <li>6. outline the principles of Fluvial system evolution.</li> <li>7. develop and understand deposits of fossils.</li> <li>8. apply basic techniques of flood plain management.</li> </ol>	<b>7. Introduction to Floodplains:</b> piedmont plain, meander floodplain, tidal floodplain, estuarine floodplain.		
	<b>8. Along-Valley Variations in Channels and Floodplains:</b> variations in channels and floodplains.		
	<b>9. Channel-Belt movements across floodplains:</b> channel shifting in the course, formation of baors and ox-bow lakes.		
	<b>10. Evolution of Fluvial Systems:</b> Long-term, large-scale evolution of fluvial systems.		
	<b>11. Fossils in Fluvial Deposits:</b> Geology of fluvial deposits, sedimentary facies, basin analysis, and petroleum geology.		
	<b>12. Flood plains Management:</b> Floods and floodplains, floodplain development, floodplain management, the national floodinsurance program (NFIP), NFIP goals and their accomplishment.		

Course: SWE-4211: Crops of Bangladesh	Credit : 3.0	Year: Fourth	Term: Second
<b>Rationale:</b> This course is designed to develop expertise in students about suitable soil, tillage, climate, fertilizer, and other conditions supportive to major crops' cultivation in Bangladesh.			
<b>Course Objectives:</b>			
<ul style="list-style-type: none"> <li>• Introduce students with types of major crops and their demands for successful growth and yield.</li> <li>• Equip students with knowledge to overcome environmental and climatic challenges for the crops</li> <li>• Developing soil-plant-rhizosphere interaction knowledge for cultivation of major crops in problem soil areas</li> </ul>			
Intended Learning Outcomes (ILOs)	Course Content		
Section – A			
<p>At the end of the course the students will be able to-</p> <ol style="list-style-type: none"> <li>1. select suitable crops for the growth in specific location of Bangladesh.</li> <li>2. design the present status and future possibility of increasing crop cultivation.</li> <li>3. examine the growth of important cereal crops as well as fiber and vegetable crops for the economy of Bangladesh</li> </ol>	<b>1. Major crops of Bangladesh and Sub-continent:</b> Classification of crops.		
	<b>2. Agronomy of arable crops of Bangladesh:</b> Origin, climate, soil requirements, cultural practices, fertilization, harvesting and storing of the main crops of Bangladesh.		
	<b>3. Cereal crops of Bangladesh:</b> Rice, wheat and maize, brief description about other minor cereal crops of Bangladesh.		
	<b>4. Fibre crops of Bangladesh:</b> Jute and cotton, brief description about other minor fiber crops.		
	<b>5. Vegetable and spices :</b> Commercially important vegetable and spices with their economic viability.		
Section – B			
<ol style="list-style-type: none"> <li>4. select commercially important crops with their economic feasibility.</li> <li>5. design the major cropping systems of Bangladesh.</li> <li>6. discover the cause of diseases and their control measures.</li> </ol>	<b>6. Other important crops of Bangladesh:</b> Sugarcane, potato, tobacco, pulse and oilseed crops.		
	<b>7. Agronomy of perennial crops:</b> Tea, rubber, jackfruit, mango and coconut.		
	<b>8. Cropping systems practiced in Bangladesh:</b> Monocropping, mixed cropping, multiple cropping and crop rotation.		
	<b>9. Cropping intensity:</b> Definition, present status of cropping intensity in Bangladesh, ways to increase cropping intensity with special reference to the coastal areas of Bangladesh.		
	<b>10. Diseases and their control measures:</b> Survey for the crop specific diseases, organic and inorganic measures for the control of diseases, doses for specific disease.		

