

OUTCOME-BASED CURRICULUM
BACHELOR OF
SCIENCE (HONOURS) IN
SOIL, WATER AND ENVIRONMENT



Soil, Water and Environment Discipline
Khulna University
August 2022

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01

Title of the Academic Program

Bachelor of Science (Honours) in Soil, Water and Environment

Program Overview

Degree	Bachelor of Science (Honours) in Soil, Water and Environment
Abbreviated form of the Degree	BSc (Hons) in SWE
Discipline/Program Offering Entity (POE)	Soil, Water and Environment Discipline
School	Life Science School
Awarding Institution	Khulna University
Location	Khulna, Bangladesh
Bangladesh National Qualifications Framework (BNQF) Level	7
International Standard Classification of Education (ISCED) Code	0888
Mode of Study	Full Time
Language of Study	English
Applicable Session	2021-22 and onwards

02

Name of the University

Khulna University

03

Vision of the University

Creation of global leaders who will contribute to make knowledge-based just society through accelerating inclusive and transformative growth of Bangladesh and the world. The university aims to achieve this vision through scholarly enquiry and contribution to the global knowledge pool.

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Mission of the University

University Mission & Details

UM1	Explore human potential to the fullest extent and produce self-motivated, aspiring leaders to work for the betterment of the humankind based on wisdom, freethinking, creativity and unhindered intellectual exercises;
UM2	Ensure a transformative educational experience that enables creative learning, entrepreneurship and inquisitiveness among the students;
UM3	Create an inclusive research environment that enables graduates to make demonstrable economic and social impacts through translating knowledge and innovation into practice driven by moral values and professional ethics.

UM = University Mission

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Name of the Discipline/Program Offering Entity (POE)

Soil, Water and Environment Discipline

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Vision of the Discipline/POE

Conservation and management of soil, water and environment for achieving healthy ecosystems to ensure food, water and nutrition security for the survival and sustainable development of all forms of life.

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Mission of the Discipline/POE

Discipline Mission & Details

M1	To recruit top quality students, educate, graduate and transform them into skilled academic and research leaders in the domain of soil, plant, water and environmental sciences through offering progressive courses for the benefit of regional, national and global users and consumers.
M2	To build partnership, research collaboration, student-faculty exchange programs, among national and international institutions for the formulation of integrated intervention appreciating present and future crises and respond for improving ecosystem services, natural resource balance and agricultural productivity in order to enhance the quality of habitat for plant, animal and human well-being.
M3	To research and develop new knowledge (methods, tools, techniques, plans, framework, and policy) for sustainable use of soil, plant and water resources, transfer to the end-users (farmers), share and disseminate among partners and stakeholders, make policy and implement for controlling environmental degradation and combating climate change.

M = Mission of the Discipline/POE

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Objectives of the Discipline/POE

Discipline Objectives & Details

O1	To improve and sustain the quality of soil, water and environmental resources in natural and managed ecosystems.
O2	To enhance the agricultural productivity and sustainability through maintaining soil health and water quality.
O3	To predict, mitigate and adopt impacts of environmental and climate change on ecosystems and society.
O4	To provide science-based knowledge for improved decision-making and a better-informed citizenry.
O5	To deliver highly visible teaching, research and extension programs on the improvement, restoration and management of soil and water resources.

O = Objective of the Discipline/POE

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Name of the Degree

Bachelor of Science (Honours) in Soil, Water and Environment

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Description of the Program

Soil, Water, and Environment Discipline (formerly Soil Science Discipline) started its academic activities in 1998-1999, introducing an undergraduate program that offers a four-year Bachelor of Science (Honours) degree divided into eight terms. For thousands of years, soil and water use have been important and fundamental factors in human survival. Climate and demographic trends have made them more important than ever - both locally and globally. Since soil, water, and the environment are the major concerns at all societal levels, the discipline offers a four-year Bachelor of Science (Honours) degree in Soil, Water and Environment since 2017.

Course curricula of this discipline are designed aiming at providing the basic and applied knowledge necessary for building skills and capacity in the graduates for conducting diversified research and their application in the field of soil, water, agriculture and environment at regional, national as well as global scale.

The entity facilitates its graduates with the support of five well-equipped laboratories (Soil Physics, Soil Chemistry, Soil Microbiology, Soil Fertility and Plant Nutrition, and Soil Processing and Digestion) for conducting research and practical/sessional works. It also supports its graduates with a seminar library enriched with updated books, journals, periodicals, reports and magazines. Its curricula offer opportunities for observation of the field-level applications of the theories learned at the classroom level through short and long field study tours and visits to relevant institutions, research organizations and industries, encourage and support participation in sports and cultural programs and competitions for building leadership and teamwork attitude, and promote for building self-awareness and responsibility for societal well-being.

The program prepares its graduates for building their careers in a variety of educational and research institutes, GOs, NGOs and private consultation farms as scientists, experts, analysts, advisors, consultants and entrepreneurs. It also builds confidence and aspiration for perusing higher educational degrees at home and abroad.

This program offers an array of multidisciplinary courses for providing a solid foundation in soil, water and environment for developing new knowledge in soil's physical, chemical and biological domains necessary for addressing relevant SDGs, Delta plans, regional and global crises.

This program intends to incorporate skills in the graduates for the efficient dealing with the issues of fertility, productivity and biodiversity of the ecosystems, soil, water and environmental health, management, conservation and sustenance of the natural resources, environmental impact assessment and monitoring, attenuation of health risk of plant, animal and human. It also takes up the challenges of feeding the increasing world population, developing methods for enhancing carbon sequestration for combating climate change, provisioning soil ecosystem services with the ultimate objective of ensuring a healthy planet for living and human well-being.

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Graduate Attributes

Graduate Attributes		Domain
GA1	<p>Subject Specialists</p> <p>Graduates have comprehensive knowledge and understanding of their subject areas, the ability to engage with different genres of thought, and the ability to apply their knowledge in practice including multi-disciplinary or multi-professional contexts.</p>	Fundamental
GA2	<p>Digital Literacy</p> <p>Graduates have the state-of-the-art digital skills to intervene with the environmental processes and support life with easiness and comfort in a digital society.</p>	Fundamental
GA3	<p>Critical thinking, problem solving and decision-making skills</p> <p>Graduates are able to apply critical, creative, innovative and effective problem-solving aptitudes, and are able to respond to the forthcoming challenges.</p>	Thinking
GA4	<p>Professionalism and leadership</p> <p>Graduates engage in professional behaviour and have the potential to be entrepreneurial and take leadership roles in their chosen occupations or careers and communities.</p>	Personal
GA5	<p>Self-awareness and responsibility</p> <p>Graduates are self-aware and reflective; they are flexible and resilient and have the capacity to accept and give constructive feedback; they act with integrity and take responsibility for their actions.</p>	Personal
GA6	<p>Teamwork and communication skills</p> <p>Graduates convey ideas and information effectively to a range of audiences for a variety of purposes and contribute in a positive and collaborative manner to achieving common goals.</p>	Social
GA7	<p>Intercultural and ethical competency</p> <p>Graduates are responsible and effective global citizens whose personal values and practices are consistent with their roles as responsible members of society.</p>	Social

GA = Graduate Attributes

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Program Educational Objectives (PEOs)

Program Educational Objectives		Domain
PE01	To educate and train graduates with both theoretical and practical knowledge and skills in Soil, Water and Environment with a broad-based education in agriculture, soil and water management issues.	Fundamental
PE02	To develop/build career-relevant creativity and innovativeness to capacitate graduates for managing and sustaining the use and life of the resources (soil, water, and vegetation) keeping harmony with nature and the ecosystem maintaining increasing agricultural production quantitatively and qualitatively.	Fundamental
PE03	To incorporate knowledge and skills for the formulation and designing research to address and resolve contemporary issues.	Thinking, Personal
PE04	To capacitate graduates to be leaders in the research and development domain for integrating multidisciplinary teams for making policies to achieve sustainable development at regional, national and global scale.	Social, Personal
PE05	To relate and realize the implication of ethical issues and the societal responsibility of serving society and the environment at large and maintain that in education, research and implementation throughout.	Social, Personal

PEO = Program Educational Objective

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Program Learning Outcomes (PLOs)

After successful completion of the degree, the learners will be able to:

A. Fundamental Skills

PL01	Explain the fundamental concepts of soil and water and correlate their influence on other components of the environment.
PL02	Infer the involvement of soil, water and environmental components to address regional, national and global issues.
PL03	Apply the principles of soil, water and environment to ensure safety, security and wellbeing of future generation.

B. Social Skills

PL04	Respond to societal problems and demand through the finding of the research communication, motivation and extension.
PL05	Create social awareness regarding environmental components and promote the measures to sustain and/or improve their health.

C. Thinking Skills

PL06	Identify and analyze soil and water related problems and resolve by applying appropriate strategies knowledge of these branches.
PL07	Apply the scientific methods to investigate the soil, water and environmental processes, and their interactive systems utilizing standard scientific field and laboratory methods.

D. Personal Skills

PL08	Apply the knowledge base and research skills to current issues about soil, water and environmental resources management and remediation with emphasis on related climate, economic, social and public policy dimensions.
PL09	Have the ability to speak, communicate, write and publish original scientific work in various publications and media using appropriate spelling, grammar and composition skills; and construct and present professional-level presentations of their research.
PL010	Justify knowledge and information technology on the scientific method, experiment design, research implementation and perform qualitative and quantitative analysis and interpret the results using appropriate statistical techniques and computer applications.

PL0 = Program Learning Outcome

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Mapping Mission of the University with PEOs

PEOs \ Missions	UM1	UM2	UM3
PE01	3	1	2
PE02	2	3	1
PE03	2	1	3
PE04	3	1	2
PE05	1	3	2

Level of association: 3=High, 2=Medium, 1=Low

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Mapping PLOs with PEOs

Program Learning Outcomes (PLOs)		Program Educational Objectives (PEOs)				
		PE01	PE02	PE03	PE04	PE05
Fundamental Domain	PL01	•	•	•		•
	PL02	•	•	•		•
	PL03	•	•	•	•	
Social Domain	PL04			•		•
	PL05		•		•	•
Thinking Domain	PL06	•	•	•	•	•
	PL07	•		•	•	
Personal Domain	PL08	•	•	•	•	•
	PL09		•	•	•	•
	PL010	•		•	•	

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Mapping Courses with PLOs

Course Code and Course Title	Program Learning Outcomes (PLOs)									
	Fundamental Domain			Social Domain		Thinking Domain		Personal Domain		
	PL01	PL02	PL03	PL04	PL05	PL06	PL07	PL08	PL09	PL010
First Year First Term										
0888 13 SWE 1111 Introductory Soil Science	•	•								
0888 13 SWE 1112 Introductory Soil Science Sessional and Fieldwork	•	•				•				
0888 13 SWE 1121 Introductory Hydrology	•	•	•	•						
0888 13 SWE 1122 Introductory Hydrology Sessional and Fieldwork	•		•			•	•			
0888 13 SWE 1131 Introductory Environmental Science	•	•								
0888 13 SWE 1142 Orientation to University Education System Fieldwork				•						
0531 13 Chem 1151 Chemistry	•	•	•							
0531 13 Chem 1152 Chemistry Sessional	•									•
0714 13 CSE 1154 Word Processing and Spread Sheet Analysis	•								•	•
0231 13 Eng 1155 Communicative English								•	•	•
0413 13 HRM 1157 Human Resource Management	•	•	•		•					
0388 13 DS 1159 Introduction to Development Studies		•	•	•						
First Year Second Term										
0888 13 SWE 1211 Soil Chemistry I	•	•								
0888 13 SWE 1212 Soil Chemistry I Sessional						•	•	•		
0888 13 SWE 1213 Soil Physics I	•	•								
0888 13 SWE 1214 Soil Physics I Sessional and Fieldwork		•				•	•			
0888 13 SWE 1244 Comprehensive Viva voce I	•	•						•	•	
0714 13 CSE 1252 Database Systems Sessional	•								•	•
0314 13 Soc 1253 Principles of Sociology	•	•		•	•					
0532 13 Geol 1255 Geology	•		•			•		•		•
0532 13 Geol 1256 Geology Sessional						•				
0511 13 Bot 1257 Plant Diversity and Plant Physiology	•	•	•							
0511 13 Bot 1258 Plant Diversity and Plant Physiology Sessional and Fieldwork	•	•	•			•				
0541 13 Math 1259 Mathematics	•									•

Course Code and Course Title	Program Learning Outcomes (PLOs)									
	Fundamental Domain			Social Domain		Thinking Domain		Personal Domain		
	PL01	PL02	PL03	PL04	PL05	PL06	PL07	PL08	PL09	PL010
Second Year First Term										
0888 13 SWE 2111 Soil Mineralogy	•	•	•							
0888 13 SWE 2112 Soil Mineralogy Sessional and Fieldwork		•				•				
0888 13 SWE 2113 Surface Chemistry	•	•								
0888 13 SWE 2114 Surface Chemistry Sessional						•	•			
0888 13 SWE 2115 Soil-Water-Plant Relationship		•				•	•			
0888 13 SWE 2116 Soil-Water-Plant Relationship Sessional						•	•			
0888 13 SWE 2121 Water and Soil Pollution	•	•	•							
0888 13 SWE 2131 Environmental Chemistry	•		•							
0888 13 SWE 2132 Environmental Chemistry Sessional and Fieldwork							•	•		•
0532 13 Geog 2151 Fundamentals of Geography and Environment	•	•								
0511 13 Mbio 2153 Fundamentals of Microbiology	•	•								
0511 13 Mbio 2154 Fundamentals of Microbiology Sessional	•					•				
0311 13 Econ 2155 Principles of Economics	•		•	•	•					
Second Year Second Term										
0888 13 SWE 2211 Soil Physics II	•	•					•			
0888 13 SWE 2212 Soil Physics II Sessional and Fieldwork						•		•		•
0888 13 SWE 2221 Water Quality	•	•	•	•	•		•			
0888 13 SWE 2222 Water Quality Sessional and Fieldwork						•	•	•		
0888 13 SWE 2231 Ecology and Ecosystems	•	•	•							
0888 13 SWE 2232 Ecology and Ecosystems Sessional and Fieldwork	•		•			•				•
0888 13 SWE 2233 Atmospheric Science	•	•								
0888 13 SWE 2234 Atmospheric Science Sessional and Fieldwork						•	•	•		•
0888 13 SWE 2235 Stress Environment Agriculture		•	•				•			
0888 13 SWE 2236 Stress Environment Agriculture Sessional and Fieldwork		•	•				•			
0888 13 SWE 2244 Comprehensive Viva voce II	•	•						•	•	
0811 13 Agr 2251 Agronomy	•	•	•							
0811 13 Agr 2252 Agronomy Sessional and Fieldwork		•	•		•	•				
0512 13 Bchm 2253 Fundamentals of Biochemistry	•	•	•							
0512 13 Bchm 2254 Fundamentals of Biochemistry Sessional						•	•			

Course Code and Course Title	Program Learning Outcomes (PLOs)									
	Fundamental Domain			Social Domain		Thinking Domain		Personal Domain		
	PL01	PL02	PL03	PL04	PL05	PL06	PL07	PL08	PL09	PL010
Third Year First Term										
0888 13 SWE 3111 Soil Genesis	•	•	•				•			
0888 13 SWE 3112 Soil Genesis Sessional and Fieldwork							•	•		
0888 13 SWE 3113 Soil Fertility and Nutrient Management	•	•	•	•		•	•			
0888 13 SWE 3114 Soil Fertility and Nutrient Management Sessional and Fieldwork			•			•	•	•		
0888 13 SWE 3115 Soil and Environmental Microbiology	•	•	•	•			•			
0888 13 SWE 3116 Soil and Environmental Microbiology Sessional						•	•	•		
0888 13 SWE 3121 Watershed and Wetland Management	•	•	•	•	•	•				
0888 13 SWE 3122 Watershed and Wetland Management Sessional and Fieldwork			•			•	•			•
0888 13 SWE 3131 Environmental Hazards and Disaster Management		•	•			•	•			•
0542 13 Stat 3151 Statistics	•	•	•				•			•
0542 13 Stat 3152 Statistics Sessional										•
0731 13 URP 3154 Geographical Information System Sessional								•		•
Third Year Second Term										
0888 13 SWE 3211 Soil Chemistry II	•	•	•			•	•			
0888 13 SWE 3212 Soil Chemistry II Sessional						•	•			
0888 13 SWE 3213 Soil Erosion and Conservation		•	•			•	•			
0888 13 SWE 3214 Soil Erosion and Conservation Fieldwork			•		•	•	•			
0888 13 SWE 3215 Problem Soils of Bangladesh		•			•	•	•	•		
0888 13 SWE 3216 Problem Soils of Bangladesh Sessional and Fieldwork			•			•	•			
0888 13 SWE 3231 Biochar Concept and Application	•	•	•	•						
0888 13 SWE 3232 Biochar Concept and Application Sessional			•			•	•			•
0888 13 SWE 3241 Research Methodology								•	•	•
0888 13 SWE 3242 Research Methodology Sessional and Fieldwork							•	•		•
0888 13 SWE 3244 Comprehensive Viva voce III	•	•						•	•	
0811 13 Agr 3251 Principles and Practices of Organic Farming	•	•	•				•			
0811 13 Agr 3252 Principles and Practices of Organic Farming Sessional and Fieldwork			•			•	•			
0811 13 Agr 3253 Crops of Bangladesh			•	•		•	•			

Course Code and Course Title	Program Learning Outcomes (PLOs)									
	Fundamental Domain			Social Domain		Thinking Domain		Personal Domain		
	PL01	PL02	PL03	PL04	PL05	PL06	PL07	PL08	PL09	PL010
Fourth Year First Term										
0888 13 SWE 4111 Soil Survey and Land Evaluation	•	•	•			•	•			
0888 13 SWE 4112 Soil Survey and Land Evaluation Sessional and Field Work			•			•	•	•		
0888 13 SWE 4113 Environmental Soil Mechanics	•	•				•	•	•		
0888 13 SWE 4114 Environmental Soil Mechanics Sessional and Fieldwork		•	•			•				•
0888 13 SWE 4115 Forest Soil and Management	•	•	•			•	•	•		
0888 13 SWE 4116 Forest Soil and Management Sessional and Fieldwork	•	•				•	•	•		•
0888 13 SWE 4117 Biogeochemistry of Submerged Soils	•	•	•			•		•		
0888 13 SWE 4118 Biogeochemistry of Submerged Soils Sessional and Fieldwork			•			•	•	•		
0888 13 SWE 4121 Water and Wastewater Treatment	•	•	•	•	•	•	•			
0888 13 SWE 4122 Water and Wastewater Treatment Sessional and Fieldwork			•	•	•	•	•			
0888 13 SWE 4131 Natural Resource Management	•	•		•	•	•	•			
0888 13 SWE 4142 Thesis Proposal Development						•	•	•	•	
0888 13 SWE 4144 Project						•	•	•		•
0888 13 SWE 4146 Internship			•			•	•	•		•
Fourth Year Second Term										
0888 13 SWE 4211 Soil Classification and Soils of Bangladesh						•		•		•
0888 13 SWE 4212 Soil Classification and Soils of Bangladesh Sessional and Fieldwork						•	•		•	
0888 13 SWE 4221 Irrigation and Drainage Management		•	•	•	•	•	•	•		
0888 13 SWE 4222 Irrigation and Drainage Management Sessional and Fieldwork				•	•	•	•	•		
0888 13 SWE 4223 Soil and Water Salinity	•	•				•	•			
0888 13 SWE 4224 Soil and Water Salinity Sessional and Fieldwork				•	•	•	•			
0888 13 SWE 4225 River and Floodplain Management		•	•			•	•	•		
0888 13 SWE 4231 Climate Change and Food Security	•	•	•	•	•	•				
0888 13 SWE 4233 Waste Management		•	•			•		•		
0888 13 SWE 4234 Waste Management Sessional and Fieldwork			•	•	•			•		•
0888 13 SWE 4242 Thesis	•		•			•	•	•	•	•
0888 13 SWE 4244 Comprehensive Viva voce IV	•	•						•	•	
0231 13 Eng 4253 Professional English									•	
0223 13 Phil 4255 Ethics									•	•

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Structure of the Curriculum

a) Duration of the Program	04 Years	08 Terms
b) Admission Requirements	The applicants having HSC or equivalent degree will be eligible for admission into this program. Other terms and conditions are set or revised periodically by the appropriate authority.	
c1) Graduating Credits / Total Minimum Credit Requirement to Complete the Program	160	
c2) Available Credits	220	
d) Total Class Weeks in a Term*	14	
e) Minimum CGPA Requirements for Graduation	2.50 (Out of 4.0)	
f) Maximum Academic Years of Completion	07 Years	

*Term Duration

Teaching and Learning	Preparatory Leave	Term Final Examination	Term Break	Total
14 Weeks	2 Weeks	4 Weeks	2 Weeks	22 Weeks

g1) Area-wise Credit Distribution

Area	Course Type	Number of Courses	Credits	Total Credits	
General Education (GED) Courses**	Theory	Core	7	21	62 (28.18%)
		Optional	10	30	
	Sessional	Core	6	6	
		Optional	5	5	
Core/Compulsory Courses	Theory	22	66	91	
	Sessional	25	25		
Optional/Elective Courses	Theory	15	45	55	
	Sessional	10	10		
Capstone Courses***	Sessional	4	12	12	
Non-credit Courses	Theory	1	0	0	
	Sessional	1	0		
Total		106		220	

** 28.18% from GED courses of total available credits

*** Thesis, project, internship etc. courses

g2) Category of Courses

Area	Course Type	Course Title	Credits
General Education (GED) Courses	Theory	01. Chemistry 02. Geology 03. Mathematics 04. Agronomy 05. Fundamentals of Microbiology 06. Fundamentals of Biochemistry 07. Communicative English 08. Human Resources Management 09. Introduction to Development Studies	51

Area	Course Type	Course Title	Credits
		10. Plant Diversity and Plant Physiology 11. Principles of Sociology 12. Statistics 13. Fundamentals of Geography and Environment 14. Principles of Economics 15. Principles and Practices of Organic Farming 16. Crops of Bangladesh 17. Professional English	
	Sessional	01. Chemistry Sessional 02. Geology Sessional 03. Word Processing and Spread Sheet Analysis 04. Database System Sessional 05. Agronomy Sessional and Fieldwork 06. Fundamentals of Microbiology Sessional 07. Fundamentals of Biochemistry Sessional 08. Plant Diversity and Plant Physiology Sessional and Fieldwork 09. Statistics Sessional 10. Geographical Information System Sessional 11. Principles and Practices of Organic Farming Sessional and Fieldwork	11
Core/ Compulsory Courses	Theory	01. Introductory Soil Science 02. Introductory Hydrology 03. Introductory Environmental Science 04. Soil Chemistry I 05. Soil Physics I 06. Soil Mineralogy 07. Water Quality 08. Surface Chemistry 09. Soil Physics II 10. Ecology and Ecosystems 11. Soil Genesis 12. Watershed and Wetland Management 13. Soil Fertility and Nutrient Management 14. Soil and Environmental Microbiology 15. Soil Chemistry II 16. Soil Erosion and Conservation 17. Research Methodology 18. Soil Survey and Land Evaluation 19. Environmental Soil Mechanics 20. Problem Soils of Bangladesh 21. Soil Classification and Soils of Bangladesh 22. Irrigation and Drainage Management	66
	Sessional	01. Introductory Soil Science Sessional and Fieldwork 02. Introductory Hydrology Sessional and Fieldwork 03. Soil Chemistry I Sessional 04. Soil Physics I Sessional and Fieldwork 05. Comprehensive Viva voce I 06. Soil Mineralogy Sessional and Fieldwork 07. Water Quality Sessional and Fieldwork 08. Surface Chemistry Sessional 09. Soil Physics II Sessional and Fieldwork 10. Ecology and Ecosystems Sessional and Fieldwork 11. Comprehensive Viva voce II	25

Area	Course Type	Course Title	Credits
		12. Soil Genesis Sessional and Fieldwork 13. Watershed and Wetland Management Sessional and Fieldwork 14. Soil Fertility and Nutrient Management Sessional and Fieldwork 15. Soil and Environmental Microbiology Sessional 16. Soil Chemistry II Sessional 17. Soil Erosion and Conservation Fieldwork 18. Problem Soils of Bangladesh Sessional and Fieldwork 19. Research Methodology Sessional and Fieldwork 20. Comprehensive Viva voce III 21. Soil Survey and Land Evaluation Sessional and Fieldwork 22. Environmental Soil Mechanics Sessional and Fieldwork 23. Soils Classification and Soils of Bangladesh Sessional and Fieldwork 24. Irrigation and Drainage Management Sessional and Fieldwork 25. Comprehensive Viva voce IV	
Optional/ Elective Courses	Theory	01. Environmental Chemistry 02. Water and Soil Pollution 03. Climate Change and Food Security 04. Atmospheric Science 05. Environmental Hazards and Disaster Management 06. Water and Wastewater Treatment 07. Soil-Water-Plant Relationship 08. Natural Resource Management 09. Biochar Concept and Application 10. Biogeochemistry of Submerged Soils 11. Forest Soil and Management 12. Waste Management 13. River and Floodplain Management 14. Stress Environment Agriculture 15. Soil and Water Salinity	45
	Sessional	01. Environmental Chemistry Sessional and Fieldwork 02. Atmospheric Science Sessional and Fieldwork 03. Water and Wastewater Treatment Sessional and Fieldwork 04. Forest Soil and Management Sessional and Fieldwork 05. Waste Management Sessional and Fieldwork 06. Soil-Water-Plant Relationship Sessional and Fieldwork 07. Biochar Concept and Application Sessional 08. Biogeochemistry of Submerged Soils Sessional and Fieldwork 09. Stress Environment Agriculture Sessional and Fieldwork 10. Soil and Water Salinity Sessional and Fieldwork	10
Capstone Courses	Sessional	01. Thesis Proposal Development	2
		02. Thesis	4
		03. Project	3
		04. Internship	3
Capstone Courses	Theory	01. Ethics	0
	Sessional	01. Orientation to University Education System Fieldwork	0
Total			220

Course Code	Course Title	Course Status	Contact Hours/Week		Credits	Prerequisites
			Theory	Sessional		
First Year First Term						
0888 13 SWE 1111	Introductory Soil Science	Core	3.0	-	3.0	None
0888 13 SWE 1112	Introductory Soil Science Sessional and Fieldwork	Core	-	1.5	1.0	None
0888 13 SWE 1121	Introductory Hydrology	Core	3.0	-	3.0	None
0888 13 SWE 1122	Introductory Hydrology Sessional and Fieldwork	Core	-	1.5	1.0	None
0888 13 SWE 1131	Introductory Environmental Science	Core	3.0	-	3.0	None
0888 13 SWE 1142	Orientation to University Education System Fieldwork	Core	-	1.5	0.0	None
0531 13 Chem 1151	Chemistry	Core	3.0	-	3.0	None
0531 13 Chem 1152	Chemistry Sessional	Core	-	1.5	1.0	None
0714 13 CSE 1154	Word Processing and Spread Sheet Analysis	Core	-	1.5	1.0	None
0231 13 Eng 1155	Communicative English	Core	3.0	-	3.0	None
0413 13 HRM 1157	Human Resource Management	Optional	3.0	-	3.0	None
0388 13 DS 1159	Introduction to Development Studies	Optional	3.0	-	3.0	None
Total	Core Courses: 10, Optional Courses: 02, Theory Courses: 07, Sessional Courses: 05, Non-credit course: 01		21.0	7.5	25.0	
			28.5			
First Year Second Term						
0888 13 SWE 1211	Soil Chemistry I	Core	3.0	-	3.0	None
0888 13 SWE 1212	Soil Chemistry I Sessional	Core	-	1.5	1.0	None
0888 13 SWE 1213	Soil Physics I	Core	3.0	-	3.0	None
0888 13 SWE 1214	Soil Physics I Sessional and Fieldwork	Core	-	1.5	1.0	None
0888 13 SWE 1244	Comprehensive Viva voce I	Core	-	1.5	1.0	None
0714 13 CSE 1252	Database Systems Sessional	Core	-	1.5	1.0	None
0314 13 Soc 1253	Principles of Sociology	Optional	3.0	-	3.0	None
0532 13 Geol 1255	Geology	Core	3.0	-	3.0	None
0532 13 Geol 1256	Geology Sessional	Core	-	1.5	1.0	None
0511 13 Bot 1257	Plant Diversity and Plant Physiology	Optional	3.0	-	3.0	None
0511 13 Bot 1258	Plant Diversity and Plant Physiology Sessional and Fieldwork	Optional	-	1.5	1.0	None
0541 13 Math 1259	Mathematics	Core	3.0	-	3.0	None
Total	Core Courses: 09, Optional Courses: 03, Theory Courses: 06, Sessional Courses: 06		18.0	9.0	24.0	
			27.0			

Course Code	Course Title	Course Status	Contact Hours/Week		Credits	Prerequisites
			Theory	Sessional		
Second Year First Term						
0888 13 SWE 2111	Soil Mineralogy	Core	3.0	-	3.0	None
0888 13 SWE 2112	Soil Mineralogy Sessional and Fieldwork	Core	-	1.5	1.0	None
0888 13 SWE 2113	Surface Chemistry	Core	3.0	-	3.0	None
0888 13 SWE 2114	Surface Chemistry Sessional	Core	-	1.5	1.0	None
0888 13 SWE 2115	Soil-Water-Plant Relationship	Optional	3.0		3.0	None
0888 13 SWE 2116	Soil-Water-Plant Relationship Sessional	Optional	-	1.5	1.0	None
0888 13 SWE 2121	Water and Soil Pollution	Optional	3.0	-	3.0	None
0888 13 SWE 2131	Environmental Chemistry	Optional	3.0	-	3.0	None
0888 13 SWE 2132	Environmental Chemistry Sessional and Fieldwork	Optional	-	1.5	1.0	None
0532 13 Geog 2151	Fundamentals of Geography and Environment	Optional	3.0	-	3.0	None
0511 13 Mbio 2153	Fundamentals of Microbiology	Optional	3.0	-	3.0	None
0511 13 Mbio 2154	Fundamentals of Microbiology Sessional	Optional	-	1.5	1.0	None
0311 13 Econ 2155	Principles of Economics	Core	3.0	-	3.0	None
Total	Core Courses: 05, Optional Courses: 08, Theory Courses: 08, Sessional Courses: 05		24.0	7.5	29.0	
			31.5			
Second Year Second Term						
0888 13 SWE 2211	Soil Physics II	Core	3.0	-	3.0	None
0888 13 SWE 2212	Soil Physics II Sessional and Fieldwork	Core	-	1.5	1.0	None
0888 13 SWE 2221	Water Quality	Core	3.0	-	3.0	None
0888 13 SWE 2222	Water Quality Sessional and Fieldwork	Core	-	1.5	1.0	None
0888 13 SWE 2231	Ecology and Ecosystems	Core	3.0	-	3.0	None
0888 13 SWE 2232	Ecology and Ecosystems Sessional and Fieldwork	Core	-	1.5	1.0	None
0888 13 SWE 2233	Atmospheric Science	Optional	3.0	-	3.0	None
0888 13 SWE 2234	Atmospheric Science Sessional and Fieldwork	Optional	-	1.5	1.0	None
0888 13 SWE 2235	Stress Environment Agriculture	Optional	3.0	-	3.0	None
0888 13 SWE 2236	Stress Environment Agriculture Sessional and Fieldwork	Optional	-	1.5	1.0	None
0888 13 SWE 2244	Comprehensive Viva voce II	Core	-	1.5	1.0	None
0811 13 Agr 2251	Agronomy	Core	3.0	-	3.0	None
0811 13 Agr 2252	Agronomy Sessional and Fieldwork	Core	-	1.5	1.0	None
0512 13 Bchm 2253	Fundamentals of Biochemistry	Optional	3.0	-	3.0	None
0512 13 Bchm 2254	Fundamentals of Biochemistry Sessional	Optional	-	1.5	1.0	None
Total	Core Courses: 09, Optional Courses: 06, Theory Courses: 07, Sessional Courses: 08		21.0	12.0	29.0	
			33.0			

Course Code	Course Title	Course Status	Contact Hours/Week		Credits	Prerequisites
			Theory	Sessional		
Third Year First Term						
0888 13 SWE 3111	Soil Genesis	Core	3.0	-	3.0	None
0888 13 SWE 3112	Soil Genesis Sessional and Fieldwork	Core	-	1.5	1.0	None
0888 13 SWE 3113	Soil Fertility and Nutrient Management	Core	3.0	-	3.0	None
0888 13 SWE 3114	Soil Fertility and Nutrient Management Sessional and Fieldwork	Core	-	1.5	1.0	None
0888 13 SWE 3115	Soil and Environmental Microbiology	Core	3.0	-	3.0	None
0888 13 SWE 3116	Soil and Environmental Microbiology Sessional	Core	-	1.5	1.0	None
0888 13 SWE 3121	Watershed and Wetland Management	Core	3.0	-	3.0	None
0888 13 SWE 3122	Watershed and Wetland Management Sessional and Fieldwork	Core	-	1.5	1.0	None
0888 13 SWE 3131	Environmental Hazards and Disaster Management	Optional	3.0	-	3.0	None
0542 13 Stat 3151	Statistics	Core	3.0	-	3.0	None
0542 13 Stat 3152	Statistics Sessional	Core	-	1.5	1.0	None
0731 13 URP 3154	Geographical Information System Sessional	Optional	-	1.5	1.0	None
Total	Core Courses: 10, Optional Courses: 02, Theory Courses: 06, Sessional Courses: 06		18.0	9.0	24.0	
			27			
Third Year Second Term						
0888 13 SWE 3211	Soil Chemistry II	Core	3.0	-	3.0	None
0888 13 SWE 3212	Soil Chemistry II Sessional	Core	-	1.5	1.0	None
0888 13 SWE 3213	Soil Erosion and Conservation	Core	3.0	-	3.0	None
0888 13 SWE 3214	Soil Erosion and Conservation Fieldwork	Core	-	1.5	1.0	None
0888 13 SWE 3215	Problem Soils of Bangladesh	Core	3.0	-	3.0	None
0888 13 SWE 3216	Problem Soils of Bangladesh Sessional and Fieldwork	Core	-	1.5	1.0	None
0888 13 SWE 3231	Biochar Concept and Application	Optional	3.0	-	3.0	None
0888 13 SWE 3232	Biochar Concept and Application Sessional	Optional	-	1.5	1.0	None
0888 13 SWE 3241	Research Methodology	Core	3.0	-	3.0	None
0888 13 SWE 3242	Research Methodology Sessional and Fieldwork	Core	-	1.5	1.0	None
0888 13 SWE 3244	Comprehensive Viva voce III	Core	-	1.5	1.0	None
0811 13 Agr 3251	Principles and Practices of Organic Farming	Optional	3.0	-	3.0	None
0811 13 Agr 3252	Principles and Practices of Organic Farming Sessional and Fieldwork	Optional	-	1.5	1.0	None
0811 13 Agr 3253	Crops of Bangladesh	Optional	3.0	-	3.0	None
Total	Core Courses: 09, Optional Courses: 05, Theory Courses: 07, Sessional Courses: 07		21.0	9.0	27.0	
			24.00			

Course Code	Course Title	Course Status	Contact Hours/Week		Credits	Prerequisites
			Theory	Sessional		
Fourth Year First Term						
0888 13 SWE 4111	Soil Survey and Land Evaluation	Core	3.0	-	3.0	None
0888 13 SWE 4112	Soil Survey and Land Evaluation Sessional and Field Work	Core	-	1.5	1.0	None
0888 13 SWE 4113	Environmental Soil Mechanics	Core	3.0	-	3.0	None
0888 13 SWE 4114	Environmental Soil Mechanics Sessional and Fieldwork	Core	-	1.5	1.0	None
0888 13 SWE 4115	Forest Soil and Management	Optional	3.0	-	3.0	None
0888 13 SWE 4116	Forest Soil and Management Sessional and Fieldwork	Optional	-	1.5	1.0	None
0888 13 SWE 4117	Biogeochemistry of Submerged Soils	Optional	3.0	-	3.0	None
0888 13 SWE 4118	Biogeochemistry of Submerged Soils Sessional and Fieldwork	Optional	-	1.5	1.0	None
0888 13 SWE 4121	Water and Wastewater Treatment	Optional	3.0	-	3.0	None
0888 13 SWE 4122	Water and Wastewater Treatment Sessional and Fieldwork	Optional	-	1.5	1.0	None
0888 13 SWE 4131	Natural Resource Management	Optional	3.0	-	3.0	None
0888 13 SWE 4142*	Thesis Proposal Development	Optional	-	3.0	2.0	None
0888 13 SWE 4144*	Project	Optional	-	4.5	3.0	None
0888 13 SWE 4146*	Internship	Optional	-	4.5	3.0	None
Total	Core Courses: 04, Optional Courses: 10, Theory Courses: 06, Sessional Courses: 08 *N. B.: '0888 13 SWE 4142', '0888 13 SWE 4144' and '0888 13 SWE 4146' courses are mutually exclusive. One of the aforementioned courses is mandatory for the completion of the program.		18.0	19.5	31.0	
			37.5			
Fourth Year Second Term						
0888 13 SWE 4211	Soil Classification and Soils of Bangladesh	Core	3.0	-	3.0	None
0888 13 SWE 4212	Soil Classification and Soils of Bangladesh Sessional and Fieldwork	Core	-	1.5	1.0	None
0888 13 SWE 4221	Irrigation and Drainage Management	Core	3.0	-	3.0	None
0888 13 SWE 4222	Irrigation and Drainage Management Sessional and Fieldwork	Core	-	1.5	1.0	None
0888 13 SWE 4223	Soil and Water Salinity	Optional	3.0	-	3.0	None
0888 13 SWE 4224	Soil and Water Salinity Sessional and Fieldwork	Optional	-	1.5	1.0	None
0888 13 SWE 4225	River and Floodplain Management	Optional	3.0	-	3.0	None
0888 13 SWE 4231	Climate Change and Food Security	Core	3.0	-	3.0	None
0888 13 SWE 4233	Waste Management	Optional	3.0	-	3.0	None
0888 13 SWE 4234	Waste Management Sessional and Fieldwork	Optional	-	1.5	1.0	None
0888 13 SWE 4242*	Thesis	Optional	-	6.0	4.0	None
0888 13 SWE 4244	Comprehensive Viva voce IV	Core	-	1.5	1.0	None
0231 13 Eng 4253	Professional English	Optional	3.0	-	3.0	None
0223 13 Phil 4255	Ethics	Core	3.0	-	0	None
Total	Core Courses: 06, Optional Courses: 07, Theory Courses: 07, Sessional Courses: 06 *N. B.: '0888 13 SWE 4242' course is mandatory for those who registered the '0888 13 SWE 4142' course earlier.		24.0	13.5	30.0	
			37.5			

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Course Description

First Year First Term		
Course Code: 0888 13 SWE 1111	Year: First	Term: First
Course Title	Introductory Soil Science	
Course Status	Core	
Credit	3.0	
Prerequisite(s)	None	
Rationale	This course is designed to introduce the freshers of this discipline to the most valuable natural resource of the planet Erath, which provides humans with 99.7 percent of all food consumed worldwide. It focuses on the birth of soil science, weathering of rocks and soil formation, its composition, properties and their interrelationship, which collectively establish the foundation for studying soil as a medium of plant growth.	

