UNIVERSITY OF DHAKA

Outcome-based Curriculum
of
Bachelor of Science (Honors) in
Soil, Water and Environment

(Session: 2023-2024 and onwards)

Department of Soil, Water and Environment
The University of Dhaka
Bangladesh
2024

OUTCOME-BASED CURRICULUM

PART - A and B

1. **Title of the Academic Program:** Bachelor of Science (Honors) in Soil, Water and Environment

Program Overview	
Degree	Bachelor of Science (Honors) in Soil, Water and Environment
Abbreviated form of the Degree	B. S. (Hons.) in SWE
Program Offering Entity (POE)	Department of Soil, Water and Environment
Acronym of the POE	Department of SWE
Faculty	Faculty of Biological Sciences
Awarding Institution	University of Dhaka
Location	Dhaka, Bangladesh
Bangladesh National Qualifications Framework (BNQF) Level	7 and 9
Mode of Study	Full Time
Language of Study	English
Applicable Session	2023-2024 and onwards

2. **Name of the University:** The University of Dhaka

3. **Vision of the University:**
   - To create new areas of knowledge and disseminate this knowledge to the society and the nation as well.
   - To enrich the global pool of knowledge by making notable contributions in the fields of teaching and research.
   - To strive and transform the world in positive ways through advanced education, impactful research with new knowledge, and the translation of knowledge into solutions.
   - To create sustained environments to advance the motto of the University and to build and maintain excellence.

4. **Mission of the University:**

Sl. No	Description
UM1	Generating new knowledge through a broad array of scholarly, research and creative endeavors, which provide a foundation for dealing with the immediate and long-range needs of society.
UM2	Building strength through creative innovation, entrepreneurship, research, intellectual curiosity and partnerships.
UM3	Empowering our students to fulfill their academic and professional passions in the university that is diverse, welcoming, and inclusive for all students, faculty, and staff.

UM4	Serving society through coordinated countrywide outreach programs that meet continuing educational needs in accordance with the university's designated status.
UM5	Fostering a diverse community of students, staff, and faculty. It is dedicated to access, affordability, and ensuring that the benefits of its transformative educational opportunities are not limited by financial circumstance or background.
UM6	Maintaining a level of excellence and standards in all programs that will give them national and international significance.
UM7	Supporting the community of alumni through imaginative programs that enrich their lifelong relationship with the University and that expand the collective contributions to the world.

5. **Name of the Program Offering Entity:** Department of Soil, Water and Environment

6. **Vision of the Program Offering Entity:**

The vision of the department is to be a regional hub that will take the lead in solving all the regional problems and global problems, for that matter. The department will advance the understanding of soil, water, and environmental sciences by devoting its cutting-edge facilities to research. The department is also committed to transferring its research-based findings to all the stakeholders, including farmers, policymakers, scientists, and other citizens.

7. **Mission of the Program Offering Entity:**

Sl. No	Description
M1	To recruit top quality students and educate them into skilled academic and research scholars in the focal area of soil, plants, water and environmental sciences through offering advanced courses.
M2	To create partnership in research collaboration, student-faculty exchange programs in the academic institutions, among national and international institutions in such a manner that students could keep up with the changing needs of the local people looking for soil, water, and environmental sciences graduates.
M3	To innovate new technology and develop new knowledge for the sustainable utilization of soil, agriculture, ecosystem and water resources, transfer them to the end-users, research partners and stakeholders for making policy, and to formulate necessary packages for the restoration of environmental degradation, mitigating, adopting and combating climate change and other natural disasters.

8. **Name of the Degree:**

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

9. **Description of the Program:**

The department was established in 1949 in the name of the Department of Soil Science. The Department of Soil Science was renamed as the Department of Soil, Water and Environment in the year 2000 to broaden the scope of the academic arena. Since then, the department has been offering a 4-yr Bachelor of Science (Honors) degree in Soil, Water and Environment with an aim to produce trained personnel for agriculture and environment related fields.

For the 1st year syllabus has been developed giving emphasis on the introductory ideas on soil, water and environmental sciences. For 2nd year courses emphasis has been given on more advanced ideas on assessment and management of ecosystem services, soil mineralogy, general

microbiology, plant biochemistry and keeping in mind to correlate the research using mathematics and biostatistics.