Course: Eng-4257: Professional English	Credit : 3.0	Year: Fourth	Term: Second
<p><b>Rationale:</b> To meet the challenges of current employment scenario, it is necessary that the job-seekers are adept in oral and written communication, in interviews, presentations and in other related domains. This course has been designed to make the students better prepared for the competitive job market with regard to the state-of-the-art of effective communication.</p>			
<p><b>Course Objectives:</b></p> <p>This course is designed to-</p> <ul style="list-style-type: none"> <li>• help students achieve better comprehension of English in workplace or other daily life settings</li> <li>• increase their accuracy and fluency in workplace spoken communication</li> <li>• help them overcome challenges of speaking in public and deliver oral presentation</li> <li>• develop their croSWE-cultural communication ability in both monocultural and multicultural workplace settings</li> </ul>			
Intended Learning Outcomes (ILOs)	Course Content		
Section – A			
<p>At the end of the course the students will be able to-</p> <ol style="list-style-type: none"> <li>1. get a scope to learn and practice the basics of the major skills</li> <li>2. understand better the communication requirements in workplace as well as other daily' life settings</li> <li>3. increase their accuracy and fluency in workplace spoken communication</li> </ol>	<p><b>1. Writing:</b> Variety of business writings (emails, letters&amp; short reports etc. ),filling out different types of forms and analyzing and working with graphs and tables, Business writings.</p>		
	<p><b>2. Speaking:</b> making small talks and introduction, clarifying instructions, presenting options and suggestions, interrupting politely and dealing with sensitive topics, giving directions, requesting permission, giving updates, taking initiatives, giving feedback.</p>		
	<p><b>3. Presentation Skills:</b> Work place communication (to inform, train, persuade, entertain, or to sell); Planning, structuring and delivering the presentation, developing audience rapport, using visual aids, reducing anxiety, handling questions, impromptu speaking; Pronunciation techniques for public speaking (e.g. pacing, pausing, emphasis, stress, intonation, articulation etc.).</p>		
Section – B			
<ol style="list-style-type: none"> <li>4. learn and practice correct and culturally appropriate language for common workplace speech functions</li> <li>5. think critically about the workplace culture</li> <li>6. improve their croSWE-cultural communication skills and know how to make culturally effective choices.</li> </ol>	<p><b>4. Understanding workplace culture:</b> defining and interpreting culture, values, rituals and managing relationships.</p>		
	<p><b>5. Workplace meeting skills:</b> Common types &amp; purposes of meetings, techniques for note-taking, role of recorder/secretary, documents needed for effective meetings, minutes-taking.</p>		
	<p><b>6. Letter and CV:</b> Writing cover letter, preparing resume and CV for a job, developing interview skills, workplace communication</p>		
	<p><b>7. Other Communication Skills:</b> Telephone communication, croSWE-cultural communication, developing negotiation skills, presentation skills, arranging conferences and seminars.</p>		

## 7. Instructional Strategies

The following are the teaching methods commonly followed by the teachers. Each course teacher will choose the method(s) by his own based on the available facilities, logistic supports, and ambient environment to achieve expected learning outcomes by the students.

Common teaching methods:

1. Lecture
2. Demonstration
3. Reading Assignment
4. Project/Assignment
5. Group Assignment
6. Small Group Discussion
7. Panel Discussion
8. Videotapes
9. Debate
10. Simulation Game
11. Brainstorming
12. Case Studies
13. Role Playing
14. Seminar/ Workshop
15. Cooperative Learning
16. Interactive teaching learning and peer discussion
17. Problem-Based Learning (PBL)
18. Inquiry-Based Learning (IBL)

## 8. Assessment and Evaluation of Learning Achievements

### 8.1 Distribution of Marks:

Each course, theoretical or practical, irrespective of credit values is evaluated over 100 marks. The performance of a student is evaluated by continuous assessment and final examination. Forty percent (40%) of marks is allotted for continuous assessment (quizzes, class tests, presentation, homework assignment and class participation), provided that out of 40%, class attendance will constitute ten percent (10%). The remaining sixty percent (60%) marks is allotted for final examination.

#### 8.1.1 Marks distribution for theory courses

Table 8.1 Marks distribution for theory courses	
Description	Marks
Class participation/attendance	10
Continuous assessment	30
Final examination (Section A and B)	60 (30+30)
<b>Total</b>	<b>100</b>

The duration of final examination of each course is three hour. For each theory course maximum 25% options can be given in the total number of questions. There are four questions in each section.