Course Contents		CLOs
Section A		
1	Introduction: Concept of Soil; historical development of Soil Science; objectives of studying Soil Science. Soil as a medium of plant growth, Plant growth factors. Mass volume relationship in soil.	1, 3
2	Weathering: Weathering processes - physical and chemical weathering, factors affecting weathering.	2
3	Soil Formation: Soil layer as geological formation, Soil forming materials-rocks, minerals; factors influence soil formation; basic ideas on soil forming processes; development of soil horizons and soil profiles.	2
4	Soil Phases: Volume composition of soil, Soil is a three-dimensional body, Soil as a three-phase disperse system; description of the three phases of soils.	3
Section B		CLOs
5	Soil properties: List of soil properties, importance and their interrelationship.	3
6	Physical properties: Soil separates (Size, characteristics and importance of sand, silt and clay), soil texture (definition, importance, classes, determination and importance), soil structure (definition, importance, formation and description), porosity (definition, formation, importance and classification), soil density (definition, importance and derivation of particle density and bulk density), soil colour (concept, importance, Munsell notation, factors influencing soil colour), soil air (definition, importance and composition), soil consistency (definition, importance, Atterberg limits, factors influencing soil consistency), soil temperature (significance, albedo, diurnal and seasonal fluctuations), Soil water (soil moisture constants, physical and biological classification of soil water with their agricultural significance).	3
7	Chemical properties: Soil organic matter (definition of organic matter and humus, source, composition, importance and decomposition), soil pH (definition, importance, pH scale, pH of various soils, influence on other soil properties), soil water (formation of water molecule, polarity and related properties, soil colloids (definition, colloidal properties, types of colloids, phyllosilicate minerals, fundamentals of alluminosilicate minerals, silica tetrahedral, aluminum octahedral, and isomorphous substitution)	3
8	Biological properties: Classification of organisms present in soil (macroorganisms and microorganisms), major characteristics of bacteria, actinomycetes, fungi, algae, protozoa and viruses), importance of these organisms in soil.	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	explain the importance of soil for the existence of civilization;	2
	CLO2	describe the processes of weathering and soil formation;	1
	CLO3	identify the fundamental soil properties and its relation to plant growth and environment.	1, 2

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Team Teaching	Quiz and Class Test
CLO2	Problem-based Learning and Presentation	Assignment and Final Exam
CLO3	Lecture and Group Discussion	Viva voce and Final Exam

Learning Materials

Recommended Readings	Havlin, J. L., Tisdale, S. L., Nelson, W. L., & Beaton, J. D. (2014). Soil fertility and fertilizers. (8th ed.). PHI Learning, Delhi.
	Miller, R. W., & Donahue, R. L. (1990). Soils: an introduction to soils and plant growth (6th ed.). Prentice-Hall International Inc.
	Weil, R. R., & Brady, N. C. (2017). The nature and properties of soils. (15th ed.). Upper Saddle River, NJ: Prentice Hall.
Supplementary Readings	Rai, M. M. (2002). Principles of soil science. Macmillan.
	Tortora, G. J., Funke, B. R., & Case, C.L. (2013). Microbiology-an introduction. (11th Ed.). Pearson.

Course Code: 0888 13 SWE 1112	Year: First	Term: First
Course Title	Introductory Soil Science Sessional and Fieldwork	
Course Status	Core	
Credit	1.0	
Prerequisite(s)	None	
Rationale	This course is designed to make students capable of measuring important soil physical, chemical parameters and description soil in field.	

Course Contents/Tasks		CLOs
1	Soil sampling techniques; soil sample collection and preparation for laboratory analysis.	1
2	Determination of soil reaction (pH), EC and salt content in soil and water.	1
3	Determination of water content and textural class of soil in laboratory.	1
4	Description of soil properties in the field (Soil color, texture by hand feel method, pore space etc.).	2

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:	Mapping with PLOs
CL01	Collect representative soil sample and determine soil pH, EC, particle size and water content of soil;	1, 6
CL02	describe and determine soil properties in the field.	2

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CL01	Lecture and Presentation	Assignment and Final Exam.
CL02	Lecture and Group Discussion	Viva voce and Final Exam.

Learning Materials

Recommended Readings	Black, C. A. (1965). Methods of soil analysis. Agronomy No. 9 part 2. Amer. Soc. Agronomy, Madison, Wisconsin, USA. Huq, S. M. I., & Alam, M. D. (2005). A handbook on analysis of soil, plant and water. Bangladesh-Australia Centre for Environmental Research (BACER-DU), Dhaka.
Supplementary Readings	Kibria, K. Q. (2015). Laboratory manual. SWE Discipline, Khulna University (Unpublished).

Course Code: 0888 13 SWE 1121	Year: First	Term: First
Course Title	Introductory Hydrology	
Course Status	Core	
Credit	3.0	
Prerequisite(s)	None	
Rationale	The course is designed to provide the students with the fundamental knowledge of dealing with one of the most valuable resources on Earth: water. It focuses on the understanding of how water moves from the Earth's surface to the atmosphere and then returns to Earth, how it cycles through hydrologic processes and interacts with its environment, and nourishes all lives and ecosystems including its occurrence and distribution into the surface and below ground reservoirs.	

Course Contents		CLOs
Section A		
1	Hydrology and hydrologic cycle: Concept of hydrology, the hydrologic cycle and the various stages of this cycle, evaporation, condensation, transportation, precipitation, interception, run-off, infiltration, Global distribution of water, Watershed, water balance of a watershed, drainage basin/watersheds, drainage divides.	1, 2
2	Precipitation: Process and subsequent events, Types of precipitation, measurement of rainfall intensity, Duration and frequency relationship, Global and regional patterns of precipitation.	1, 2, 3
3	Surface Hydrology: Sources of stream flow, Formation of streams, Stream flow hydrographs, Precipitation, and runoff, Overland flows, Reservoirs: rivers, lakes, wetlands, estuaries, oceans.	2
4	Floods and their control: Definition, types, intensity, discharge, velocity and related measurements, Factors controlling flood frequency, duration, and extension, Effects of flood in soil formation and replenishment, flood control measures.	2
Section B		CLOs
5	Introduction to Groundwater: Introduction; Water and groundwater availability; Origin and age of groundwater; Groundwater systems; Utilization of groundwater; Science and engineering of groundwater; Planning and management of groundwater; People's perception: public awareness; Groundwater protection: concerns and acts.	1, 2, 3
6	Groundwater Properties: Introduction; Vertical distribution of subsurface; Aquifers; Aquiclude; Aquifuge; Aquitard; Types of aquifers; Groundwater balance; Compressibility and effective stress; Compressibility of water; Aquifer compressibility; Aquifer characteristics; Water-level fluctuations.	2
7	Groundwater Hydrology: Introduction; Groundwater movement; Darcy's law; Hydraulic head; Hydraulic conductivity; Permeability; Transmissivity; Groundwater flow rates; Groundwater flow directions; Infiltration: the Green-Ampt method.	1, 2
8	Groundwater Quality: Introduction; Groundwater constituents and contaminants; Water quality standards; Groundwater solubility; Sources of groundwater contamination; Mass transport of dissolved contaminants; Saline groundwater and sources of salinity.	3
9	Surface Water and Groundwater Interaction: Introduction; Interaction between surface and groundwater; Conjunctive use of surface and groundwater; Saline water intrusion in aquifers; Ghyben-Herzberg relation between fresh and saline waters; Control of saline water intrusion.	4

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	define the hydrologic cycle, its components and the interaction between its components;	1
	CLO2	infer the need to study the surface and groundwater storage, movement and balance in a watershed or catchment or basin and concepts properties and quality parameters to take measures for improvement;	2
	CLO3	outline the fundamentals of groundwater, Identify contaminants, and analyze groundwater field data;	3
	CLO4	allocate groundwater use based on the yield of the existing aquifer, detect conflicting water needs, and make decisions about consumptive water use.	4

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, group discussion and presentation	Written examination, presentation by student, quizzes and class test
CLO2	Lecture, presentation, question and answer, problem-based learning and presentation	Assignment and Final Exam, Quiz and Class Test
CLO3	Lecture, presentation, question and answer	Written examination, multiple-choice examination, homework
CLO4	Lecture, problem-based learning, group discussion and presentation	Interactive application assignments, presentation by students, written examination

Learning Materials

Recommended Readings	<p>Han, D. (2010). Concise hydrology. Bookboon.</p> <p>Heath, R. C. (2004). Basic ground-water hydrology (Vol. 2220). US Geological Survey.</p> <p>Karamouz, M., Ahmadi, A., & Akhbari, M. (2020). Groundwater hydrology: Engineering, planning, and management. CRC press.</p> <p>Robinson, M., & Ward, R. C. (2017). Hydrology: principles and processes. Iowa Publishing.</p> <p>Todd, D. K., & Mays, L. W. (2004). Groundwater hydrology. John Wiley & Sons.</p>
Supplementary Readings	<p>Linsley Jr, R. K., Kohler, M. A., & Paulhus, J. L. (1975). Hydrology for engineers.</p> <p>Maidment, D. R. (1993). Handbook of hydrology (No. 631.587). McGraw-Hill</p> <p>Raghunath, H. M. (2006). Hydrology: principles, analysis and design. New Age International.</p>

Course Code: 0888 13 SWE 1122		Year: First	Term: First
Course Title	Introductory Hydrology Sessional/ Fieldwork		
Course Status	Core		
Credit	1.0		
Prerequisite(s)	None		
Rationale	This course is designed to identify, measure and analyze the hydrological component and processes, comprehend their interrelationship and functions of hydrological components; provide learners with knowledge for hydrological sample collection, methods of sampling and preparation for laboratory analyses. It will also provide students hand-on experience of common techniques in labs and exposure to equipment and machines.		

Course Contents/Tasks		CLOs
1	Field measurement of precipitation, runoff and infiltration.	1, 2
2	Hydrologic data collection and field water balance interpretation.	1, 2
3	Hydrograph construction and interpretation.	1, 2
4	Field measurement of sediment transport and discharge.	3
5	Groundwater sampling methods, sample collection, preservation, transportation and storage.	4
6	Groundwater sample analysis for field and laboratory parameters.	4
7	Data interpretation for drinking water and irrigation water standard.	4

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	estimate different hydrologic components and their functions and data collection and their interpretation;	
CLO2	construct and interpret hydrograph;		3
CLO3	calculate sediment transport and discharges for a stream as well as for a catchment;		6, 7
CLO4	collect groundwater sample for water quality analyses and interpret the results.		6, 7

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Theoretical lessons for field measurement, sample collection and field work, In-situ field demonstration	Hands-on work in the field, field exercise, written test and oral examination
CLO2	Theoretical lessons, exercise	Laboratory exercise, written test and oral examination
CLO3	Theoretical lessons, field work, laboratory exercise, single and/or group assignment	Laboratory exercise, report and oral examination
CLO4	Theoretical lessons, field tour, laboratory analysis, exercise, single and/or group assignment	Laboratory exercise, report and oral examination

Learning Materials

Recommended Readings	Han, D. (2010). Concise hydrology. Bookboon. Karamouz, M., Ahmadi, A., & Akhbari, M. (2020). Groundwater hydrology: Engineering, planning, and management. CRC press. Maidment, D. R. (1993). Handbook of hydrology (No. 631.587). McGraw-Hill Pinder, G. F., & Celia, M. A. (2006). Subsurface hydrology. John Wiley & Sons.
Supplementary Readings	Raghunath, H. M. (2006). Hydrology: principles, analysis and design. New Age International. Robinson, M., & Ward, R. C. (2017). Hydrology: principles and processes. Iwa Publishing.

Course Code: 0888 13 SWE 1131		Year: First	Term: First
Course Title	Introductory Environmental Science		
Course Status	Core		
Credit	3.0		
Prerequisite(s)	None		
Rationale	This course is designed to give a basic understanding of environment and environmental science, its challenges and scopes, earth's components, life-supporting and ecological systems, regional and global environmental issues and environmental ethics.		

Course Contents		CLOs
Section A		
1	Introduction to Environment: Basic terminologies and concepts of environment, Ecology and Ecosystem, its types, functions and structure, nature and organization of matter, energy and matter flow through ecosystem, Tropic level food chain.	1
2	Components of environment: Atmospheric sciences, Environmental chemistry, Geosciences, The relationship among environmental components (Freshwater ecology, Marine ecology, Terrestrial ecology), The basis of the relationship, interior of the earth, composition of earth crust, Environmental toxicology.	1
3	Interactions among Components: Types of interactions, Interrelated scientific principles (matter, energy and environment), Interaction between environment and organisms.	2
Section B		
CLOs		
4	Environmental Ethics: Concept of environmental ethics (definition, importance, objectives, principles), Ethics and issues of environment (historic and modern environmental issues, issues related to epidemics, and related social and managerial issues), Ethical responsibility to humans, Ethical values for pollution control and depletable natural resources, Ethics and climate change, Ethics of ecosystems management.	3
5	Global Environmental Issues: Basic terminologies and concepts of global warming (definition, causes, effects, solution, facts), Greenhouse effect (definition, greenhouse gasses, reflection, refraction and absorption in greenhouse gases, causes of greenhouse effect, control measures of global greenhouse effect), Climate change (history of earth's climate, causes of earth's climate to change -natural and anthropogenic processes), Global warming and Sea-level rise, Ozone layer depletion, Acid rain (causes and effects), El Nino and La Nino, Environmental degradation (environmental hazards/ disasters, pollution, deforestation, ecosystem degradation, natural resources depletion, biodiversity loss).	4
6	The methods of studying environmental issues: Identification of issues, source and significance of the issues, Parameters considered for the issue, Probable consequences of global environmental problems, How to resolve challenging environmental issues affecting nature.	4

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	label and define the terminologies and match components with ecological functions;	1
	CLO2	comprehend and relate environment with its living organisms;	2
	CLO3	explain environmental ethics and interdisciplinary relationship of ethical, and social aspects of global environmental issues;	2
	CLO4	identify and evaluate environmental threats, control measures, global scale of environmental problems and degradation, state the probable consequences and how to resolve challenging environmental issues affecting nature.	2

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and group discussion	Quiz and Class Test
CLO2	Lecture and Presentation	Assignment and Final Exam.
CLO3	Lecture and group discussion	Class Test and Final Exam.
CLO4	Lecture and Problem based Learning	Assignment and Final Exam

Learning Materials

Recommended Readings	<p>Barry, R. G., & Chorley, R. J. (2009). Atmosphere, weather and climate. Routledge.</p> <p>Benson, J. (2013). Environmental ethics: An introduction with readings. Routledge.</p> <p>Griffero, T. & Tedeschini, M. (2019). Atmosphere and aesthetics. London: Palgrave Macmillan.</p> <p>Manahan, S. E. (2000). Fundamentals of environmental chemistry, CRC Press, LLC Boca Raton, FL.</p>
Supplementary Readings	<p>Hardy, J. T. (2003). Climate change: causes, effects, and solutions. John Wiley & Sons.</p> <p>O'riordan, T. (2014). Environmental science for environmental management. Routledge.</p> <p>Suhrke, A. (1994). Environmental degradation and population flows. Journal of International Affairs, pp.473-496.</p>

Course Code: 0888 13 SWE 1142	Year: First	Term: First
Course Title	Orientation to University Education System Fieldwork	
Course Status	Core	
Credit	Non-Credit	
Prerequisite(s)	None	
Rationale	This course is designed to guide undergraduate students in adjusting to the academic, social, and cultural life of the Khulna University. Transitioning from college to university is challenging for many reasons, so this course is here to teach students the skills and knowledge they need to be successful students.	

Course Contents/Tasks		CLOs
1	Introducing University Environment: Self-awareness (student as an individual, student and member of a society, and where they want to go in life, motivation, learning styles, goal setting, values clarification, and responsibility).	1
2	Academic Integrity: Introducing course curriculum, course registration process, Classroom decorum, Academic rules and regulations, Code of conducts, Understanding academic calendar, Introducing various offices of Khulna University,	2
3	University Resources: Residential Halls, Library (steely and online) Medical Centre, Office of The Director of Students Affairs (DSA), Student Scholarships, Student Financial Assistance, Student Advising and Counselling (Health and Wellness), Student organizations, Health services and the healthy health practices, Modern language centre.	2
4	Responsibilities of Students: Responsibilities to the university, family, society and country, presentation communication technique with advisors and faculties, participation, attitude, behavior and violence, academic and research integrity, Pros and cons of University culture and environment, organizing and participation in orientation, farewell, alumni get-together, tour, picnic, academic event-seminar, workshop, presentation, job fair.	3, 4
5	Social Awareness: Personal moral values, social values, religious values, national values (observing national days and events), institutional ethics and standards, social responsibility, voluntary works (blood donation, emergency relief), responses to moral skepticism-hygiene, pollution, vaccination, dowry, child marriage, drug, littering, ragging, teasing, sexual harassment.	3
6	Sports and Culture: Participation in different sports (football, cricket, badminton, volleyball, chess, swimming, etc.) and cultural events, debate.	4

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	orient oneself with the University campus and academic environment;	1
	CLO2	be access the university resources and utilize the resources;	3
	CLO3	bear the responsibilities as a student to the university, society, family and country;	6, 7
	CLO4	organize and participate in the sports, cultural, academic, and voluntary events and national and international days' observation programs.	6, 7

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, presentation, group discussion, place visit,	Quizzes, Assignment, Presentation, Oral examination
CLO2	Motivational speech, place visit, presentation, classroom discussion	Quizzes, Report, Presentation, Oral examination
CLO3	Motivational speech, classroom discussion	Project/report submission
CLO4	Motivational speech, classroom discussion, participation	Quizzes, Documentation and records, Report, Project

Learning Materials

Recommended Readings	KU. (2022a). Ordinance for Undergraduate Program, Khulna University. KU. (2022b). Ordinance for Undergraduate Examination, Khulna University. Outcome Based Curriculum for Bachelor of Science (Honours) for Soil, Water and Environment Discipline.
Supplementary Readings	Materials provided by the course teacher.

Course Code: 0531 13 Chem 1151		Year: First	Term: First
Course Title	Chemistry		
Course Status	Core		
Credit	3.0		
Prerequisite(s)	None		
Rationale	The course is designed to provide students with the theoretical knowledge and concepts required for basic chemistry and related subject areas.		

Course Contents		CLOs
Section A		
1	Introduction to chemistry: Definition and scope; the nature and composition of matter: the chemical structure of matter.	1
2	Atomic structure and the periodic table: Early views, atomic spectra of hydrogen and the Bohr theory, Bohr-Sommerfeld model, quantum number; wave mechanical approach; atomic orbital, build-up elements, the periodic table of the elements, atomic properties and the periodic table.	1
3	The structure of molecules: The origin of bonding, types of bonding; covalent vs ionic bonding: bond polarity, bonding of some representative molecules and their chemical geometry.	1
4	Chemical reaction and stoichiometry: Synthesis in chemistry, the stoichiometry of chemical reactions, precipitation reactions, acid-base reactions and oxidation-reduction reactions: ion electron method for balancing redox reactions.	1
5	Introduction to analytical chemistry: 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.	1, 2
6	Colloids: Colloids and crystalloid: classification of colloids; general methods of preparation of colloidal solution; properties of colloids; coagulation; peptization and electrophoresis.	1, 2
Section B		CLOs
7	Matter and energy: 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 Gibb's free energy.	1
8	System in equilibrium: 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, Le Chatelier principle, equilibria in ionic solutions, acid-base equilibria, concept of pH and buffer solution.	3
9	Chemical kinetics: First and second order reactions and their simple treatment; determination of order of reaction; outline of Arrhenius and Collision theory.	3
10	Introduction to organic chemistry: 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.	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	build knowledge on chemical properties and behaviour of elements;	1
	CLO2	evaluate analytical and colloidal phenomena of chemistry;	2
	CLO3	explain physico-chemical equilibrium of chemical reactions, conceptualize organic chemistry and chemical kinetics.	2, 3

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Presentation	Quiz and Class Test
CLO2	Lecture and Group Discussion	Assignment and Final Exam
CLO3	Lecture and Debate	Viva voce and Final Exam

Learning Materials

Recommended Readings	<p>Andrade-Garda, J. M., Carlosena-Zubieta, A., Gómez-Carracedo, M. P., Maestro-Saavedra, M. A., Prieto-Blanco, M. C., & Soto-Ferreiro, R. M. (2017). Problems of instrumental analytical chemistry: a hands-on guide. Essential Textbooks in Chemistry. World Scientific Europe.</p> <p>Atkins, P. W. (1994). Physical chemistry. ELBS with Oxford Univ Press.</p> <p>Bahl, B. S., & Bahl, A. (1998). Modern organic chemistry. S. Chand & Co. Ltd. India.</p>
Supplementary Readings	<p>Bahl, B. S., & Tuli, G. D. (1985). Essentials of physical chemistry. S. Chand & Co. Ltd. India.</p> <p>Haider, S. Z. (1977). Introduction to modern inorganic chemistry. Students Publication, Dhaka.</p> <p>Hoque, M.M. & Nawab, M.A. (1974). Principles of physical chemistry. Students Publication, Dhaka.</p>

Course Code: 0531 13 Chem 1152		Year: First	Term: First
Course Title	Chemistry Sessional		
Course Status	Core		
Credit	1.0		
Prerequisite(s)	None		
Rationale	This intends to provide hands on knowledge and skills on laboratory safety and maintenance. This course also provides knowledge and exercises on different instrumental and chemical analytical methods.		

Course Contents/Tasks		CLOs
1	Maintenance of chemistry laboratory and safety: maintaining safety and precautions in handling chemicals and instruments; preparation of solutions.	1
2	Practice of volumetric and other chemical methods of analysis.	2
3	Practice with instrumental analysis practiced in soil, water and environment courses	2
4	Interpretation and presentation of reports of chemical and instrumental analysis	1, 2, 3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	build knowledge and experience on maintenance and safety issues in chemistry laboratories;	1, 3
	CLO2	demonstrate skills in handling chemicals and doing chemical and instrumental analysis;	2
	CLO3	to interpret and evaluate the results of analysis.	3

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lab work	Report and viva-voce
CLO2	Lab work	Report and viva-voce
CLO3	Lab work	Report and viva-voce

Learning Materials

Recommended Readings	Andrade-Garda, J. M., Carlosena-Zubieta, A., Gómez-Carracedo, M. P., Maestro-Saavedra, M. A., Prieto-Blanco, M. C., & Soto-Ferreiro, R. M. (2017). Problems of instrumental analytical chemistry: a hands-on guide. Essential Textbooks in Chemistry. World Scientific Europe. Eaton, A. D., Greenberg A. E., & Cleceri, L. S., (1996). Standard methods. APHA
Supplementary Readings	

Course Code: 0714 13 CSE 1154	Year: First	Term: First
Course Title	Word Processing and Spread Sheet Analysis	
Course Status	Core	
Credit	1.0	
Prerequisite(s)	None	
Rationale	This course is designed to provide basic knowledge on computer, Microsoft office and spread sheet package.	

Course Contents/Tasks		CLOs
1	Introduction to computer.	1
2	Detailed practice of word processing using contemporary word processing packages.	2
3	Spread sheet analysis using contemporary spread sheet packages.	2

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:	Mapping with PLOs
CLO1	acquaint with the basic principles and fundamental applications of computer;	1
CLO2	apply the principles of word processing and spread sheet analysis.	10

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and team Teaching	Quiz and problem based assessment
CLO2	Problem-based Learning and Group Discussion	Viva voce and final exam

Learning Materials

Recommended Readings	Arató, M., & Bujdosó, G. (2006). New style in teaching word processing. <i>Teaching Mathematics and Computer Science</i> , 4(2), 417-426. Bangert-Drowns, R. L. (1993). The word processor as an instructional tool: A meta-analysis of word processing in writing instruction. <i>Review of Educational research</i> , 63(1), 69-93. Capron, H. L. (1987). <i>Computers: tools for an information age</i> . Benjamin-Cummings Publishing Co., Inc.
Supplementary Readings	Grant, D. M., Malloy, A. D., & Murphy, M. C. (2009). A comparison of student perceptions of their computer skills to their actual abilities. <i>Journal of Information Technology Education: Research</i> , 8(1), 141-160.

Course Code: 0231 13 Eng 1155	Year: First	Term: First
Course Title	Communicative English	
Course Status	Optional	
Credit	2.0	
Prerequisite(s)	None	
Rationale	This course is designed to build competence and confidence in language skills (reading, writing, speaking) essential for effective communication. The course offers the students an opportunity to know the skills of English Language and their proper uses.	

Course Contents		CLOs
Section A		
1	Development of Vocabulary: Processes of word formation and Transformation; proper use of parts of speech.	1
2	Sentence Structure: Structures of basic sentences, identification of clauses and phrases, joining sentences, transformation of sentences, framing W/H questions.	1, 2
3	Reading and Understanding: 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.	2
Section B		CLOs
4	Development of Speaking skills: Art of Good Speaking, Notions and Functions, Speaker-listener Rapport, Intonation and Stress.	3
5	Development of Writing Skills: 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.	2
6	Development of Listening Skills: Guidelines for Developing Listening Skills, Role of a Good Listener, Listening Comprehension.	2

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	apply how to transform one part of speech into another part, differentiate between clauses and phrases;	9
	CLO2	explicate the elements of reading, writing, and perform the role of ideal listeners;	9
	CLO3	implement the notions of speaking and explain the mechanics in writing.	9

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Group Discussion	Quiz and Class Test
CLO2	Lecture and Presentation	Assignment and Final Exam
CLO3	Problem-based Learning and Presentation	Viva voce and Final Exam

Learning Materials

Recommended Readings	Leech, G., & Svartvik, J. (2013). A communicative grammar of English. Routledge. Spada, N. (2007). Communicative language teaching. International handbook of English language teaching.
Supplementary Readings	Wren, P. C., & Martin, H. (2000). English grammar and Composition. New Delhi: S Chand & Company Ltd.

Course Code: 0413 13 HRM 1157	Year: First	Term: First
Course Title	Human Resource Management	
Course Status	Optional	
Credit	3.0	
Prerequisite(s)	None	
Rationale	This fundamental course is designed to discuss human resource management theories, functions, concepts, techniques, and practices in the context of complex, dynamic, changing and globalizing business world.	

Course Contents		CLOs
Section A		
1	Introduction: 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.	1
2	Management Theory and Thought: 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.	2
3	Management Planning and Decision Making: 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.	2
4	Objectives: Nature of objectives-Management by objectives; Process of MBO-Setting objectives; Benefits and weakness of MBO.	2, 3
Section B		CLOs
5	Organizing: Designing Jobs, Grouping Jobs: Departmentalization; Establishing reporting relationships; Distributing authority; Coordinating activity; differentiating between positions; Line and staff position.	1, 2
6	Motivation: 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.	2
7	Leadership: 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.	2, 3
8	Controlling: Meaning and purpose of control; Types of control; Steps in control process; Characteristics of effective control; Resistance to control; Overcoming resistance to control.	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	explain management process, discuss managerial roles, managerial skills. Outline the importance of history and theory, the classical management perspective, the behavioral management perspective;	1, 2
	CLO2	infer and apply a selected management topic to a real organizational setting;	2, 3
	CLO3	have a reflection of contemporary trends in management. explain 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.	3, 4

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CL01	Lecture and Group Discussion	Quiz and Class Test
CL02	Lecture and Presentation	Assignment and Final Exam
CL03	Problem-based Learning and Presentation	Viva voce and Final Exam

Learning Materials

Recommended Readings	Jackson, J. H., Mathis, R. L., & Sean, R. (1994). Valentine human resource management. (15th ed.). Cengage Learning, USA.
	Mathis, R. L., Jackson, J. H., Valentine, S. R., & Meglich, P. (2016). Human resource management. Cengage Learning.
Supplementary Readings	Verhulst, S. L. & DeCendo, D. A. (1994). Fundamentals of human resource management. (14th ed.). Wiley & Sons Inc.

Course Code: 0388 13 DS 1159	Year: First	Term: First
Course Title	Introduction to Development Studies	
Course Status	Optional	
Credit	3.0	
Prerequisite(s)	None	
Rationale	This course intends to provide an introduction to the field of development studies by orienting students with the debate around the meaning of development as well as with new approaches to the development process.	

Course Contents		CLOs
Section A		
1	Meaning of Development: Definitions, Dimensions and Interpretations of Development; Key Aspects of Development.	1
2	Development Studies as a Discipline: Origin and Evolution; Nature, Scope and Focus	1
3	History of Development Thought: Ideas and Evolution of Development Thinking; Modern Critics of Development Thinking.	1
4	Measuring Development: Development Indicators and Uses; Example of Development Indicator- Human development Index; Challenges to Measure Development.	1, 2
Section B		CLOs
5	Issues in Development: Globalization; Poverty and Inequality; Health and Education; Gender; Environment, Sustainability and Climate Change.	2
6	Global Initiatives for Development: Millennium Development Goals (MDGs); Sustainable Development Goals (SDGs); North-South Cooperation; South-South Cooperation.	2, 3
7	Civil Society and NGOs for Development: Role of Local and International NGOs; Civil Society and Social Movements; Grassroots Development.	2, 3
8	Development Aid and International Financial Institutions: Bilateral and Multilateral Donor Agencies and Financial Institutions- DFID, USAID, AusAid, UNDP, ADB, World Bank, IDB, IMF.	2

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	acquire knowledge on development and development studies, orient the students with the theoretical underpinnings on different development issues in Bangladesh;	2, 4
	CLO2	assess the main components of development in the global south with particular reference to economic, social and environmental processes and issues;	2, 4
	CLO3	assemble different approaches from the macro level of international development agencies to the micro-level of grassroots organizations.	3, 4

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CL01	Lecture and Group Discussion	Quiz and Class Test
CL02	Lecture and Presentation	Assignment and Final Exam
CL03	Problem-based Learning and Presentation	Viva voce and Final Exam

Learning Materials

Recommended Readings	de Beer, F., & Swanepoel, H. (2001). Introduction to development studies (2nd ed.). Oxford University Press.
Supplementary Readings	Pattanaik, B. K. (2019). Introduction to development studies. SAGE Texts.

First Year Second Term			
Course Code: 0888 13 SWE 1211		Year: First	Term: Second
Course Title	Soil Chemistry I		
Course Status	Core		
Credit	3.0		
Prerequisite(s)	None		
Rationale	The course intends to provide the basic concepts on soil chemistry and chemical processes directly and indirectly involved in nourishing soil environment for plant growth.		

Course Contents		CLOs
Section A		
1	Introduction to Soil Chemistry: Concept of soil chemistry; Soil chemistry and its relation to other fields of science; Chemical composition of soil; Elements needed for plant growth and their sources; Chemical reactions in soils; Phases and chemical processes in soil; Elements in the soil environment: their concentrations and important species; Soil chemistry and environmental toxicology; Units in soil chemistry; Grand soil science challenges for 2050.	1, 2
2	Soil Organic Matter (SOM): Concept of SOM; Sources and types of SOM; Composition of plant residues; Functions of SOM; Factors affecting SOM; Practices that influence the SOM; Carbon-Nitrogen (C:N) ratio; C-sequestration; Contribution to SOM to C-sequestration.	2, 3
3	Soil Solution: Definition; Importance; Composition; Properties; Soil solution as a dynamic entity; Dynamic equilibrium in soil solution.	1, 3
4	Soil Acidity: Introduction; Soil-pH scale, Soil acidification processes; Measurement of soil acidity; Role of aluminum in soil acidity; Pools of soil acidity; Human-influenced soil acidification; Biological effects of soil pH; Factors affecting soil pH; Effects of soil pH on plant growth; Concept of buffering; Buffering capacity of soils; Importance of soil buffering.	1, 3
Section B		CLOs
5	Chemical principles: Chemical units. Concentrations and activity of ions, Ionic strength, solubility product, Thermodynamics, laws of thermodynamics, free energy concept, Reaction kinetics, rate constant, reaction order	1, 2, 3
6	EC and Eh of soil: Definition of EC and Eh, Importance of EC and Eh for crop production, Resistance, resistivity, conductance, conductivity, Soil properties influencing EC and Eh, Measurement of EC, Importance and calculation of PBS, ESP, SAR and RSC	1, 3
7	Ion exchange phenomenon: Concept of soil colloid, their properties and types Definition and types of ion exchange – cation exchange, anion exchange, root interception, contact exchange, Fundamentals of ion exchange, Principles regulating ion exchange reactions, Importance of ion exchange reactions in soil, inner sphere and outer-sphere surface complex formation, Cation exchange capacity (CEC) and anion exchange capacity (AEC), Factors affecting CEC and AEC, Determination of CEC and AEC of soil, Problems and solution of CEC in soil	1, 2
8	Important ions in soil: Major cations and anions found in soil solution, Various forms of ions, Oxidized and reduced state of ions and their importance, Radicles and their significance, Interaction of ions in soil	2, 3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	develop a basic understanding of soil chemistry, including soil acidity and soil solution, especially how they relate to nutrient availability and that can improve conditions for plant growth;	1
	CLO2	explain various mineral and organic components of soils, including how changes in various quantities affect soil physical and chemical properties;	2
	CLO3	explain the mechanisms of chemical reactions and processes occurring in soils, soil minerals and soil organic matter.	2

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Team Teaching	Quiz and Class Test
CLO2	Problem-based Learning and Presentation	Assignment and Final Exam
CLO3	Lecture and Group Discussion	Viva voce and Final Exam

Learning Materials

Recommended Readings	<p>Bot, A., & Benites, J. (2005). The importance of soil organic matter. <i>FAO Soils Bulletin</i> 80. <i>FAO Soils Bulletin</i>. https://doi.org/10.1080/03650340214162.</p> <p>Cresser, M., Killham, K., & Edwards, T. (1993). <i>Soil chemistry and its applications</i> (Vol. 5). Cambridge University Press.</p> <p>Forth, H. D. (1978). <i>Fundamentals of soil science</i>. John Wiley & Sons.</p> <p>Tan, K. H. (2010). <i>Principles of soil chemistry</i>. Marcel Dekker.</p> <p>Weil, R. R., & Brady, N. C. (2017). <i>The nature and properties of soils</i>. (15th ed.). Upper Saddle River, NJ: Prentice Hall.</p>
Supplementary Readings	<p>Bear, R. E. (1964). <i>Chemistry of the soil</i>. Oxford and IBH.</p> <p>Osman, K. T. (2012). <i>Soils: principles, properties and management</i>. Springer Science & Business Media.</p> <p>Sposito, G. (2008). <i>The chemistry of soils</i>. Oxford university press.</p>

Course Code: 0888 13 SWE 1212		Year: First	Term: Second
Course Title	Soil Chemistry I Sessional		
Course Status	Core		
Credit	1.0		
Prerequisite(s)	None		
Rationale	This course is designed to make students capable of detecting and measuring important soil chemical and physico-chemical parameters.		

Course Contents/Tasks		CLOs
1	Soil processing for laboratory analysis.	1
2	Safety in the laboratory; Unit of measures; Accuracy and precision; Use of measuring instruments; Preparation of reagents.	1
3	Determination of soil organic carbon by different methods.	1, 2
4	Determination of pH and electrical conductivity (EC) of the liquid phase of the soil.	1, 2

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:	Mapping with PLOs
CLO1	recognize and identify all analytical equipment exists in the laboratory, laboratory tools and chemicals needed to perform soil analyses;	6, 7, 8
CLO2	operate minor equipment safely to conduct laboratory analyses of chemical characteristics of soil.	7, 8

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Theoretical lessons, practical laboratory exercise	Laboratory exercise, written test and oral examination
CLO2	Theoretical lessons, practical laboratory exercise, single and group assignment	Laboratory exercise, report and oral examination

Learning Materials

Recommended Readings	Black, C. A. (1951). Methods of soil analysis (2nd ed.). American Society of Agronomy. Klute, A., Nielson, D. R., & Jackson, R. D. (1986). Methods of soil analysis. Part I. Physical and mineralogical methods, 2. Page, A. L., Miller, R. H., & Keency, D. R. (1989). Methods of soil analysis. Part II Amer. Soc. Agron. Inc. Madison, Wisconsin, USA, 539-622.
Supplementary Readings	Singh, D., Chhonkar, P. K., & Pandey, R. N. (1999). Soil plant water analysis: a methods manual. IARI, New Delhi, 80-82. Stoops, G. (2021). Guidelines for analysis and description of soil and regolith thin sections (Vol. 184). John Wiley & Sons.

Course Code: 0888 13 SWE 1213	Year: First	Term: Second
Course Title	Soil Physics I	
Course Status	Core	
Credit	3.0	
Prerequisite(s)	None	
Rationale	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.	

Course Contents		CLOs
Section A		
1	Introduction: 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).	1
2	Soil Phases: Definition, measurement and practical relevance of the proportions of the three phases: Mass-volume relationship of phases. Problems of bulk density, particle density, porosity, moisture content, mass of soil, volume of soil, degree of saturation, void ratio.	2
3	Particle Size Analysis: 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.	3
4	Soil Structure (aggregate): Definition, classification, formation, factors affecting aggregate formation and destruction, cultural practices favor aggregate formation and stability, dynamics of aggregate stability, organic amendments and aggregate stability, methods of evaluation of aggregate stability, agricultural and environmental significance of soil aggregation and structural stability, consequences of structural degradation.	3
5	Soil Color: 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.	3
Section B		CLOs
6	The soil liquid phase: 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.	2
7	Soil Consistency: Definition, Atterberg's constants and practical significance of liquid limit, plastic limit, shrinkage limit and plasticity index to tillage and soil mechanics	3
8	The gaseous phase: 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	2
9	Soil temperature: 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.	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	explain the role of soil physics in agricultural productivity;	1
	CLO2	illustrate the interactions among the soil phases and role in plant productivity;	1, 2
	CLO3	gain basic knowledge regarding to soil texture, structure, color, consistency, air, water and temperature and their inter relationship in the rhizosphere.	1, 2

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Team Teaching	Quiz and Class Test
CLO2	Problem-based Learning and Presentation	Assignment and Final Exam
CLO3	Lecture and Group Discussion	Viva voce and Final Exam

Learning Materials

Recommended Readings	Baver, L.D. (1948). Soil physics (3rd edition). NY John Wiley and Sons. Ghildyal, B.P., & Tripathi, R.P. (1987). Soil physics. Wiley Eastern Ltd. Publisher, India. Hillel, D. (1998) Environmental soil physics. CA Academic Press, USA.
Supplementary Readings	Halder, M., Liu, S., Zhang, Z.B., Guo, Z.C., Peng, X.H. (2021). Effects of residue stoichiometric, biochemical and C functional features on soil aggregation during decomposition of eleven organic residues. <i>Catena</i> , 202: 105288. Hillel, D. (2004). Introduction to environmental soil physics. Elsevier Academic Press, Amsterdam. ISBN 0-12-348655-6.

Course Code: 0888 13 SWE 1214	Year: First	Term: Second
Course Title	Soil Physics I Sessional and Fieldwork	
Course Status	Core	
Credit	1.0	
Prerequisite(s)	None	
Rationale	This course is designed to deal with determination, interpretation and pathways of improvement in the soil physical environment in the rhizosphere.	

Course Contents/Tasks		CLOs
1	Determination of soil structure, textural class in field (Hand Feel Method) and laboratory analysis.	1
2	Determination of bulk density and particle density of soil.	1
3	Aggregate size separation by dry and wet sieving method, and mean weight diameter (MWD)	2
4	Determination of moisture content by gravimetric and tensiometer methods.	3
5	Field study of soil color and correlate with soil properties.	1
6	Determination of field capacity moisture.	3
7	Measurement of soil temperature.	1
8	Determination of liquid limit and plastic limit.	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	determine the soil structure in field, texture in field and in the laboratory; bulk density, particle density, identify and interpret color in the field its bearing in plant productivity;	3, 6, 7
	CLO2	determine soil aggregation status and interpretation interpret of aggregate stability based on mean weight diameter by wet sieving and dry sieving;	7
	CLO3	determine soil moisture and soil consistency in the field as well as in the laboratory.	6, 7

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture	Quiz and Class Test
CLO2	Group Discussion and Problem based Learning	Quiz Test and Final Exam.
CLO3	Lecture and Group Discussion	Viva voce and Final Exam.

Learning Materials

Recommended Readings	Dane, J. H., & Topp, G. C. (2020). Methods of soil analysis Part 4: Physical methods (1st ed.). ACSESS publisher. Huq, S. M. I., & Alam, M. D. (2005). A hand book on analyses of soil, plant and water. BACER-DU, ISBN: 984-32-1770-5, University of Dhaka, Bangladesh.
Supplementary Readings	Halder, M., Liu, S., Zhang, Z. B., Guo, Z. C., Peng, X. H. (2022). Effects of organic matter characteristics on soil aggregate turnover using rare earth oxides as tracers in a red clay soil. Geoderma, 421:115908.

Course Code: 0888 13 SWE 1244		Year: First	Term: Second
Course Title	Comprehensive Viva voce I		
Course Status	Core		
Credit	1.0		
Prerequisite(s)	None		
Rationale	The course is designed to provide the students with the opportunity to have a face to face session with the examiner. It also aims to develop the presentation skills and to review the basic subjective knowledge learned from the course offered in the first year of the program.		