Courses for 3rd Year has been planned to disseminate knowledge on in depth soil science, water science and environmental science. Courses for 4th Year has been developed to give emphasis on soil conservation and soil management, advanced hydrology, environmental pollution, and climate change, mitigation and adaptation.

10. Program Educational Objectives (PEOs):

PEOs	Description	Domain
PEO 1	To educate and train the graduates theoretically and practically on Soil, Water and Environment with a broad-based knowledge regarding agriculture, soils, water and the sustainable resource utilization and management, climate change, greenhouse effects, etc.	Fundamental
PEO 2	To develop innovative ideas and knowledge to capacitate graduates for managing and sustaining the bio-resources for the survival of human habitats and of ecosystem restoration.	Fundamental
PEO 3	To incorporate advance knowledge and skills for the designing and formulation of contemporary issues regarding soil-plant-water-air continuum	Thinking, personal
PEO 4	To facilitate the graduates to be leaders in the research and development domain for accelerating the society development through agro-farming, mitigation and adaptation strategis and entrepreneurship development.	Social, personal
PEO 5	Implication of research knowledge/ideas on society development through livelihood development with integrating much awareness involving local stakeholders.	Social, personal

11. Program Learning Outcomes (PLOs):

PLOs	Statement
PLO 1	Explain the fundamental concepts of soil, water and environment and correlate their influence on ecosystems and their services.
PLO 2	Explore the nature and properties of soil, water and environmental components to address regional, national and global issues.
PLO 3	Highlight the principles of soil, water and environment to ensure safety, security and wellbeing of future generation.
PLO 4	Respond to societal problems and demand through the findings of the research communication, motivation and extension.
PLO 5	Create social awareness regarding environmental components and promote the measures to sustain soil health, food security, soil-plant-lithoshere management, soil ecology and environmental safety.
PLO 6	Identify and analyze soil, water and environment related problems and resolve by applying appropriate strategic knowledge of these branches.
PLO 7	Proper scientific methods to investigate the soil-plant-water-environmental processes and their interactive systems on food security for healthy environments and their utilization in valid and logical field and laboratories.
PLO 8	Apply the knowledge base and research skills to current issues about soil, water and environmental resources, their management, and ecological balance with long-term sustainability which creates bridge between economic, social and policy level.

PLO 9	Ability to speak, communicate, write up of thesis and publish original scientific work in the peer reviewed journals professional-level presentations of their research.
PLO 10	Justify knowledge and information technology on the scientific method, experiment design, research implementation in qualitative and quantitative analysis and interpret the results using appropriate statistical techniques and computer applications.

12. Graduate Attributes (GAs):

GAs	Description	Domain
GA1	Comprehensive knowledge and understanding of the subject areas, and the ability to applying their knowledge in multidisciplinary areas.	Fundamental domain
GA2	Digital skills to compete with the different aspects of Soil, Water and Environment	Fundamental domain
GA3	Application of critical thinking in innovative and problem-solving aptitudes.	Thinking domain
GA4	Creative responses and advanced thinking should be applied to combat the future challenges.	Thinking domain
GA5	Professional development in applying the entrepreneurial and take leadership roles in their chosen occupations.	Personal domain
GA6	Self-awareness and reflective attitudes of the graduates; flexible and resilient and have the capacity to accept and give constructive feed back; hence they act with integrity and take responsibility for their actions.	Personal domain
GA7	Leadership in managing in their respective professions with positive and collaborative ways.	Social domain
GA8	Carries social values and ethics in society development as a responsible member of the valued society.	Social domain
GA 9	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	Life-long learning domain

13. Mapping mission of the university with PEOs

PEOs	UM1	UM2	UM3	UM4	UM5	UM6	UM7
PEO1	3	1	2	3	3	1	2
PEO2	2	3	1	1	2	2	1
PEO3	2	1	3	2	1	3	3
PEO4	1	2	2	2	3	2	2
PEO5	3	3	3	3	2	3	2

Level of correlation: (*1) Weak, (2) Moderate, and (3) Strong*

14. Mapping PLOs with the PEOs

PLOs	PEO 1	PEO 2	PEO 3	PEO 4	PEO 5
PLO 1	*	*			
PLO 2		*	*		
PLO 3		*	*		
PLO 4				*	*
PLO 5				*	*
PLO 6		*	*		
PLO 7	*	*	*	*	*
PLO 8		*			
PLO 9			*		
PLO 10			*		

15. Teaching- Learning and Assessment Strategy[a]

[a]**Strategy:** Students in each class will have two class representatives (one male and one female) to communicate with the students, several study circles to discuss the delivered lectures within/among the circles and finally with the teacher if needed. Regular attendance, counseling, asking questions, creation of problems and make solutions, arrangement of discussions, demonstrations, etc. will be maintained.