#### 8.1.2 Marks distribution for sessional courses

Table 8.2 Marks distribution for sessional courses	
Description	Marks
Class participation/attendance	10
Internal criticism/evaluation/observation	60
Viva-voce	30
<b>Total</b>	<b>100</b>

#### 8.1.3 Bases for class attendance marks (both for theory and sessional)

Table 8.3 Bases for class attendance marks	
Attendance	Marks
Above 90%	10
85% to less than 90%	9
80% to less than 85%	8
75% to less than 80%	7
70% to less than 75%	6
65% to less than 70%	5
60% to less than 65%	4
less than 60%	0

## 8.2 Continuous Assessment:

The continuous assessment in terms of class tests, quizzes, assignments, term papers etc. are arranged according to the following table:

No. of credit of the course	No. of assessment required	Best assessments to be considered
2	4 (2 from each section)	2 (best one from each section)
3	4 (2 from each section)	2 (best one from each section)
4	4 (2 from each section)	2 (best one from each section)

Two class tests are taken from each section. The duration of each class test is generally one class hour. The course teacher will determine the nature of test items. The course teacher may take more class tests than specified without increasing the ratio of marks. Teacher should promptly provide feedback of the class test either by showing the answer scripts to the students or any other way explaining their mistakes done in the answer script. When a student repeats a course for which he/she obtained F grade in previous term he/she may be allowed to repeat the continuous assessment to improve the grade, but he/she has to apply to the Head through concerned course teacher within 20 working days from the beginning of the term. However, the marks of class attendance and participation will be taken from the previous records.

For a theory course of each term-final examination each question is divided two sections 'A' and 'B' following syllabus of the course. Two question setters will set two questions over two sections. After receiving the question-papers the examination committee (EC) chairman will make arrangement for moderation of question-papers. Each examiner evaluates one section as determined by the concerned EC.

## 8.3 Thesis Evaluation:

A thesis is evaluated by two examiners: one is by the respective supervisor and other is external examiner from inside/outside of the Discipline. A thesis is evaluated on the basis of the following marks distribution-

Description	Marks
Class participation/attendance	10
Evaluation	60
Viva-voce	30
<b>Total</b>	<b>100</b>

Each examiner will evaluate the thesis out of 60 marks and the average marks will be considered for grading. However, when the marks given by the examiners vary 20% or more, third examiner is to be appointed by the concerned examination committee and average of the closest two numbers are averaged and use for grading. However, if the marks given by the third examiner happen to stand at the middle of the first two examiners, the average of the higher two is considered for grading.

## 8.4 Grading System and Grading Scale:

The total performance of a student in a course is scaled in a grading scale as following:

Numerical Grade	Letter Grade	Grade Point
80% and above	A (plus)	4.00
75% to less than 80%	A (regular)	3.75
70% to less than 75%	A (minus)	3.50
65% to less than 70%	B (plus)	3.25
60% to less than 65%	B (regular)	3.00
55% to less than 60%	B (minus)	2.75
50% to less than 55%	C (plus)	2.50
45% to less than 50%	C (regular)	2.25
40% to less than 45%	D	2.00
Less than 40%	F	0.00
Incomplete	I	
Withdrawn	W	
Continuation of thesis	X	

## 8.5 Guidelines for Assessment and Evaluation of Learning Outcomes:

Assessment is the engine which drives student learning. A student undertaking any form of study will be subject to assessment in one form or another. It can be a significant determinant of what, when and how students learn. It focuses on the opportunities to develop students' ability to evaluate them, to make judgments about their own performance and improve upon it. Getting assessment 'right' is therefore essential, both for students and for teacher. John Cowan, an educationist says, 'Nothing we do to, or for our students are more important than our assessment of their work and the feedback we give them on it. The results of our assessment influence students for the rest of their lives...'

It has already been noticed by almost all academicians of the HEIs of Bangladesh and other stakeholders of the real world that the best student according to our assessment does not perform best. Rather, it is frequently noticed that the best assessed one (student) stands somewhere away from the best performer. But where are the shortfalls lying? Is the curriculum appropriately updated to fit the students for the purpose? Are we teaching in a correct way to fit the graduates of the purpose? Are the graduates achieving the program learning outcomes? Are we assessing the students correctly and in appropriate way whether they achieved the program learning outcomes? If it is so then the best-graded student should perform best in the real world but actually it seldom occurs.