Course Contents/Tasks		CLOs
1	The 'Comprehensive Viva Voce I' requires the students to face a viva voce/defense board at the end of the concerned term 2 (end of year 1). The concerned Examination Committee/ Academic Committee of the Discipline will form viva voce board to conduct the viva and assess the students out of 100 marks. If deemed necessary to the concerned Examination Committee, these sessions might be arranged online. The contents of this viva voce will include the gained knowledge, issues covered and concepts handled through the theory/sessional courses up to first two terms of the program.	1 to 5

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	review subjective knowledge gained through first year of the program;	1, 2
	CLO2	improve oral presentation skill;	9
	CLO3	demonstrate the principles of audience-centered message adaptation;	8, 9
	CLO4	demonstrate communication behaviors appropriate for effective comprehensive and supportive listening;	9
	CLO5	build skills, roles, and methods of proceeding in task groups in order to achieve high levels of motivation, productivity.	8

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	As reported for various courses	Viva voce
CLO2	As reported for various courses	Viva voce
CLO3	As reported for various courses	Viva voce
CLO4	As reported for various courses	Viva voce
CLO5	As reported for various courses	Viva voce

Learning Materials

Recommended Readings	As reported for various courses.
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Course Code: 0714 13 CSE 1252		Year: First	Term: Second
Course Title	Database Systems Sessional		
Course Status	Core		
Credit	1.0		
Prerequisite(s)	None		
Rationale	This course is designed to provide basic knowledge on database, input and output designs, data query and analysis of data using statistical package.		

Course Contents/Tasks		CLOs
1	Concept on database.	1
2	Input and output designs.	2
3	Data query.	1
4	Analysis of data using statistical packages.	2

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:	Mapping with PLOs
CLO1	acquaint with the basic principles and fundamental applications of database, input and output designs and data query;	1, 9, 10
CLO2	apply statistical Package.	9, 10

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Inquiry based Learning and Team Teaching	Quiz, Presentation, Assignment, Class Test and Final Exam
CLO2	Problem-based Learning and Presentation	Viva voce and Final Exam

Learning Materials

Recommended Readings	Coronel, C., & Morris, S. (2016). Database systems: design, implementation, & management. Cengage Learning Date, C. J. (1975). An introduction to database systems. Pearson Education India.
Supplementary Readings	Garcia-Molina, H. (2008). Database systems: the complete book. Pearson Education India.

Course Code: 0314 13 Soc 1253	Year: First	Term: Second
Course Title	Principles of Sociology	
Course Status	Optional	
Credit	3.0	
Prerequisite(s)	None	
Rationale	This course will pay attention to the ways of observing the world around us, systematic understanding of social relations, structure, social organization, social institutions, culture and social change. This course will also introduce students to the key issues addressed by contemporary sociologists.	

Course Contents		CLOs
Section A		
1	Definition and development of the subject; nature and scope of sociology in soil-, water- and environmental sciences.	1
2	Conceptualization of society, community, association, institution, group, norms, values, social process.	1, 2
3	Culture and social structure: Meaning and elements of culture, culture and civilization; social structure.	1, 2
4	Socialization and institutions: Family, marriage, kinship, property, division of labour, religion, education, government and state.	2, 3
5	Social stratification and inequality: Determinants and forms of social stratification; social inequality; social mobility	1, 2, 3
Section B		
6	Changing world: Social change, urbanization, industrialization etc.	1, 2, 3
7	Sociological perspectives of mass media and communication, New communication technologies and collective behavior.	3, 4
8	Theories of deviance and crime; Juvenile delinquency.	2
9	Population, health and environment: Theories of population, demographic processes	3
10	Social structure of colonial Bangladesh; Neo-colonialism and the emergence of Bangladesh; Changing political system and social problems of Bangladesh.	4

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	clarify the association between societal well-being and environmental quality;	
CLO2	explore the various form of interaction among human society, family and the environment;		2
CLO3	outline a variety of topics, including agri-food systems, environmentalism as a social movement;		4
CLO4	appreciate culture and cultural organization and study social stratification and demography.		5

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Team Teaching	Quiz and Class Test
CLO2	Problem-based Learning and Presentation	Assignment and Final Exam
CLO3	Problem-based Learning and Presentation	Assignment and Final Exam
CLO4	Lecture and Group Discussion	Viva voce and Final Exam

Learning Materials

Recommended Readings	Hannigan, J. A. (1995). Environmental sociology. Routledge, London. Horton, P. B., & Hant, C.L. (1964). Sociology (5th ed.). Mc-GrawHill. Thompson, K. (2015). Sociology: An Introduction study guide (5th ed.). McGrawHill.
Supplementary Readings	

Course Code: 0532 13 SWE 1255	Year: First	Term: Second
Course Title	Geology	
Course Status	Core	
Credit	3.0	
Prerequisite(s)	None	
Rationale	This course is designed to provide preliminary ideas and concepts of basic Geology.	

Course Contents		CLOs
Section A		
1	Introduction to Geology: Important Terminologies- Lithology, Geology, Petrology etc., Scope and branches 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, and characteristics. Mineralogy: 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.	1
2	Petrology: Rock cycle, Types of rocks, Rock formation processes. Consequences of weathering on rocks. Igneous rocks: definition, classification, characteristics of intrusive & extrusive igneous rocks, various forms of igneous rocks, structure & texture of igneous rocks, common igneous rocks.	1
3	Sedimentary rocks: Sedimentary Processes: Introduction to basic concepts: description and classification of sedimentary rocks, sedimentary environments, common sedimentary rocks; sedimentary texture, sedimentary structures.	1
4	Metamorphic rocks: Metamorphism, agents of metamorphism, kinds of metamorphism, depth of metamorphism, facies and grades of metamorphism, texture and structure of metamorphic minerals, classification & nomenclature of metamorphic rocks.	1
Section B		CLOs
5	Age: Principles used to determine numerical (absolute) age, decay, Radiometric dating technique, of an isotopic system, Carbon-14 dating, Physical principles used to determine relative age, Application of these principles, Uniformitarianism	2
6	Contacts: Unconformity, Disconformity, Angular unconformity, Nonconformity. Correlations: Physical continuity, Similarity of rock types, Correlation by fossils. Fossils: Rock that contain fossil, Fossil preservation, importance. The Geologic column (Time scale)	2
7	Structural Geology: Stress & strain in the earth's crust, Behavior of rocks to stress & strain, Present deformation of the crust, Folds, Fracture in rocks (joints & faults). Maps & Satellite imagery: Maps, Projections, Scale, Locating system, Distance and direction, Topographic maps and Geologic maps), Basic principles of Remote sensing & satellite imagery, Use of satellite imagery	3
8	Super continent and plate tectonics: Continental Drift Theory, Supercontinents throughout geologic history, Supercontinent cycles, Evidences, Relation with plate tectonics, Lithosphere & asthenosphere, Principal world lithospheric plates, Present movement of the earth plates, Different plate boundaries. Natural disasters: Major kinds of natural disasters around the world, Natural disasters in Bangladesh and its consequences	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	explain the basic processes of the Earth and describe the common minerals and rocks;	1
	CLO2	apply the knowledge to determine numerical and relative age of materials and explain contacts, correlations and fossil;	3
	CLO3	identify the components of structural Geology, interpreting Geologic, topographic maps and satellite imagery, various processes of natural disasters with special reference to Bangladesh.	6, 8, 10

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Team Teaching and Group Discussion	Quiz, Viva voce, Presentation, Class Test and Final Exam
CLO2	Problem-based Learning and Presentation	Viva voce, Assignment, Presentation and Final Exam
CLO3	Lecture and Group Discussion	Viva voce and Final Exam

Learning Materials

Recommended Readings	<p>Bennington, J. B., Merguerian, C., & Sanders, J. E. (2004). Physical geology laboratory manual. McGraw-Hill Custom Publishing.</p> <p>Laudan, R. (1987). From mineralogy to geology: the foundations of a science, 1650-1830. University of Chicago Press.</p> <p>Plummer, C. C., Carlson, D., & Hammersley, L. (2021). Physical geology. McGraw-Hill US Higher Ed USE.</p>
Supplementary Readings	<p>Monroe, J. S., Wicander, R., & Hazlett, R. W. (2007). Physical geology: exploring the earth (Vol. 584). Belmont: Thomson Brooks/Cole.</p> <p>Stein, S., & Wysession, M. (2009). An introduction to seismology, earthquakes, and earth structure. John Wiley & Sons.</p> <p>Tarbuck, E. J., Lutgens, F. K., Tasa, D., & Tasa, D. (2005). Earth: an introduction to physical geology (p. 744). Upper Saddle River: Pearson/Prentice Hall.</p> <p>Wegener, A. (1966). The origin of continents and oceans. Courier Corporation</p>

Course Code: 0532 13 SWE 1256	Year: First	Term: Second
Course Title	Geology Sessional	
Course Status	Core	
Credit	1.0	
Prerequisite(s)	None	
Rationale	This course is introduced to study and recognition of common minerals and rocks in hand specimen.	

Course Contents/Tasks		CLOs
1	Identification and characterization of igneous, sedimentary and metamorphic rocks.	1
2	Identification and characterization of physical properties of primary and secondary minerals, i.e., 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.	2

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:	Mapping with PLOs
CLO1	identify and characterize common igneous, sedimentary and metamorphic rocks,	6
CLO2	identify and characterize common minerals,	6

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Team Teaching and Group Discussion, Field work and In-class activities	Sessional report, Quiz, Viva voce and Final Exam
CLO2	Lecture, Field work, In class activities and Laboratory Analysis	Sessional report, Quiz, Viva voce and Final Exam

Learning Materials

Recommended Readings	Knödel, K., Lange, G., & Voigt, H. J. (2007). Environmental geology: handbook of field methods and case studies. Springer Science & Business Media. Mavko, G., Mukerji, T., & Dvorkin, J. (2020). The rock physics handbook. Cambridge university press. Potts, P. J. (2012). A handbook of silicate rock analysis. Springer Science & Business Media.
Supplementary Readings	Bennington, J. B., Merguerian, C., & Sanders, J. E. (2004). Physical Geology Laboratory Manual. McGraw-Hill Custom Publishing.

Course Code: 0511 13 Bot 1257	Year: First	Term: Second
Course Title	Plant Diversity and Plant Physiology	
Course Status	Optional	
Credit	3.0	
Prerequisite(s)	None	
Rationale	The course intends to provide fundamental and applied knowledge and concept on systematic botany, physiological processes and diversity of plants and stresses that affect the plants.	

Course Contents		CLOs
Section A		
1	Introduction to plant Diversity: 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.	1, 2
2	Tissue and Tissue Systems: 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.	1, 2, 3
3	Adaptation to the Environment: 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, and theories.	2
4	Study of Plant Diseases: 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.	3
Section B		CLOs
5	Plant Physiological Processes: 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.	1, 2, 3
6	Absorption and Translocation of Water and Mineral Nutrients: 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.	1, 3
7	Plant Growth Regulators: 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.	1, 2
8	Responses of Plants to Environmental Stresses: Concept of stress and stressful environments, crop production under different stresses; effects of different stresses on plant physiology with mitigation.	2, 3, 4

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	explain ways of conservation of plant diversity, list the types of plant tissues and tissue systems, characterize their structures, functions and distribution;	1, 2
	CLO2	describe the adaptation strategies of different types of plants under different climatic conditions, identify diseases and their causes and control different plant diseases;	1, 3
	CLO3	define water potential, diffusion, osmosis, plasmolysis and imbibition, explain different physiological processes of plants, state the mechanism of water and mineral absorption and translocation, illustrate the use of growth regulators in the growth and development of plants;	1
	CLO4	define and classify stress, explain the effects of different stresses on crop production with their mitigation.	1

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Team Teaching	Quiz and Class Test
CLO2	Problem-based Learning and Presentation	Assignment and Final Exam
CLO3	Problem-based Learning and Presentation	Assignment and Final Exam
CLO4	Lecture and Group Discussion	Viva voce and Final Exam

Learning Materials

Recommended Readings	Bhatla, S. C. and Lal, M. A. (2018). Plant physiology, development and metabolism. Devlin, R. M. (2017). Outline of plant physiology. MedTech. Raven, P. H. (1992). Biology of plants. Worth Publishers, USA.
Supplementary Readings	Rudall, P. J. (2007). Anatomy of flowering plants. Cambridge University Press.

Course Code: 0511 13 Bot 1258	Year: First	Term: Second
Course Title	Plant Diversity and Plant Physiology Sessional and Fieldwork	
Course Status	Optional	
Credit	1.0	
Prerequisite(s)	None	
Rationale	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.	

Course Contents/Tasks		CLOs
1	Study of internal structures of stem, root and leaf of dicot and monocot plants as well as hydrophytes, mesophytes, halophytes and xerophytes.	1, 2
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.	1, 2, 3
3	Study of plant diseases covered in the theory course causing damage to food stuff.	2
4	Determination of chlorophyll pigments by using spectrophotometer.	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	identify different types of plants on the basis of anatomical structure;	1
CLO2	estimate plant diversity with their types;	3	
CLO3	measure chlorophyll pigments and transpiration;	6	
CLO4	recognize symptoms of particular plant disease.	2	

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Team Teaching	Quiz and Class Test
CLO2	Problem-based Learning and Presentation	Assignment and Final Exam
CLO3	Problem-based Learning and Presentation	Assignment and Final Exam
CLO4	Lecture and Group Discussion	Viva voce and Final Exam

Learning Materials

Recommended Readings	Bhatla, S. C. and Lal, M. A. (2018). Plant physiology, development and metabolism. Devlin, R. M. (2017). Outline of plant physiology. MedTech. Raven, P. H. (1992). Biology of plants. Worth Publishers, USA.
Supplementary Readings	Rudall, P. J. (2007). Anatomy of flowering plants. Cambridge University Press.

Course Code: 0541 13 Math 1259	Year: First	Term: Second
Course Title	Mathematics	
Course Status	Optional	
Credit	3.0	
Prerequisite(s)	None	
Rationale	The course is desinged to serve students with practical skills related to higher mathematics.	

Course Contents		CLOs
Section A		
1	Diferential calculus: Functions- Understanding the geometric behavior of elementary functions and families of curves-	1, 2
2	$y = mx + c, y = x^n, y = \frac{1}{x^n}, \log x, \ln x, e^x$.	1
3	Basic concepts of limit and continuity.	1
4	Differentiation of different types of functions e.g. parametric and explicit etc. differentials, differentiability and physical meaning of differentiation; application of differentiation.	1, 2
5	Basics of successive and partial differentiation.	1
6	Maxima and minima.	1
Section B		
CLOs		
7	Integral calculus: Basics of integration: definite and indefinite, proper and improper integrals, antiderivative physical meaning of integration.	3
8	Integration by method of substitution.	3
9	Integration by parts	3
10	Definite integrals; properties of definite integrals.	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	develop the ability of students to apply their practical knowledge and skills to the solution of theoretical and practical problems of mathematics- permutation, combination, addition, subtraction, multiplication and inverse of matrices to solve the algebraic equations;	1, 10
	CLO2	interpret variables, functions and their graphs;	3, 10
	CLO3	conceptualize of integration and its nature.	1

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Team Teaching	Presentation and Class Test
CLO2	Problem-based Learning and Presentation	Assignment and Quiz Test
CLO3	Lecture and Group Discussion	Viva voce and Final Exam

Learning Materials

Recommended Readings	Cheney, E.W., & Cheney, W. (2001). Analysis for applied mathematics (Vol. 1). New York: Springer.
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Second Year First Term			
Course Code: 0888 13 SWE 2111		Year: Second	Term: First
Course Title	Soil Mineralogy		
Course Status	Core		
Credit	3.0		
Prerequisite(s)	None		
Rationale	This course is designed to illustrate the nature, properties, behavior and occurrence of geogenic and pedogenic minerals found in soils in the context of agriculture, environment, geology, toxicology and engineering applications and problems and to demonstrate in a practical way how clay minerals can be identified and characterized using the primary analytical techniques.		

Course Contents		CLOs
Section A		
1	An Introduction to Mineralogy: Important terminologies and crystallographic concepts, Scope and importance of soil minerals; Formation processes of minerals; phyllosilicate minerals in soils; aluminosilicate minerals with short-range order.	1
2	Phyllosilicate Minerals: Nature and properties of phyllosilicate mineral surfaces; processes at phyllosilicate mineral surface. Nomenclature of phyllosilicate minerals, types of phyllosilicate minerals.	1, 2
3	1:1 Minerals: Kaolin-Serpentine group: Kaolin-Serpentine Minerals, Structural properties; morphological characteristics of kaolinite and halloysite; formation; occurrence in soils; physical and chemical properties and identification.	1, 2
4	2:1 Minerals (expandable and non-expandable): Talc-Pyrophyllite, Mica, Smectite and Vermiculite Minerals: morphological characteristics; formation; occurrence in soils; physical and chemical properties Structural properties and their weathering and synthesis relationships.	2
Section B		
5	Soil mineralogy: Soil minerals relationship with soil fertility, soil chemistry, pedology and other field of sciences. Major Silicate Structures. Bowen's reaction series. Pauling's rules of coordination.	1
6	Chlorites and Hydroxy-Interlayered Vermiculite and Smectite: Origin and source, structural properties, weathering of chlorite, hydroxy-interlayered vermiculite and (HIV) and smectites (HIS). Interstratification in Layer Silicates. Feldspar, Olivine, Pyroxene, and Amphiboles: Structural properties, natural occurrence, physicochemical properties. Aluminum Oxides, Oxyhydroxides and Iron Oxides: Nomenclature and structural properties; mechanism of formation; gibbsite, goethite and hematite in soils; reactions in soils.	1, 2
7	Identification Clay Minerals: Principle and application of XRD; FTIR; thermal analysis; optical microscopy and chemical analysis for the identification of soil clay minerals.	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	gather knowledge, using proper terminology, about minerals and their behavior in soils as well as demonstrate the composition of clay minerals and their behavior in natural environment;	1
	CLO2	explain the importance of clay minerals in agriculture, environment and engineering applications;	2
	CLO3	utilize the principles of common soil mineral analysis methods and instruments and distinguish clay minerals and make a comparison about their role and environmental conditions.	1, 3

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CL01	Lecture, Team Teaching and Group Discussion	Quiz, Viva voce, Presentation, Class Test and Final Exam
CL02	Problem-based Learning and Presentation	Viva voce, Assignment, Presentation and Final Exam
CL03	Lecture, problem-based learning, group discussion and presentation	Interactive application assignments, presentation by students, written examination

Learning Materials

Recommended Readings	<p>Dixon, J. B., & Weed, S. B. (eds.), (1977). Minerals in soil environments. Madison, Wisconsin: Soil Science Society of America.</p> <p>Dixon, J. B., & Schulze, D. G. (2002). Soil mineralogy with environmental applications. Soil Science Society of America Inc.</p> <p>Moore, D. M., & Reynolds Jr, R. C. (1989). X-ray diffraction and the identification and analysis of clay minerals. Oxford University Press (OUP).</p>
Supplementary Readings	<p>Grim, R. E. (1968). Clay mineralogy: 2nd Edn McGraw-Hill. New York.</p> <p>Schulze, D. G. (2002). An introduction to soil mineralogy. Soil mineralogy with environmental applications, 7, 1-35.</p> <p>Wenk, H. R., & Bulakh, A. (2016). Minerals: their constitution and origin. Cambridge University Press.</p>

Course Code: 0888 13 SWE 2112		Year: Second	Term: First
Course Title	Soil Mineralogy Sessional and Fieldwork		
Course Status	Core		
Credit	1.0		
Prerequisite(s)	None		
Rationale	This course is designed to provide the students with the skills for the identification, quantification, and characterization of the soil minerals using chemical analysis as well as the state-of-the-art instruments including XRD, FTIR and SEM.		

Course Contents/Tasks		CLOs
1	Field observations of common soil minerals in soils, clays and sediments of Bangladesh and factors affecting the weathering and formation processes of these minerals and rocks.	2
2	The principles of analytical techniques and instruments of common soil minerals, their advantages and limitations.	1
3	Identification and characterization of minerals in Bangladesh through field method, chemical analysis as well as the state-of-the-art instruments including XRD, FTIR and SEM.	2

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:	Mapping with PLOs
CLO1	explain the causes of the principal physical properties of minerals;	2
CLO2	identify and characterize common soil minerals in Bangladesh.	6

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Team Teaching and Group Discussion, Field work and In-class activities	Sessional report, Quiz, Viva voce and Final Exam
CLO2	Lecture, Field work, In class activities and Laboratory Analysis	Sessional report, Quiz, Viva voce and Final Exam

Learning Materials

Recommended Readings	Al-Ani, T., & Sarapää, O. (2008). Clay and clay mineralogy. Physical-chemical properties and industrial uses. Brown, G. (1982). Crystal structures of clay minerals and their X-ray identification (Vol. 5). The Mineralogical Society of Great Britain and Ireland. Grim, R. E. (1968). Clay mineralogy. (2nd ed.). McGraw-Hill. New York.
Supplementary Readings	Repacholi, M. H. (ed.). (2012). Clay mineralogy: spectroscopic and chemical determinative methods. Springer Science & Business Media. Science & Business Media. Moore, D. M., & Reynolds Jr, R. C. (1989). X-ray diffraction and the identification and analysis of clay minerals. Oxford University Press.

Course Code: 0888 13 SWE 2113		Year: Second	Term: First
Course Title	Surface Chemistry		
Course Status	Core		
Credit	3.0		
Prerequisite(s)	None		
Rationale	This course is designed to provide the concepts about colloids, their basic properties and uses with special reference to soil colloids.		

Course Contents		CLOs
Section A		
1	Colloids: Definitions, Colloidal systems, Comparison of solution, colloid and suspension. Classification of colloids on the basis of state of aggregation, mutual affinity and deform system. Development of charges: Adsorption of ions from medium, ionization of surface groups (pH dependent charge) and isomorphous substitution (permanent charge). Stability of sols: Reasons to stabilize (like charge and solvent layer), Lyophilic sols are more stable than lyophobic sols. Coagulation (precipitation) of sols: Principle, reasons for precipitation, different coagulation methods a) addition of electrolytes (Hardy-Schulze rule, flocculation value), b) electrophoresis, c) mixing two oppositely charged sols and d) boiling.	1
2	Formation of sols: a) condensation (reduction, oxidation, dissociation, hydrolysis, double decomposition, replacement of solvent and cooling of solution) b) Dispersion (addition of peptizing agent, removal of agglomerating agent, mechanical dispersion, electrochemical disintegration and partial solution), Purification of sols: Dialysis, electrodialysis and ultrafiltration	1
3	Colloidal characteristics: Size, surface area, adsorption, nature of the gas, heat of adsorption, reversibility, effect of temperature, effect of pressure. Variation of specific surface with extent of surface, shape and clay mineralogy. Brownian movement, tyndall effects, hydration and swelling of clay, electrophoresis and electroosmosis.	1
4	Soil colloids: Types of soil colloids, CEC, PBS, ESP, SAR and their practical significance, Comparison of pure colloidal system and soil colloidal system, Role of colloids to reduce metal bioavailability in soil.	1
Section B		CLOs
5	Double layer theory: Introduction to double layer and triple layer theories of soil colloids; function and importance of double layer.	2
6	Adsorption: Definition, classification, characteristics, forces of adsorption.	3
7	Adsorption isotherms: Langmuir adsorption isotherm, Freundlich adsorption isotherm, Gibb's equation, BET equation.	3
8	Adsorption of water and ions: Adsorption of water by soil colloids, Adsorption of water by organic compounds, Adsorption of organic compounds by silicate clay, interparticle attraction, adsorption of cations and anions by soil colloids.	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	outline the properties of colloids, various processes of colloid formation, purification, destruction and basic differences between pure colloid and soil colloid;	1, 2
	CLO2	describe the diffuse double layer of soil colloids;	1
	CLO3	classify the adsorption phenomena and demonstrate the mechanisms of adsorption.	1

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CL01	Lecture and Team Teaching	Quiz, Viva voce and Class Test
CL02	Lecture and Group Discussion	Presentation, Assignment and Final Exam
CL03	Problem-based Learning and Presentation	Viva voce and Final Exam

Learning Materials

Recommended Readings	Bahl, A. (2008). Essentials of physical chemistry. S. Chand Publishing. Rai, M. M. (2002). Principles of soil science. Macmillan. Weil, R. R. & Brady, N. C. (2017). The nature and properties of soils. (15th ed.). Upper Saddle River, NJ: Prentice Hall.
Supplementary Readings	Tan, K. H. (2010). Principles of soil chemistry. CRC press.

Course Code: 0888 13 SWE 2114		Year: Second	Term: First
Course Title	Surface Chemistry Sessional		
Course Status	Core		
Credit	1.0		
Prerequisite(s)	None		
Rationale	This course is designed to provide basic practical knowledge on soil colloids and ion exchange phenomenon.		

Course Contents/Tasks		CLOs
1	Determination of CEC, PBS, ESP, SAR of soil.	1
2	Correlation between surface area and ion exchange phenomenon.	2
3	Measurement of the influence of lyotropic series on ion exchange.	2
4	Identification of types of clays	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:	Mapping with PLOs
CLO1	determine and calculate the CEC, PBS, ESP, SAR;	7, 8
CLO2	determine the ion exchange phenomena and specific surface area;	7, 8
CLO3	identify clay types.	10

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Inquiry based Learning	Quiz, Assignment, Viva voce and Final Exam
CLO2	Lecture, Group Discussion and Problem based Learning	Viva voce and Final Exam
CLO3	Lecture, Demonstration, Lab exercise	Lab test, viva voce

Learning Materials

Recommended Readings	Imam, S. M. H., & Didar, M. A. (2005). A handbook on analysis of soil, plant and water. Bangladesh-Australia Centre for Environmental Research (BACER-DU), Dhaka, 31-40. Sparks, D. L., Page, A. L., Helmke, P. A., & Loeppert, R. H. (Eds.). (2020). Methods of soil analysis, part 3: Chemical methods (Vol. 14). John Wiley & Sons.
Supplementary Readings	Kibria, K. Q. Laboratory manual. SWE Discipline, Khulna University (Unpublished).

Course Code: 0888 13 SWE 2115	Year: Second	Term: First
Course Title	Soil-Water-Plant Relationship	
Course Status	Optional	
Credit	3.0	
Prerequisite(s)	None	
Rationale	The main objective of this course is to introduce the students to the basic concepts of soil-water, plant-soil, and plant-water relations. Mechanisms of water and nutrient movement in soils and plants, and their relationships with plant growth are also included in this course.	

Course Contents		CLOs
Section A		
1	Functions and properties of water: Ecological Importance of Water; Physiological Importance of Water; Uses of Water in Plants; Properties of Water; Properties of Aqueous Solutions;	1, 2
2	Soil and Water: Important Characteristics of Soil; How Water Occurs in Soil; Movement of Water in Soil; Infiltration; Movement of Water within Soils; Water Vapor Movement; Upward and Horizontal Movement and Evaporation;	1, 2, 3
3	Water Movement in the Soil-Plant-Atmosphere Continuum: The Soil-Plant-Atmosphere Continuum Concept; Driving Forces and Resistances; Water Movement in Soil; Water Movement from Soil into Roots; Water Movement through Plants; Varying Resistances in Roots;	2, 3
4	Water Deficits and Plant Growth: Cause and Development of Water Deficits; Effects of Water Deficits; Effects of Water Deficits on Plant Growth; Physiological Effects of Water Stress; Biochemical Effects of Water Stress; Measurement of Plant Water Stress; Beneficial Effects of Water Stress;	2, 3
Section B		CLOs
5	Cell Water Relations: Cell Structure; Distribution of Water in Cells; Cell Membranes; Movement of Water and Solutes in Plants; Cell Water Terminology; Components of the Water Potential Equation;	3
6	The Absorption of Water and Root and Stem Pressures: Absorption Mechanisms; Differences between Slowly and Rapidly Transpiring Plants; Passive Absorption by Transpiring Plants; Osmotic Absorption and Root Pressure; Relative Importance of Osmotic and Passive Absorption Root and Stem Pressures;	2, 3
7	Factors Affecting the Absorption of Water: Efficiency of Root Systems as Absorbing Surfaces; Extent of Root Systems; Root Surfaces; Root Permeability; Environmental Factors Affecting Water Absorption; Availability of Soil Water; Movement from Soil to Roots; Concentration and Composition of the Soil Solution; Nitrogen Deficiency; Soil Temperature; Soil Aeration and Water Absorption;	2, 3
8	Transpiration and the Ascent of Sap: Importance of Transpiration; The Process of Transpiration; Plant Factors Affecting Transpiration; Measurement of Stomatal Aperture or Resistance; Interaction of Factors Affecting Transpiration; Measurement of Transpiration; Evaporation from Stands of Plants; The Conducting System; The Ascent of Sap; Conduction in Leaves;	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	explain the functions and properties of water, relation between soil and water;	1
	CLO2	describe how soil solution (water and solutes) moves through the soil and factors affecting water movement in the soil, mechanisms of water movement from the soil to the plant through the root system;	2
	CLO3	recognize the mechanisms of water movement through the shoot up the stem throughout the leaves;	3

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Team Teaching	Quiz and Class Test
CLO2	Problem-based Learning and Presentation	Assignment and Final Exam
CLO3	Lecture and Group Discussion	Viva voce and Final Exam

Learning Materials

Recommended Readings	Hillel, D. (2007). Soil in the environment: crucible of terrestrial life. Elsevier. Kirkham, M. B. (2014). Principles of soil and plant water relations. Academic Press. Kramer, P. J., & Boyer, J. S. (1995). Water relations of plants and soils. Academic press.
Supplementary Readings	Jury, W. A., & Horton, R. (2004). Soil physics. John Wiley & Sons.

Course Code: 0888 13 SWE 2116	Year: Second	Term: First
Course Title	Soil-Water-Plant Relationship Fieldwork and Sessional	
Course Status	Optional	
Credit	1.0	
Prerequisite(s)	None	
Rationale	This course is designed to provide students about the field and laboratory measurement of soil water; water potential components, stomatal aperture, transpiration, plant water stress etc. Provide students hand-on experience of common techniques in labs and exposure to equipment and machines.	

Course Contents/Tasks		CLOs
1	Measurement of Soil Water Potential Components	1, 2
2	Field Measurements of Soil Water	1, 2
3	Laboratory Measurements of Soil Water	1, 2
4	Measurement of Stomatal Aperture or Resistance	3
5	Measurement of Transpiration	4
6	Field Measurement of Plant Water Stress	4

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	measure soil water and water potential components at field and laboratory condition;	1
	CLO2	measure stomatal aperture and transpiration;	2
	CLO3	determine plant water stress.	3

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Theoretical lessons, field work, laboratory exercise;	Hands-on work in the field, field exercise, written test and oral examination
CLO2	Theoretical lessons, laboratory exercise;	Laboratory exercise, written test and oral examination
CLO3	Theoretical lessons, field work, single and/or group assignment;	Field exercise, report and oral examination

Learning Materials

Recommended Readings	Hillel, D. (2007). Soil in the environment: crucible of terrestrial life. Elsevier. Kirkham, M. B. (2014). Principles of soil and plant water relations. Academic Press. Kramer, P. J., & Boyer, J. S. (1995). Water relations of plants and soils. Academic press.
Supplementary Readings	Jury, W. A., & Horton, R. (2004). Soil physics. John Wiley & Sons.

Course Code: 0888 13 SWE 2121	Year: Second	Term: First
Course Title	Water and Soil Pollution	
Course Status	Optional	
Credit	3.0	
Prerequisite(s)	None	
Rationale	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 on the environment and human health.	

Course Contents		CLOs
Section A		
1	Water Pollution: Nature and types of water pollutants, elemental pollutants, heavy metals- Hg and Cd, inorganic pollutants, algal nutrients and eutrophication, organic pollutants, agrochemicals: pesticides and fertilizer in water, radionuclides.	1
2	Water Quality Standards: Parameters for evaluation of water quality; water quality for drinking purpose, irrigation; Bangladesh national water policy, Bangladesh national drinking water quality, DoE standards in Bangladesh.	1
3	Arsenic in Water and Soil Environment: Sources and occurrence of arsenic in the environment; environmental levels and human exposure; surface water and groundwater contamination; Remedial measures for arsenic in soil and drinking water.	2
4	Remediation of Pollutants: Selection of remediation procedure; factors involved in selection of procedure; classification of techniques; physical, chemical, thermal and biological methods of removal of pollutants.	4
Section B		CLOs
5	Soil Pollution: Introduction; pollutants in soil; types of soil pollution; causes of soil pollution; effects and control of soil pollution; contaminants.	3
6	Heavy Metals in Soils: 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.	3
7	Bioremediation of Contaminated Sites: Concept of bioremediation; different types of bioremediation techniques used for removal of pollutants.	4
8	Biochar and Soil Additives for Remediation: 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.	4

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	explain the nature and types of water pollutants and illustrate the water quality for drinking water, irrigation water and water for livestock;	2, 3
	CLO2	gather knowledge about the source, occurrence of arsenic, severity of As pollution, its effect on soil, plant and human health and apply different remedial measures of As in soil and drinking water;	1
	CLO3	classify sources and types of pollutant in soil; causes, effect and control of soil pollutants;	2
	CLO4	rephrase bioremediation and biochar application for soil remediation.	1, 3

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CL01	Lecture and Presentation	Quiz and Class Test
CL02	Problem-based Learning and Presentation	Assignment and Final Exam
CL03	Lecture and Group Discussion	Viva voce and Final Exam
CL04	Lecture and Debate	Class Test and Final Exam

Learning Materials

Recommended Readings	<p>Alloway, B. J. (ed.) (2012). Heavy metals in soils: trace metals and metalloids in soils and their bioavailability (Vol. 22). Springer Netherlands Publishers.</p> <p>Billah, S. M. (2010). Environmental biology. Millennium Publication, Bangla Bazar, Dhaka.</p> <p>De, A. K. (2003). Environmental chemistry. New Age International Publishers.</p> <p>Manahan, S. E. (2011). Fundamentals of environmental chemistry. CRC press.</p>
Supplementary Readings	<p>Sarkar, B. (2002). Heavy metals in the environment. CRC press.</p> <p>Singh, A., & Ward, O. P. (eds.) (2004). Applied bioremediation and phytoremediation (Vol. 1). Berlin: Springer.</p> <p>Zhang, X., Wang, H., He, L., Lu, K., Sarmah, A., Li, J., Bolan, N. S., Pei, J., & Huang, H. (2013). Using biochar for remediation of soils contaminated with heavy metals and organic pollutants. Environmental Science and Pollution Research, 20(12), pp.8472-8483.</p>

Course Code: 0888 13 SWE 2131	Year: Second	Term: First
Course Title	Environmental Chemistry	
Course Status	Optional	
Credit	3.0	
Prerequisite(s)	None	
Rationale	The course covers concepts and applications of chemical kinetics and chemical thermodynamics for environmental science.	

Course Contents		CLOs
Section A		
1	Concept and Introduction of Environmental Chemistry: Concept of environmental chemistry, environmental science, environmental biochemistry; concept of ecology and the biosphere; energy and cycles of energy; matter and cycles of matter; human impact and pollution.	1
2	The Geosphere and Geochemistry: The nature of solids in the geosphere; physical form of the geosphere; environmental aspects of the geosphere; waste pollution and its effect. Soil pollution and its effect.	2
3	Atmospheric Chemistry and Air Pollution: Composition of atmosphere, Structure of 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. Greenhouse effect and global warming.	1
4	Water Chemistry and Water Pollution: Chemical and physical properties of water; important natural water reservoirs; sources, classes and reactions of pollutants in water; remediation of polluted water. Surface and ground water pollution, Acid rain, Water pollution by As and Hg.	2
Section B		CLOs
5	The Greenhouse Effect, Climate Change, Fossil Fuels and CO ₂ : The greenhouse effect; energy use, fossil fuels, CO ₂ emissions, and global climate change; bio fuels and other alternative fuels; renewable energy technologies: hydroelectric, wind, solar, geothermal, and marine energy; radioactivity, radon, and nuclear energy.	2
6	Environmental Chemistry of Hazardous Wastes: 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.	3
7	Green Chemistry: Concept of green chemistry; principle of green chemistry; components of green chemistry; application of green chemistry for waste minimization, utilization and treatment.	3
8	Toxic elements and compounds: Toxic heavy metals; pesticides; dioxins, furans, and PCBs; other toxic compounds of environmental.	1

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	explain basic concepts of geosphere and its interaction with air, water, and human and demonstrate basic concepts of water chemistry and water pollution;	1, 3
	CLO2	describe the greenhouse effect, climate change; distinguish between fossil fuels and renewable energy technologies;	1
	CLO3	develop an understanding of green chemistry, identify hazardous wastes and explain their effect on the environment and remediation technologies.	1

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CL01	Lecture and Presentation	Quiz and Class Test
CL02	Lecture and Group Discussion	Assignment and Final Exam
CL03	Lecture and Debate	Viva voce and Final Exam

Learning Materials

Recommended Readings	<p>Baird, C., & Cann, M. (2012). Environmental chemistry. (5th ed.). W. H. Freeman and Company.</p> <p>Behmel, S., Damour, M., Ludwig, R., & Rodriguez, M. J. (2016). Water quality monitoring strategies—A review and future perspectives. <i>Science of the Total Environment</i>, 571, 1312-1329.</p> <p>Bessou, C., Ferchaud, F., Gabrielle, B., & Mary, B. (2011). Biofuels, greenhouse gases and climate change. <i>Sustainable Agriculture Volume 2</i>, 365-468.</p> <p>Hardy, J. T. (2003). <i>Climate change: causes, effects, and solutions</i>. John Wiley & Sons.</p>
Supplementary Readings	<p>Sawyer, D. T., & Martell, A. E. (Eds.). (2013). <i>Industrial environmental chemistry: Waste minimization in industrial processes and remediation of hazardous waste</i>. Springer Science & Business Media.</p> <p>Sarkar, B. (2002). <i>Heavy metals in the environment</i>. CRC press.</p> <p>Zeng, Z., Liu, J., & Savenije, H. H. (2013). A simple approach to assess water scarcity integrating water quantity and quality. <i>Ecological indicators</i>, 34, 441-449.</p>

Course Code: 0888 13 SWE 2132	Year: Second	Term: First
Course Title	Environmental Chemistry Sessional and Fieldwork	
Course Status	Optional	
Credit	1.0	
Prerequisite(s)	None	
Rationale	This course is designed to provide the knowledge of sampling, identification, quantification, and characterization of soil, water, and atmospheric pollutants. This course also provides hands on knowledge on laboratory safety and maintenance.	

Course Contents/Tasks		CLOs
1	Water quality: Collection of water samples from industrial sites, lakes, rivers, and tube wells and make a comparison where relevant.	1
2	Soil Quality: 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
3	Air Quality: Determine the air quality in different sites (Urban, rural and industrial areas).	2
4	Acid rain: Make a laboratory experiment to find out the effect of acid rain on soil and aquatic system.	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	select field to collect soil, water and air samples for laboratory analysis as well as research purposes;	7, 8
	CLO2	make use of the methods for the analyses of soil, water and air samples;	7, 8
	CLO3	interpret the data from different sources and conclude.	10

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Field work and Laboratory analysis	Sessional report, viva voce and Final Exam
CLO2	Lecture and In class activities	Quiz and Final Exam
CLO3	In class activities	Sessional report, viva voce and Final Exam

Learning Materials

Recommended Readings	
	Gopalan, R., Anand, A., & Sugumar, R. W. (2013). A laboratory manual for environmental chemistry. IK International Pvt Ltd.
	Vowles, P. D., & Connell, D. W. (2013). Experiments in environmental chemistry: a laboratory manual (Vol. 4). Elsevier.

Course Code: 0532 13 Geog 2151	Year: Second	Term: First
Course Title	Fundamentals of Geography and Environment	
Course Status	Optional	
Credit	3.0	
Prerequisite(s)	None	
Rationale	This course is designed to provide the basic knowledge on of physical and historical geography with its properties, elements, tools, and techniques.	