[b]**Visual:** Picture, Diagram, Demonstration, Display, Handouts, Films, Flip-chart

[c]**Auditory:** To the spoken word, sounds and Noise

[d]**Kinesthetic**/Practical: Physical experience- touching, feeling, holding, doing, practical hands on experience

B. S. (Honors) Degree
Session: 2023-2024 and onward

General description of the program:

1. Department of Soil, Water and Environment (SWE) offers B. S. (Honors) degree with an aim to produce trained personnel for Agriculture, Water and Environment related fields.

2. The duration of the Program will be of 4 (four) academic years divided into 4 (four) sessions, so that there will be one session in each academic year. The entire program is covered by a set of theoretical, practical (laboratory/field), and seminar courses. A student must have to earn 140 credits for successful completion of his/her graduation program.

3. The total performance of a student in a given course will be evaluated on the basis of a scheme of continuous assessment and course final examinations. For theory courses the continuous assessment will be made through a set of in-course examinations, class participation and a course final examination. Continuous assessment of practical (laboratory/field) courses will be made through observation of the student at work, *viva-voce*, assignments and evaluation of practical reports.

The distribution of marks for theoretical and practical courses will be as follows:

Items	Marks
Class attendance	5%
In-course assessment	35%
Course Final Examination	60%

Basis for awarding marks for class attendance will be as follows:

Attendance (% of total class held)	Marks (%)
95 and above	5
90 to less than 95	4
85 to less than 90	3
80 to less than 85	2
75 to less than 80	1
Less than 75	0

4. Marks obtained for each course will be converted to grades. A basic four-point (4.00) grading scale will be followed. The following letter grades and corresponding grade-points will be used to determine the student's grade point average (GPA):

Marks Obtained	Corresponding Letter Grade	Grade Point
80% or above	A+	4.00
75% to less than 80%	A	3.75
70% to less than 75%	A-	3.50
65% to less than 70%	B+	3.25
60% to less than 65%	B	3.00
55% to less than 60%	B-	2.75
50% to less than 55%	C+	2.50
45% to less than 50%	C	2.25
40% to less than 45%	D	2.00
Less than 40%	F	0.00

Summary of Course Distribution for B. S. (Hons.) Degree in SWE

Courses for 1st Year

Course Code	Course Title	Course Type	Credits
	Departmental Courses		
SWE 101	Introduction to Pedology and Soil Physics	Core course	2
SWE 102	Introduction to Soil Chemistry and Soil Fertility	Core course	2
SWE 103	Introduction to Environmental Science	Core course	2
SWE 104	Introduction to Water Science	Core course	2
SWE 105	Introduction to Natural Hazards and Disaster	Core course	2
SWE 106	Practical	Core course	2
SWE 107	Field Work and Community Outreach	GED course	2
SWE 108	Viva-voce	Core course	2
	Extra-Departmental Courses		
CM 100F	Fundamentals of Chemistry	GED course	4
BOT 001	Diversities in Plant Kingdom and Plant Physiology	GED course	4
GLT 101	Geology	GED course	2
GLP 102	Petrology and Mineralogy Lab	GED course	2
Total Credits			**28**

Courses for 2nd Year

Course	Course Title	Course Type	Credits
	Departmental Courses		
SWE 201	Soil Mineralogy and Soil Colloids	Core course	2
SWE 202	Soil Physics	Core course	4
SWE 203	General Microbiology	Core course	2
SWE 204	Calculus	GED course	2
SWE 205	Biostatistics	GED course	2
SWE 206	Plant Biochemistry	Core course	2
SWE 207	Water Chemistry	Core course	2
SWE 208	Introduction to Ecosystem Services	Core course	2
SWE 209	Practical	Core course	2
SWE 210	Field Work and Community Outreach	GED course	2
SWE 211	Viva-voce	Core course	2
	Extra-Departmental Courses		
FC2	Functional and Communicative English	GED course	2
CM 241H	Chemistry of the Elements	GED course	2
CMGL 101H	General Chemistry Laboratory	GED course	2
GMT 201	Introduction to Geography and Environment	GED course	2
GML 202	Fundamentals of GIS	GED course	2
Total Credits			**34**