### **Students are to be assessed for different levels of learning**

It was experienced by many peer reviewers through peer reviewing of different self-assessment reports in different universities of Bangladesh that most tests administered by faculty rely too heavily on students' recall and understand of information. Bloom argues that the process of critical thinking begins with the ability of students to remember and understand, but it is truly realized when the student demonstrates the ability to apply, analyze, evaluate, and create knowledge, procedures, processes, or products to discern bias, challenge assumptions, identify consequences, arrive at reasoned conclusions, generate and explore new questions, solve challenging and complex problems, and make informed decisions. So, it is important for tests to measure higher learning as well. The levels of measurement of learning according to Blooms' model are:

- i. To measure *recall or remembering* (common terms, facts, principles, procedures), ask these kinds of questions: Define, Describe, Identify, Label, List, Match, Name, Outline, Reproduce, Select, State. Example: "List the steps involved in titration."
- ii. To measure *comprehension* (understanding of facts and principles, interpretation of material), ask these kinds of questions: Convert, Defend, Distinguish, Estimate, Explain, Extend, Generalize, Give examples, Infer, Predict, Summarize. Example: "Summarize the basic tenets of deconstructionism."
- iii. To measure *application* (solving problems, applying concepts and principles to new situations), ask these kinds of questions: Demonstrate, Modify, Operate, Prepare, Produce, Relate, Show, Solve, Use. Example: "Calculate the deflection of a beam under uniform loading."
- iv. To measure *analysis* (recognition of unstated assumptions or logical fallacies, ability to distinguish between facts and inferences), ask these kinds of questions: Diagram, Differentiate, Distinguish, Illustrate, Infer, Point out, Relate, Select, Separate, Subdivide. Example: "In the president's State of the Union Address, which statements are based on facts and which are based on assumptions?"
- v. To measure *evaluation* (judging and assessing), ask these kinds of questions: Appraise, Compare, Conclude, Contrast, Criticize, Describe, Discriminate, Explain, Justify, Interpret, Support. Example: "Why is Bach's Mass in B Minor acknowledged as a classic?"
- vi. To measure *synthesis* (integrate learning from different areas or solve problems by creative thinking), ask these kinds of questions: Categorize, Combine, Compile, Devise, Design, Explain, Generate, Organize, Plan, Rearrange, Reconstruct, Revise, Tell. Example: "How would you restructure the school day to reflect children's developmental needs?"

Many faculty members have found it difficult to apply this six-level taxonomy, and some educators have simplified and collapsed the taxonomy into three general levels. The first category is recall or remembering (recall or recognition of specific information). The second category combines comprehension and application. The third category is described as "problem solving," transferring existing knowledge and skills to new situations.

### **8.6 Assessment Tools:**

A range of assessment tools is available to adapt. Depending upon the circumstances, time frame, course content, level of knowledge and purpose of the course any one or preferably any combination from the following types can be chosen to be tool by the course teacher.

#### **8.6.1 Class room assessment**

It is a process of knowing how much learners have experienced in your class. Class room assessment does not intend to grade students, it is only useful in evaluating the effectiveness of teaching so that instructor can change the way and mode of future teaching in a more effective way.

#### **8.6.2 Written examination**

Essay question (Elaborate or broad type question is popularly termed as essay type question. It measures student's attitude, values and opinions and ability to compose answer presented in prose).

Short question (Short questions deserve more merit, more validity and more reliability. Keeping no option and tight time allocation in short questions increases the rigidity of evaluation).

Objective questions (The generic name 'objective questions' encompasses a variety of test formats such as Multiple Choice Questions (MCQ), True-False, Fill in the blanks, Matching etc. The tool has gained much popularity to test over large course content meticulously).

**8.6.3 Viva-voce** (Face-to-face interaction between student and examiner(s) brings an excellent opportunity to examine interactive skills apart from language proficiency which cannot be judged by any other way. Usually practical examination obligatorily followed by oral assessment. Thesis is also defended by this kind of assessment. The following measures would improve the consistency of the examiner:

- use of structured marking sheets or rating form
- employ 3-6 members for a viva board in general
- call student one by one
- make several shorter session rather than one longer session
- give same length of time for each student
- mark independently by the examiner and finally collate
- avoid bias due to differences in student's and examiner's age, sex, appearance, religion, regionalism, ideology and ethnicity

**8.6.4 Thesis** (Preparation of thesis manuscript is a partial requirement for graduation)

We acknowledge even up to 20% difference for the same between two examiners. This great difference can be reduced by following some important criteria for evaluating thesis which are as follows:

- **Title:** It should be correct, complete, and comprehensive, and reflect objectives. Keywords in title should be arranged in accordance with importance. Vague words and unnecessary words (deadwoods) should be avoided in title.
- **Abstract:** Should include purpose, methods, principal results and concluding remarks in brief. It should be independent, and should not include formula, figure, and references in it.
- **Introduction:** Should lead to the problem, giving "general to specific" information, filling the knowledge gap and motivating the reader. It should include background information, statement of problem, importance/justification of the research, exiting body of knowledge, concluding remarks and correct & specific objectives.
- **Methodology:** Should be appropriate (for the research), repeatable (detail enough for reproduction), and chronologically described. It should include:
  - i. Place, time and duration of the study
  - ii. Design of research/selection of attributes
  - iii. Research materials/instruments used
  - iv. Lay-out or experimental design
  - v. Population and sampling for collecting data
  - vi. Operation of the research (mainly procedures)
  - vii. Recording/collecting data (measurement etc.)
  - viii. Analysis of data and statistical methods used
- **Results and Discussion:** Should be stated in logical order, fulfilling the objectives, highlighting major findings, and avoiding hanging references and duplication of data presentation. This section should be comprehensive. It should include:
  - i. Tables, figures for data presentation (appropriateness in its form)
  - ii. Sub-headings and topic/lead sentence used
  - iii. Explanation/justification of results
  - iv. Comparison and contrast with other works (ref used)
  - v. Mention of any limitations or shortcomings
  - vi. Conclusion with summary of evidence
  - vii. Indication of any new possibilities of further exploration
- **References:** Should be complete, correct and should conform to the style of presentation of guidelines provided.

In addition to the above-mentioned points a thesis or term paper should follow some general guidelines such as adequacy, sequencing, pace, economy of space and readability. It should also:

- i. Demonstrate appropriate lay-out
- ii. Organize the sections/sub-sections in order
- iii. Broken-down into appropriate paragraphs (one idea/para)
- iv. Use simple sentence structure (simple <complex <compound)

The above-mentioned qualities of a thesis provide the communication value of the content mainly. However, it is important to keep in mind that the soul of a thesis is its uniqueness, fundamentality and creativeness. Based on discipline, nature of work and practicality criterion of standard may differ.

For obtaining maximum reliability in assessing a thesis:

- i. should be examined by more than one examiner

- ii. sufficient time must be given to the examiner
- iii. anonymousness must be ensured
- iv. examiner must be selected from closely relevant field of expertise
- v. marking and comments are to be made very specifically like sections by sections, points by points

**8.6.5 Term paper:** Term paper is a report to be written by the students from their own experience on given topic or problem. Assessment principles of term paper are very similar to that described in case of thesis.

**8.6.6 Assignment:** Assignment is a 'take home' type tool of assessment under a particular course. Course teacher select individual topic for individual student. Students are given considerable time to prepare assignment gathering information from sources like books, research reports, newspapers , periodicals, theses, internet etc. Through assignment writing students have to travel over a range of available literature that helps to develop their reviewing skill. Besides it enriches synthesizing ability and depth of knowledge of the students on the particular area.

Following considerations seem to be worthy for a teacher in giving and assessing assignment

- i. relevance with the course
- ii. interesting (?) topic
- iii. student's depth of knowledge
- iv. availability of literature
- v. area of coverage in respect of weightage (marks)
- vi. time allocation for submission
- vii. outline as template
- viii. examination at least by two examiner

Assignment may be -

- i. Literature based
- ii. Survey based
- iii. Experience based
- iv. Experiment based

A good assignment should incorporate: i) Introduction ii) Review iii) Discussion with appropriate illustration, picture, graphical presentation, photograph, map etc, iv) Remarks, and v) References.

**8.6.7. Sessional (Practical) Examination:** Each course teacher may choose assessment procedure by his/her own. However, some common assessment methods of learning outcomes of practical courses are cited here:

- i. Class room assessment,
- ii. Short question, objective (MCQ, T/F, Fill in the blanks, Y/N, etc),
- iii. Note book assessment,
- iv. Herbarium assessment,
- v. Presentation assessment,
- vi. On farm field work assessment,
- vii. Laboratory practice assessment,
- viii. Problem solving/calculation based assessment,
- ix. Assignment assessment,
- x. Presentation assessment,
- xi. Identification,
- xii. Reporting on field visit assessment
- xiii. Viva-voce, etc.