Course Contents		CLOs
Section A		
1	Introduction: Introduction to geography and Environment, basic terminologies: Spheres/realms, Location, connectivity, Scale, Organization, Movement. The nature of geography as a dynamic academic discipline. objectives and scope of modern geography	1, 2
2	Properties of geographical data, levels of measurement, problems and methods of data classification. Measures of spatial distributions and analysis of structure and processes, spatial pattern regularity, spatial system.	1, 2, 3
3	Tools and Techniques in Geography: Maps and other simple models, problems of scale, size and shape in mapping, terrestrial space, absolute and relative location in spatial distribution; types of map and their use, remote sensing, GIS and field work in geography and environment.	2, 3
Section B		
4	Elements in Geography: Physical and Human basis of Geography, Galaxy and solar system, Earthquake, Wind, Soil and Geology, Hydrosphere and the Atmosphere,	2
5	Introduction to pollution and Environmental management: 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, Bioremediation, phytoremediation and biotechnological approach in environmental management. environmental laws, policy and decision-making.	2, 3
6	Historical Geography of Bangladesh: source materials of historical geography, origin of Bengali's, early settlements of Bengal, Bengal under the Mughal, the British, Pakistan (Economic Condition of Bengal -Agriculture, Industry, Transport and Trade)	1

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	strengthen understanding of physical and historical geography with its tools and techniques;	1, 2
	CLO2	learn about environmental geographic system;	2
	CLO3	summarize the environmental pollution and its management.	2

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Team Teaching	Quiz, Presentation, Class Test and Final Exam
CLO2	Problem-based Learning and Presentation	Assignment and Final Exam
CLO3	Lecture and Group Discussion	Viva voce and Final Exam

Learning Materials

Recommended Readings	Henderson, J. V., Shalizi, Z., & Venables, A. J. (2001). Geography and development. <i>Journal of Economic Geography</i> , 1(1), 81-105. Liverman, D. M. (1999). <i>Geography and the global environment</i> . Rashid, H. E. (2019). <i>Geography of Bangladesh</i> . Routledge.
Supplementary Readings	Mason, R. L., Gunst, R. F., & Hess, J. L. (2003). <i>Statistical design and analysis of experiments: with applications to engineering and science</i> . John Wiley & Sons. Shonchoy, A. S., & Tsubota, K. (2016). Partition, independence, and population geography in Bengal (No. 590). Institute of Developing Economies, Japan External Trade Organization (JETRO).

Course Code: 0511 13 Mbio 2153	Year: Second	Term: First
Course Title	Fundamentals of Microbiology	
Course Status	Optional	
Credit	3.0	
Prerequisite(s)	None	
Rationale	This course is designed to equip students with theoretical knowledge needed to illustrate soil and environmental microbial habitat, their interaction etc.	

Course Contents		CLOs
Section A		
1	Origin of life in earth: Spontaneous generation theory, Creation theory, Comparison between these two theories, Limitation of these theories.	1
2	Place of microorganisms in the living world (Haeckels protist, Five kingdom classification and three domain classification, Universal phylogenetic tree), Bergey's Manual of Systematic Bacteriology, Prokaryotic and eukaryotic cells.	1
3	Resource and condition, Nutritional requirements of organisms (List of nutritional requirements, Classification of organisms on the basis of their nutrition), Environmental factors (Solutes, water, pH, temperature, O ₂ , pressure, radiation etc.) Resource and condition, Nutritional requirements of organisms (List of nutritional requirements, Classification of organisms on the basis of their nutrition), Environmental factors (Solutes, water, pH, temperature, O ₂ , pressure, radiation etc.).	1
4	Control of microorganisms: Sterilization [Objectives of sterilization, General modes of action of different methods, Quality of suitable chemical antimicrobial agent, Quality of antibiotics, Concept of antibiotics, Chemotherapy & chemotherapeutic agent, Various methods of sterilization physical: High temperature, desiccation, radiation, filter, filter, osmotic pressure and tension. chemical: Phenol & phenolic compounds, alcohols, halogens heavy metals & their compounds, dye, detergents, quaternary ammonium compounds, aldehydes and gaseous agents (ethylene oxide, formaldehyde, β -propiolactone etc.) Biological: Penicillin, streptomycin etc.	1
5	Mutation Mutagenic agents and their mode of action, types of mutation (Point mutation, frameshift mutation, germinal and somatic mutation), Effect of different type of mutations.	1
6	Major groups of microorganisms (Bacteria, algae, fungi, protozoa and viruses)	2
Section B		CLOs
7	Basic laboratory techniques (Inoculation, culture transfer techniques, agar media and broth, deep, pour plate and streak plate, inoculating loop and needle, mix and pure culture, Durham's tube etc.).	3
8	Microscopy (Principle, classification, application, modern microscopes, oil immersion, sample preparation)	3
9	Staining (Principle, stain composition and classification, classification and principle of different staining), Hanging drop technique, microscopic size measurement technique, antimicrobial sensitivity testing,	3
10	Microbial growth (Growth curve and its characteristics, measurement of microbial growth, growth in natural environment)	3
11	Identification of bacteria (colony characteristics, microscopic examination and biochemical tests), Morphology of bacteria, Bacterial growth in broth, Enumeration of bacteria (Direct count, viable count, turbidimetric method etc.), Culture of anaerobic bacteria	3
12	Identification of algae through microscopic observation.	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	outline the origin of life, classification of organism, their control;	1, 2
	CLO2	describe the common microorganisms in nature;	1
	CLO3	extend the fundamental knowledge to deal with microbes in laboratory.	1

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Team Teaching	Quiz and Class Test
CLO2	Problem-based Learning and Presentation	Assignment and Final Exam
CLO3	Lecture and Group Discussion	Viva voce and Final Exam

Learning Materials

Recommended Readings	<p>Black, J. G. (2005). <i>Microbiology: principles and explorations</i>. (6th ed.). John Wiley and Sons, New York.</p> <p>Madigan, M. T., Martinko, J. M., & Parker, J. (1999). <i>Brock's Biology of Microorganisms</i>. (9th Ed.). Prentice Hall, New Jersey.</p> <p>Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. (2012). <i>Microbiology: concepts and applications</i>. Tata McGraw Hill.</p> <p>Tortora, G. J., Funke, B. R., & Case, C.L. (2013). <i>Microbiology-an introduction</i>. (11th Ed.). Pearson.</p>
Supplementary Readings	<p>Mandelstam, J., McQuillen, K., & Dawes, L. (1992). <i>Biochemistry of Bacterial Growth</i>. (3rd ed.). Blackwell Scientific Publications, Oxford.</p> <p>Ketchum, P. A. (1984). <i>Microbiology: concepts and applications</i>. John Wiley and Sons, New York.</p> <p>Prescott, L. M., Harley, J. P., & Klein, D. A. (1999) <i>Microbiology</i>. McGraw Hill, New Delhi.</p>

Course Code: 0511 13 Mbio 2154		Year: Second	Term: First
Course Title	Fundamentals of Microbiology Sessional		
Course Status	Optional		
Credit	1.0		
Prerequisite(s)	None		
Rationale	This course is designed to equip students with practical knowledge needed to deal with microbe and related processes.		

Course Contents/Tasks		CLOs
1	Introduction with common equipment and utensils in microbiology laboratory.	1
2	Handling techniques of different types of microscopes and preparation of specimen.	1
3	Perform staining under bright field microscopy.	2
4	Size measurement of microscopic specimen.	2
5	Microscopic observation of algae.	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	apply requisite skill in the use and care of basic microbiological equipment; performance of basic laboratory procedures in microbiology;	
CLO2	explain the processes used by microorganisms for their replication, survival, and interaction with their environment, hosts, and host populations;		6
CLO3	apply the fundamental knowledge to identify algae.		6

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Inquiry based Learning	Quiz, Assignment, Viva voce and Final Exam
CLO2	Lecture, Group Discussion and Problem based Learning	Viva voce and Final Exam.
CLO3	Lecture, Group Discussion and Problem based Learning	Viva voce and Final Exam.

Learning Materials

Recommended Readings	Collee, J. C., Duguid, J. P., Fraser, A. C.; & Marimon, B. P. (1996). Mackie and McCartney Practical medical microbiology. (14th ed.) Churchill Livingstone, London. Dubey, R. C. & Maheswari, D. K. (2002). Practical Microbiology. (1st ed.) S. Chand & Co. Ltd., New Delhi. Finegold, S. M. (2000). Diagnostic microbiology. (10th ed.) C.V. Mosby Company, St. Louis
Supplementary Readings	Madigan, M. T., Martinko, J. M., & Parker, J. (1999). Brock's Biology of Microorganisms. (9th ed.). Prentice Hall, New Jersey. Mandelstam, J., McQuillen, K., & Dawes, L. (1992). Biochemistry of Bacterial Growth. (3rd ed.). Blackwell Scientific Publications, Oxford. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. (2012). Microbiology: Concepts and Applications. Tata McGraw Hill. Tortora, G. J., Funke, B. R., & Case, C.L. (2013). Microbiology-an introduction. (11th Ed.). Pearson.

Course Code: 0311 13 Econ 2155	Year: Second	Term: First
Course Title	Principles of Economics	
Course Status	Optional	
Credit	3.0	
Prerequisite(s)	None	
Rationale	The course is designed to provide knowledge on basic and agricultural Economics, demand-supply, consumer behavior, agricultural finances and marketing, land reform policies, market mechanism and government interventions.	

Course Contents		CLOs
Section A		
1	Introduction: Definition and scope of economics and agricultural economics; concept of- scarcity, commodity, production, distribution, consumption; solution of basic economic problems; production Possibility Curve (PPC).	1
2	Demand and supply: 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.	1
3	Theory of production: 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.	2
4	Introduction to macroeconomics and Bangladesh economy: 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.	2
Section B		CLOs
5	Agricultural Finance: Definition, nature and scope of agricultural finances; sources and types of agricultural credit; role of NGOs and informal credit market; institutional credit agencies.	3
6	Land Reform and land tenure system: Definition, objectives, and forms of land reforms; merits and demerits of land reform; dimensions, and evaluation criteria for a land tenure policy; land rental markets – theories of share-cropping and fixed-rent contracts; effects – incentive effects; risk effects and other effects on land tenure system; Role of land tenure in agriculture; land reforms in Bangladesh; effect of different farm sizes on productivity.	3
7	Agricultural marketing: Definition, functions, importance threats of agricultural marketing; agricultural marketing-cost, margin, efficiency, intelligence, grading, integration; distinction between agricultural and consumer marketing; creation of utility, definition and benefits of cooperative marketing; imperfections in agricultural marketing in LDC's.	3, 4
8	Market Mechanisms and Government interventions: Definitions and importance of market mechanisms and government interventions; internalizing the externality effect, input subsidy, open market purchase, ceiling price for primary agro-product, deficiency payment system, buffer stock, and other market mechanisms and interventions to correct market failures.	3, 4

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	develop basic concepts of agricultural economics, its scope, and explain demand-supply equilibrium, determinants, curves and their application.	1, 3
	CLO2	apply the theory of production and describe basic macroeconomic concepts, and overview of the economy of Bangladesh.	1, 3
	CLO3	identify and analyze the strategies of agricultural finance, agricultural marketing, sources, role of agricultural credit, market failures, and price change induced effects.	4
	CLO4	evaluate the effects of market mechanisms, interventions and government policy on agricultural development.	4, 5

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture	Quiz test
CLO2	Lecture and Presentation	Continuous Assessment, Final Exam
CLO3	Lecture and Group Work	Continuous Assessment, Final Exam
CLO4	Lecture and Group Discussion	Viva voce and Final Exam

Learning Materials

Recommended Readings	Barkley, A., & Barkley, P. W. (2016). Principles of agricultural economics. Routledge. Debertin, D. L. (2012). Agricultural production economics. Pearson Education, N.J, USA. Mankiw, N. G. (2020). Principles of economics. Cengage Learning.
Supplementary Readings	Das, N., de Janvry, A., & Sadoulet, E. (2019). Credit and land contracting: A test of the theory of sharecropping. <i>American Journal of Agricultural Economics</i> , 101(4): 1098-1114. Gardner, B. L., Evenson, R. E., Rausser, G. C., & Pingali, P. (2001). <i>Handbook of Agricultural Economics: Agricultural development: farmers, farm production and farm markets (Vol. 3)</i> . Elsevier.

Second Year Second Term			
Course Code: 0888 13 SWE 2211		Year: Second	Term: Second
Course Title	Soil Physics II		
Course Status	Core		
Credit	3.0		
Prerequisite(s)	None		
Rationale	This course is designed to provide concepts on soil water retention characteristics, water loss and movement and plant availability in different soils.		

Course Contents		CLOs
Section A		
1	Equilibrium physical state of water: 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.	1
2	Pore geometry and water retention: Water retention characteristics, effect of texture and structure on soil moisture retention; Hysteresis- definition, factors affecting hysteresis.	1
3	Water flow in saturated soil: 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.	2
4	Water flow in unsaturated soil: 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.	2
5	Water movement in soil: 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.	2
Section B		CLOs
6	Atmospheric Energy Balance: 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.	3
7	Evaporation and Evapotranspiration: 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.	3
8	Infiltration: 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.	3
9	Soil Erosion: 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.	1

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	relate soil water potential, soil water to pore geometry, kinetic water energy to soil erosion;	1, 2
	CLO2	outline the mechanism the soil water entry and movement under saturated and unsaturated soil profile and apply different laws and empirical models to calculate the rate of water movement throughout the profile;	2, 7
	CLO3	outline basic knowledge on atmospheric energy and water balance throughout the environment particularly within the soil profile and the measurement of energy and water balance by following different equation and methods.	1, 2

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CL01	Lecture	Quiz and Class Test
CL02	Lecture and Presentation	Assignment and Final Exam.
CL03	Group Discussion and Problem based Learning	Class Test and Final Exam.

Learning Materials

Recommended Readings	Baver, L. D. (1948). Soil physics (3rd ed.). NY John Wiley and Sons. Ghildyal, B. P., & Tripathi, R. P. (1987). Soil physics. Wiley Eastern Ltd. Publisher, New Delhi, India. Hillel, D. (1998). Environmental soil physics. San Diego, CA, Academic Press.
Supplementary Readings	Hillel, D. (2004). Introduction to environmental soil physics, Elsevier Academic Press, Amsterdam. Huq, S. M. I., & Alam, M. D. (2005). A handbook on analysis of soil, plant and water. Bangladesh-Australia Centre for Environmental Research (BACER-DU), Dhaka.

Course Code: 0888 SWE 2212	Year: Second	Term: Second
Course Title	Soil Physics II Sessional and Fieldwork	
Course Status	Core	
Credit	1.0	
Prerequisite(s)	None	
Rationale	This course is designed to provide skills in analyzing soil physical properties to yield results to explain soil water retention, movement, loss and availability.	

Course Contents/Tasks		CLOs
1	Determination of moisture content by gravimetric and tensiometer method.	1
2	Determination of saturated and unsaturated hydraulic conductivity by constant head and falling head method.	2
3	Construction of soil-moisture characteristic curve for different texture soil by primary and secondary data.	3
4	Field demonstration of water infiltration through layered and homogenous soils.	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:	Mapping with PLOs
CLO1	determine the moisture content by different methods;	6
CLO2	estimate hydraulic conductivity and interpret in relation to soil properties;	6, 8, 10
CLO3	explain the soil moisture retention curve and curve of infiltration rate.	6, 8, 10

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture	Quiz and Class Test
CLO2	Lecture and Presentation	Assignment and Final Exam.
CLO3	Group Discussion and Problem based Learning	Class Test and Final Exam.
CLO4	Lecture and Group Discussion	Viva voce and Final Exam.

Learning Materials

Recommended Readings	
	Dane, J. H., & Topp, G. C. (eds.) (2020). Methods of soil analysis Part 4: Physical Methods (1st ed.). ACSESS publisher.
	Huq, S. M. I., & Alam, M. D. (2005). A handbook on analysis of soil, plant and water. Bangladesh-Australia Centre for Environmental Research (BACER-DU), Dhaka.

Course Code: 0888 13 SWE 2221	Year: Second	Term: Second
Course Title	Water Quality	
Course Status	Core	
Credit	3.0	
Prerequisite(s)	None	
Rationale	This course is designed to provide the ideas about water resources, its quality for different uses, water supply systems, water resources projects and water quality monitoring to promote sustainable use of water and advanced assessment and prediction of the status of water environment	

Course Contents		CLOs
Section A		
1	Sources of Water: Introduction; hydrological cycle; surface water; groundwater: ground water aquifer, flow towards wells; groundwater in Bangladesh: problems in ground water development.	1
2	Water Quantity and Water Quality: 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.	1
3	National Water Policy: Objectives, planning and management; river basin management; economic and financial management; research and information management; stakeholder participation; institutional policy	2
4	Water Quality Challenges and Impacts: Sources of pollution; strategies to negotiate water quality problems; restoration and protection of water body and ecosystems; clean water for today and tomorrow.	1
Section B		
CLOs		
5	Introduction to Water Supply: 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, water right and allocation	2
6	Water Supply Technologies: 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.	2
7	Water Resource Projects: Introduction; physical factors; economic considerations; environmental effects; adverse effects of dams and reservoirs on environment; pre-construction investigations; choice of dams; planning of reservoirs.	3
8	Water Quality Monitoring: 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	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	explain different sources of water, water quality, chemical compositions of waters and identify the water quality challenges and impacts;	1, 3, 4
	CLO2	outline water supply systems, different water supply technologies, its construction and maintenance as well as comprehend national water policy to treat water and to promote its consequences and efficient use;	2, 5
	CLO3	strengthen understanding of planning, construction, and management of water resource projects and apply the implications of water quality monitoring in global scale as well as Bangladesh perspective.	3, 4, 7

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and presentation	Class Test and final exam
CLO2	Lecture and problem-based learning	Assignment and Final Exam
CLO3	Lecture and Group discussion	Viva voce and Final Exam

Learning Materials

Recommended Readings	<p>Bartram, J., & Ballance, R. (Eds.). (1996). <i>Water quality monitoring: a practical guide to the design and implementation of freshwater quality studies and monitoring programmes</i>. CRC Press.</p> <p>Gray, N. F. (1994). <i>Drinking water quality: problems and solutions</i>. John Wiley & Sons.</p> <p>Ostfeld, A. (ed.). (2012). <i>Water supply system analysis: selected topics</i>. BoD-Books on Demand.</p> <p>Ward, R. C., Loftis, J. C., & McBride, G. B. (1991). <i>Design of water quality monitoring systems</i>. John Wiley & Sons.</p>
Supplementary Readings	<p>Behmel, S., Damour, M., Ludwig, R., & Rodriguez, M. J. (2016). Water quality monitoring strategies—A review and future perspectives. <i>Science of the Total Environment</i>, 571, 1312-1329.</p> <p>Stephenson, D. (1970). Optimum design of complex water resource projects. <i>Journal of the Hydraulics Division</i>, 96(6), 1229-1246.</p> <p>Omer, N. H. (2020). Water quality parameters, <i>Water Quality-Science, Assessments and Policy</i>.</p>

Course Code: 0888 13 SWE 2222		Year: Second	Term: Second
Course Title	Water Quality Sessional and Fieldwork		
Course Status	Core		
Credit	1.0		
Prerequisite(s)	None		
Rationale	This course is designed to provide knowledge and exercises on different instrumental and chemical analytical methods on water quality including their sampling, identification, quantification, interpretation, and significance.		

Course Contents/Tasks		CLOs
1	Water sample collection and preservation.	1
2	Analysis of water quality: Laboratory analysis of different parameters of water sample and grading.	2
3	Calculation of water quality index.	2
4	Water quality monitoring.	2

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:	Mapping with PLOs
CLO1	carry out field tour to collect water sample and preserve it for laboratory analysis and grading;	6, 7, 8
CLO2	monitor water quality by measuring and calculating the water quality parameters for a particular region.	6, 7, 8

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, In-Class Activity, Field work and lab analysis	Sessional report, viva voce and Final Exam
CLO2	Field work, In-class activities and lab analysis	Sessional report viva voce and Final exam

Learning Materials

Recommended Readings	<p>Ouyang, Y., Nkedi-Kizza, P., Wu, Q. T., Shinde, D., & Huang, C. H. (2006). Assessment of seasonal variations in surface water quality. <i>Water research</i>, 40(20), 3800-3810.</p> <p>Bartram, J., & Balance, R. (Eds.). (1996). <i>Water quality monitoring: a practical guide to the design and implementation of freshwater quality studies and monitoring programmes</i>. CRC Press.</p> <p>Nielsen, D. M. (Ed.). (2005). <i>Practical handbook of environmental site characterization and ground-water monitoring</i>. CRC press.</p>
Supplementary Readings	<p>Ahmed, S. (2020). Integrated Water Resources Management: From Policy to Practice through a Comprehensive National Water Management Plan: A Case Study of Bangladesh. In <i>Water Resources Policies in South Asia</i> (pp. 116-133). Routledge India.</p> <p>Ward, R. C., Loftis, J. C., & McBride, G. B. (1991). <i>Design of water quality monitoring systems</i>. John Wiley & Sons.</p>

Course Code: 0888 13 SWE 2231	Year: Second	Term: Second
Course Title	Ecology and Ecosystems	
Course Status	Core	
Credit	3.0	
Prerequisite(s)	None	
Rationale	The course intends to provide fundamental concepts on soil ecology and ecosystems.	

Course Contents		CLOs
Section A		
1	Organism and Environmental Complex: Scope of Ecology; stress and strain; adaptation; habitat and niche; functional attributes of ecosystem- energy flow, food chain and soil food webs: ecological pyramid, energy exchange in ecosystem, energy available for food chains and webs; hierarchical approach to organisms in soils.	1, 2
2	Community and Population Ecology: Concept and basic terms, structure, composition and stratification; community function; population fluctuations and interactions; basic techniques in ecology.	1, 2, 3
3	Ecosystems: Definition, structure, different components, biome; terrestrial, fresh water and marine ecosystems.	2
4	Forest Ecology and its Conservations: Forest vegetation, structure and environment; acid rains – their impact on soil and plant. Salt marsh soils-their nature and importance in ecology.	3
Section B		
5	Ecological Interactions: Competition; Predation, herbivory, parasitism, and disease; Mutualism and commensalism; Ecological consequences of positive interactions.	3
6	Nutrient Supply, Cycling and Retention: Nutrient requirements and sources; Nutrient transformations; Nutrient cycles and losses; Nutrients in aquatic ecosystems.	4
7	Ecology of Coastal Ecosystems: Properties of coastal environments; Geomorphic and hydrographic features; Biological components; Fertility of coastal environments; Salt marshes; Mangroves; Mangrove ecosystem functions and services; Management issues and strategies.	4
8	Managing Soil Biodiversity and Ecosystem Services: Ecosystem concepts in management; Natural variability; Resilience and stability; Managing plant diversity; Tillage, chemical application, organic material and organic cropping system impacts on ecosystem services and soil biodiversity; Maintenance and restoration of ecosystem services.	3, 4

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	explain the major principles and concepts of ecology, ecological process, habitat-species relationships and the dynamics of ecosystems;	1
	CLO2	describe all the components of an ecosystem, identify the pollutant ecology and radioactive elements that affect ecology and ecosystem;	2
	CLO3	recognize the major interactions of soil biota that play a significant role in ecosystem and illustrate the relationship between biodiversity and different soil processes within the ecosystem;	2, 3
	CLO4	Outline major biogeochemical cycles including nutrients, metals and synthetic organic compounds for management of terrestrial and coastal ecosystem.	2, 3

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CL01	Lecture and Team Teaching	Quiz and Class Test
CL02	Problem-based Learning and Presentation	Assignment and Final Exam
CL03	Lecture and Presentation	Class test and final exam
CL04	Lecture and Presentation	Final exam

Learning Materials

Recommended Readings	<p>Barnes, R. S. K., & Mann, K. H. (eds.). (2009). <i>Fundamentals of aquatic ecology</i>. John Wiley & Sons.</p> <p>Bowman, W. D., & Hacker, S. D. (2021). <i>Ecology</i>. Oxford University Press.</p> <p>Clarke, R. (2009). <i>Essentials of ecology</i>, Colin R. Townsend, Michael Begon, John L. Harper, Blackwell Science, Oxford.</p> <p>Kathiresan, K., & Bingham, B. L. (2001). <i>Biology of mangroves and mangrove ecosystems</i>.</p>
Supplementary Readings	<p>Molles, M. (2015). <i>Ecology: concepts and applications</i>. McGraw-Hill Education.</p> <p>Monson, R. K. (ed.). (2014). <i>Ecology and the environment</i>. Springer.</p> <p>Wall, D. H., Behan-Pelletier, V., Jones, T. H., Ritz, K., Six, J., Strong, D. R., & van der Putten, W. H. (2012). <i>Soil ecology and ecosystem services</i>. Oxford University Press.</p>

Course Code: 0888 13 SWE 2232		Year: Second	Term: Second
Course Title	Ecology and Ecosystems Sessional and Fieldwork		
Course Status	Core		
Credit	1.0		
Prerequisite(s)	None		
Rationale	This course gives a practical skills for studying ecology and different ecosystem-based management tools, methods and strategy.		

Course Contents/Tasks		CLOs
1	Study of major ecosystems in Bangladesh including the Sundarbans.	1
2	Diversity measurements of an ecosystem.	1, 2
3	Community analysis of a particular ecosystem.	1, 2
4	Estimation of biomass of carbon, nitrogen and phosphorus.	3
5	Measuring dissolved oxygen, and chlorophyll content as a measure of potential primary productivity.	4
6	Intra- and interspecific plant competition.	2, 4

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	get the practical idea about major ecosystems of Bangladesh;	
CLO2	calculate the index of diversity and dominance of a community; analyze community on the basis of quantitative data;		10
CLO3	measure biomass C, N and P;		6
CLO4	calculate the primary productivity in an aquatic community; observe the effect of plant competition.		3

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Theoretical lessons for field measurement, field visit, field work and sample collection	Quiz and Class Test
CLO2	Theoretical lessons, field exercise	Assignment and Final Exam.
CLO3	Theoretical lessons, laboratory exercise	Class Test and Final Exam.
CLO4	Theoretical lessons, field tour, laboratory experiment and analysis, exercise, single and/or group assignment	Viva voce and Final Exam.

Learning Materials

Recommended Readings	Clarke, R. (2009). Essentials of ecology. Blackwell Science, Oxford. Wall, D. H., Behan-Pelletier, V., Jones, T. H., Ritz, K., Six, J., Strong, D. R., & van der Putten, W. H. (2012). Soil ecology and ecosystem services. Oxford University Press.
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Course Code: 0888 13 SWE 2233		Year: Second	Term: Second
Course Title	Atmospheric Science		
Course Status	Optional		
Credit	3.0		
Prerequisite(s)	None		
Rationale	This course is designed to provide the ideas and concepts of atmosphere focused on various atmospheric phenomena.		

Course Contents		CLOs
Section A		
1	Introduction, composition and structure of the atmosphere: 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.	1
2	Climate, Solar radiation and the global energy budget: 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.	2
3	Atmospheric moisture budget: 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	4
4	Atmospheric motion: 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.	4
Section B		
CLOs		
5	Atmospheric chemistry related to atmospheric processes: 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.	2
6	Atmospheric aerosols: 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.	2
7	Atmospheric Pollution, Greenhouse Effect, Ozone Layer Depletion: Air pollution, transformation, transport and sinks of gases in the troposphere, greenhouse 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.	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	explain the basic characteristics of the atmosphere- structure, composition and layering of atmosphere;	1
	CLO2	organize knowledge on chemical and photochemical reactions in the atmosphere;	1, 2
	CLO3	discuss the importance of the following atmospheric components: greenhouse gases, sinks of gases and ozone.	1, 2
	CLO4	discuss humidity, basic cloud-forming processes, and the mechanisms that initiate the movement of air.	1, 2

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CL01	Lecture and Team Teaching	Quiz and Class Test
CL02	Problem-based Learning and Presentation	Assignment and Final Exam
CL03	Lecture and Group Discussion	Viva voce and Final Exam
CL04	Lecture and Presentation	Final Exam

Learning Materials

Recommended Readings	<p>Brasseur, G. P., & Jacob, D. J. (2017). Modeling of atmospheric chemistry (1st ed.). Cambridge University Press.</p> <p>Hobbs, P. V., & Wallace, J. M. (2006). Atmospheric science: an introductory survey (International Geophysics) (2nd ed.). Academic Press Inc. Publisher.</p> <p>Vallis, G. K. (2019). Essentials of atmospheric and oceanic dynamics (1st ed.). Cambridge University Press.</p>
Supplementary Readings	<p>Jacobson, M. Z. (2012). Air pollution and global warming: history, science, and solutions (2nd ed.). Cambridge University Press.</p>

Course Code: 0888 13 SWE 2234	Year: Second	Term: Second
Course Title	Atmospheric Science Sessional and Fieldwork	
Course Status	Optional	
Credit	1.0	
Prerequisite(s)	None	
Rationale	This course is designed to recognize, illustrate and analyze the atmospheric functioning.	

Course Contents/Tasks		CLOs
1	Measurement of physical parameters of atmosphere.	1
2	Collection of air sample from different locations and determination of nature and concentration of pollutants.	2
3	Construction a model containing different spheres of atmosphere.	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:	Mapping with PLOs
CLO1	recognize the components of the atmosphere;	6
CLO2	estimate atmospheric components and their functions;	6, 8
CLO3	formulate the different model based on climate change.	7, 10

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Presentation	Assignment and Final Exam.
CLO2	Group Discussion and Problem based Learning	Class Test and Final Exam.
CLO3	Lecture and Group Discussion	Viva voce and Final Exam.

Learning Materials

Recommended Readings	Brasseur, G. P., & Jacob, D. J. (2017). Modeling of atmospheric chemistry (1st ed.). Cambridge University Press. Jacobson, M. Z. (2012). Air pollution and global warming: History, Science, and Solutions (2nd ed.). Cambridge University Press. Vallis, G. K. (2019). Essentials of atmospheric and oceanic dynamics (1st ed.). Cambridge University Press.
Supplementary Readings	Hobbs, P. V., & Wallace, J. M. (2006). Atmospheric science: An introductory survey (International Geophysics) (2nd ed.). Academic Press Inc. Publisher.

Course Code: 0888 13 SWE 2235	Year: Second	Term: Second
Course Title	Stress Environment Agriculture	
Course Status	Core	
Credit	3.0	
Prerequisite(s)	None	
Rationale	The course intends to give the graduate students to develop understanding about different environmental stresses and how these stresses are influencing plant growth. It also delivers knowledge about different phenotypic changes that plant can adopt under various stresses.	

Course Contents		CLOs
Section A		
1	Nutrient Stress	1, 2
2	Salinity/Sodicity Stress	1, 2
3	Drought and Flooding Stress Tolerance in Plants	1, 2
4	Heat stress	2, 3
5	Effect of different stresses and their interaction on plant growth	
Section B		
6	Plant and Crop Responses to Pollution Stress	1, 2
7	Plant and Crop Responses to Weeds, Pests, Pathogens, and Agrichemical Stress Conditions.	1, 2
8	Mechanisms of tolerance to different stresses:	2, 3
9	Management of plant growth under stressed environments	2, 3
10	Beneficial Aspects of Stress	2, 3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	outline the unique features of plant cells and a general grounding on plant physiology and growth;	7
	CLO2	recognize a brief introduction to the various physiological, molecular, and biochemical mechanisms plants use to respond to environmental stresses like extreme temperature, drought, salt, and pathogens;	3
	CLO3	infer the mechanisms of tolerance and management of plant growth under stressed environments.	2

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Team Teaching	Quiz and Class Test
CLO2	Problem-based Learning and Presentation	Assignment and Final Exam
CLO3	Lecture and Group Discussion	Viva voce and Final Exam

Learning Materials

Recommended Readings	Gupta, U.S. (2004). Physiology of stressed crops. Science Publishers, Enfield, NH, USA. Marschner, H. (2003). Mineral nutrition of higher plants. Elsevier Science Ltd., San Diego, CA, USA. Pessarakli, M. (ed.). (1999). Handbook of plant and crop stress. Marcel Dekker, New York, USA.
Supplementary Readings	Maloo, S. R. 2002. Sustainable crop production under stress environments. Shabala, S. (2017). Plant stress physiology. (2nd ed.). Taiz, L., & E. Zeiger. (2006). Plant physiology. (4th ed.) Wadsworth Publication Co., Sunderland, MA, USA.

Course Code: 0888 13 SWE 2236	Year: Second	Term: Second
Course Title	Stress Environment Agriculture Sessional and Fieldwork	
Course Status	Core	
Credit	1.0	
Prerequisite(s)	None	
Rationale	The course intends to give the practical knowledge about different environmental stresses and how these stresses are influencing plant growth. This course will also make the students capable of conducting experiments with plants under various stresses.	

Course Contents/Tasks		CLOs
1	Demonstration of plant growth under stressed environments.	1, 2
2	Field observation of growth parameter in areas of different stress environment.	1, 3
3	Field and/or laboratory experiment under stress conditions.	2, 3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	demonstrate of plant response under stressed environments;	2
	CLO2	set up an experiment dealing with different stresses under field and controlled condition;	3
	CLO3	mange proper plant growth by overcoming the stress.	7

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Theoretical lessons for field observation, sample collection and field work, In-situ field demonstration	Hands-on work in the field, written test, oral examination
CLO2	Theoretical lessons, exercise	Laboratory exercise, written test, oral examination
CLO3	Theoretical lessons, field work, laboratory exercise, single and/or group assignment	Laboratory exercise, report, oral examination

Learning Materials

Recommended Readings	Gupta, U.S. (2004). Physiology of stressed crops. Science Publishers, Enfield, NH, USA. Marschner, H. (2003). Mineral nutrition of higher plants. Elsevier Science Ltd., San Diego, CA, USA. Pessaraki, M. (ed.). (1999). Handbook of plant and crop stress. Marcel Dekker, New York, USA.
Supplementary Readings	Maloo, S. R. 2002. Sustainable crop production under stress environments. Shabala, S. (2017). Plant stress physiology. (2nd ed.). Taiz, L., & E. Zeiger. (2006). Plant physiology. (4th ed.) Wadsworth Publication Co., Sunderland, MA, USA.

Course Code: 0888 13 SWE 2244		Year: Second	Term: Second
Course Title	Comprehensive Viva Voce II		
Course Status	Core		
Credit	1.0		
Prerequisite(s)	None		
Rationale	The 'Comprehensive Viva Voce II' aims to develop interview and viva-voce skill of the students. The course inspires the students to gain knowledge on etiquette of viva. The course also aims to develop oral presentation skills and self-expressive capacity of the students and review subjective knowledge learned throughout year 2 of the program.		

Course Contents/Tasks		CLOs
1	The 'Comprehensive Viva Voce II' requires the students to face a viva voce/defense board at the end of the concerned term 4 (end of year 2). The concerned Examination Committee/ Academic Committee of the Discipline will form viva voce board to conduct the viva and assess the students out of 100 marks. If deemed necessary to the concerned Examination Committee, these sessions might be arranged online. The contents of this viva voce will include the gained knowledge, issues covered and concepts handled through the theory/sessional courses up to first two terms of the program.	1 to 5

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	review subjective knowledge gained through year 2 of the program;	1, 2
	CLO2	improve oral presentation skill;	9
	CLO3	develop critical thinking to link theoretical knowledge and applicability of Soil, Water and Environmental studies,	8, 9
	CLO4	demonstrate communication behaviors appropriate for effective comprehensive and supportive listening;	9
	CLO5	build skills, roles, and methods of proceeding in task groups in order to achieve high levels of motivation, productivity.	8

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CL01	As reported for various courses	Viva Voce
CL02	As reported for various courses	Viva Voce
CL03	As reported for various courses	Viva Voce
CL04	As reported for various courses	Viva Voce
CL05	As reported for various courses	Viva Voce

Learning Materials

Recommended Readings	As reported for various courses
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Course Code: 0811 13 Agr 2251	Year: Second	Term: Second
Course Title	Agronomy	
Course Status	Core	
Credit	3.0	
Prerequisite(s)	None	
Rationale	This course is designed to provide the fundamental concepts of agronomy, different aspects of cropping systems and practices involved in crop production.	

Course Contents		CLOs
Section A		
1	Introduction: Concept, importance and scope of agriculture and agronomy; history of agriculture; chronology of Bangladesh agriculture; basic principles of agronomy; agricultural research institutes of Bangladesh.	1
2	Weather and Climate: Definition of weather and climate; differences between weather and climate; weather elements and their role on the growth and development of crops; climatological equipment. Different crops of Bangladesh with its classification related to monsoon climatic condition.	2
3	Weeds: Definition, classification, advantage and disadvantage of weeds, weed control.	3
4	Seeds: 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.	3
Section B		
5	Cropping systems: Concept, types and determinants.	4
6	Cropping pattern: Concept; factors affecting cropping pattern; basic information about the major cropping patterns of Bangladesh, efficiency in cropping system, interaction in intercropping and sequential cropping, sequential cropping and intercropping with their advantages and disadvantages; land equivalent ratio (LER); relative yield total (RYT), crop equivalent yield (CEY), multiple cropping index (MCI).	4
7	Crop rotation: Objectives, principles; advantages and limitations	4
8	Production technology of crops: Soil, climate, varieties, planting and harvesting of jute, rice, sugarcane, wheat and tea.	4

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO 1	depict various aspects of agriculture and agronomy;	1, 2
CLO 2	explain the weather and climate and their influence on crops;	1, 2	
CLO 3	describe the seed, its germination, quality and dormancy and weeds with its control;	1, 3	
CLO 4	build knowledge of crop production, cropping pattern and crop rotation.	1, 3	

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CL01	Lecture	Quiz and Class Test
CL02	Lecture and Presentation	Assignment and Final Exam.
CL03	Group Discussion and Problem based Learning	Class Test and Final Exam.
CL04	Lecture and Group Discussion	Viva voce and Final Exam.

Learning Materials

Recommended Readings	De, G. C. (1999). Fundamentals of agronomy. Oxford and IBH publishing co. pvt. Ltd., New Delhi. Kabir, M. H. (1986). Handbook of agronomy. Salimabad printing house, Nawabbari, Dhaka. Pearson, L. C. (1967). Principles of Agronomy. Van Nost. Reinhold
Supplementary Readings	Sing, S. S. (2001). Principles and practices of agronomy. Kalyani Publishers, Calcutta.

Course Code: 0811 13 Agr 2252		Year: Second	Term: Second
Course Title	Agronomy Sessional and Fieldwork		
Course Status	Core		
Credit	1.0		
Prerequisite(s)	None		
Rationale	The course is oriented to provide applied knowledge on morphological and physiological attributes of crop and crop rotational scheduling, planning and agricultural farm management.		

Course Contents/Tasks		CLOs
1	Study of the external morphology of the following crops - rice, wheat, jute; familiarize with agricultural tools.	1
2	Morphological and physiological attributes of crops and preparation of crop rotation schedules.	1
3	Recording local rainfall, temperature, and humidity; Measurement of precipitation by rain gauge.	3
4	Identification of seeds, seed germination, seed rate, purity of seed, real value of seed and collection of different weeds.	2
5	Identification of fake fertilizers.	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	determine the physiological characteristics of seed and weeds;	7, 10
	CLO2	make use of the knowledge of weather and climatic parameter on the growth of crops;	8
	CLO3	select cropping systems and cropping patterns of Bangladesh and suggest necessary practices for improvement.	10

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Presentation	Quiz and Class Test
CLO2	Problem-based Learning and Presentation	Assignment and Final Exam
CLO3	Lecture and Group Discussion	Viva voce and Final Exam

Learning Materials

Recommended Readings	De, G. C. (1999). Fundamentals of agronomy. Oxford and IBH publishing co. pvt. Ltd., New Delhi. Kabir, M. H. (1986). Handbook of agronomy. Salimabad printing house, Nawabbari, Dhaka. Pearson, L. C. (1967). Principles of agronomy. Van Nost. Reinhold
Supplementary Readings	Sing, S. S. (2001). Principles and practices of agronomy. Kalyani Publishers, Calcutta.

Course Code: 0512 13 Bchm 2253	Year: Second	Term: Second
Course Title	Fundamentals of Biochemistry	
Course Status	Optional	
Credit	3.0	
Prerequisite(s)	None	
Rationale	This course is designed to provide the preliminary ideas about basic biochemistry.	

Course Contents		CLOs
Section A		
1	Introduction: Basic biochemistry and application of biochemistry in soil, water and environment, concepts of macromolecules, their monomers (building blocks). Carbohydrates: Definition, classification, monosaccharides, structure, isomerism, stereochemistry and synthesis, cyclization, important polysaccharides, their composition and function in nature, detail study of cellulose.	1
2	Nucleic acids: 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.	1
3	Lipids: Definitions, functions, classification, fatty acids (saturated and unsaturated fatty acids, physical properties and chemical reactions), glycerides (neutral glycerides and phosphoglycerides).	1
4	Lignin: Natural occurrence, importance, composition, lignification and wood quality.	1
Section B		
CLOs		
5	Proteins: The α -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.	1
6	Enzymes: Characteristics and functions of enzymes, nomenclature and classification, mechanism of enzyme functions, Michaelis-Menten equation and significance of K_m , exoenzyme, endoenzyme, factors affecting enzyme activity, regulation of enzyme activity, coenzyme and cofactor, inhibition of enzyme activity and its significance.	2
7	Overview of catabolic processes: 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.	3
8	Antibiotics: Concepts of immunology, specific and nonspecific immunity, structure of immunogens (antigens), structure of immunoglobulin (antibody), classification of IgG, mechanisms of antibody-antigen reaction.	2
9	Vitamin and minerals: Definitions, role in catabolism, major groups of vitamins, solubility of vitamins and their significance in nutrition.	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO 1	outline the basic concept of carbohydrate, protein, nucleic acids, lipids and lignin along with properties, structure and functions;	1
	CLO 2	explain enzyme, antibody with structure and functions;	1, 3
	CLO 3	clarify the overview of catabolic processes.	1, 2

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, presentation, question and answer, problem-based learning and presentation	Assignment and Final Exam
CLO2	Lecture, presentation, question and answer	Written examination, multiple-choice examination, homework
CLO3	Lecture, problem-based learning, group discussion and presentation	Interactive application assignments, presentation by students, written examination

Learning Materials

Recommended Readings	<p>Denniston, K. J., Topping, J. J., & Caret, R. L. (2006). General, organic, and biochemistry. (4th Ed.), McGraw Hill Companies, New York.</p> <p>Devlin, R. M., & Witham, F. H. (1983). Plant physiology. CBS Publishers, New Delhi, India.</p> <p>Mengel, K., & Kirkby, E. A. (2001). Principles of plant nutrition (5th ed.), Dordrecht: Kluwer Academic Publishers.</p> <p>Stevenson, F.J., & Cole, M. A. (1999). Cycles of soil: carbon, Nitrogen, phosphorus, sulfur, micronutrients. (2nd ed.), Wiley.</p>
Supplementary Readings	<p>Nelson, D. L., & Cox, M. M. (2017). Lehninger principles of biochemistry. (7th ed.). W.H. Freeman.</p> <p>Salisbury, F. B., & Ross, C. W. (1986). Plant physiology. CBS Publishers, New Delhi, India.</p> <p>Weil, R. R., & Brady, N. C. (2017). The nature and properties of soils. (15th Ed.). Upper Saddle River, NJ: Prentice Hall.</p>

Course Code: 0512 13 Bchm 2254	Year: Second	Term: Second
Course Title	Fundamentals of Biochemistry Sessional	
Course Status	Optional	
Credit	1.0	
Prerequisite(s)	None	
Rationale	This course is designed to provide the basic practical knowledge on biochemistry.	

Course Contents/Tasks		CLOs
1	Reducing and non-reducing sugar determination by Fehling method.	1
2	Determination of crude protein content of a sample.	2

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:	Mapping with PLOs
CLO1	categorize reducing and non-reducing sugar;	6
CLO2	determine the crude protein content of a sample.	6, 7

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Presentation	Assignment and Final Exam.
CLO2	Group Discussion and Problem based Learning	Class Test and Final Exam.
CLO3	Lecture and Group Discussion	Viva voce and Final Exam.

Learning Materials

Recommended Readings	Denniston, K. J., Topping, J. J., & Caret, R. L. (2006). General, organic, and biochemistry. (4th ed.), McGraw Hill Companies, New York. Devlin, R. M., & Witham, F. H. (1983). Plant physiology. CBS Publishers, New Delhi, India. Mengel, K., & Kirkby, E. A. (2001). Principles of plant nutrition (5th ed.), Dordrecht: Kluwer Academic Publishers.
Supplementary Readings	Nelson, D. L., & Cox, M. M. (2017). Lehninger principles of biochemistry (7th ed.). W.H. Freeman. Salisbury, F. B., & Ross, C. W. (1986). Plant physiology. CBS Publishers, New Delhi, India.

Third Year First Term			
Course Code: 0888 13 SWE 3111		Year: Third	Term: First
Course Title	Soil Genesis		
Course Status	Core		
Credit	3.0		
Prerequisite(s)	None		
Rationale	This course is designed for undergraduate students in soils, natural resources, biological sciences, and related fields. The course is taught through a combination of lectures and hands-on laboratory and field activities. The course is divided into soil morphology, soil formation, and the twelve soil orders.		

Course Contents		CLOs
Section A		
1	Overview of Soil Genesis: Concept of soil as a natural system, Summarizing the history of key concepts of Pedology, including soil forming processes and factors.	1
2	Weathering and Soil Formation: Physical and Chemical weathering process; Mineral weathering reactions and sequences; Environmental factors of soil formation: Parent material, time, relief, climate and organisms.	2
3	Soil Morphology: General relationship between particle size and particle mineralogy, Soil colors and the primary pigmenting agents, Soil profile description-soil morphological studies. Properties used in describing soil layers; Presentation of soil profile data, Soil micromorphology, Pedofeatures: Fabric, Nodules, Cutans. Soil horizonation, Soil horizon designations: surface horizon (epipedon) and subsurface horizon (endopedon); Master horizons and layers; Transitional and mixed horizons; The sequum concept.	1
4	Soil Forming Processes: Additions, Losses, Translocation and Transformations; Important soil forming processes in Bangladesh: Ripening, Homogenization, Reduction, Ferrolysis, Calcification and Decalcification, Flood coating, Ploughpan, Mottles, Alkalization, Salinization, Acidification, Clay migration.	2
Section B		CLOs
5	Soils in relation to landscape: Catena concept; Soil profile, relief features and their relation to structure; Soil-Landscape relationship. Effects of slope aspect on soil morphology.	2
6	Zonality concept in soils: Zonal, Intrazonal and Azonal soils	3
7	Soil Orders: 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.	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO 1	describe and explain fundamental concepts of soil genesis for classifying soil profiles down to the subgroup level using the United States Soil Taxonomy;	1, 2
	CLO 2	describe 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;	1, 2, 7
	CLO 3	classify soils using the key characteristics of soils in the 12 soil orders of US Soil Taxonomy.	3

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Team Teaching	Quiz and Class Test
CLO2	Problem-based Learning and Presentation	Assignment and Final Exam
CLO3	Lecture and Group Discussion	Final Exam
CLO4	Lecture and Group Discussion	Final Exam

Learning Materials

Recommended Readings	<p>Buol, S. W., Southard, R. J., Graham, R. C., & McDaniel, P. A. (2011). Soil genesis and classification. (6th ed.). Wiley-Blackwell.</p> <p>Randall, J., Schaetzl, Michael, L., & Thompson. (2015). Soils: genesis and geomorphology. (2nd ed.). ISBN: 9781107016934</p> <p>Soil Survey Staff. (2022.) Keys to soil taxonomy (13th ed.). USDA National Resource Conservation Service.</p>
Supplementary Readings	<p>FAO (Food and Agriculture Organization of the United Nations). (2006). Guidelines for soil description. (4th ed.).</p>

Course Code: 0888 13 SWE 3112		Year: Third	Term: First
Course Title	Soil Genesis Sessional and Field Work		
Course Status	Core		
Credit	1.0		
Prerequisite(s)	None		
Rationale	This course focuses on observing and describing soils in the field and interpreting soil suitability for various uses. As field observations play a key role in teaching and learning about soil and its properties, students find field visits as one of the most exciting aspects of their work. The primary emphasis is on Bangladesh soils with significant attention to global soils. One of the fundamental skills of a soil scientist is to accurately describe a soil profile. To do so, soil scientists need to have a thorough understanding of many concepts that have already been covered in this course, including soil color, texture, structure, taxonomic classification, soil development processes, and the five soil forming factors. Using those soil science concepts students will work in groups to fill out a soil profile description sheet at different sites over the course of two field trips.		
Course Objectives	Students will gain hands on experience in describing various soil profiles using qualitative morphological properties (e.g. colour, texture, structure, reaction, consistency and drainage). This will help in understanding the various soil forming factors and processes that have led to the development of various soil types in Bangladesh and be invaluable diagnostic tools which students can use in practice to ascertain limitations and determine appropriate management strategies.		

Course Contents/Tasks		CLOs
1	Soil Morphology: Intensive in situ description and evaluation of soil morphology. The course learning outcomes are met through a 3/4-day field work, keeping a detailed field notebook, describing a soil at one of the soil master pits (one meter by one meter) at the end of the field work, and preparing a report. Description of soil profile features, Labeling soil profile horizons Field trips integrated into the laboratory component of the course, descriptions and interpretation of soils: Identify and differentiate soil horizons, Demonstration of standard equipment and techniques; Master pit description, identification of diagnostic horizons, Practice in the field description and interpretation. Preparation of a monograph of the profile morphology.	1, 2
2	Examining Soil-Landscape-Vegetation relationships: Genetic interpretation; Land-use interpretation	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	identify the main soil horizons, and describe the basic differences between each;	7, 8
CLO2	make a thorough and technically accurate description of a soil in the field;	8	
CLO3	estimate soil chemical and physical properties from field observations and laboratory analysis;	8	
CLO4	relate soil morphology to landforms and specific landscape positions and land use interpretation.	8	

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Theoretical lessons for field measurement, sample collection and field work, In-situ field demonstration	Hands-on work in the field, field exercise, written test and oral examination
CLO2	Theoretical lessons, field work, laboratory exercise, single and/or group assignment	Laboratory exercise, report and oral examination
CLO3	Theoretical lessons, field tour, laboratory analysis, exercise, single and/or group assignment	Laboratory exercise, report and oral examination
CLO4	Lecture and Group Discussion	Viva voce and Final Exam

Learning Materials

Recommended Readings	Buol, S. W., Southard, R. J., Graham, R. C., & McDaniel, P. A. (2011). Soil genesis and classification. (6th ed.). Wiley-Blackwell.
	Randall, J., Schaetzl, Michael, L., & Thompson. (2015). Soils: genesis and geomorphology. (2nd ed.). ISBN: 9781107016934
	Soil Survey Staff. (2022.) Keys to soil taxonomy (13th ed.). USDA National Resource Conservation Service.
Supplementary Readings	FAO (Food and Agriculture Organization of the United Nations). (2006). Guidelines for soil description. (4th ed.).

Course Code: 0888 13 SWE 3113	Year: Third	Term: First
Course Title	Soil Fertility and Nutrient Management	
Course Status	Core	
Credit	3.0	
Prerequisite(s)	None	
Rationale	The course intends to provide knowledge for the improvement in crop production, increase in the ecological efficiency integrity and incorporation of progressive nutrient management strategies for crop production agricultural system.	

Course Contents		CLOs
Section A		
1	Introduction to Soil Fertility and Productivity: Definition and concept of soil fertility and productivity; Past and recent advances in soil fertility and plant nutrition research; Crop growth pattern, growth curve and yield curve; Some terms related to yield curve- hidden hunger; Steenberg effect, dilution effect, luxury consumption; Crop growth index – crop growth rate (CGR), relative growth rate (RGR).	1, 2
2	Nutrients and Plant Growth: Essential, beneficial, functional and quasi essential nutrients in plants; Criteria of essentiality of plant nutrients; Classification of nutrients on the basis of mobility in soil and plant, on the basis of plant requirement, on the basis of physico chemical properties; Functions and deficiency symptoms of essential nutrients; Law of minimum and law of limiting factor; Mathematical approaches to express plant growth – Mitscherlich law of diminishing return, Bray's nutrient mobility concept, N-inversion law and Wilcox agrobiology law; Baule unit concept.	1, 2
3	Fertilizer Materials: Terminologies: single-, straight-, compound-, complex-, and mixed fertilizer; slow-release fertilizer, fertilizers grade, fertilizer ratio, fertilizer guarantee, acid and base-forming fertilizers; Sources and manufacture of major fertilizer materials; organic fertilizer and bio-fertilizers; Types of fertilizers, common fertilizers, inorganic versus organic fertilizers, compost and composting; Fertilizer use and demand in Bangladesh, fertilizer law.	1
4	Fertilizer Response: Nutrient interaction; antagonistic – synergistic activity among the fertilizer nutrient; Fertilizer response in plants; mathematical models to express fertilizer response; various equations and curves; Fate of added nutrients (fertilizers) in soil; residual effects of fertilizers; Nutrient mobility in soils (mobile, relatively mobile, immobile nutrients); factors affecting movements of nutrients; Salt index of fertilizers; Balanced fertilization; The impact of fertilizer application on soil quality and the environment.	1, 3
Section B		CLOs
5	Soil Fertility Evaluation: Needs for soil fertility evaluation; Different approaches to diagnosis – visual symptoms, soil and plant analysis, biological methods, laboratory, greenhouse and field experimentation; Nutrient use efficiency (NUE) – partial factor productivity, agronomic efficiency, physiological efficiency and crop recovery efficiency; Nutrient uptake calculation, nutrient harvest index.	3, 4
6	Recommendation and Application of Fertilizer: Know-how to the estimation of the amount of recommended fertilizer; Calculation of fertilizer needed for different soils in the crop field; Methods of fertilizer application; Application the methods (conditions, reasons and rationale of the methods); Fertilizer movement in soil.	1, 3
7	Fertilizer Recommendation Service in Bangladesh: Fertility status of Bangladesh; Factors responsible for declining soil fertility level; Fertilizer research in Bangladesh; Fertilizer recommendation – fertilizer recommendation guide, land and soil utilization guide, online fertilizer recommendation system.	3, 4
8	Fertility Management: Nutrient budget, nutrient management, nutrient index level, the meaning of index level for the crop; Nutrient management planning; Liming, organic farming, circular agriculture; Regional and global best management practices (BMPs) for nutrient management; Harmful effects of inorganic fertilizers (over and under application) on soil and water quality (physical, chemical and biological) and human health.	4

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	describe soil fertility and productivity, essential nutrients, their available forms and describe role in soil fertility and functions in growth, and reproduction of plant;	1, 2
	CLO2	interpret growth and growth curves nutrient disorders by the symptoms in plants and theories to assess soil fertility status;	2, 3, 7
	CLO3	outline the concepts of nutrient interaction mobility, the fertilizer application, fertilizer response and fate of fertilizers;	2, 3
	CLO4	illustrate recommendation process for estimating the amount of fertilizers and the management practices for better environment and human health.	3, 4, 6

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Team Teaching	Quiz and Class Test
CLO2	Problem-based Learning and Presentation	Assignment and Final Exam
CLO3	Lecture and Group Discussion	Viva voce and Final Exam
CLO4	Lecture and Group Discussion	Viva voce and Final Exam

Learning Materials

Recommended Readings	<p>Havlin, J. L., Tisdale, S. L., Nelson, W. L., & Beaton, J. D. (2014). Soil fertility and fertilizers. (8th ed.). PHI Learning, Delhi.</p> <p>Kabata-Pendias, A., & Pendias, H. (1992). Trace elements in soils and plants. CRC Press.</p> <p>Mengel, K., & Kirkby, E. A. (1982). Principles of plant nutrition. International Potash Institute, Switzerland.</p> <p>Tisdale, S. L., Nelson, W. L. & Beaton, J. D. (1985). Soil Fertility and Fertilizers (4th Ed.). Macmillan Publishing Company, New York.</p> <p>Weil, R. R., & Brady, N. C. (2017). The nature and properties of soils. (15th ed.). Upper Saddle River, NJ: Prentice Hall.</p>
Supplementary Readings	<p>Kannaiyan, S., Kumar, K., & Govindarajan, K. (2004). Biofertilizers technology. scientific publ.</p> <p>Pierzinsky, G. M., Sims, T. J., & Vance, J. F. (2002). Soils and environmental quality. (2nd ed.) CRC Press.</p> <p>Stevenson, F. J., & Cole, M. A. (1999). Cycles of soil: carbon, nitrogen, phosphorus, sulphur, micronutrients. John Wiley & Sons.</p>

Course Code: 0888 13 SWE 3114	Year: Third	Term: First
Course Title	Soil Fertility and Nutrient Management Sessional and Fieldwork	
Course Status	Core	
Credit	1.0	
Prerequisite(s)	None	
Rationale	This course is designed to provide skills for evaluation of soil fertility status and setting management requirements for the target improvement.	

Course Contents/Tasks		CLOs
1	Techniques of soil for soil fertility assessment and evaluation.	1
2	Visual symptom analysis in the field for identifying nutrient elements responsible either for toxicity or for deficiency.	2
3	Extraction and determination of N, P, K, and micronutrients in soils and plants.	3
4	Estimation of the lime requirement of a given crop field.	3
5	Techniques of Fertilizer recommendation.	3
6	Preparation of compost and quick compost fertilizers.	2
7	Quick methods for testing the purity of market available fertilizers in Bangladesh.	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	apply appropriate techniques/ methods for soil and plant sampling and soil and plant sample extraction;	
CLO2	prepare compost and test purity of major fertilizers available in the market;		7
CLO3	assess fertility status and recommend fertilizer needs;		6, 7
CLO4	explain the procedures followed for manufacturing, refining, packaging and labeling fertilizer in the visited factory;		7, 8

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Team Teaching	Quiz and Class Test
CLO2	Problem-based Learning and Presentation	Assignment and Final Exam
CLO3	Lecture and Group Discussion	Viva voce and Final Exam

Learning Materials

Recommended Readings	<p>BARC. (2018). Fertilizer recommendation guide, Bangladesh Agricultural Research Council (BARC), New Airport Road, Dhaka-1215.</p> <p>BARI. (2014). Krishi Projukti Hatboi (Handbook on Agro-technology), (6th ed.), Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gajipur-1701, Dhaka.</p> <p>Jaiswal, P. C. (2003). Soil, plant and water analysis. Kalyani Publishers, Ludhiana, New Delhi-110002, India ISBN 81-272-0690-3.</p>
Supplementary Readings	SRDI. (2018). Soil and Land Resources Utilization Guide, Soil Resources Development Institute, Ministry of Agriculture, Farmgate, Dhaka.

Course Code: 0888 13 SWE 3115	Year: Third	Term: First
Course Title	Soil and Environmental Microbiology	
Course Status	Core	
Credit	3.0	
Prerequisite(s)	None	
Rationale	This course is designed to equip students with theoretical knowledge needed to illustrate soil and environmental microbial habitat, their interaction and related environmental processes.	

Course Contents		CLOs
Section A		
1	Soil as a Diversified Microbial Habitat: Soil minerals as a source of nutrients, Soil organic matter as a source of nutrients, Living biomass as a source of nutrients, Soil water, Soil atmosphere, Soil redox potential, Soil pH, Soil temperature, Soil light and soil microsites.	1
2	Terminal Electron Acceptors: List of terminal electron acceptors in absence of O ₂ and the related processes-denitrification, manganese reduction, fermentation, iron reduction, dissimilatory nitrate reduction, sulfate reduction, methanogenesis.	2
3	Pyruvic Acid: The key metabolite in life-Relation of pyruvic acid in the link between catabolic and anabolic process, Concept of fermentation, Different fermentative products formed from pyruvic acid and their importance.	2
4	Interaction of Organisms: symbiosis-Mutualism, proto cooperation, neutralism, commensalism, antagonism (competition, ammensalism, predation, parasitism), synergism. C:N ratio: Definition, C:N ratio of organic materials, agricultural significance.	2
Section B		CLOs
5	Macromolecule Decomposition in Soil: Natural occurrence, composition, biochemistry of decomposition, enzymes, decomposing microorganisms and factors governing the decomposition of cellulose, hemicellulose, lignin, starch, pectic substances, inulin and chitin.	2
6	Biofertilizers: BNF Classification of BNF with examples, composition of nitrogenase, mechanism of Legume-Rhizobium association, processes of Legume-Rhizobium association, cross inoculation groups, factors affecting nodulation, Classification of Rhizobia on different basis, characteristics of Rhizobium, ARA test and its significance. Mycorrhiza [General features of the association, benefit of plant and fungi from the association, classification of mycorrhiza, general discussion on ectomycorrhiza and endomycorrhiza (VAM)]. Cyanobacteria (BGA) -General features of Cyanobacteria, naming controversy, pigments, N-fixing Cyanobacteria, different mode of N fixation (heterocystous and nonheterocystous), ecological significance, geosmin, growth of rice plants in contact with Cyanobacteria]. Azolla [General features, Azolla-Anabaena symbiosis, their ecological significance]. Phosphate solubilizing microorganisms in soil	3
7	Sulfur Transformation: Major transformations of S in soil, forms of soil S, organic S mineralization, oxidation of inorganic S, organisms involved in S transformations, reduction of inorganic S compounds, volatile S compounds.	2
8	Omics Tools in Soil Microbiology: The State of the Art Bioremediation of polluted soils; Biological control.	4
9	Soil Microorganisms and Remediation: Biogeochemistry, Biodeterioration, solid and liquid wastes, bioremediation, biodegradation, biological pest control.	4

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	describe soil as a diversified microbial habitat;	1, 2
	CLO2	able to describe the basic transformations of compounds and related processes;	2, 3
	CLO3	illustrate the fundamentals of biofertilizer application;	3
	CLO4	evaluate the scope of microbial involvements to remediate soil and environment.	4, 7

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, group discussion and presentation	Written examination, presentation by student, quizzes and class test
CLO2	Lecture, presentation, question and answer, problem-based learning and presentation	Assignment and Final Exam
CLO3	Lecture, presentation, question and answer	Written examination, multiple-choice examination, homework
CLO4	Lecture, problem-based learning, group discussion and presentation	Interactive application assignments, presentation by students, written examination

Learning Materials

Recommended Readings	<p>Alexander, M. (1977). Introduction to soil microbiology. (2nd ed.). Wiley Eastern limited. New Delhi, India.</p> <p>Benson, H. J. (2001). Microbiological applications: A Laboratory manual in general microbiology. (8th ed.). McGraw-Hill Science.</p> <p>Killham, K. (1994) Soil ecology. Cambridge University Press, USA.</p> <p>Madign, M. T., Martinko, T. M., & Panker, J. (2008). Biology of microorganisms. (12th ed.). Pearson Education, Inc.</p> <p>Tortora, G. J., Funke, B. R., & Case, C.L. (2013). Microbiology-an introduction. (11th Ed.). Pearson.</p>
Supplementary Readings	<p>Hurst, C. J. (Ed.). (2002). Manual of Environmental Microbiology. (2nd ed.) American Society for Microbiology Press, Washington, DC.</p> <p>Paul, E. A., & Clark, F. E. (1996). Soil microbiology and biochemistry. (2nd ed.) Academic Press, San Diego, CA.</p> <p>Weaver, R. W. et al. (Eds.). (1994). Methods of soil analysis—Part 2. Microbiological and biochemical properties. Soil Science Society of America, Inc., Madison, WI.</p>

Course Code: 0888 13 SWE 3116	Year: Third	Term: First
Course Title	Soil Fertility and Nutrient Management Sessional and Fieldwork	
Course Status	Core	
Credit	1.0	
Prerequisite(s)	None	
Rationale	This course is designed to equip students with the practical knowledge and analytical skills methods and processes to identify, culture and to describe different microbes in the soil environment and their role.	

Course Contents/Tasks		CLOs
1	Isolation, purification, preservation and identification of bacteria in soil and environment.	1
2	Describing root nodulation.	2
3	Identification and description of mycorrhiza in the field.	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:	Mapping with PLOs
CLO1	isolate and identify bacteria in soil and environment;	6
CLO2	interpret root nodulation;	7, 8
CLO3	identify and describe mycorrhiza.	6, 7

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture	Quiz and Class Test
CLO2	Lecture and Presentation	Assignment and Final Exam.
CLO3	Group Discussion and Problem Based Learning	Class Test and Final Exam.

Learning Materials

Recommended Readings	Benson, H. J. (2002) Microbiological applications a laboratory manual in general microbiology. (8th ed.). McGraw-Hill Science. Dirk et al. (2019). Modern soil microbiology. (3rd ed.). CRC Press, Taylor & Francis Group.
Supplementary Readings	Weaver, R. W. et al. (eds.). (1994). Methods of soil analysis—Part 2. Microbiological and biochemical properties. Soil Science Society of America, Inc., Madison, WI.

Course Code: 0888 13 SWE 3121	Year: Third	Term: First
Course Title	Watershed and Wetland Management	
Course Status	Core	
Credit	3.0	
Prerequisite(s)	None	
Rationale	This course is designed to provide students with the theoretical knowledge base for the efficient monitoring, management, conservation of water resources.	

Course Contents		CLOs
Section A		
1	Introduction to Watershed: Definitions, classification of the watershed; watershed boundary; watershed resources; watershed morphology; causes and consequences of watershed deterioration; principles and objectives of watershed management.	1
2	Watershed Hydrology: Hydrologic cycle: precipitation, interception, infiltration, runoff, evaporation and transpiration; Surface, subsurface and groundwater; basic hydrologic processes within a watershed boundary; land use impact on watershed hydrology.	1
3	Watershed Survey and Planning: Objectives, The need for watershed survey and planning; identification of watershed problems; survey and planning mechanisms; survey data reporting and analysis; recommendations for improvement.	2
4	Integrated Watershed Management (IWM): Principles of IWM; multidisciplinary approach to watershed management; parameters of a watershed; organizations involvement needed; participatory watershed management; watershed management in different Asian countries and Bangladesh, control and mitigate watershed problems.	2
Section B		CLOs
5	Sedimentation: Types of sediment, sediments in a water body, fluid velocity-sediment concentration interaction, sediment transport, sediment production, sedimentation process, factors affecting the movement of sediments, sediment deposition, reservoir sedimentation.	2
6	Hill Soil and Watershed Management: Concepts on hill soils, soils in the watershed, effects of land use and land capability, soil erosion and its management in a watershed program, forests and erosion, human activities in forests and their impacts on erosion, forest and water availability, hilly watershed problems and their solutions, landslides, unstable slope, slope stability analysis, prevention and stabilization measures.	2
7	Wetland and Global Climate Change: Definition, types of wetlands; 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.	3
8	Wetland Restoration: Wetlands in Bangladesh: past, present and future; wetland deterioration: causes and consequences; wetland biodiversity; needs of wetland restoration, and wetland and water security.	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	illustrate the concepts of the watershed, watershed hydrology and watershed management and their effect on land, water, wetland and ecosystem resources;	1, 2, 3
	CLO2	execute watershed survey for the assessment and planning, develop mitigation techniques for controlling watershed deterioration problems;	2, 3, 6
	CLO3	Categorize and characterize wetlands, illustrate their functions and benefits in the ecosystem and climate and project the needs of wetland preservation and restoration.	4, 5, 6

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CL01	Lecture and Team Teaching	Quiz Test
CL02	Problem-based Learning and Presentation	Assignment and Class Test
CL03	Lecture and Group Discussion	Viva voce and Final Exam

Learning Materials

Recommended Readings	<p>Khan, L. R. (1991). Watershed management. Field Document No. 44, UNDP/FAO-BGD/85/011, Inst. of Forestry, Chittagong University, Bangladesh.</p> <p>Khan, M. A. (2012). Watershed Management For Sustainable Agriculture, Bio-Green Books Publishers.</p> <p>Watershed Management in Asia and the Pacific. (1986). Needs and Opportunities for Action. AS/85/017, Tech. Report, Food and Agriculture Organization of the United Nations, Rome.</p> <p>Lal, R. (2000). Integrated watershed management in the global ecosystem, CRC Press.</p>
Supplementary Readings	<p>FAO Watershed Management Field Manual (Landslide Prevention Measures), FAO conservation guide 13/1 Vegetative and Soil Treatment Measures</p> <p>Leyon, J. G. (2003). GIS for Water Resources and Watershed Management.2020</p> <p>Wani, S. P., Rockström, J., & Sahrawat, K. L. (2011). Integrated watershed management in rainfed agriculture. CRC Press.</p>

Course Code: 0888 13 SWE 3122	Year: Third	Term: First
Course Title	Watershed and Wetland Management Sessional and Fieldwork	
Course Status	Core	
Credit	1.0	
Prerequisite(s)	None	
Rationale	This course is designed to provide skills to conduct survey to monitor change in characterizing watershed, and prioritize needs for the optimization of the environmental processes for better watershed health.	

Course Contents/Tasks		CLOs
1	Conduct a field visit and survey to hill and plain land watershed.	1
2	Characterization of the given watershed by conducting a survey.	1
3	Analysis of watershed hydrology: drainage density, stream ordering, surface water and groundwater sources, volume of surface and groundwater storage recharge, evaporation and runoff.	3
4	Determination of stream velocity and estimation of sediment load of a reservoir.	2
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.	2, 3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	measure different watershed parameters to indicate its condition and detect the problems and delineate the extent of the problem;	3, 6
	CLO2	calculate stream velocity and graph the sediment load of the reservoir across the depth and the distance;	7, 10
	CLO3	Compute storage capacity and runoff volume of a given precipitation for partitioning of rainwater into infiltration runoff.	3, 6, 7

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Team Teaching	Quiz Test
CLO2	Problem-based Learning and Presentation	Assignment
CLO3	Lecture and Group Discussion	Viva voce and Final Exam

Learning Materials

Recommended Readings	Hewlett, J. D. (1982). Principles of forest hydrology, The University of Georgia Press, Athens. Khan, L. R. (1991). Watershed management. Field Document No. 44, UNDP/FAO-BGD/85/011, Inst. of Forestry, Chittagong University, Bangladesh. Khan, M. A. (2012). Watershed management for sustainable agriculture, Bio-Green Books Publishers.
Supplementary Readings	Pereira, H. C. (1973). Land use and water resources. Cambridge Univ. Press, U.K. Watershed Management in Asia and the Pacific. (1986). Needs and Opportunities for Action. AS/85/017, Tech. Report, Food and Agriculture Organization of the United Nations, Rome.

Course Code: 0888 13 SWE 3131	Year: Third	Term: First
Course Title	Environmental Hazards and Disaster Management	
Course Status	Optional	
Credit	3.0	
Prerequisite(s)	None	
Rationale	This course is designed to acquire knowledge and illustrate environmental hazards and disaster and their measures of control.	

Course Contents		CLOs
Section A		
1	Definition of hazards and disaster, risk, and vulnerability.	1
2	Climate hazards: floods, storms, drought.	1
3	Geohazards: Earthquakes, landslides and volcanic hazards.	2
4	Other hazards: natural, semi-natural and man-made hazards.	2
Section B		CLOs
5	Assessment of vulnerability by using different indices.	3
6	Monitoring and modeling hazards; impact and mitigation measures.	2
7	Risk assessment and the crisis management cycle, Disaster risk reduction strategies.	3
8	Assessment of vulnerability by using different indices	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	differentiate between types of hazards and relate the natural processes and anthropogenic activities with the hazards take place;	1, 2, 3
	CLO2	illustrate the concepts of monitoring and projection of global changes, risks, vulnerability, and their impacts;	2, 3, 6
	CLO3	assess risk and vulnerability and suggest measures of controlling frequency of hazards and their impact.	4, 5, 6

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Team Teaching	Quiz and Class Test
CLO2	Problem-based Learning and Presentation	Assignment and Final Exam
CLO3	Lecture and Group Discussion	Viva voce and Final Exam

Learning Materials

Recommended Readings	Farid, A. (2016). Geohazards caused by human activity. Publisher: ExLi4EvA. Delgado, R. S. (2021). Disasters and life in anticipation of slow calamity: Perspectives from the Colombian Andes. 1st edition. Routledge.
Supplementary Readings	McCall, G. J. H., Laming, D. J. C., & S. C. Scott (eds.). (1992.) Geohazards-Natural and man-made. Chapman & Hall India.

Course Code: 0542 13 Stat 3151	Year: Third	Term: First
Course Title	Statistics	
Course Status	Optional	
Credit	3.0	
Prerequisite(s)	None	
Rationale	The course intends to train students mind to like a scientist to organize, summarize, analyze and interpret data in different subject areas. The students of this course are expected to learn and illustrate the concept of basic and applied statistics.	

Course Contents		CLOs
Section A		
1	Data Collection: Introduction to the practice of statistics; Statistics and statistical thinking; Process of statistics; Variables; Observational studies, Experiments, Simple random sampling; Other effective sampling methods; Sources of errors in sampling; The design of experiments;	1, 3
2	Organizing and Summarizing Data: Organizing qualitative data in tables and graphs; Organizing quantitative data in tables and graphs; Construct histograms; Draw stem-and-leaf plots; Identify the shape of a distribution; Draw time-series graphs; Graphical misrepresentations of data;	1
3	Numerically Summarizing Data: Measures of central tendency; Measures of dispersion; Measures of central tendency and dispersion from grouped data; Measures of position; The five-number summary and boxplots;	3, 4
4	Describing the Relation between Two Variables: Scatter diagrams and correlation; Least-squares regression; The coefficient of determination;	4
Section B		
CLOs		
5	Probability and Forms of Distribution: Concept and definition of probability; Terminologies related to probability; Rules of probability; Mathematical problems of probability; Probability distribution; Normal distribution; Properties of normal distribution; Area relation in normal distribution; Problems and solution of normal distribution; Central limit theorem; Empirical rule; Bayes theorem with problems and solution;	1, 3
6	Time series analysis: Concept of time series analysis; Components of time series; Trend analysis measurement through different techniques;	3, 4
7	Moments, Skewness and Kurtosis: Computation of moments for grouped data; Skewness and Kurtosis;	4
8	Sampling: Definition of population and sample; Characteristics of good sample design; Types of population and sample; Probability and non-probability sample; Census and sample survey; Criteria of selecting a sampling procedure; Sampling procedure with or without replacement; Problems and solution for sampling;	2, 3, 4

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	illustrate the different types of variables, how they are used, and how to summarize the data; illustrate and make the different types of plots and graphs;	1, 2, 3
	CLO2	apply common statistical methods for inference; Illustrate linear relationships; apply Z-test and t-tests appropriately;	3, 7, 10
	CLO3	outline the concepts of probability, sampling distribution and estimation; calculate and correctly interpret probability data from a sampling distribution;	2, 7, 10
	CLO4	explain statistical reasoning skills correctly and contextually; use basic analytical techniques to generate results; interpret results of commonly used statistical analyses in written summaries.	10

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, question-answer, home work	Quizzes, written test
CLO2	Lecture, problem-based learning and presentation	Assignment, written test
CLO3	Lecture, group discussion	Assignment, written test
CLO4	Lecture, class room discussion, home work, student presentation	Assignment, written test, oral examination

Learning Materials

Recommended Readings	<p>Frank, H., & Althoen, S. C. (1995). Statistics-concepts and applications. Cambridge University Press.</p> <p>Mian, M. A., & Miyan, M. A. (1994). An introduction to statistics. Ideal library, Dhaka.</p> <p>Gomez, K. A., & Gomez, A. A. (1984). Statistical procedures for agricultural research. John wiley & sons.</p> <p>Singh, Y. K. (2006). Fundamental of research methodology and statistics. New Age International.</p> <p>Sullivan III, M. (2015). Fundamentals of statistics. Pearson.</p>
Supplementary Readings	<p>Waipole, R. E. (1974). Introduction to statistics. MacMillian and Co. Ltd. New York.</p> <p>Zaman, S. M. H., Rahim, K., & Howlader, M. (1982). Simple Lessons from Biometry. Bangladesh Rice Research Institute.</p>

Course Code: 0542 13 Stat 3152		Year: Third	Term: First
Course Title	Statistics Sessional		
Course Status	Optional		
Credit	1.0		
Prerequisite(s)	None		
Rationale	This course is introduced to familiarize students with practical knowledge about statistics and computer packages as statistical tools.		

Course Contents/Tasks		CLOs
1	Formation of frequency distributions; diagrammatic and graphical presentations of statistical data.	1, 3
2	Computation of different measures of central tendency and dispersion; coefficient of variation.	1, 3
3	Computation of simple, multiple and partial correlation coefficient; computation of regression coefficient and regression equations; fitting of linear regression models for prediction.	2, 3
4	Study of time series with agronomic and incubation data	1, 3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	construct frequency table and present data graphically and measure central tendency and dispersion. Use time data for research purpose;	10
	CLO2	calculate, compute and analyze the correlation coefficient, regression coefficient and regression equations;	10
	CLO3	use computer built-in software packages for solving statistical problems.	10

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Team Teaching	Quiz Test
CLO2	Problem-based Learning and Presentation	Assignment
CLO3	Lecture and Group Discussion	Viva voce and Final Exam

Learning Materials

Recommended Readings	
	Gomez, K. A., & Gomez, A. A. (1984). Statistical procedures for agricultural research. John Wiley & sons. Zaman, S. M. H., Rahim, K. & Howlader, M. (1982). Simple lessons from biometry. Bangladesh Rice Research Institute.

Course Code: 0731 13 URP 3154	Year: Third	Term: First
Course Title	Geographical Information System Sessional	
Course Status	Optional	
Credit	1.0	
Prerequisite(s)	None	
Rationale	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 for intended purpose.	

Course Contents/Tasks		CLOs
1	Developing spatial database: Digitizing; Digitizing Considerations: format, ID, error reduction in digitizing; Topology creation and map correction, Error identification and editing. Coordinate System and map projection.	1
2	GIS Map and Database: joining database with map. Query: attribute and spatial query, summarization. Table Manipulations, Overlay Techniques, Model Builder.	2
3	Spatial analysis: Interpolation, Hill shade, slope, aspect. IDW, Kriging, spline. 3D Analysis: Creating and managing 3D GIS data. 3D Data Visualization, DEM, 3D Terrain and Surface Analysis,	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	gain proficiency in GIS software;	10
	CLO2	produce effective maps of analytical results which adhere to established cartographic standards;	8, 10
	CLO3	gain proficiency in spatial data analysis and 3D data analysis.	8, 10

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Team Teaching	Quiz Test
CLO2	Problem-based Learning and Presentation	Assignment
CLO3	Lecture and Group Discussion	Viva voce and Final Exam

Learning Materials

Recommended Readings	
	Saif, S. I., (2014). Aerial photography, photogeology, GIS, R.S. And image processing, LAP LAMBERT Academic Publishing (February 5, 2014). Armstrong, L. (2015). Mapping and modeling weather and climate with GIS. (1st ed.), Esri Press.

Third Year Second Term			
Course Code: 0888 13 SWE 3211		Year: Third	Term: Second
Course Title	Soil Chemistry II		
Course Status	Core		
Credit	3.0		
Prerequisite(s)	None		
Rationale	The course is designed to provide the students with the concepts of soil chemical phenomena involved in the fixation of soil environment for plant growth.		

Course Contents		CLOs
Section A		
1	Cation Exchange and Anion Exchange in Soil: Concepts of adsorption of cations and anions, cation exchange capacity (CEC) and anion exchange capacity (AEC), types of CEC and AEC, factors affecting CEC, methods of CEC and AEC determination, cation and anion exchange reactions, empirical equations of cation and anion exchange.	1
2	Fixation of Nutrients in Inorganic Way: Non-biological fixation of N and P: factors affecting non-biological fixation of N and 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.	2, 3
3	Chelation and Complexation/Chemistry of Soil Organic Matter Interaction: 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; complex formation with soil pollutants, speciation of soil pollutants; soil as a source and sink of soil pollutants.	2
4	Buffering: Definition, buffering action and buffer solution soil as a buffer, importance of buffering in agriculture, nutrient buffering; base saturation percentage.	1
Section B		CLOs
5	Fractionation and Characterization of Nutrients: Fractionation and characterization of N, P, K and S as major nutrients and some micronutrients in soil, Factors controlling the fractions in soil, Significance of individual fractions in crop production.	4
6	Humus/Colloidal Chemistry of Humus: Definition and terminology – humus, humic matter, humic substances, Classification of humic substances on the basis of solubility, Extraction and isolation of humic substances from soil and water, Fractionation of humic substances, Chemical characteristics of humic substances, Spectral characteristics of humic substances, Structural chemistry/ formation of humic substances, Agricultural, industrial and environmental importance of humic substances.	3
7	Isotope and Radiation: Definition – radiation, stable and radioisotope, background radiation, Characteristics of radiation, Techniques for detection of radiation, Application of isotopes in soil fertility research.	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	analyze ion exchange principles and buffering mechanisms to manage soil and water related processes;	6
	CLO2	explain the concept of inorganic nutrient fixation in soil with their implication and complex formation in soil;	1, 3
	CLO3	learn the theories of humus formation, characterize humic substances, and apply tracer techniques in soil and plant study;	2, 3
	CLO4	choose schemes for nutrient fractionation and assess the significance of nutrient fractions in crop production.	2, 7

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Team Teaching	Quiz and Class Test
CLO2	Problem-based Learning and Presentation	Assignment and Final Exam
CLO3	Problem-based Learning and Presentation	Assignment and Final Exam
CLO4	Lecture and Group Discussion	Viva voce and Final Exam

Learning Materials

Recommended Readings	<p>Bear, R. E. (1964). Chemistry of the soil. Oxford and IBH.</p> <p>Bolt, G. H., & Bruggenwert, M. G. M. (1978). Soil chemistry. Elsevier.</p> <p>Forth, H. D. (1984). Fundamentals of soil science. John Willey & Sons, NY.</p> <p>Tan, K. H. (1998). Principles of soil chemistry. Mercel Dekker, Inc.</p>
Supplementary Readings	<p>McBride, M.B. (1994). Environmental chemistry of soils. Oxford University Press.</p> <p>Mortvedt, J. (1972). Micronutrients in agriculture. Wiley & Sons.</p> <p>Sposito, G. (1989). The chemistry of soils. Oxford University Press.</p> <p>Stevenson, F. J. (1982). Nitrogen in agriculture. American Society of Agronomy.</p> <p>Stevenson, F. J. (1999). Cycles of soil. carbon, nitrogen, phosphorus, sulfur. Springer</p>

Course Code: 0888 13 SWE 3212	Year: Third	Term: Second
Course Title	Soil Chemistry II Sessional	
Course Status	Core	
Credit	1.0	
Prerequisite(s)	None	
Rationale	This course is designed to build practical skills in the graduates in order to make use of the soil chemical phenomena in the field and laboratory for the intended purpose.	

Course Contents/Tasks		CLOs
1	Determination of nutrient fixing capacity of soil: N, P, K – fixation in different soils.	1
2	Fractionation of humic substances in soil: isolation and fractionation of humic acid, fulvic acid and humin in different soil under varying conditions	2
3	Fractionation of various macro and micronutrients in soil including N, P, K, S.	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	determine nutrient fixing capacity in soils and apply the knowledge to manage nutrient related problems;	10
	CLO2	fractionate major soil nutrients in soil for explaining the importance of individual fractions in crop production;	8, 10
	CLO3	identify and assess various fractions of humic substances in soil and water that will help in different soil and environmental issues.	8, 10

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Group Discussion	Lab Test and Exam
CLO2	Problem based learning and Group Discussion	Lab Test and Viva Voce
CLO3	Group Reporting and Presentation	Sessional Report and Viva Voce

Learning Materials

Recommended Readings	Bear, R. E. (1964). Chemistry of the soil. Oxford and IBH. Bolt, G. H. & Bruggenwert, M. G. M. (1978). Soil chemistry. Elsevier. Forth, H. D. (1984). Fundamentals of soil science. John Willey & Sons, NY.
Supplementary Readings	Kumaragamage, D., Warren, J., & Spiers, G. (2021). Soil Chemistry. Krzic, M., Walley, F.L., Diochon, A., Paré, M.C., & Farrell, R.E. (Eds.) 2021. Digging into Canadian soils: An introduction to soil science. Pinawa, MB: Canadian Society of Soil Science.

Course Code: 0542 13 SWE 3213	Year: Third	Term: Second
Course Title	Soil Erosion and Conservation	
Course Status	Core	
Credit	3.0	
Prerequisite(s)	None	
Rationale	his course is designed to focus on the concern that topsoil erosion implicates loss of inherent soil fertility, which leads to soil degradation and decline in agricultural productivity. The scope of this course is, therefore, intended to encompass the theoretical foundation on the types, grades and extents of soil erosion and degradation, their impacts on the environment and measures of control.	

Course Contents		CLOs
Section A		
1	Introduction to soil Erosion and Conservation: Soil as a basic and irreplaceable resource, soil as an endangered ecosystem, population versus resource base of the world and Bangladesh; Definition and types of soil erosion, history of soil erosion and conservation in different civilizations, soil erosion in modern times, harmful effects of soil erosion (on-site and off-site). The interlink between soil erosion, agricultural productivity, and food security.	1
2	Wind Erosion: Classification of soil erosion, mechanism of particle movement in wind erosion, factors affecting water erosion and wind erosion, wind erosion hazard, wind erosion model, practices for controlling wind erosion.	1
3	Water Erosion: Terminologies; erosivity and erodibility, classification of water erosion (soil erosion), physical factors affecting water erosion, rainfall erosivity indices, soil erodibility indices, quantifying the impact of water erosion, practices controlling water erosion.	1
4	Agronomic and Mechanical Methods of Soil Conservation: 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.	3
Section B		CLOs
5	Agriculture in Hill Tracts: Shifting (jhum) cultivation, methods of cultivation & cropping practices, Problem associated with jhum cultivation. Land use in hilly areas that triggers erosion, Sloping land and Erosion, slope and soil vulnerability, landslides- types, identification and mitigation of landslide hazard, guidelines for people at risky areas, guidelines for people at risky areas.	1
6	Agronomic and Mechanical Methods of Soil Conservation: 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.	3
7	Land capability classification (LCC): LCC as a guide to conservation, LCC system of USA, Description of the major 8 classes of lands. LCC system of Bangladesh class, major subclass and ordinary subclass), Description of the major 5 classes of lands.	3
8	Soil Conservation and Sustainable Land Use: Need of conservation, Conservation practice verses sustainable practice, soil conservation in Bangladesh, 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. Concept of sustainability, sustainable land use and soil resilience, measurement of sustainability, land use, soil management and sustainability relationship, technological options for sustainable land use.	4

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	recognize and illustrate the types of erosion and landslides vulnerability in the sloping land, provide guidelines to people for safety and security and describe agriculture in hill tracts;	2, 3
	CLO2	relate the agents of change in the sloping land with erosion and degradation and show the probable impacts;	3, 6
	CLO3	illustrate the needs for the adoption of land capability classification system and conservation practices;	3, 6
	CLO4	identify and select appropriate management practices and evidences of their efficacy in controlling erosion.	6, 7

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Team Teaching	Quiz and Class Test
CLO2	Problem-based Learning and Presentation	Assignment and Final Exam
CLO3	Lecture and Group Discussion	Viva voce and Final Exam
CLO4	Lecture, Group Report Submission, Presentation	Class Test and Final Exam

Learning Materials

Recommended Readings	<p>Morgan, R. P. C. (2009). Soil erosion and conservation. John Wiley & Sons.</p> <p>El-Swaify, S. A., Moldenhauer, W. C., & Lo, A. (1985). Soil erosion and conservation. Soil Conservation Society of America.</p> <p>Zahid, A. M., Kohinnor, N. A., Hossain, M. A., & Shoaib, J.U.M. (2020). Land degradation in Bangladesh – Baseline study of land degradation processes 1985-2000. Soil Resource Development Institute (SRDI), Ministry of Agriculture, Bangladesh</p> <p>DoE. (2019). National Report on Land Degradation Neutrality Target Setting Programme. Department of Environment (DoE), Ministry of Environment, Forest and Climate Change (MoEFCC), Bangladesh.</p>
Supplementary Readings	<p>Toy, T. J., Foster, G. R., & Renard, K. G. (2002). Soil erosion: processes, prediction, measurement, and control. John Wiley & Sons.</p> <p>Showers, K. B. (2005). Imperial gullies: soil erosion and conservation in Lesotho. Ohio University Press.</p> <p>Haregeweyn, N., Tsunekawa, A., Nyssen, J., Poesen, J., Tsubo, M., Tsegaye Meshesha, D., ... & Tegegne, F. (2015). Soil erosion and conservation in Ethiopia: a review. Progress in Physical Geography, 39(6), 750-774.</p>

Course Code: 0888 13 SWE 3214	Year: Third	Term: Second
Course Title	Soil Erosion and Conservation Fieldwork	
Course Status	Core	
Credit	1.0	
Prerequisite(s)	None	
Rationale	This course is designed for the assessment of soil erosion and degradation. It focuses on the identification of the primary causes of soil degradation, quantification of soil loss, and the field level training for developing skill for the installation or construction of measures of erosion control essential for soil and water conservation practices, sustainable use of land.	

Course Contents/Tasks		CLOs
1	Estimation of soil erosion and soil erodibility.	2
2	Measurement of slope attributes and contour line formation by A-frame; stabilization of vulnerable slope.	1
3	Agronomic and mechanical measures of erosion control – ways to select plant species and construct hedge row, strip and buffer strip cultivation.	3
4	Mechanical measures of erosion control - constructing of gabion dam, safe-water ways for the protection of gully erosion.	2, 3
5	Field trip to CHTs for conduct a survey on hilly agricultural practices, jhum cultivation, spotting and delineation of slope vulnerability to the practices in place for gully erosion, mass wasting, landslides, slop failure etc.	1, 2, 3
6	Demonstration of different soil conservation, water conservation and erosion control measures constructed in the research stations in CHTs with their know-hows of construction and precautionary measures, application of technologies in farmers field.	1, 2, 3, 4

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	determine slope gradient and classify sloping land and identify vulnerable areas and stabilize slope;	6, 7
	CLO2	estimate the amount of water erosion and soil erodibility;	3, 6, 7
	CLO3	construct contour line for different terraces and design and construct gabion check dam, safe-water ways and retention terrace;	3, 7
	CLO4	identify agronomic and mechanical measures of erosion control, water storage and conservation practices.	5, 6

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Team Teaching	Quiz and Class Test
CLO2	Problem-based Learning and Group Discussion	Field Test and Exam
CLO3	Field lecture, Field training	Field Demonstration Test and Viva voce
CLO4	Group Reporting and Presentation	Sessional Report and Viva voce

Learning Materials

Recommended Readings	Blilotta, S.G., Grove, M., & Mudd, S. (2012). Assessing the significance of soil erosion. Transaction of the institute of British Geographers 37(3), 342-345. http://10.2307/41678635 . Showers, K. B. (2005). Imperial gullies: soil erosion and conservation in Lesotho. Ohio University Press. Stocking, M. A., & Murnaghan, N. (2013). A handbook for the field assessment of land degradation. Routledge.
Supplementary Readings	Gould, B. W., Saupe, W. E., & Klemme, R. M. (1989). Conservation tillage: the role of farm and operator characteristics and the perception of soil erosion. Land economics, 65(2), 167-182. Showers, K. B. (2005). Imperial gullies: soil erosion and conservation in Lesotho. Ohio University Press.

Course Code: 0888 13 SWE 3215	Year: Third	Term: Second
Course Title	Problem Soils of Bangladesh	
Course Status	Core	
Credit	3.0	
Prerequisite(s)	None	
Rationale	This course is designed to introduce with some problems soils of Bangladesh, their locations, nature, potentials, possibilities, and remediation or adaptation techniques/technologies as these soils too are critical to the environment, food and fiber production.	

Course Contents		CLOs
Section A		
1	Salt Affected Soils: Problem statement for all problem soils; introduction; classification; properties; extent; major agricultural constraints; reclamation and management of salt affected soils.	1, 2
2	Acid Sulphate Soils: Introduction; types; characteristics; extent; constraints; management.	1
3	Hill Soils: Introduction; classification; major problems in the hills; management of hill soils	1, 2
4	Deeply Flooded Soil/Very Poorly Drained Soil: Introduction; beel, jheel, haor, baor; problems related to deeply flooded soil; management of deeply flooded soil	1, 2
5	Soils with Plough Pan: Introduction; causes; problems; management.	3
Section B		
6	Peat Soils (Organic Soils): Introduction; types; distribution; problems related to crop production; management.	1, 2, 3
7	Organic Matter Deficient Soil: 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.	1, 2, 3
8	Charland Soil: Introduction; soil related problems; distribution; char forming process and agents; soils of charland; agricultural developments potentials.	1, 2
9	Drought Prone Soil: Introduction; types; causes of drought; location and extent; problems; management. 10. Course Textured Soils: Introduction; location and extent; characteristics; problems; management.	1, 2
10	Course Textured Soils: Introduction; location and extent; characteristics; problems; management.	1, 3
11	Nutrient Deficient Soil (Sulphur and Zinc): Introduction; classification; problems; recognition; causes; types, management.	1, 2, 3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	identify and classify existing problem soils of Bangladesh;	2, 6, 5
	CLO2	get the idea about the reclamation and maintenance of problem soils;	4, 7, 8
CLO3	manage and solve the problems related to these soils and its management.	5, 6, 7	

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Team Teaching	Quiz, presentation and Class Test
CLO2	Problem-based Learning and Presentation	Assignment and Final Exam
CLO3	Lecture and Group Discussion	Viva voce and Final Exam

Learning Materials

Recommended Readings	<p>Balba, A. M. (2018). Management of problem soils in arid ecosystems. CRC Press.</p> <p>Huq, S. I., & Shoaib, J. M. (2013). The soils of Bangladesh (Vol. 1). Dordrecht: Springer.</p> <p>Ponnamperuma, F. N. (1972). The chemistry of submerged soils. <i>Advances in agronomy</i>, 24, 29-96.</p> <p>Bresler, E., McNeal, B. L., & Carter, D. L. (2012). Saline and sodic soils: principles-dynamics-modeling (Vol. 10). Springer Science & Business Media.</p>
Supplementary Readings	<p>Osman, K. T. (2018). Saline and sodic soils. In <i>Management of soil problems</i> (pp. 255-298). Springer, Cham.</p> <p>Podder, M., Akter, M., Saifullah, A.S.M. and Roy, S., 2012. Impacts of plough pan on physical and chemical properties of soil. <i>Journal of Environmental Science and Natural Resources</i>, 5(1), pp.289-294.</p> <p>Wong, V.N., Greene, R.S.B., Dalal, R.C. and Murphy, B.W., 2010. Soil carbon dynamics in saline and sodic soils: a review. <i>Soil use and management</i>, 26(1), pp.2-11.</p>

Course Code: 0888 13 SWE 3216	Year: Third	Term: Second
Course Title	Problem Soils of Bangladesh Sessional and Fieldwork	
Course Status	Core	
Credit	1.0	
Prerequisite(s)	None	
Rationale	The course is designed to deal with management related issues associated with problem soils formation, field identification of problem soils and their imposed limitations towards successful crop production.	

Course Contents/Tasks		CLOs
1	Categories Salt affected soils in terms of soil chemical and physical properties	1, 2
2	Examination and description of problem soils in the field based on their limitation imposed.	1, 2
3	Field identification of actual and potential Acid sulphate Soils associated with undergoing geochemical changes	1, 2
4	Case study of in situ morphological characteristics and local techniques that are being applied to overcome management issues for problem soils	2

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:	Mapping with PLOs
CL01	conduct soil research to categories land quality based on their imposed limitations and demonstrate differences in problem soils;	8
CL02	reveal land use management issues for best possible approaches.	3

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CL01	Field Lecture, Team Teaching, Problem-based Learning and Presentation	Quiz, Viva voce and Final Exam
CL02	Field work	Sessional report and Final Exam

Learning Materials

Recommended Readings	<p>Balba, A. M. (2018). Management of problem soils in arid ecosystems. CRC Press.</p> <p>Beek, K. J., Blokhuis, W. A., Driessen, P. M., Breemen, N. V., Brinkman, R., & Pons, L. J. (1980). Problem soils: their reclamation and management. Land reclamation and water management. Developments, problems and challenges, 9-72.</p> <p>Diop, S., Stapelberg, F., Tegegn, K., Ngubelanga, S., & Heath, L. (2011). A review on problem soils in South Africa. Council for Geoscience Report, (2011-0062).</p>
Supplementary Readings	<p>Morin, W. J., & Todor, P. C. (1975). Laterite and lateritic soils and other problem soils of the tropics. Agency for International Development.</p> <p>Williams, A. A. B., Pidgeon, J. T., & Day, P. W. (1985). Expansive soils: problem soils in South Africa-state of the art. Civil Engineer in South Africa, 27(7), 367-401.</p>

Course Code: 0888 13 SWE 3231	Year: Third	Term: Second
Course Title	Biochar Concept and Application	
Course Status	Optional	
Credit	3.0	
Prerequisite(s)	None	
Rationale	This course is designed to provide an overview of current biochar knowledge related to its application to soil, and gives ideas for using biochar in a variety of soil management systems.	

Course Contents		CLOs
Section A		
1	Background and introduction of biochar.	1
2	Physical, chemical and biological properties of biochar.	2, 3
3	Impact of biochar on soil properties.	2, 3
4	Biochar and soil nutrient transformations.	2, 3
5	Change and stability of biochar in soil.	2, 3
Section B		CLOs
6	Biochar and climate change.	3
7	Biochar and emission of greenhouse gases.	2, 3
8	Biochar production technology.	1
9	Economics of biochar production and utilization.	4
10	Socio-economic assessment of biochar projects.	3, 4
11	Some essential concepts for commercial success of biochar.	1, 4

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	extend biochar and biochar production technology;	1
	CLO2	explain the effects of applying biochar on soil nutrient transformations and soil fertility;	2
	CLO3	realize the impact of biochar on climate change;	3
	CLO4	assess the economics of biochar production and utilization.	4

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, homework	Quizzes and written test
CLO2	Lecture, class room discussion	Assignment, oral examination, written test
CLO3	Lecture, student assignment, group discussion	Assignment, written test
CLO4	Lecture, group discussion	Question-answer, written test

Learning Materials

Recommended Readings	Bates, A. (2010). The biochar solution: carbon farming and climate change. New Society Publishers. O'Laughlin, J., & McElligott, K. (2009). Biochar for environmental management: science and technology. Johannes Lehmann, Stephen M. Joseph (Eds.), Earthscan, London UK (2009), 448 p. Sohi, S., Lopez-Capel, E., Krull, E., & Bol, R. (2009). Biochar, climate change and soil: A review to guide future research. CSIRO Land and Water Science Report, 5(09), 17-31.
Supplementary Readings	Verheijen, F., Jeffery, S., Bastos, A. C., Van der Velde, M., & Diafas, I. (2010). Biochar application to soils. A critical scientific review of effects on soil properties, processes, and functions. EUR, 24099, 162.

Course Code: 0888 13 SWE 3232	Year: Third	Term: Second
Course Title	Biochar Concept and Application Sessional and Fieldwork	
Course Status	Optional	
Credit	1.0	
Prerequisite(s)	None	
Rationale	This course is designed to give the students practical knowledge on biochar production, its characterization and application to soil.	

Course Contents/Tasks		CLOs
1	Biochar preparation from different materials under varying temperature	1
2	Biochar characterization and testing of biochar materials	1, 2
3	Biochar effects on soil fertility and nutrient cycling	3, 4

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	Prepare biochar individually,	
CLO2	Characterize biochar,		6, 7
CLO3	Find the effect of biochar application in soil,		3
CLO4	Interpret the experimental findings.		10

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Theoretical lessons, field and laboratory exercise	Field or laboratory exercise, oral examination
CLO2	Theoretical lessons, laboratory exercise	Laboratory exercise, report, oral examination
CLO3	Theoretical lessons, field experiment	Field observation, report, oral examination
CLO4	Theoretical lessons, exercise	Report, presentation, oral examination

Learning Materials

Recommended Readings	Bates, A. (2010). The biochar solution: carbon farming and climate change. New Society Publishers. O'Laughlin, J., & McElligott, K. (2009). Biochar for environmental management: science and technology. Johannes Lehmann, Stephen M. Joseph (Eds.), Earthscan, London UK (2009), 448 p. Sohi, S., Lopez-Capel, E., Krull, E., & Bol, R. (2009). Biochar, climate change and soil: A review to guide future research. CSIRO Land and Water Science Report, 5(09), 17-31.
Supplementary Readings	Verheijen, F., Jeffery, S., Bastos, A. C., Van der Velde, M., & Diafas, I. (2010). Biochar application to soils. A critical scientific review of effects on soil properties, processes, and functions. EUR, 24099, 162

Course Code: 0888 13 SWE 3241	Year: Third	Term: Second
Course Title	Research Methodology	
Course Status	Core	
Credit	3.0	
Prerequisite(s)	None	
Rationale	The course is designed to provide the students with knowledge of the development research methodology and integration of its major components. Students are expected to apply their knowledge by conducting a research study and writing a comprehensive thesis.	

Course Contents		CLOs
Section A		
1	Perception of Research: 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.	1
2	Research Process: 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. Defining the Research Problem What is a research problem? Necessity of defining the problem Technique involved in defining a problem	1
3	Research Proposal and Report Writing: 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.	1
4	Data Analysis and Presentation of Research Results: 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.	2
Section B		CLOs
5	Elements of Experimentation: 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.	3
6	Experimental Designs: 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.	3, 4
7	Analysis of Variance and Covariance: 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.	3, 4
8	Comparison Between Treatment Means: Least significant difference test (LSD), Duncan's multiple range test (DMRT).	3, 4
9	Reliability and Validity in Measurements: 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.	3,4

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	develop the ability to apply the methods while working on a research project work;	8
	CLO2	describe the appropriate statistical methods required for a particular research design;	10
	CLO3	choose the appropriate research design and develop appropriate research hypothesis for a research project;	8, 10
	CLO4	develop an appropriate framework for research studies;	8, 9, 10

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, group discussion and presentation	Presentation by student, quizzes and class test
CLO2	Lecture, presentation, question and answer, problem-based learning and presentation	Assignment and Final Exam
CLO3	Lecture, presentation, question and answer	Written examination, multiple-choice examination, homework
CLO4	Lecture, problem-based learning, group discussion and presentation	Interactive application assignments, presentation by students, written examination

Learning Materials

Recommended Readings	Gomez, K. A., & Gomez, A. A. (1984). Statistical procedures for agricultural research. John Wiley & Sons. Hatcher, L. (2013). Advanced statistics in research: reading, understanding, and writing up data analysis results. Shadow Finch Media LLC. Tuckman, B. W., & Harper, B. E. (2012). Conducting educational research (6th ed.). Lanham, MD: Rowan & Littlefield Publishers.
Supplementary Readings	Hinkelmann, K., & Kempthorne, O. (2005). Design and analysis of experiments, advanced experimental design. Wiley-Interscience

Course Code: 0888 13 SWE 3242	Year: Third	Term: Second
Course Title	Research Methodology Sessional and Fieldwork	
Course Status	Core	
Credit	1.0	
Prerequisite(s)	None	
Rationale	This course is designed to have contents and practices for capacity building in the graduates for proper questionnaire preparation, operation of statistical software, research data handling, arrangement, input, illustration and interpretation.	

Course Contents/Tasks		CLOs
1	Exercises in review of literature; Identification of research problem; Establishing hypothesis; Designing experiments;	1, 2
2	Preparation of questionnaire and field data collection; Research proposal development;	1
3	Scientific papers writing; Exercise in writing abstract, introduction, result, discussion and conclusion	2
4	Citation and reference writing style; application of referencing soft tools;	2
5	Formation of plots and blocks, randomization and layout of CRD, CRBD and LS design; analysis of data obtained from CRD, CRBD, LS design.	3
6	Analyses of quantitative and qualitative data using biostatistics, informatics, computer-based programming (SAS, Minitab etc).	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	develop an independent research proposal, synopsis, questionnaire;	8
	CLO2	write research report, thesis, scientific article for publishing;	7, 8
	CLO3	analyze experimental data using statistical software and present research results.	10

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Theoretical lessons for field measurement, sample collection and field work, In-situ field demonstration	Hands-on work in the field, field exercise, written test and oral examination
CLO2	Theoretical lessons, exercise	Laboratory exercise, written test and oral examination
CLO3	Theoretical lessons, field work, laboratory exercise, single and/or group assignment	Laboratory exercise, report and oral examination

Learning Materials

Recommended Readings	Hatcher, L. (2013). Advanced statistics in research: reading, understanding, and writing up data analysis results. Shadow Finch Media LLC. Dowdy, S., Weardon, S., & Chilko, D. (2004). Statistics for research. (3rd ed.). John Wiley & Sons, Inc., Hoboken, New Jersey. Cody, R. (2011). SAS® statistics by example. Cary, NC: SAS Institute Inc.
Supplementary Readings	Dunnett, C. W. (1955). A multiple comparison procedure for comparing several treatments with a control. Journal of the American Statistical Association, 50: 1096-1121.

Course Code: 0888 13 SWE 3244	Year: Third	Term: Second
Course Title	Comprehensive Viva voce III	
Course Status	Core	
Credit	1.0	
Prerequisite(s)	None	
Rationale	The 'Comprehensive Viva voce III' aims to review subjective knowledge learned throughout year 3 of the program, and develop depth of academic knowledge, ability to defend one's standing. The course inspires the students to grow in cognitive domain focusing attitude and communication skill. The course also aims to develop students' identity in expressing ideas, thoughts in a logical manner.	

Course Contents/Tasks		CLOs
1	The 'Comprehensive Viva voce III Voce' requires the students to face a viva voce/ defense board at the end of the concerned term 6 (end of year 3). The concerned Examination Committee/ Academic Committee of the Discipline will form viva voce board to conduct the viva and assess the students out of 100 marks. If deemed necessary to the concerned Examination Committee, these sessions might be arranged online. The contents of this viva voce will include the gained knowledge, issues covered and concepts handled through the theory/sessional courses conducted in year 3 of the program.	1 to 5

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	review subjective knowledge gained through year 3 of the program;	1, 2
	CLO2	sharpen communication skill with various stakeholders;	9
	CLO3	develop critical thinking to link theoretical knowledge and applicability of Soil, Water and Environmental studies,	8, 9
	CLO4	demonstrate communication behaviors appropriate for effective comprehensive and supportive listening;	9
	CLO5	Develop critical thinking and ethical aspects, and considers local aspects for policy debates.	8

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	As reported for various courses	Viva voce
CLO2	As reported for various courses	Viva voce
CLO3	As reported for various courses	Viva voce
CLO4	As reported for various courses	Viva voce
CLO5	As reported for various courses	Viva voce

Learning Materials

Recommended Readings	As reported for various courses.
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Course Code: 0811 13 Agr 3251	Year: Third	Term: Second
Course Title	Principles and Practices of Organic Farming	
Course Status	Optional	
Credit	3.0	
Prerequisite(s)	None	
Rationale	This course is designed to teach methods and technologies for farming organically to reduce soil pollution and the residues of pollutants in the product thereby minimizing health hazards to humans and animals.	

Course Contents		CLOs
Section A		
1	Organic farming: History, concept and definition, its relevance to Bangladesh and global agriculture and future prospects	1
2	Principles of organic agriculture, components of organic farming, conversion of conventional to organic farming	1
3	Organic farming and water use efficiency; soil fertility, nutrient recycling, roles of soil biota for decomposition of organic residues, biofertilizer for improvement of soil health.	1, 3
4	organic residues management, Organic mulches, characterization of FYM/Rural compost, city compost, Oil cakes, animal wastes, Vermicomposts etc., Green Manure with Leguminous crops in crop rotation.	2
Section B		
5	Pollution Prevention, Best Management Practices, Farming systems, crop rotations, multiple and relay cropping systems, intercropping in relation to maintenance of soil productivity.	1, 3
6	Organic farming in protecting water quality, what are the different ways by which water quality deteriorates? organic farming: environmental benefits nutrient leaching and runoff how organic farming controls nutrient leaching and runoff positive management practices to minimize nutrient leaching and runoff	2
7	Nature saves products for control of weeds and diseases management, biological agents and pheromones and biopesticides.	3
8	Socio-economic impacts; marketing and export potential: inspection, certification, labeling and accreditation procedures; organic farming and national economy.	1, 3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	study of organic farm management and usage of natural resources for maximizing agricultural productivity.	
CLO2	techniques of crop residues and farm waste recycling.		3, 7
CLO3	use of environmentally safe and natural pesticides for pest control		2, 3

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Team Teaching	Quiz and Class Test
CLO2	Problem-based Learning and Presentation	Assignment and Final Exam
CLO3	Lecture and Group Discussion	Viva voce and Final Exam

Learning Materials

Recommended Readings	Dahama, A. K. (2002). Organic farming for sustainable agriculture (2nd ed.). Agrobios publishers, Jodhpur, India. Fosel, P.V. (2007). Organic Farming: Everything you need to know. MBI Publishing Co., USA. Francis, C. A., Flora, C. A., & King, L. D. (1990). Sustainable agriculture and temperate zones. Wiley, New York, USA.
Supplementary Readings	Hatfield, J. L. & Karlen, L. D. (1994). Sustainable agriculture systems. Lewis Pub. Boca Raton, FL, USA.

Course Code: 0811 13 Agr 3252	Year: Third	Term: Second
Course Title	Principles and Practices of Organic Farming Sessional and Fieldwork	
Course Status	Optional	
Credit	1.0	
Prerequisite(s)	None	
Rationale	This course is intended for sustainable improvement of soil health and crop production.	

Course Contents/Tasks		CLOs
1	Aerobic and anaerobic methods of making compost.	1
2	Making of Vermicompost.	2
3	Efficient use of biofertilizers technique (Rhizobium cultures, Azotobacter, Azospirillum, mycorrhiza fungi, and PSB cultures).	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:	Mapping with PLOs
CLO1	to achieve the knowledge to prepare the compost;	7
CLO2	recognize the vermicompost as a soil conditioner;	6
CLO3	know the efficient use biofertilizer technique.	3, 7

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CL01	Field class	Quiz
CL02	Field work	Sessional report and viva voce
CL03	In class activities	Sessional report and viva voce

Learning Materials

Recommended Readings	
	Fossel, P. V. (2007). Organic Farming: Everything you need to know. MBI Publishing Co., USA. Francis, C. A., Flora, C. A., & King, L. D. (1990). Sustainable agriculture and temperate zones. Wiley, New York, USA.

Course Code: 0811 13 Agr 3253	Year: Third	Term: Second
Course Title	Crops of Bangladesh	
Course Status	Optional	
Credit	3.0	
Prerequisite(s)	None	
Rationale	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.	

Course Contents		CLOs
Section A		
1	Major Crops of Bangladesh and Sub-continent: Classification of crops.	1
2	Agronomy of Arable Crops of Bangladesh: Origin, climate, soil requirements, cultural practices, fertilization, harvesting and storing of the main crops of Bangladesh.	1
3	Cereal Crops of Bangladesh: Rice, wheat and maize, brief description about other minor cereal crops of Bangladesh.	3
4	Fibre Crops of Bangladesh: Jute and cotton, brief description about other minor fiber crops.	3
5	Vegetable and Spices: Commercially important vegetable and spices with their economic viability.	3
Section B		CLOs
6	Other Important Crops of Bangladesh: Sugarcane, potato, tobacco, pulse and oilseed crops.	3
7	Agronomy of Perennial Crops: Tea, rubber, jackfruit, mango and coconut.	3
8	Cropping Systems Practiced in Bangladesh: Monocropping, mixed cropping, multiple cropping and crop rotation.	4
9	Cropping Intensity: Definition, present status of cropping intensity in Bangladesh, ways to increase cropping intensity with special reference to the coastal areas of Bangladesh.	2
10	Diseases and their Control Measures: Survey for the crop specific diseases, organic and inorganic measures for the control of diseases, doses for specific disease.	4

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	select suitable crops for the growth in specific location of Bangladesh;	1, 2
	CLO2	design the present status and future possibility of increasing crop cultivation;	3
	CLO3	examine the growth of important cereal crops as well as fiber, vegetable and perennial crops for the economy of Bangladesh;	6, 8
	CLO4	outline the major cropping systems of Bangladesh and identify the cause of diseases with their control measures.	3, 6

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Team Teaching	Quiz and Class Test
CLO2	Problem-based Learning and Presentation	Assignment and Final Exam
CLO3	Lecture and Group Discussion	Presentation and Final Exam
CLO4	Group Discussion and Problem based Learning	Viva voce and Final Exam

Learning Materials

Recommended Readings	<p>Dawe, D. (Ed.). (2012). <i>The rice crisis: Markets, policies and food security</i>. Routledge.</p> <p>Hoque, M. E. (2001). Crop diversification in Bangladesh. <i>Crop diversification in the Asia-Pacific region</i>, 5-23.</p> <p>Mahmud, W., Rahman, S. H., & Zohir, S. (1994). <i>Agricultural growth through crop diversification in Bangladesh</i> (No. BOOK). Washington: IFPRI.</p>
Supplementary Readings	<p>Al Mamun, S., Nasrat, F., & Debi, M. R. (2011). Integrated farming system: prospects in Bangladesh. <i>Journal of Environmental Science and Natural Resources</i>, 4(2), 127-136.</p> <p>Chowdhury, M. A. H., & Hassan, M. S. (2013). <i>Handbook of agricultural technology</i>. Bangladesh. Agricultural Research Council, Farmgate, Dhaka, 230.</p> <p>Sarwar, A. K. M. G., & Biswas, J. K. (2021). Cereal Grains of Bangladesh—Present Status, Constraints and Prospects. <i>Cereal Grains: Volume 1</i>, 19.</p>

Fourth Year First Term			
Course Code: 0888 13 SWE 4111		Year: Fourth	Term: First
Course Title	Soil Survey and Land Evaluation		
Course Status	Core		
Credit	3.0		
Prerequisite(s)	None		
Rationale	This course is designed to illustrate what soil survey and land evaluation are about. It focuses on the tools and methods of soil survey in order to meet the information demand for land evaluation including its scale and purpose. The main emphasis will be on the linkage between soil survey, soil survey interpretation and physical land evaluation for the intended purpose.		

Course Contents		CLOs
Section A		
1	Introduction: History and scope of soil survey; Definition and importance of soil survey; Agricultural and non-agricultural uses of survey data.	1
2	Types of soil Survey: Exploratory, reconnaissance, semi-detailed and detailed. Intensity and scale considerations for soil surveys; Techniques of the types of soil survey with special emphasis on reconnaissance and detailed soil survey.	1
3	Principal types of base material: Base material and their scale, merits and demerits. Interpretation and uses of base materials especially aerial photographs and aerial mosaics, soil survey work plan.	2
4	Soil properties and techniques related to soil survey: Technique of soil survey in the field; use of remote sensing in soil survey.	2
Section B		
CLOs		
5	Soil Mapping and Soil Classification: Soil maps; Mapping types and units; homogeneity of mapping unit, soil mapping legend: principles and types.	3
6	Plotting of soil boundaries: Soil correlation and interpretation, soil grouping on the map.	3
7	Land evaluation: Concept of land evaluation, nature and principles of land evaluation, land capability/suitability classification, land evaluation procedure, approaches of land evaluation.	4
8	Land Use and Land Use Planning: Definition, land use type, major types of rural land use, land use in Bangladesh, and national land use policy. Land cover difference between land use and land cover.	4

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	explain soil survey, its importance, uses and the types and techniques of soil survey;	1, 2
	CLO2	interpret base materials, aerial photographs and demonstrate the knowledge of remote sensing;	3
	CLO3	make use of soil maps, units and legend and interpret plotting of soil boundaries;	6, 8
	CLO4	apply use of soil survey information for the assessment of land capability classification and interpret land use and land use planning.	3, 6

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CL01	Lecture and Presentation	Quiz and Class Test
CL02	Lecture and Group Discussion	Assignment and Final Exam
CL03	Lecture and Debate	Viva voce and Final Exam
CL04	Problem-based Learning and Presentation	Class Test and Final Exam

Learning Materials

Recommended Readings	<p>Brammer, H. (2002). Land use and land use planning in Bangladesh. University Press Ltd.</p> <p>Driessen, P. M., & Konijn, N. T. (1992). Land-use systems analysis. WAU and Interdisciplinary Research (INRES).</p> <p>Rossiter, D. G., & Van Wambeke, A. R. (1997). Automated land evaluation system ALES version 4.65 user's manual. <i>Management</i>, 6(1), 7-20.</p>
Supplementary Readings	<p>Sitorus, S. R. P. (2010). Land capability classification for land evaluation: A review. <i>Jurnal Sumberdaya Lahan</i>, 4(2), 69-78.</p> <p>United States Department of Agriculture (USDA) (1993). Soil Survey Division. Soil survey manual (No. 18).</p>

Course Code: 0888 13 SWE 4112	Year: Fourth	Term: First
Course Title	Soil Survey and Land Evaluation Sessional and Fieldwork	
Course Status	Core	
Credit	1.0	
Prerequisite(s)	None	
Rationale	The course is designed to provide the students with the scope for achieving knowledge and skills through practicing and exercising aerial maps, aerial mosaics and other necessary tools used in remote sensing and soil survey in order to mapping soils for appropriate land uses and land use planning.	

Course Contents/Tasks		CLOs
1	Soil profile examination and description of soil horizons in the field.	1
2	Collection of soil samples.	1
3	Preparation of soil survey report, soil survey interpretation for agricultural uses.	2
4	Study and interpret aerial mosaics and aerial photographs.	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	conduct a soil survey on land uses and demonstrate differences in soil series along catena;	3, 6
	CLO2	appraise land quality for complete evaluation for agronomic and other purposes;	3, 7
	CLO3	demonstrate the uses of aerial photographs and aerial mosaics.	7, 8

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Field class	Field exercise and observation
CLO2	Field work	Sessional report and viva voce
CLO3	In class activities	Sessional report and viva voce

Learning Materials

Recommended Readings	Costantini, E. A. (2017). Manual of methods for soil and land evaluation. CRC Press.
Supplementary Readings	United States Department of Agriculture (USDA). (1993). Soil Survey Division. Soil survey manual (No. 18).

Course Code: 0888 13 SWE 4113	Year: Fourth	Term: First
Course Title	Environmental Soil Mechanics	
Course Status	Core	
Credit	3.0	
Prerequisite(s)	None	
Rationale	This course is designed to illustrate the concepts of basic soil mechanics. It focuses on the physical and mechanical properties of soils, mass-volume relationship, load and stresses, compaction, compression, consolidation due to load, behaviour of soils under the influence of loading forces and soil-water interactions (puddling). This knowledge is applied to classify soils for their use in engineering as well as agricultural purposes.	

Course Contents		CLOs
Section A		
1	Basic Principle of Soil Mechanics: Introduction to Soil Mechanics, Basic definitions, Soil particle size, Clay minerals, Soil structure, Mechanical analysis of soil, Particle size distribution, Sieve analysis and Hydrometer analysis, 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.	1
2	Stress and Strain in Soils: Stress-strain relationship of soil, Type of stresses in soil, Stress distribution in soil: Stress at point, Equilibrium equation, Distribution of stresses within soil mass caused by concentrated load, uniformly distributed load on circular and rectangular areas, Effective stress concept, Effect of water table fluctuation on effective stress, Effects of seepage and capillarity on effective stress, Stress in soil due to the applied load, Boussinesq's equation, Poisson's ratio.	1
3	Soil Compaction and Consolidation: consolidation and compaction; process of compaction; the 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 Modulus of elasticity.	1
4	Compression and Consolidation: One-Dimensional Consolidation, Introduction to consolidation process, Spring analogy, Terzaghi's theory, Laboratory consolidation test, Determination of coefficient of consolidation (cv), e -log p curve, Compression index (cc), Pre-consolidation pressure Primary consolidation and secondary compression, Time rate of consolidation, Settlement of soils.	3
Section B		CLOs
5	Shear strength of soil: Definition; factors affecting soil strength; Mohr's cycle; Mohr-Coulomb failure theory, determination of soil strength; direct shear – triaxial compression.	1
6	Soil compression and compressibility: Unconfined compression test, Triaxial compression test, Shear strength parameter, Types of Triaxial test, Vane shear test, Pore pressure parameters, Sensitivity & Thixotropy of clay, Review of lecture	3
7	Slope stability: Slope failure mechanisms; types; total stress analysis for saturated clay- Fellenius method, friction circle method; use of stability number; mechanical measures for slope stability.	3, 4, 5
8	Effect of tillage (puddling) stresses on soil: Definition of tillage, objectives, advantages and disadvantages of puddling; soil's suitability to puddling, mechanism of puddling; indices of puddling, evaluation of the degree of puddling; effects of puddling, management of puddling.	3, 6

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	define and classify soils for engineering purposes based on their characteristics;	2,7
	CLO2	elaborate the soil structure manifestation, aggregate dynamics, aggregate turnover and turnover time and factors influence them;	1,2
	CLO3	illustrate and demonstrate the agents causing slope failure; explain and compare the effects of soil swelling and puddling on soil structure, density, pan formation and compaction.	6,7,8

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Team Teaching	Presentation and Class Test
CLO2	Problem-based Learning and Presentation	Assignment and Quiz Test
CLO3	Lecture and Group Discussion	Viva voce and Final Exam

Learning Materials

Recommended Readings	<p>Budhu, M. (2011). Soil mechanics & foundations (3rd ed.). John Wiley & Sons, Inc.</p> <p>Das, B. M. and Sobhan, K. (2010). Principles of Geotechnical Engineering, 8th Edition, Cengage Learning.</p> <p>Hillel, D. (2003). Introduction to environmental soil physics (1st ed.). Elsevier academic press, Amsterdam.</p> <p>Knappett, J., & Craig, R. F. (2019). Craig's soil mechanics (9th ed.). CRC Press.</p>
Supplementary Readings	<p>Hillel, D. (1998). Environmental soil physics (1st ed.). San Diego, CA, Academic Press.</p> <p>Halder, M., Liu, S., Zhang, Z. B., Guo, Z. C., & Peng, X. H. (2022). Effects of organic matter characteristics on soil aggregate turnover using rare earth oxides as tracers in a red clay soil. Geoderma, 421, 115908.</p>

Course Code: 0888 13 SWE 4114	Year: Fourth	Term: First
Course Title	Environmental Soil Mechanics Sessional and Fieldwork	
Course Status	Core	
Credit	1.0	
Prerequisite(s)	None	
Rationale	This course is designed to build capacity and skills in the students to make use of soil physical as well as soil mechanical properties for the evaluation, interpretation and classification of soils for intended purposes.	

Course Contents/Tasks		CLOs
1	Particle size distribution, sieve analysis and hydrometer analysis; Purposive classification of soils; Evaluation of the soil mechanical properties	1
2	Determination of bulk density- compaction curve.	1
3	Tri-axial compression test to measure the mechanical properties of soils and construction of soil moisture-compaction curve.	1
4	Dry and wet sieving of procedure to evaluate aggregate stability	2
5	Evaluation of soil puddling- structure, bulk density, porosity.	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	determine evaluate and interpret the liquid limit, plastic limit, shrinkage limit, plasticity index;	3, 6, 10
	CLO2	construct moisture-density relationship (under compactive force) curve of different soils; compare soils' compactibility and evaluate soils for their suitability to the use for mechanical purposes;	3, 6
	CLO3	calculate the effects of crushing strength of tillage force (puddling) on soil structure, plough pan formation and compaction;	2, 6

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture	Quiz test and presentation
CLO2	Presentation and inquiry-based learning	Assignment and final exam.
CLO3	Group discussion and problem-based learning	Viva voce and final exam.

Learning Materials

Recommended Readings	Das, B. M. (2012). Soil mechanics laboratory manual (8th ed.). Oxford University Press. Dane, J. H., & Topp, G. C. (Ed.). (2020). Methods of soil analysis Part 4: Physical Methods (1st ed.). ACSESS publisher. Huq, S. M. I., & Alam, D. (2005). A handbook on analysis of soil, plant and water. BACER-DU, University of Dhaka, Bangladesh.
Supplementary Readings	

Course Code: 0888 13 SWE 4115	Year: Fourth	Term: First
Course Title	Forest Soil and Management	
Course Status	Optional	
Credit	3.0	
Prerequisite(s)	None	
Rationale	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.	

Course Contents		CLOs
Section A		
1	Introduction to Forest Soils: History of forest soil, science and management, global patterns in forest soils, Climate-forest-soil relationship.	1
2	Forest Environment: Site factors, classification of site factors, interrelations between site factors, effects of forest vegetation on-site factors.	1
3	Composition of forest soils: Soil formation and minerals; soil organic matter; water, pore space and soil structure.	2
4	Nutrient Dynamics and Mineral Nutrition of Forests: 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; nutrient dynamics.	2
Section B		CLOs
5	Water Relations in Forests: Soil water and air; water retention in the soil; evapotranspiration in forest; rainfall and forest.	3
6	Life and chemistry in Forest soils: Life in forest soils; forest biogeochemistry; chemistry of soil surface and solutions.	3
7	Measuring Forest Soils: Sampling soils across space and time; common approaches to measuring soils.	3
8	Dynamics of Forest Soils: Influence of tree species, soil management- harvesting, site preparation, conversion, and drainage, fire influences, nutrition management, managing forest soils for carbon sequestration.	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	define and distinguish soils under different forest type and describe their characteristics. recognize about definition and global pattern of forest soil and analyze about the forest environment and site factors;	
CLO2	explain the nutritional composition of forest soils and compare the mineral nutrition of forest and the biogeochemistry of forest soil;		3, 7
CLO3	perceive and demonstrate the basic techniques in sampling of forest soil explain the dynamic properties of forest soil.		7, 6, 8

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Team Teaching	Quiz and Class Test
CLO2	Problem-based Learning and Presentation	Assignment and Final Exam
CLO3	Lecture and Group Discussion	Viva voce and Final Exam

Learning Materials

Recommended Readings	Khan, T. H. (2016). Forest soils: Properties and management (1st ed.). Springer. Schutte, A., & Ruhiyat, D. (Ed.). (1998). Soils of tropical forest ecosystems: characteristics, ecology and management. Springer. Shukla, R. S., & Chandel, P. S. (2005). A textbook of plant ecology (10th ed.). S. Chand & Co Ltd.
Supplementary Readings	Shukla, R. S., & Chandel, P. S. (1994). Plant ecology and soil science (10th ed.). S. Chand Publishing.

Course Code: 0888 13 SWE 4116	Year: Fourth	Term: First
Course Title	Forest Soil and Management Sessional and Fieldwork	
Course Status	Optional	
Credit	1.0	
Prerequisite(s)	None	
Rationale	This course is designed to provide knowledge on forest soil, their composition, different types of forest in Bangladesh.	

Course Contents/Tasks		CLOs
1	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).	1, 2
2	Nutrient stock and partitioning of nutrients in the mangrove forest and afforested land ecosystems, Soil and plant sample collection and analysis.	1, 2

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:	Mapping with PLOs
CLO1	visit different forest types of Bangladesh to enrich their knowledge on different types of vegetation.	8, 6
CLO2	collect soil sample and forest tree samples from the forest.	1, 2, 7, 10

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CL01	Lecture, Group Discussion and Team Teaching	Quiz, Viva voce, Class Test, and Final Exam
CL02	Problem-based Learning and Presentation	Report and Final Exam

Learning Materials

Recommended Readings	Khan, T. H. (2016). Forest soils: Properties and management (1st ed.). Springer. Schutte, A., & Ruhayat, D. (Ed.). (1998). Soils of tropical forest ecosystems: characteristics, ecology and management. Springer. Shukla, R. S., & Chandel, P. S. (2005). A textbook of plant ecology (10th ed.). S. Chand & Co Ltd.
Supplementary Readings	Shukla, R. S. & Chandel, P. S. (1994). Plant ecology and soil science (10th ed.). S. Chand Publishing.

Course Code: 0888 13 SWE 4117	Year: Fourth	Term: First
Course Title	Biogeochemistry of Submerged Soils	
Course Status	Optional	
Credit	3.0	
Prerequisite(s)	None	
Rationale	The course is designed to provide knowledge on biogeochemistry of hydric soils and wetlands, changes in transformation and availability of micronutrients in submerged soils and adaptation of plants to waterlogged soils.	

Course Contents		CLOs
Section A		
1	Global Extent of Submerged Soils and Wetlands: Biogeochemical Characteristics, Types of Submerged Soil, Organic Soils, Mineral Soils, Relation between Soils and Landform.	1
2	Reduction and Oxidation: Thermodynamics and Kinetics of Redox Reactions: Electron Activities and Free Energy Changes, Redox Potentials, Relation between pe and Concentration of Redox Couple, pe-pH Diagrams, Energetics of Reactions Mediated by Microbes.	2
3	Redox Conditions in Soils: Changes with Depth in the Soil, Changes with Time, Calculated Changes in pe, pH and Fe During Soil Reduction, Measurement of Redox Potential in Soil.	2
4	Electrochemical changes (redox potential, electrical conductivity, soil reaction) due to soil reduction.	2, 3
Section B		CLOs
5	Transformations of Nutrient Elements Accompanying Changes in Redox: Transformations of Carbon, Transformations of Nitrogen, Transformations of Sulfur, Transformations of Phosphorus.	3
6	Oxidation of Reduced Soil: Kinetics of Fe ²⁺ Oxidation, Simultaneous Diffusion and Oxidation in Soil.	3
7	Biological Processes in the Soil and Floodwater: Microbiological Processes: Processes Involved in Sequential Reduction, Nitrate Reduction, Iron and Manganese Reduction, Methanogenesis, Aerobic Processes.	3
8	Other changes in submerged soils: Changes in transformation and availability of micronutrients in submerged soils. Changes during drying of waterlogged soils. Adaptation of plants to waterlogged soils. Organic matter decomposition in submerged soils. Nutrient and Acidity Balances in rice fields.	3, 4

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	explain the concepts of submerged soil biogeochemistry with recent developments;	1, 2
	CLO2	interpret the kinetics of Redox Reactions in submerged soil;	6
	CLO3	gain knowledge on the transformation of macro and micronutrient elements in submerged soil;	2, 3
	CLO4	utilize the biogeochemistry in relation to problem and management of submerged soil.	8

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, group discussion and presentation	Written examination, presentation by student, quizzes and class test
CLO2	Lecture, presentation, question and answer, problem-based learning and presentation	Assignment and Final Exam
CLO3	Lecture, presentation, question and answer	Written examination, multiple-choice examination, homework
CLO4	Lecture, problem-based learning, group discussion and presentation	Interactive application assignments, presentation by students, written examination

Learning Materials

Recommended Readings	Kirk, G. J. D. (2004). <i>The biogeochemistry of submerged soils</i> (1st ed.). John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex PO19 8SQ, England.
Supplementary Readings	Ponnamperuma, F. N. (1972). The chemistry of submerged soils. <i>Advances in Agronomy</i> , 24, 29-96.

Course Code: 0888 13 SWE 4118	Year: Fourth	Term: First
Course Title	Biogeochemistry of Submerged Soils Sessional and Fieldwork	
Course Status	Optional	
Credit	1.0	
Prerequisite(s)	None	
Rationale	The course is designed to provide practical knowledge about soil reduction and characterization of submerged soils.	

Course Contents/Tasks		CLOs
1	Biogeochemical Features of Wetlands: Measurement of Redox Potentials, Field Indicators of Hydric Soils: Electrochemical Properties, Measurement of Eh, Eh-pH Relationships.	1, 2, 3
2	Nutrient Dynamics in Submerged Soils (Changes in pH, EC, Eh, N, P, K, S and Fe due to soil submergence).	2, 3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	analyze properties of submerged soils for their characterization	6, 8
	CLO2	interpret the changes in nutrient status of soil due to submergence	3
	CLO3	measure indicators of a hydric soil	7

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, group discussion and presentation	Lab exercise, presentation by student, quizzes
CLO2	Lecture, presentation, question and answer, problem-based learning and presentation	Report and Final Exam
CLO3	Lecture, presentation, question and answer	Written examination, field exercise

Learning Materials

Recommended Readings	Ponnamperuma, F. N. (1972). The Chemistry of submerged soils. <i>Advances in Agronomy</i> , 24, 29-96. Kirk, G. J. D. (2004). The biogeochemistry of submerged soils. John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex PO19 8SQ, England.
Supplementary Readings	Vepraskas, M. J. (1996). Redoximorphic features for identifying aquatic conditions, <i>Tech. Bull.</i> 301. North Carolina State University, Agricultural Research Service, Raleigh. Weston, N. B., Vile, M. A., Neubauer, S.C., & Velinsky, D. J. (2011). Accelerated microbial organic matter mineralization following salt-water intrusion into tidal freshwater marsh soils. <i>Biogeochemistry</i> , 102:135-151

Course Code: 0888 13 SWE 4121	Year: Fourth	Term: First
Course Title	Water and Waste Water Treatment	
Course Status	Optional	
Credit	3.0	
Prerequisite(s)	None	
Rationale	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.	

Course Contents		CLOs
Section A		
1	Water resource: 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.	1
2	Water quality: 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.	2
3	Water resource management: 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.	1
Section B		
4	Water treatment: Water treatment, importance of water treatment, impurities of water, waste water treatment plants; methods, principles and procedures of waste water treatments.	3
5	Techniques of water treatment: 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.	3
6	Waste water re-use: Definition and types of waste water re-use, water quality requirements, sludge dewatering and disposal.	4

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	illustrate the status of the water resource of Bangladesh and focus on the need of water resource management in Bangladesh;	1, 2
	CLO2	explain water quality concepts and interpret the common water quality parameters;	3
	CLO3	outline the principles of water treatment technologies and describe basic techniques of waste water treatment;	3, 6, 7
	CLO4	utilize waste water for re-use.	4, 5

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Presentation	Quiz and Class Test
CLO2	Lecture and Group Discussion	Assignment and Final Exam
CLO3	Problem-based Learning and Presentation	Viva voce and Final Exam
CLO4	Lecture and Debate	Class Test and Final Exam

Learning Materials

Recommended Readings	<p>Droste, R. L., & Gehr, R. L. (2018). Theory and practice of water and wastewater treatment (2nd ed.). John Wiley & Sons.</p> <p>Einschlag, F. S. G., & Carlos, L. (Ed.). (2013). Waste water: treatment technologies and recent analytical developments. BoD-Books on demand publisher.</p> <p>Henze, M., van Loosdrecht, M. C., Ekama, G. A., & Brdjanovic, D. (Ed.). (2008). Biological wastewater treatment (illustrated ed.). IWA publishing.</p> <p>Nayak, P. (Ed.). (2012). Water Resources Management and Modeling. BoD-Books on Demand.</p> <p>Schroeder, E. D. (1977). Water and wastewater treatment. McGraw-Hill, New York.</p>
Supplementary Readings	<p>Sincero, A. P., & Sincero, G. A. (2002). Physical-chemical treatment of water and wastewater. CRC press.</p> <p>Von Sperling, M. (2007). Wastewater characteristics, treatment and disposal. IWA publishing.</p> <p>Sharma, S. K., & Sanghi, R. (Ed.). (2013). Wastewater reuse and management. Springer Netherlands.</p>

Course Code: 0888 13 SWE 4122	Year: Fourth	Term: First
Course Title	Water and Waste Water Treatment Sessional and Fieldwork	
Course Status	Optional	
Credit	1.0	
Prerequisite(s)	None	
Rationale	The course is designed to provide applied knowledge on physical, chemical and biological water and waste water quality parameters.	

Course Contents/Tasks		CLOs
1	Collection and preparation of water, waste water and effluents samples.	1
2	Visit of different water sources including industries releasing effluents.	1
3	Determination of the following parameters from water sample, waste water and industrial effluents: pH, EC, TDS, TSS, turbidity, temperature, CO ³⁻ , HCO ₃ ⁻ , Cl ⁻ , hardness, Ca ²⁺ , Mg ²⁺ , Na ⁺ , K ⁺ , NH ₄ ⁺ , BOD, COD, color, odor, DO, SO ₄ ²⁻ , PO ₄ ³⁻ , NO ₃ ⁻ .	2

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:	Mapping with PLOs
CLO1	assess the quality levels of water and waste water from any source and suggest fit or unfit for different uses;	3, 4, 5
CLO2	determine different water quality parameters.	6, 7

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Field work and Laboratory work	Quiz and Final Exam
CLO2	Laboratory Work and Data analysis	Sessional report, viva voce and Final Exam

Learning Materials

Recommended Readings	Adams, V. D. (2017). Water and wastewater examination manual. Routledge. Bartram, J., & Ballance, R. (eds.). (1996). Water quality monitoring: a practical guide to the design and implementation of freshwater quality studies and monitoring programmes. CRC Press. Chapman, D. (2021). Water quality assessments: a guide to the use of biota, sediments and water in environmental monitoring. CRC Press.
Supplementary Readings	Russell, D. L. (2019). Practical wastewater treatment. John Wiley & Sons. Von Sperling, M. (2007). Wastewater characteristics, treatment and disposal. IWA publishing.

Course Code: 0888 13 SWE 4131	Year: Fourth	Term: First
Course Title	Natural Resource Management	
Course Status	Optional	
Credit	3.0	
Prerequisite(s)	None	
Rationale	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.	

Course Contents		CLOs
Section A		
1	Concept of sustainability: Principles and concept, components of sustainability, history, criteria and indicators, measurements, sustainable development goals.	1
2	Introduction to natural resource bases: 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.	1
3	Sustainable land management: 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.	1
4	Energy resources: Growing energy needs, renewable and nonrenewable energy sources, use of alternative renewable energy sources.	1
Section B		
CLOs		
5	Sustainable forest management: 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.	2
6	Water resources management: 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.	2
7	Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources and using mineral resources.	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:	Mapping with PLOs
CLO1	describe land and energy resources and their sustainable management;	1, 2
CLO2	demonstrate understanding of utilization and the management of forest and water from different sources;	4, 6
CLO3	comprehend common international resources and management.	6, 7, 8

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Team Teaching	Quiz Test
CLO2	Problem-based Learning and Presentation	Assignment and Class Test
CLO3	Lecture and Group Discussion	Viva voce and Final Exam

Learning Materials

Recommended Readings	Dawson, C. P., & Hendee, J. C. (2019). Introduction to forests and renewable resources, (9th ed.).
Supplementary Readings	Management Association Information Resources. (2020). Natural Resources Management: Concepts, Methodologies, Tools, and Applications. Publisher: Engineering Science Reference.

Course Code: 0888 13 SWE 4142	Year: Fourth	Term: First
Course Title	Thesis Proposal Development	
Course Status	Optional	
Credit	2.0	
Prerequisite(s)	None	
Rationale	This course is intended for learning experiences in research and to design and execute a research work.	

Course Contents/Tasks		CLOs
1	Introduction: Background of the research, problem identification, finding out the research gap, the recent development of the respective research in brief, justification of the research.	1
2	Literature review: Details description of the past and present development of the work, current literature available on the respective work.	2
3	Materials and methods: Description of research area/ location, materials used for conducting research, research design, and methods used for laboratory analysis in the current study, the statistical procedure used in the research.	3
4	Manuscript writing: Writing the introduction, literature review, materials and methods	4

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	introduce and identify the research gap;	6
	CLO2	write literature review and enriched with knowledge about past and present information about his/her research;	9
	CLO3	utilize the materials and apply methods for conducting research;	7, 8
	CLO4	achieve the writing skill of thesis.	9

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, group discussion and presentation	Report writing and viva voce
CLO2	Lecture, presentation, question and answer, problem-based learning and presentation	Report writing and viva voce
CLO3	Lecture, presentation, question and answer	Report writing and viva voce
CLO4	Lecture, presentation	Report writing and viva voce

Learning Materials

Recommended Readings	The thesis guidelines will be provided from the discipline. Glatthorn, A. A., & Joyner, R. L. (2005). Writing the winning thesis or dissertation: A step-by-step guide. Corwin Press. Mauch, J., & Park, N. (2003). Guide to the successful thesis and dissertation: A handbook for students and faculty (Vol. 62). CRC Press.
Supplementary Readings	Madsen, D. (1983). Successful Dissertations and Theses: A Guide to Graduate Student Research from Proposal to Completion.

Course Code: 0888 13 SWE 4144		Year: Fourth	Term: First
Course Title	Project		
Course Status	Optional		
Credit	3.0		
Prerequisite(s)	None		
Rationale	The course is designed to provide knowledge on the integration of comprehensive knowledge on a specific research area.		

Course Contents/Tasks		CLOs
1	Collection of research papers from reputed journal (at least 50)	1
2	Collection of data from the published article tables and figures (for collection of data from figure by using Webplotdigitizer 4.1 version).	2
3	Compilation of data for writing a review or meta-analysis.	2

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:	Mapping with PLOs
CLO1	utilize the knowledge on a specific area;	6, 7, 8
CLO2	extract, describe, and interpret the data with appropriate statistical methods.	10

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture	Viva-voce
CLO2	Lecture and presentation	Assignment and Viva-voce

Learning Materials

Recommended Readings	The discipline will provide the necessary documents <ul style="list-style-type: none"> • Manuscript writing guidelines provided by SWE discipline • Documents provided by the supervisor
Supplementary Readings	Sandelowski, M., & Barroso, J. (2003). Writing the proposal for a qualitative research methodology project. <i>Qualitative health research</i> , 13(6), 781-820.

Course Code: 0888 13 SWE 4146		Year: Fourth	Term: First
Course Title	Internship		
Course Status	Optional		
Credit	3.0		
Prerequisite(s)	None		
Rationale	This course is designed to provide knowledge about different research organization and their roles to national development.		

Course Contents/Tasks		CLOs
1	Visit the different soil, water and environment research related research organization (e.g. SRDI, BCSIR, BTRI, BARI, BIRRI).	1, 3
2	Conduct the research work as co-worker with researcher in the respective organization	2
3	Documentation of the research activities of visited organization	2

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	achieve basic knowledge on activities of different organization and documentation of research data.	3, 8
	CLO2	conduct a research as an independent researcher	6, 7, 8
	CLO3	operate different instruments for research in the field of Soil, Water and Environment.	7, 8, 10

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and presentation	Viva-voce
CLO2	Lecture, presentation, question and answer, problem-based learning and presentation	Assignment
CLO3	Lecture, presentation and laboratory work	Lab exercise and Viva-voce

Learning Materials

Recommended Readings	<p>The discipline will provide the necessary documents</p> <ul style="list-style-type: none"> • Manuscript writing guidelines provided by SWE discipline • Documents provided by the supervisor
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Fourth Year Second Term			
Course Code: 0888 13 SWE 4211		Year: Fourth	Term: Second
Course Title	Soil Classification and Soils of Bangladesh		
Course Status	Core		
Credit	3.0		
Prerequisite(s)	None		
Rationale	The course deals with soil systems and its environments from the perspective of soil classification. The primary emphasis is on Bangladesh soils and classification, with significant attention to global soils. This field-based course introduces the basics in soil classification and field descriptions and assessments using the US Soil Taxonomy and other common techniques.		

Course Contents		CLOs
Section A		
1	The Theoretical Bases of Soil Classifications: Introduction to Classifications with an Emphasis on Soil Taxonomies, Soil Classifications: Their Peculiarity, Diversity and Correlation. Philosophy of soil classification, Utilitarian expectations of soil classification-analytical and political needs.	1
2	Developmental History of Soil Classification: Ancient era, early scientific era, founding of pedology, Marbutian era, two historic system of classification systems, the US great soil group system of classification, natural system of soil classification in Europe. Construction of soil classification systems.	2
3	Modern Systems of Soil Classification: Detail study of US soil taxonomic system, Horizons and characteristics diagnostic for the higher categories, Control sections, Identification of the taxonomic class of a soil. The World Reference Base (WRB) for soil resources, a comparison of these classification systems.	2
4	Soil Orders of Bangladesh: Identification and classification of soil orders of Bangladesh based on the USDA soil classification system.	2, 3
Section B		CLOs
5	Soil Classification in Bangladesh: Geologic-physiographic basis of soil classification, Soil Tracts of Bangladesh-Types and characteristics. Pedoclimatic zonality basis of soil classification	2, 3
6	General soil types: General soil types (GST) system of classification-Types and characteristics. Classification of Bangladesh soils based on US and WRB classification systems, correlation of general soil types with other systems. Soil series and families in Bangladesh, Benchmark soils of Bangladesh,	3
7	Agro-Ecological Zone (AEZ): Concept and classification of AEZs, agro-ecological subregions, agro-ecological units, physical, chemical and mineralogical properties and land utilization pattern in different AEZs of Bangladesh.	4

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	propose the need and importance of soil classification systems;	6
	CLO2	classify soil profiles using the US and WRB systems of soil classification;	8
	CLO3	arrange a correlation between all the classification systems;	8, 10
	CLO4	describe AEZs of Bangladesh emphasizing land topography, properties of soil and land utilization pattern.	10

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and team teaching	Quiz and class test
CLO2	Problem-based learning and presentation	Assignment and final exam
CLO3	Lecture and group discussion	Viva voce and final exam
CLO4	Lecture and field study	Assignment, presentation and final exam

Learning Materials

Recommended Readings	<p>Buol S. W., Southard, R. J., Graham, R. C., & McDaniel, P. A. (2011). Soil genesis and classification. (6th ed.). Wiley-Blackwell.</p> <p>Hussain, M. S. (2020). Soil classification. Dhaka University Prakashana Sangstha.</p> <p>IUSS Working Group WRB. (2015). World reference base for soil resources, 2014, International soil classification system for naming soils and creating legends for soil maps. World Soil Resources Reports No. 106. FAO, Rome.</p>
Supplementary Readings	<p>Huq, S. M. I., & Shoaib, J. U. M. 2013. The soils of Bangladesh. Springer Science & Business Media.</p> <p>Krasilnikov, P., Martí, J. J. I., Arnold, R.W., & Shoba, S. 2009. A handbook of soil terminology correlation and classification. Earthscan.</p> <p>Soil Survey Staff. 2014. Keys to soil taxonomy. (12th ed.). United States Department of Agriculture Natural Resources Conservation Service.</p>

Course Code: 0888 13 SWE 4212	Year: Fourth	Term: Second
Course Title	Soil Classification and Soils of Bangladesh Sessional and Fieldwork	
Course Status	Core	
Credit	1.0	
Prerequisite(s)	None	
Rationale	This course focuses on identifying soils in the field and classifying soils into different classification systems for various uses. This course will cover procedures for observing, measuring, and describing soils in the field. The goal is to produce consistent data for soil inventory and classify soils in Bangladesh using soil horizons and properties measured in the field.	

Course Contents/Tasks		CLOs
1	Soil Classification: Soil scape sequences: types of sampling- horizon sampling, incremental sampling, fixed-depth sampling. sampling techniques, Master pit and Mini pit description, identification of diagnostic horizons, physical and chemical analysis and classify soils based on US Taxonomy and WRB classification systems.	1, 2
2	Field trips: Field trips in the different floodplains, terrace and hilly areas observe and record landform, land use, crop diversity and soil characteristics in the field.	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	predict the soil order that exists at the field site;	6
	CLO2	record accurate soil description data for subsequent soil classification in the field and verify with other groups;	7, 9
	CLO3	classify Bangladesh soils in different classification systems for the identification of potentiality and limitations of Bangladesh soils and make a correlation among all the classification systems.	6

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Theoretical lessons, field work	Hands-on work in the field, field exercise, written test and oral examination
CLO2	Theoretical lessons, laboratory exercise	Laboratory exercise, written test and oral examination
CLO3	Theoretical lessons, field work, single and/or group report	Field exercise, report and oral examination

Learning Materials

Recommended Readings	Huq, S. M. I., & Shoaib, J. U. M. (2013). The soils of Bangladesh. Springer Science & Business Media. Hussain, M. S. (1992). Soil classification: with special reference to the soils of Bangladesh. University Press limited. Soil Survey Staff. (2014). Keys to soil taxonomy. (12th ed.). United States Department of Agriculture Natural Resources Conservation Service.
Supplementary Readings	American Society for Testing and Materials (ASTM). (2004). Standard practice for description and identification of soils. D2488 Annual Book of ASTM Standards. Construction. Section 4, Soil and Rock; Dimension Stone. Vol. 04.08. Philadelphia, PA. IUSS Working Group WRB. (2015). World reference base for soil resources, 2014, International soil classification system for naming soils and creating legends for soil maps. World Soil Resources Reports No. 106. FAO, Rome. Soil Survey Staff. (2015). Illustrated guide to soil taxonomy, version 2. U.S. Department of Agriculture, Natural Resources Conservation Service, National Soil Survey Center, Lincoln, Nebraska.

Course Code: 0888 13 SWE 4221	Year: Fourth	Term: Second
Course Title	Irrigation and Drainage Management	
Course Status	Core	
Credit	3.0	
Prerequisite(s)	None	
Rationale	This course is designed to provide the knowledge exact amount and uniform application as well as the removal of excess water from the crop field. It focuses on dealing with the methods of irrigation and drainage with precision and ensures prevalence of PAW in the field, maximum utilization of applied water, and optimum crop production.	

Course Contents		CLOs
Section A		
1	Introduction to Irrigation: Definition and types of irrigation, extent of irrigation, the scope of irrigation with reference to Bangladesh, Selection of land for irrigation; factors affecting irrigation needs, amount and frequency of irrigation; Crop production and food security.	1
2	Diagnosis of Irrigation Need: 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.	1, 2
3	Methods of Irrigation: Methods of irrigation, selection of irrigation methods, factors affecting the selection of surface irrigation methods, Designing surface irrigation methods, advantages and disadvantages of different methods, Conservation irrigation practices, Distribution of irrigation water.	1, 4
4	Irrigation Engineering: 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.	2, 4
5	Evaluation and Monitoring of Irrigation Water Availability and Quality: Standards for irrigation water, typical analyses of irrigation waters, Evaluation and monitoring of irrigation water (short-term and long-term), Feasibility study of saline/brackish water for irrigation.	2, 3
6	Irrigation in Bangladesh: Irrigation projects in Bangladesh, Modes of Irrigation, irrigation systems and irrigation projects of Bangladesh, Irrigation water requirement and withdrawal of irrigation water, Irrigation needs of major crops of Bangladesh, Sources (surface and groundwater), storage and distribution of irrigation water, Safe yields from reservoirs (surface and subsurface/groundwater), feasibility of groundwater abstraction and development, Recharging surface and groundwater sources, Consequences of groundwater irrigation.	2, 3, 4
Section B		CLOs
7	Introduction to Drainage: 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.	1
8	Drainage Systems: 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, Coastal drainage	2, 3
9	Groundwater drainage systems: 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, and ditch systems.	2, 3
10	Drainage of irrigated land: Pipe drainage system, well drainage, main drainage systems and outlet.	2, 3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	select soil and crop-specific appropriate irrigation and drainage techniques for ensuring profitable production by quantity and quality;	2, 3
	CLO2	measure, evaluate and monitor irrigation and drainage water quality and reuse of drainage water for irrigation;	3, 6
	CLO3	mitigate over and under irrigation and drainage and relevant impacts on the soil-water environment and crop production;	4, 5
	CLO4	regulate use, storage, recharge, sustain and conserve surface and subsurface water.	6, 7, 8

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Team Teaching	Quiz and Class Test
CLO2	Reading and Inquiry based Learning	Class Test
CLO3	Problem-based Learning and Presentation	Assignment and Final Exam
CLO4	Lecture and Group Discussion	Presentation and Viva voce

Learning Materials

Recommended Readings	<p>Adrian, L. (2011). Irrigation systems: Design, planning and construction. Adrian Laycock Ltd, UK.</p> <p>Bhattacharya, A. K., & Michael, A. M. (2006). Land drainage: principles, methods and applications. Vikas Publishing House.</p> <p>C. M. Burt, A. J. Clemmens, R. Bliesner, J. L. Merriam, & L. Hardy. (2000). Selection of Irrigation Methods for Agriculture.</p> <p>Javaid, M. S. ed. (2012). Drainage systems. BoD-Books on Demand.</p> <p>Malano, H. M. & Van Hofwegen, P. J. (2018). Management of irrigation and drainage systems-A service approach. CRC Press.</p> <p>Panigrahi, B. (2020). A handbook on irrigation and drainage. New India Publishing Agency.</p>
Supplementary Readings	<p>Dadgar, M. A., Nakhai, M., Porhemmat, J., Eliasi, B. and Biswas, A. (2020). Potential groundwater recharge from deep drainage of irrigation water. Science of the Total Environment, 716, 137105.</p> <p>Glória, A., Dionisio, C., Simões, G., Cardoso, J. and Sebastião, P. (2020). Water management for sustainable irrigation systems using internet-of-things. Sensors, 20(5), 1402-1408.</p> <p>Scholz, M. (2015). Sustainable drainage systems. Water, 7(5), 2272-2274.</p>

Course Code: 0888 13 SWE 4222	Year: Fourth	Term: Second
Course Title	Irrigation and Drainage Management Sessional and Fieldwork	
Course Status	Core	
Credit	1.0	
Prerequisite(s)	None	
Rationale	This course is designed to provide the experimental and judgmental skill to select irrigation and drainage methods, prepare land and adopt measures for each method to save water and yield maximum benefit per unit of water used.	

Course Contents/Tasks		CLOs
1	Analysis of water sample for determining irrigation water quality.	1
2	Estimation of the amount of irrigation water.	2
3	Determination of time and frequency of irrigation.	2
4	Ensuring equal infiltration opportunity time over the crop field.	2
5	Application of cut-off ratio, paired row and alternate row irrigation, and other measures of conservation irrigation techniques.	3
6	Estimation of the different components of irrigation efficiency.	3
7	Selection of drainage options and estimation of drainable water content.	4
8	Designing drainage methods with reuse of drainage water for irrigation.	4

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	adopt conservation irrigation and techniques to save water and measure irrigation efficiency;	4, 5
	CLO2	select suitable irrigation options and design for specific soil and crops and ensure uniform distribution of water in the field;	6, 7, 8
	CLO3	design suitable drainage options and reuse drainage water for irrigation.	6, 7, 8

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and discussions	Written test and Viva voce
CLO2	In-field lectures and field work	Observation and evaluation
CLO3	Field work output and Group discussions	Sessional report, final exam and Viva voce

Learning Materials

Recommended Readings	<p>Ali, H. (2010). Fundamentals of irrigation and on-farm water management: Volume 1 (Vol. 1). Springer Science & Business Media.</p> <p>Doneen, L. D., & Westcot, D.W. (1984). Irrigation practice and water management.</p> <p>Keith, W. (2015). Handbook of drainage systems. Callisto Reference.</p> <p>Merriam, J. L., & Keller, J. (1978). Farm irrigation system evaluation: A guide for management (3rd ed.). Utah State University, Logan, Utah.</p>
Supplementary Readings	<p>Murray-Rust, H., & Snellen, W. B. (1993). Irrigation system performance assessment and diagnosis. International Irrigation Management Institute, Colombo, Sri Lanka.</p> <p>Om Bos, M. G., Burton, M. A., & Molden, D. J. (2005). Irrigation and drainage performance assessment: practical guidelines. CABI.</p>

Course Code: 0888 13 SWE 4223	Year: Fourth	Term: Second
Course Title	Soil and Water Salinity	
Course Status	Optional	
Credit	3.0	
Prerequisite(s)	None	
Rationale	Salinization is an environmental and agriculture problem that leads yield reduction, soil and infrastructures damage and can affect human well-being. The course deals with different aspects of the salinization phenomena, its impact on the environment and agriculture systems, and on various practices to address the problem. It also aims to study the effects of water and soil salinity, environmental importance, impact on plant growth and crop yield, measurement methods, and prevention methods.	

Course Contents		CLOs
Section A		
1	Introduction: The salinity problem; sources of salts; impact of salinity on the development of saline soil.	1
2	Basic Chemistry of Salinity: Salt-affected soils: thermodynamic aspects of the soil solution; colloid properties of clay minerals in saline and sodic solution.	1, 2
3	Chemical Reaction and Control of Soil Physical Properties: The effect of electrolyte concentration on the hydraulic properties of sodic soils; soil structure in saline and sodic soils; potassium, magnesium and boron in soils under saline and sodic conditions.	2, 3
4	Movement and Accumulation of Salts in Soils: Salt and water movement in the soil profile; field scale water and solute transport through unsaturated soils.	3
Section B		
5	Irrigation Management and Field Salt Balance: Salt balance at the field scale; leaching for salinity control; drainage design for salinity control; spatial variability considerations in salinity management.	2, 4
6	Management Aspect for Crop Production: Analysis of crop salt tolerance data; prediction of crop yield and water consumption under saline conditions; plant response to salinity: experimental methodology and application to the field; management of irrigation with brackish water; plant nutrition under saline conditions.	4
7	Living with Salts in Irrigation Water: Introduction; saline water; soil salinization of irrigated lands; management strategies for saline water; other strategies; alternate use of saline water; guidelines for interpreting water quality for irrigation.	2, 3
8	Reclamation of Saline and Sodic Soils: Reclaiming saline soils by leaching; the use of mulches and other surface management to enhance salt leaching; gypsum use for reclaiming sodic soils; high salt water leaching; deep mixing sodic soils for reclamation; sulfuric acid for reclaiming sodic soils; solute flow models applied to irrigation management optimization; specialized management practices.	4

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	discuss salinization phenomena in Bangladesh and worldwide;	1, 2
	CLO2	analyze the chemical composition of saline soil solution in equilibrium with the solid phase; to describe the transport of salts and to estimate their concentration in space and time;	6
	CLO3	analyze water and salt transport at the soil-root interface and to explain the impact of salinity on yield;	6
	CLO4	use quantitative tools to recommend a solution for a salinity problem.	7, 8

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Class room discussion	Quizzes, written examination
CLO2	Lecture, Group Discussion, Presentation	Assignment, written test
CLO3	Lecture, Class room discussion	Oral examination, written test
CLO4	Lecture, Homework, Presentation	Report, oral examination, written test

Learning Materials

Recommended Readings	<p>Ayers, R. S., & Westcot, D. W. (1985). Water quality for agriculture (Vol. 29, p. 174). Rome: Food and Agriculture Organization of the United Nations.</p> <p>Barna, G., & Tóth, T. (2017). Soil salinity management in agriculture: Technological advances and applications (Innovations in biological engineering), edited by SK Gupta and Megh R. Goyal, Waretown, NJ: Apple Academic Press, 2017, 454 pp., 159.95(hardcover), 134.87 (Kindle version). ISBN 978-1-77188-443-3 and 978-1-315-36599-2.</p> <p>Bresler, E., McNeal, B. L., & Carter, D. L. (2012). Saline and sodic soils: principles-dynamics-modeling (Vol. 10). Springer Science & Business Media.</p>
Supplementary Readings	<p>Agriculture Organization of the United Nations. Soil Resources, Management, & Conservation Service. (1985). Guidelines: land evaluation for irrigated agriculture (No. 55). Food & Agriculture Org.</p> <p>Shainberg, I., & Shalhevet, J. (eds.). (2012). Soil salinity under irrigation: Processes and management (Vol. 51). Springer Science & Business Media.</p>

Course Code: 0888 13 SWE 4224	Year: Fourth	Term: Second
Course Title	Soil and Water Salinity Sessional and Fieldwork	
Course Status	Optional	
Credit	1.0	
Prerequisite(s)	None	
Rationale	This course is designed to provide students about the field and laboratory observations with different aspects of the salinization phenomena, its impact on the environment and agriculture systems. The course aims the assessment of effects of water and soil salinity, environmental importance, and impact on plant growth and crop.	

Course Contents/Tasks		CLOs
1	Diagnosis of salinity problems under field condition.	1, 2
2	Measurement of salinity hazard and sodium hazard for soil, water and crop.	1, 2
3	Field experiment on salinity management strategies and leaching requirement.	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:	Mapping with PLOs
CLO1	identify the salinity problems in a specific area;	6, 7
CLO2	recommend water for irrigation and soil for plant growth;	8
CLO3	set up a salinity management experiment and give a solution.	8

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Theoretical lessons, field work	Hands-on work in the field, field exercise, written test and oral examination
CLO2	Theoretical lessons, laboratory exercise	Laboratory exercise, written test and oral examination
CLO3	Theoretical lessons, field work, single and/or group report	Field exercise, report and oral examination

Learning Materials

Recommended Readings	<p>Ayers, R. S., & Westcot, D. W. (1985). Water quality for agriculture (Vol. 29, p. 174). Rome: Food and Agriculture Organization of the United Nations.</p> <p>Barna, G., & Tóth, T. (2017). Soil salinity management in agriculture: Technological advances and applications (Innovations in biological engineering), edited by SK Gupta and Megh R. Goyal, Waretown, NJ: Apple Academic Press.</p> <p>Bresler, E., McNeal, B. L., & Carter, D. L. (2012). Saline and sodic soils: principles-dynamics-modeling (Vol. 10). Springer Science & Business Media.</p>
Supplementary Readings	<p>Agriculture Organization of the United Nations. Soil Resources, Management, & Conservation Service. (1985). Guidelines: land evaluation for irrigated agriculture (No. 55). Food & Agriculture Org.</p> <p>Shainberg, I., & Shalhevet, J. (Eds.). (2012). Soil salinity under irrigation: Processes and management (Vol. 51). Springer Science & Business Media.</p>

Course Code: 0888 13 SWE 4225	Year: Fourth	Term: Second
Course Title	River and Floodplain Management	
Course Status	Optional	
Credit	3.0	
Prerequisite(s)	None	
Rationale	This course is designed to orient the students with global and national major rivers and river systems. It also covers the diverse role of fluvial systems in the formation of an unique ecosystem, its contribution to the socio-economy highlights the national water management plan and the floodplain development plan of Bangladesh flood plains and floodplain management.	

Course Contents		CLOs
Section A		
1	Introduction: Overview of river systems in the world, South-East Asia and Bangladesh; River and floodplain formation.	1
2	Evolution of Fluvial Systems and land formation: Erosional landforms and depositional landforms; Long-term, large-scale evolution of fluvial systems. Alluvial Channel formation- Bedforms and sedimentary structures, nature of the alluvial channel, sand bar and charland formation, alluvial fans, suitability of sandbars and charland for agricultural use;	2
3	Fluvial dynamics: Characterization of rivers and river systems; Stages of a river – youthful, mature and old stage; streams and drainages; velocity of a stream, the profile of a stream, the course of a stream – processes in the upper, middle and lower stream; Transportation of sediments – processes involved in the transportation -traction, saltation, suspension, solution and floatation; Fossils in fluvial deposits: Geology of fluvial deposits, sedimentary facies, basin analysis, and petroleum geology.	2
4	River and Bank Erosion: Types of river bank erosion, factors triggering river bank failure, indices to measure the vulnerability of river bank dynamics of the different riverbank erosion; the impact of riverbank erosion, management of river bank erosion, river bank stabilization.	3
Section B		CLOs
5	Introduction to Floodplains: Definition and classification of floodplains; piedmont plain, meander floodplain, tidal floodplain, estuarine floodplain.	1
6	Channels shifting and Floodplains: variations in channels and floodplains, Channel-Belt movements across floodplains, channel shifting in the course, formation of baors and ox-bow lakes.	2
7	Riverine floodplains-present state and future trends: Floodplain biodiversity and bioproduction; Economic importance of flood plains; Natural and human influences - habitat alteration, species invasion, pollution.	1, 2
8	Floodplain Management: Flood and Bangladesh, types of the flood, flood induced damage, flood control measures, flood damages in Bangladesh; flood control measures in Bangladesh; floodplain development, floodplain management, National Water Management Plan (NWMP), the national flood insurance program (NFIP), NFIP goals and their accomplishment, delta plan of Bangladesh.	2, 3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	explain and describe the main rivers, river systems, floodplains and the importance of floodplains;	2, 3
	CLO2	explain the functions of fluvial systems, their dynamics in the formation of landforms and floodplains and their agents of change;	6, 7
	CLO3	summarize the action plan for controlling and regulating riverbank erosion and relate the delta plan of Bangladesh with floodplain biodiversity, bioproduction and management.	7, 8

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Team Teaching	Quiz and Class Test
CLO2	Problem-based Learning and Presentation	Assignment and Final Exam
CLO3	Lecture and Group Discussion	Viva voce and Final Exam

Learning Materials

Recommended Readings	<p>Brammer, H. (1990). Floods in Bangladesh: Geographical Background to the 1987 and 1988 Floods. <i>The Geographical Journal</i>. 156 (1), 12–22.</p> <p>Rahman, M. M. Hossain, M. A. & Bhattacharya, A. K. (2009). Flood management in the flood plain of Bangladesh.</p> <p>Balasubramanian, A. (2010). Fluvial processes and landforms. A technical report, University of Mysore, India</p>
Supplementary Readings	<p>Hossain, M. M. (2007). The flood problem and mitigation methods in Bangladesh. Department of Water Resources Engineering, Bangladesh University of Engineering and Technology, Dhaka, Bangladesh.</p> <p>Islam, J. (2019). Flooding in Bangladesh: A Geographical Advantage & Disadvantage of Times. <i>International Journal for Empirical Education and Research</i>, ISSN Online print: 31-41 Department of Disaster Science and Management, University of Dhaka.</p> <p>Stott, T. (2010). Fluvial geomorphology. <i>Progress in Physical Geography</i> 34(2), 221–245.</p> <p>Benito, G. & Hudson, P. F. (2010). <i>Geomorphological Hazards and Disaster Prevention</i>, eds. Alcántara-Ayala, I. & Andrew S. G. Published by Cambridge University Press.</p>

Course Code: 0888 13 SWE 4231	Year: Fourth	Term: Second
Course Title	Climate Change and Food Security	
Course Status	Core	
Credit	3.0	
Prerequisite(s)	None	
Rationale	This course is designed to evaluate the impacts of climate change and understand the various aspects of food security, and the challenges faced in food security.	

Course Contents		CLOs
Section A		
1	Atmosphere of the earth: Compositions of the atmosphere, thermal and chemical layering of the atmosphere, introduction to weather and climate, energy, temperature and heat, radiation, energy balance.	1
2	Temperature, humidity and clouds: 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.	2
3	Pressure, winds and general circulation: Atmospheric pressure, forces, types of wind-geostrophic wind, gradient winds, surface winds; small scale and local wind systems, global wind systems; atmosphere-ocean interactions-including El Niño and La Nina, Southern oscillation; middle latitude cyclones (polar front theory), weather forecasting.	1
4	Global Climate and Climate Change: The Köppen classifications principles, overview of the different climates, possible causes of climate change, feedback effects, atmospheric greenhouse effects, anthropogenic and natural climate change.	2
5	Weather and climate modeling: Meteorological phenomena leading to weather formation, meteorological sensors, weather maps, prediction of the weather based on a weather map, global climate and circulation patterns, cloud types, solar elevation and day length, weather mechanisms and formation, interpretation of weather station data and weather maps, calculation.	2
Section B		CLOs
6	Hunger and Food Security: History, crisis, world summit on food security, pillars of food security: availability, access, utilization, stability, stunting and chronic nutritional deficiencies.	3
7	Challenges to achieving food security: Global water crisis, land degradation, climate change, agricultural diseases, dictatorship and kleptocracy, food sovereignty.	3
8	Risks to food security: Population growth, fossil fuel dependence, hybridization, genetic engineering, and loss of biodiversity, price setting, land use change, global catastrophic risks.	3
9	Community food security movement: Children and food security, gender and food security, approaches by the United Nations: Food and Agriculture Organization, World Food Program, 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.	4
10	Food security in the Bangladesh: Status, Challenges, adaptation, and mitigation approaches	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	identify the composition of the atmosphere, small-scale local wind systems, demonstrate the sun's energy impacts on weather and atmospheric movement;	1, 2, 6
	CLO2	describe and classify climate and explain the relationship between the change in temperature and pressure, and the change in the global climate;	1, 2, 4, 5
	CLO3	explore the history, causes and consequences of hunger and food insecurity and provide comprehensive knowledge and skills concerning climate change adaptation and mitigation approaches in Bangladesh;	1, 2, 4, 5
	CLO4	compare the strengths and limitations of emergency food programs, federal food and nutrition assistance, and the community food security movement.	3, 4, 5

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Question-Answer	Quiz and Class Test
CLO2	Lecture and Group Discussion	Class Test and Final Exam
CLO3	Lecture, Group Discussion and Assignment	Class Test and Presentation
CLO4	Lecture, Discussion and Problem based Assignment	Quiz and Viva-voce

Learning Materials

Recommended Readings	Barry, R. G., & Chorley, R. J. (2009). Atmosphere, weather and climate. Routledge. Kuhns, M. R. (2011). Entitled to Self-Reliance: Investigating the Language of Self-Reliance and Community in the Community Food Security Movement. University of California, Davis. Saha, K. (2008). The Earth's atmosphere: Its physics and dynamics (pp. 367-1). Berlin: Springer.
Supplementary Readings	Campbell, B. M., Vermeulen, S. J., Aggarwal, P. K., Corner-Dolloff, C., Girvetz, E., Loboguerrero, A. M., Ramirez-Villegas, J., Rosenstock, T., Sebastian, L., Thornton, P.K., & Wollenberg, E. (2016). Reducing risks to food security from climate change. <i>Global Food Security</i> , 11, pp.34-43 Church, C. (2011). Community Food Security "For Us, By Us". <i>Cultivating Food Justice: Race, Class, and Sustainability</i> , p.177. Dorosh, P. A. (2001). Trade liberalization and national food security: Rice trade between Bangladesh and India. <i>World development</i> , 29(4), pp.673-689

Course Code: 0888 13 SWE 4233	Year: Fourth	Term: Second
Course Title	Waste Management	
Course Status	Optional	
Credit	3.0	
Prerequisite(s)	None	
Rationale	This course is designed to provide a foundation about waste and waste management systems.	

Course Contents		CLOs
Section A		
1	Wastes: Introduction, terminologies, composition, classification of waste, problems of wastes.	1
2	Sources of wastes: sewage sludge, tannery waste, industrial waste, shrimp processing waste (general idea, composition, chemicals and machineries used, wastes generated, process employed, treatments, heavy metals and permissible limit, benefits from wastes, limitation of using, occupational health hazards, EIA of the industries, impacts of wastes, remediation, assimilative capacity).	1
3	Collection and Storage of Waste: 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.	1
4	Disposal of Waste: Open dumps, landfills, sanitary landfill, landfill site selection, land filling methods and operations, factor affecting landfill operations. Disposal of waste in agriculture, forestry, fisheries, sea dumping, composting and incineration.	1
Section B		
5	Treatment of Human Waste: 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.	2
6	Hazardous Waste: Introduction, classification, Basel convention, nature and quantities of hazardous wastes, hazard identification, list, household hazardous wastes management.	1
7	Problems and Limitations of Waste Management: Introduction, organizational problems, human resources and capabilities, land availability and congestion, technological capabilities, financial aspects, law, legislation and enforcement, public awareness and motivation.	1
8	Solid waste management scenario in Bangladesh: Case studies of waste management regional as well as national basis. Solid waste disposal, management, impacts on ecosystem, assessment of ecological and potential health risk of toxic elements related with solid waste dumping.	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	categorize different types of waste and problem associated with it and collection, transportation, recycling and disposal of different wastes;	2
	CLO2	design waste processing, resource recovery and model the processing of human waste treatment and biogas generation;	3, 8
	CLO3	measure the status of waste management practices in different locations of Bangladesh and calculate the potential health and ecological risk.	6

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CL01	Lecture	Quiz and Class Test
CL02	Lecture and Presentation	Assignment and Final Exam.
CL03	Group Discussion and Problem based Learning	Class Test and Final Exam.

Learning Materials

Recommended Readings	<p>Kindschy, J. W., Kraft, M., & Carpenter, M. (1997). Guide to Hazardous Materials and Waste Management: Risk, Regulations, Responsibility (1st ed.). Solano Pr Publisher.</p> <p>Rajaraman, M. E. V., Siddiqui, Zia F., & Agrawal, S. (2016). Solid and Liquid Waste Management (1st ed.). PHI Learning PVT. LTD Publisher.</p>
Supplementary Readings	Tchobanoglous, G., & Kreith, F. (2002). Handbook of Solid Waste Management (2nd ed.). The McGraw-Hill Companies Inc.

Course Code: 0888 13 SWE 4234		Year: Fourth	Term: Second
Course Title	Waste Management Sessional and Fieldwork		
Course Status	Optional		
Credit	1.0		
Prerequisite(s)	None		
Rationale	This course is designed to get practical experiences about waste classification, disposal, risk analysis and resource generation.		

Course Contents/Tasks		CLOs
1	Waste classification.	1
2	Methods of waste disposal.	1
3	Resource generation from waste and its uses.	2
4	Potential ecological and health risk assessment due to solid waste dumping	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	classify and dispose of wastes;	
CLO2	generate resources from waste;		8, 10
CLO3	evaluate the impacts of solid waste dumping on the ecosystem and human health.		3, 5

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Field Work	Field Exercise and Viva-voce
CLO2	Lecture and Presentation	Field Exercise and Viva-voce
CLO3	Group Discussion and Problem based Learning	Report and Viva-voce

Learning Materials

Recommended Readings	<p>Kindschy, J. W., Kraft, M., & Carpenter, M. (1997). Guide to Hazardous Materials and Waste Management: Risk, Regulations, Responsibility (1st ed.). Solano Pr Publisher.</p> <p>Rajaraman, M.E.V., Siddiqui, Zia F., & Agrawal, S. (2016). Solid and Liquid Waste Management (1st ed.). PHI Learning PVT. LTD Publisher.</p> <p>Tchobanoglous, G., & Kreith, F. (2002). Handbook of Solid Waste Management (2nd ed.). The McGraw-Hill Companies Inc.</p>
Supplementary Readings	<p>Halder, M., Rahman, T., Mahmud, A., Jim, S. A., Akbor, M. A., Siddique, M. A. B., & Joardar, J.C. (2022). Are the vegetables grown in the soil of municipal solid waste dumping sites safe for human health? An assessment from trace elements contamination and associated health risks. Environmental Nanotechnology, Monitoring & Management, 18:100731.</p>

Course Code: 0888 13 SWE 4242		Year: Fourth	Term: Second
Course Title	Thesis		
Course Status	Optional		
Credit	4.0		
Prerequisite(s)	0888 13 SWE 4142		
Rationale	This course is intended for learning experiences in research and to design and execute a research work.		

Course Contents/Tasks		CLOs
1	Proposal writing: Students should submit a research proposal at the begging of the thesis to the corresponded supervisor. He/she would add the problem statements and research gap and justification of the thesis.	1
2	Results: Draw graph and table to represent the results, describe the important and significant results based on the statistical analysis.	1
3	Discussion: Discuss and explain the current experimental results, compare the results with other similar and dissimilar results of the identical works, and state the causes of current results.	2
4	Conclusion: Consolidate the main findings of the results, express recommendation if any.	3
5	References, Funding's information, Acknowledgement: Write the references by following the prescribe guidelines; acknowledge the funding sources or any supporting agencies or organization or person.	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	introduce and identify the research gap;	1, 3
	CLO2	write literature review and enriched with knowledge about past and present information about his research;	8, 9
	CLO3	utilize the materials and apply methods for conducting research.	8, 10

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, group discussion and presentation	Report writing and viva voce
CLO2	Lecture, presentation, question and answer, problem-based learning and presentation	Report writing and viva voce
CLO3	Lecture, presentation, question and answer	Report writing and viva voce

Learning Materials

Recommended Readings	Thesis guidelines will be provided from the discipline
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Course Code: 0888 13 SWE 4244	Year: Fourth	Term: Second
Course Title	Comprehensive Viva Voce IV	
Course Status	Core	
Credit	1.0	
Prerequisite(s)	None	
Rationale	The course is designed to provide the students with the opportunity to develop and demonstrate oral communication ability; gives students experience with the communications identified as most challenging in the workplace, i.e., interaction with a superior; help students develop explanatory skills, powers of persuasion, oral poise and self-confidence.	
Objective	The objective of comprehensive viva-voce is to assess the overall knowledge of the student in the relevant field of Soil, Water and Environment acquired over 4 years of study in the undergraduate program.	

Course Contents/Tasks		CLOs
1	The 'Comprehensive Viva Voce IV' requires the students to face a viva voce/defense board at the end of the concerned term 2. The concerned Examination Committee/ Academic Committee of the Discipline will form viva voce board to conduct the viva and assess the students out of 100 marks. If deemed necessary to the concerned Examination Committee, these sessions might be arranged online. The contents of this viva voce will include the gained knowledge, issues covered and concepts handled through the theory/sessional courses all the terms of the program.	1 to 5

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	review subjective knowledge gained through the program;	1, 2
	CLO2	improve oral presentation skill;	9
	CLO3	defend arguments in front of board members;	8, 9
	CLO4	disseminate the gained knowledge and argument;	9
	CLO5	build skills, roles, and methods of proceeding in task groups in order to achieve high levels of motivation, productivity.	8

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CL01	As reported for various courses	Viva voce
CL02	As reported for various courses	Viva voce
CL03	As reported for various courses	Viva voce
CL04	As reported for various courses	Viva voce
CL05	As reported for various courses	Viva voce

Learning Materials

Recommended Readings	As reported for various courses.
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Course Code: 0231 13 Eng 4253	Year: Fourth	Term: Second
Course Title	Professional English	
Course Status	Optional	
Credit	3.0	
Prerequisite(s)	None	
Rationale	To meet the challenges of the 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.	

Course Contents		CLOs
Section A		
1	Writing: Variety of business writings (emails, letters& short reports etc.), filling out different types of forms and analyzing and working with graphs and tables, Business writings.	1
2	Speaking: 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.	2
3	Presentation Skills: 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.).	2
Section B		
4	Understanding workplace culture: defining and interpreting culture, values, rituals and managing relationships.	3
5	Workplace meeting skills: Common types & purposes of meetings, techniques for note-taking, role of recorder/secretary, documents needed for effective meetings, minutes-taking.	3
6	Letter and CV: Writing cover letter, preparing resume and CV for a job, developing interview skills, workplace communication	4
7	Other Communication Skills: Telephone communication, cross-cultural communication, developing negotiation skills, presentation skills, arranging conferences and seminars.	1, 4

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	communicate with others in English by satisfying the mode of the case and workplace objective in concern;	9
	CLO2	deliver speech and present matters complying with the objective to be achieved;	9
	CLO3	think critically about the workplace culture and improve cross-cultural communication skills;	6, 9
	CLO4	learn and practice correct and culturally appropriate language for common workplace speech functions.	8, 9

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Team Teaching	Quiz and Class Test
CLO2	Problem-based Learning and Presentation	Assignment and Final Exam
CLO3	Lecture and Group Discussion	Presentation and Final Exam
CLO4	Group Discussion and Problem based Learning	Viva voce and Final Exam

Learning Materials

Recommended Readings	Taylor, C. (1978). Advancing language skills. The University Press Ltd., Bangladesh Thomson, A. J. A., & Martinet, V. (2019). A practical English grammar. 4th Edition. Oxford University Press.
Supplementary Readings	Pyle, M. A., & Page, M. E. M. (1986). Test of English as a foreign language. Cliffs Notes, Inc. U.S.A.

Course Code: 0223 13 Phil 4255		Year: Fourth	Term: Second
Course Title	Ethics		
Course Status	Core		
Credit	Non credit		
Prerequisite(s)	None		
Rationale	This course is designed to provide students with a preliminary philosophical study of morality, the theory of right and wrong behavior, the theory of value (goodness and badness), and the theory of virtue and vice to help students develop their abilities to read, explicate, analyze, and evaluate philosophical literature, write and express themselves well about their own ethical positions, and think critically and analytically about ethical issues.		

Course Contents		CLOs
Section A		
1	Moral Philosophy: Morally right conduct, Plato's moral philosophy, Moral relativism vs. moral objectivism, Ethics and egoism, Egoism as the beginning of morality, Sociobiology, Egoism and reciprocity.	1
2	Value: Classical hedonism, Utilitarian ethics, Deontological ethics, The foundations of ethics, Virtue ethics-Virtue and the moral life, Morality and religion-God and the moral Order. Male and female ethics, Duty ethics, Feminist ethics.	1, 2
3	Ethical Theories: Utilitarianism, Kantianism, Consequentialism, The structure of the soul, Natural law, Utilitarianism or Consequentialism Proper, Deontology- Command theory, Divine command theory, forms of command theory: state, culture, family, etc. Intention or will versus consequences and happiness.	1, 2
Section B		
4	Professional Ethics: Ethics and Justice, Citizen Advocacy, Engagement, Traditional Ecological Knowledge and Sustainable Development, Biodiversity and Environmental Education.	2, 3
5	The ethics of soil: Agriculture and environmental ethics, The spirit of the soil, Philosophy and agriculture, Environmental critics of agriculture, Sustainable agriculture and holism.	2
6	Applied Ethics: The Trolley Problem-Famine, Affluence, and Morality, Kantian Ethics and World Hunger, War and Massacre.	3

Course Learning Outcomes (CLOs)	Upon successful completion of the course, the students will be able to:		Mapping with PLOs
	CLO1	develop abilities to read, explicate, analyze, and evaluate philosophical literature, write and express themselves well about their own ethical positions, and think critically and analytically about ethical issues;	6, 9
	CLO2	develop conceptual tools for thinking through, and participating in, complex ethical discussions about nature, the environment, and ecosystems;	6, 7
	CLO3	become familiar with classic and current concepts, topics and debates in environmental ethics.	5, 6

Mapping CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Team Teaching	Quiz and Class Test
CLO2	Problem-based Learning and Presentation	Assignment and Final Exam
CLO3	Lecture and Group Discussion	Viva voce and Final Exam

Learning Materials

Recommended Readings	Goldman, A. H. (1980). <i>The moral foundations of professional ethics</i> . Rowman and Littlefield. Oakley, J., & Cocking, D. (2001). <i>Virtue ethics and professional roles</i> . Cambridge University Press, 2001. Pojman, L. P., & Tramel, P. (eds.). (2009). <i>Moral philosophy: a reader</i> . (4th ed.) Indianapolis: Hackett Publishing, 2003. Hackett Publishing Company, Inc Thompson, P. B. (2005). <i>The spirit of the soil- agriculture and environmental ethics</i> . Taylor & Francis e-Library.
Supplementary Readings	Callahan, J. C. (1988). <i>Ethical issues in professional life</i> . Oxford University Press. Rollin, B. E. (2006). <i>Science and ethics</i> . New York: Cambridge University Press. Wang, J. (2001). <i>Ethics and social responsibility in science</i> . in Marc Rothenberg (ed.), <i>The history of science in the United States: An encyclopedia</i> . New York: Garland Publishing Inc.

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Grading and Evaluation

20.1 Grading Scale

a) Letter Grades and corresponding Grade Points will be awarded following provisions shown below:

Numerical Grade	Letter Grade	Grade Point
80% or above	A+ (A plus)	4.00
75 to less than 80%	A (A regular)	3.75
70 to less than 75%	A- (A minus)	3.50
65 to less than 70%	B+ (B plus)	3.25
60 to less than 65%	B (B regular)	3.00
55 to less than 60%	B- (B minus)	2.75
50 to less than 55%	C+ (C plus)	2.50
45 to less than 50%	C (regular)	2.25
40 to less than 45%	D	2.00
Less than 40%	F	00
Incomplete	I	
Withdrawn	W	
Continuation (for the project, thesis design, etc. course)	X	

20.1.1 Evaluation of Theory Courses

a) All theory courses will be evaluated out of 100 marks, the distribution of which is given below:

Sl. No.	Items	Marks
1	Attendance and Class Participation	10
2	Continuous Assessments	30
3	Term Final Examination	60
	Total	100

b) The basis for awarding marks for class attendance and participation will be as follows:

Attendance & Participation	Marks
90% or above	10
85 to below 90%	9
80 to below 85%	8
75 to below 80%	7
70 to below 75%	6
65 to below 70%	5
60 to below 65%	4
Below 60%	0

c) The continuous assessments of the theory courses may be conducted in the form of class tests, assignments, homework, presentation, quiz, viva voce, etc. The course teacher(s) will evaluate every continuous assessment and share the result with the students within 2(two) weeks of conducting that continuous assessment.

d) The duration of a class test may be 20-45 minutes, and it will preferably be given during class hours.

e) If a student does not attend the class test for reasons satisfactory enough to the course teacher, the course teacher may allow the student one more chance for such assessment during the term; however, it must be held before the term final examinations. A student who has been absent for a short period, up to a maximum of three weeks due to illness, should approach the course teacher(s) or Coordinator(s) for make-up of quizzes/class tests or assignments, etc.,

immediately on returning to the classes. Such request should be supported by a medical certificate endorsed by the Chief Medical Officer of the University. The medical certificate issued by a registered medical practitioner (with the registration number shown explicitly on the certificate) and endorsed by the Chief Medical Officer of the University will also be acceptable only when the student has valid reasons for his/her absence from the University.

f) The number of Continuous Assessments (CAs) in each course will be as follows:

No. of credit(s)	Total no. of CA required	CAs to be considered for grading
3 – 4	4 (2 in each section)	Section best assessments shall be averaged for grading
1.5 – 2	3 (at least one in each section)	

g) If two teachers teach a course, both the teachers will conduct continuous assessments individually.

h) Answer scripts of the continuous assessment may be shown to the students to identify their strengths and weaknesses, but those would not be returned to them. The concerned teacher would submit the evaluated continuous assessment answer scripts and attendance register to the Head of the Discipline/Program Offering Entity (POE). The final score of attendance and class participation (out of 10) and continuous assessment (out of 30) should be displayed on the Discipline's notice board/ Discipline website/ Course web page before starting the term final examination.

i) The course teachers must submit the continuous assessment mark sheets to the Chair of the Examination Committee before the starting of the term final examination.

j) The Term Final Examination will carry 60 marks. There will be two separate answer scripts for Section A and Section B in the Term Final Examination.

k) When a student repeats a course in which he/she previously obtained an F grade, he/she will be given just an immediate lower grade that he/she obtained in the repeated course. However, in case he/she obtains a D grade, that will be maintained, and this grade will be shown in the transcript. If a student has to repeat a course due to punishment on him/her, the grade obtained will be maintained. If a student obtains a grade other than an F in a course, he/she will not be allowed to repeat the course for grade improvement.

l) If a student obtains an 'F' grade in any Core course in any term, this 'F' grade will not be counted for Grade Point Average (GPA) but will be shown on the grade sheet, and in such case, he/she will have to retake the course for grade improvement.

m) While registering for a retake/re-retake theoretical course, a student must be given an option to decide whether s/he intends to sit for continuous assessment of the course. If s/he opts to sit for continuous assessments, his/her fresh mark will be counted to prepare the result. However, the class attendance and participation marks will be taken from the previous record.

n) A student has to register for the backlog/retake/re-retake core courses first followed by the fresh courses offered by the Discipline for the term s/he is going to enrol subject to the compliance with: (i) completion of prerequisite courses (if any) and (ii) maximum registration limit of 25 credits per term. However, s/he may not choose to register the optional backlog/retake/re-retake courses first.

o) In addition, a student may be allowed to register for advance course(s) in a term subject to: (i) his/her all backlog/retake/re-retake and offered core courses are either clear or registered, (ii) his/her current terms' offered all core courses are registered, (iii) completion of corresponding prerequisite courses (if any), (iv) compliance with a maximum registration limit of 25 credits per term, and (v) the desired advance courses are offered by the Discipline/POE in the current term. However, such advance course registration option will not be applicable for capstone courses like Thesis/Project/ Internship/ Research study/ Monograph/ Portfolio, and so on.

p) A Special Term may be offered for the final year students who have retake/re-retake course(s). In this case, the maximum credit limit for a student will be 15 credits. This will be a Non-Taught Term. The Examination of Special Term will start 4 (four) weeks after publishing 4th-year 2nd Term results and will continue not more than 2 (two) weeks. The continuous assessment marks (40%) will be carried over from previously registered theory course(s), and Special Term Final Examination will carry the remaining (60%) marks. Final Year Term Thesis/Dissertation/Design or Core Sessional(s) supervisor(s)/course teacher(s) in consultation with the Head may allow the student(s) to re-submit the Thesis/

Dissertation Design or Core Sessional(s) within the Special Term schedule. However, it must be within the allowed limits of the Special Term credits.

20.1.2 Evaluation of Sessional Courses

a) All sessional courses will be evaluated out of 100 marks, the distribution of which is given below:

Sl. No.	Items	Marks
1	Attendance/Class Participation/Contact with teachers	10
2	Sessional Evaluation/Internal criticism/Observation	60
3	Viva Voce/ Final Jury	30
	Total	100

b) Sessional evaluation would be done through a laboratory test, class test, quiz, assignment, assigned project, report, oral test, performance/behaviour of the students, etc. The course teacher(s) will complete every sessional evaluation and share the result with the students within 2(two) weeks of conducting that item. Attendance and sessional evaluation mark sheets (out of 10+60=70) will be displayed on the Discipline's notice board/Discipline website/Course web page before starting the term final examination.

c) Viva Voce of each sessional course will usually be conducted by the course teacher(s). The senior most among the course teachers (if any) will be the Chair of the viva board. However, such viva voce/final assessment of a sessional course can also be done through jury board in applicable cases. The jury board will be headed by the Head of the Discipline or any other senior teacher of the Discipline/POE not below the rank of Assistant Professor. The Chairman of the viva/jury board may appoint other teacher(s) as a board member if necessary. A student must attend a sessional evaluation and viva voce. In case of absence in any component, he/she will get an F grade in that course.

d) The course teachers must submit the continuous assessment mark sheets to the Chair of the Examination Committee before the starting of the term final examination.

e) A student may register sessional courses as retake/re-retake (if applicable) on the Discipline Head's written approval. For retake/re-retake sessional courses, no previous records/marks will be counted.

20.1.3 Evaluation of Capstone Courses

a) The distribution of marks for a Capstone (Thesis/ Monograph/ project paper/ etc.) course will be as follows:

Sl. No.	Description	Marks
1	Contact/Discussion/Communication with the Supervisor	10
2	Evaluation	60
3	Oral presentation and/or Viva voce	30
	Total	100

b) There will be two examiners (including the Supervisor) to examine the Thesis. Each examiner will evaluate the Thesis separately, and the average marks will be considered for grading. However, if the marks given by the First and Second Examiners vary 20% or more, a Third Examiner to be appointed by the concerned Examination Committee from the outside the University will evaluate the Thesis Monograph/Project paper. Among these numbers, the average of the closest two numbers will be considered for grading. However, if the marks given by the Third Examiner happen to stand at the middle of the marks given by the first two Examiners, the average of the three marks will be considered for grading.

c) For the thesis/dissertation/final project/other projects like the thesis of the final year students, there a presentation and defense session before the defense board. If deemed necessary to the concerned defense board, these sessions might be arranged online. A three-member defense board will evaluate the presentation and defense session. The Supervisor of the thesis/ project/ internship/ research study/ monograph/ portfolio courses will normally be the Chairman of the board while the second examiner and one member nominated by the Head of the Discipline/POE will be the members of the defense board. Every member of the defense board will evaluate individually and the final marks will be calculated by averaging all the marks given by the three members. The defense board members will be remunerated individually as per the approved rate of the university. For Jury board or in other special circumstances, the Head of the Discipline/POE might include additional member(s) in the board for justifiable reasons.

d) A Discipline might allow some students to register for an Internship program/ Project paper/ Monograph/ Research study according to the course curriculum of the respective Discipline. Such an internship program/ Project paper/Research study course might be considered as the substitute of Thesis for those students. The evaluation and related activities of such Internship program/ Project paper/ Research study courses will be similar to Thesis. Usually, a Thesis will carry double weight in terms of credit compared to other alternatives like Project/ Internship/ Research study/ Monograph/ Portfolio and so on.

e) A Discipline might allow splitting the thesis/similar course into more than one term. 'X' grade may be assigned for continuing the same course in multiple terms to assign a complete grade in the last term. Alternatively, multiple courses under thesis/similar course might be assessed by providing complete grades at the end of each term. The curriculum of the concerned Discipline/Entity will clarify all such issues.

20.1.4 Evaluation of Viva Voce

a) There might be a grand viva voce in each term. A student will not usually be allowed to register for more than one course of this type bearing 01 (one) credit in a term. The concerned Examination Committee of that Term will conduct the viva and assess the students. The distribution of marks for viva voce will be as follows:

Description	Marks
Viva voce	100

20.2 Grades

Grade related issues are reported in section 20.1.

20.3 Grade Point Average (GPA) and Cumulative Grade Point Average (CGPA)

a) Grade Point Average (GPA) is the weighted average of Grade Points obtained in all the courses passed/completed by a student. For example, if a student has passed/completed five courses in a term having credits of C1, C2, C3, C4, and C5 and his/her points in these courses are G1, G2, G3, G4, and G5, respectively, then,

$$GPA = \frac{\sum C_i G_i}{\sum C_i}$$

b) A Numerical Example: Suppose a student has completed five courses in a term and obtained the following grades:

Course	Credit	Grade	Grade Point
A	3	A+	4.00
B	3	C+	3.00
C	3	A	3.75
D	2	B	3.25
E	1	B+	3.50

Then his/her GPA for the term will be computed as follows:

$$GPA = \frac{3(4.0) + 3(3.0) + 3(3.75) + 2(3.25) + 1(3.5)}{3 + 3 + 3 + 2 + 1} = 3.52$$

c) A student's performance will be evaluated in terms of three indices- Term Grade Point Average (TGPA), Yearly Grade Point Average (YGPA), and Cumulative Grade Point Average (CGPA). The TGPA is computed by dividing the total points earned in a Term by the number of credits taken in the Term. The YGPA is computed by dividing the total grade points earned in two Terms in a year by dividing the number of credits taken in that year. The CGPA is computed by dividing the total grade points accumulated till date by the total completed credits. Thus a student who has earned 275 grad points in attempting 100 credits of courses would have an overall CGPA of 2.75.

20.4 Course Withdrawal

a) 'W' is the corresponding grade for withdrawn of a course, as mentioned in section 20.1.

b) If any student cannot complete the Term Final Examination due to severe illness or serious accident, he/she may apply to the Dean through the Head of the concerned Discipline for total withdrawal from the Term within eight working days after the Term Final Examination. However, he/she may choose not to withdraw from any sessional course if the grade obtained in such a course is C or better. A medical certificate endorsed by the Chief Medical Officer of the University must support the application. The Dean of the concerned School will decide on such an application and inform the Academic Council. If a student is allowed to withdraw from a Term, he/she will have to register as fresh from the Term he/she has withdrawn. However, he/she may be allowed to register for backlog courses, if offered.

20.5 Incomplete (I) Courses

'I' is the corresponding grade for an incomplete course, as mentioned in section 20.1.

20.6 Retake

Retake related issues are reported in sections 20.1.1 and 20.1.2.

20.7 Grade Improvement

Grade improvement related issues are reported in section 20.1.1.

20.8 Dropout/Cancellation of Studentship

a) A first-year first term student's admission will stand cancelled if he/she fails to complete course registration by ten working days from the beginning of the classes.

b) A first-year first term student's admission will stand cancelled if he/she fails to attend at least 50 percent of classes during ten working days from the beginning of the classes. However, in case of severe illness/accident this provision may be relaxed subject to submission of a medical certificate issued by a registered medical practitioner (with the registration number shown explicitly on the certificate) and endorsed by the Chief Medical Officer of the University.

c) A student's studentship will stand cancelled if he/she fails to comply with registration of minimum credit requirements under article 12.2 of the latest (July 2022) 'Ordinance for Undergraduate Program' of Khulna University. According to that article, a student must register for at least 15 credits per term and may be allowed to register for up to a maximum of 25 credits if recommended by his/her Discipline Head. The Discipline/POE might offer less than, greater than or equal to 25 credits per term as per the approved curriculum. The student will enjoy the option of choosing backlog, re-take, re-retake, advance courses (subject to compliance with applicable requirements/restrictions, as reported in other articles of the Ordinance) in addition to fresh courses to comply with the restriction of maximum 25 credits per term. If any student fails to register, in any way, for minimum credits (15 credits), his/her studentship at the University will stand cancelled. This minimum 15-credit registration limit may be relaxed if: (i) the student requires less than 15-credit to complete his/her graduation, or (ii) the sum of applicable (for the student) credits offered by the Discipline is less than 15-credit in the corresponding term for any valid reason.

d) A student's studentship will stand cancelled if he/she fails to earn minimum credits under article 12.5.2 of the latest (July 2022) 'Ordinance for Undergraduate Program' of Khulna University. According to that article, when a student is going to register for his/her courses in the 3rd year 2nd term, his/her earned credits up to 2nd year 2nd term must be at least 36. Otherwise, his/her studentship at the University will stand cancelled.

Approval Records	
Approving Authority	Date of Approval
Curriculum Committee of the Discipline	
Executive Committee of the School	September 11, 2022
BOAS (if applicable)	
Academic Council	October 12, 2022
Syndicate (if applicable)	October 20, 2022

Appendix 01: Summary of Major Changes in the OBE Format Curriculum

Program : Bachelor of Science (Honours) in Soil, Water and Environment

Discipline : Soil, Water and Environment

School : Life Science School

Sl. No.	Criteria	Existing Curriculum	OBE Curriculum
1	Duration of the Program (in Year)	4	4
2	Total Available Credits	204	220
3	Minimum Credit Requirement to Complete the Degree	160	160
4	Available Credits from GED Courses		62
5	Credits from GED Courses (% of Total Credits)	28	28.18
6	Credits from GED Courses (% of Required Credits)	-	38.75
7	Available Credits from Core Theory Courses*	84	87
8	Available Credits from Core Sessional Courses*	45	31
9	Available Credits from Optional Theory Courses*	63	75
10	Available Credits from Optional Sessional Courses*	12	15
11	Available Credits from Capstone Courses	-	12
12	Term Duration (in week)	13	14
13	Credits from Newly Introduced Courses	-	45
14	Number of Newly Introduced Courses	-	25
15	Number of Omitted Courses	-	1
16	Change in Course Title (Number of Courses)	-	18
17	Change in Course Status (Number of Courses)	-	1
18	Inter-term Shift (Number of Courses)	-	6
19	Change in Course Contents (Number of Courses)	-	Most of the Courses
20	Name of Majors (if Applicable)		
21	Name of Modes (if applicable)	-	

* including GED

Appendix 02: Faculty Members of the Discipline

Sl. No.	Name and Address	Designation in Committee
01	Prof. Afroza Begum	Member
02	Prof. Dr. Shaikh Motasim Billah	Member
03	Prof. Khandoker Qudrata Kibria	Member
04	Prof. Md. Sanaul Islam	Member
05	Prof. Mohammad Zaber Hossain	Member
06	Prof. Dr. Jagadish Chandra Joardar	Member
07	Md. Sadiqul Amin, Associate Professor	Convenor
08	Dr. Md. Hanif, Associate Professor	Member
09	Sonia Nasrin, Associate Professor	Member
10	Nipa Adhikary, Associate Professor	Member
11	Milton Halder, Assistant Professor	Member
12	Falguni Akter, Assistant Professor	Member

Appendix 03: PSAC of the Discipline

Sl. No.	Name	Affiliation	Designation
1	Md Sanaul Islam	Head, SWE Discipline, KU	Chairman
2	Dr. Md. Hanif	Professor, SWE Discipline, KU	Member
3	Nipa Adhikary	Associate Professor, SWE Discipline, KU	Member

Appendix 04: Contributors and Attendees in the Dissemination Workshop

Sl. No.	Name and Address	Designation in Committee
01	Afroza Begum	Professor, Soil, Water and Environment Discipline, Khulna University
02	Dr. Shaikh Motasim Billah	Professor, Soil, Water and Environment Discipline, Khulna University
03	Khandoker Qudrata Kibria	Professor, Soil, Water and Environment Discipline, Khulna University
04	Md. Sanaul Islam	Professor, Soil, Water and Environment Discipline, Khulna University
05	Mohammad Zaber Hossain	Professor, Soil, Water and Environment Discipline, Khulna University
06	Dr. Jagadish Chandra Joardar	Professor, Soil, Water and Environment Discipline, Khulna University
07	Dr. Md. Hanif	Professor, Soil, Water and Environment Discipline, Khulna University
08	Md. Sadiqul Amin	Associate Professor, Soil, Water and Environment Discipline, Khulna University
09	Sonia Nasrin	Associate Professor, Soil, Water and Environment Discipline, Khulna University
10	Nipa Adhikary	Associate Professor, Soil, Water and Environment Discipline, Khulna University
11	Milton Halder	Assistant Professor, Soil, Water and Environment Discipline, Khulna University
12	Falguni Akter	Assistant Professor, Soil, Water and Environment Discipline, Khulna University
13	Dr Sirajul Hoque	Professor, Department of Soil, Water and Environment, Dhaka University
14	Dr. Md. Ziaul Haider	Director, IQAC, Khulna University
15	Dr. Md. Matiul Islam	Additional Director, IQAC, Khulna University
16	Md. Mostafizur Rahman	Additional Director, IQAC, Khulna University
17	Lutfu Parvin	District Coordinator, Gender-responsive Coastal Adaptation (GCA), UNDP
18	Md Atiqur Rahman	Deputy Director, Bangladesh Bank
19	Syed Alim Al Razir	Scientific Officer, SRDI, Faridpur
20	Dr Mahmood Hossain	Vice Chancellor, Khulna University
21	Khan Golam Kuddus	Dean, Life Science School, Khulna University

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