Courses for 3rd Year

Course Code	Course Title	Course Type	Credits
SWE 301	Pedology	Core course	4
SWE 302	Soil Chemistry	Core course	4
SWE 303	Soil Biochemistry	Core course	2
SWE 304	Soil Microbiology	Core course	2
SWE 305	Soil Fertility and Plant Nutrition	Core course	4
SWE 306	Water Resources and Water Quality	Core course	4
SWE 307	Atmospheric Science	Core course	4
SWE 308	Ecology and Environment	Core course	4
SWE 309	Practical	Core course	6
SWE 310	Field Work and Community Outreach	GED course	2
SWE 311	Viva-voce	Core course	2
Total Credits			**38**

Courses for 4th Year

Course Code	Course Title	Course Type	Credits
SWE 401	Soil Survey and Remote Sensing	Core course	2
SWE 402	Soil Conservation and Sustainable Land use	Core course	2
SWE 403	Soil Water Management	Core course	4
SWE 404	Soil and Ecosystem Management	Core course	2
SWE 405	Agronomy	Core course	2
SWE 406	Crops of Bangladesh	Core course	2
SWE 407	Soil Pollution and Waste management	Core course	4
SWE 408	Climate change, Mitigation and Adaptation	Core course	4
SWE 409	Soils of Bangladesh	Core course	2
SWE 410	Chemistry of the Submerged Soils	Core course	2
SWE 411	Hydrology	Core course	2
SWE 412	Seminar	GED course	2
SWE 413	Practical	Core course	6
SWE 414	Field Work and Community Outreach	GED course	2
SWE 415	Viva-voce		2
Total Credits			**40**
Total Credits for 4 years			**140**

Courses for 1st Year

Course Code: SWE 101	**Credits:** 2 (50 Marks)	**Course Status:** Core course

Course Title: Introduction to Pedology and Soil Physics

Prerequisite(s): As per University requirements for the admission into the program

Rationale of the Course: Before getting involved with various components and complex processes occurring in the soil a student needs to a basic understanding of soil from both pedological and edaphological approaches. Keeping that in mind, this course has been designed.

Course Objectives: The objective of the course is to introduce basic knowledge on formation, composition, and properties of soil, so that students' interest for studying this complex and dynamic system will be developed.

Course Learning Outcomes (CLOs) and Mapping with PLOs

Upon completion of this course the students will be able to:		**PLOs covered**
CLO1	explain the importance of soil as a natural and diverse ecosystem component;	PLO 2
CLO2	describe the processes of weathering and soil formation;	PLO 1
CLO3	identify the fundamental soil properties and its relation to plant growth	PLO 1 and 2

Course Contents

Sl. No	**Topic**	**Class Hours**	**CLOs covered**
1	**Concepts of soils**: Pedology and Edaphology; Foundation of Pedology; Soil as a heterogeneous and three phase disperse system; Spatial variability of soils in relation to landscape.	2	CLO 1
2	**Terminologies used in Pedology**: Soil series, soil Family, soil phases, soil type, mapping unit, taxonomic unit, soil Association, soil consociation, soil complex, landscape, land type, land form, soil catena, soil profile, horizon vs. layer, control section, soil sequence, soil drainage, pedon, polypedon, Soil monolith etc.	4	CLO 1
3	**Weathering of Rocks and Minerals:** Their formation, characteristics and classification; primary minerals, secondary minerals, silicate and non-silicate minerals: their characteristics; Silicate structure**.** Physical and Biogeochemical weathering process; Factors affecting weathering; Weathering sequences and results.	4	CLO 2
4	**Typical soil profile and the morphological properties**: Master horizons and their formation; Importance of soil profile study; Soil solum and regolith. Morphological properties and pedogenesis.	3	CLO 2

5	**Factors of soil formation and Processes of soil formation:** Jenny soil forming factors and their role in soil pedogenesis. Basic principles of soil forming processes; Important soil forming processes and their salient features.	3	CLO 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, Soil water potential etc.	14	CLO 1 and CLO 3

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	**Teaching- Learning Strategy[a]**	**Assessment Strategy**
CLO1	[b]Visual and [c]Auditory	Class attendance, Continuous assessment, Incourse Exam, assignment,Final theory and practical Exam, oral exam and presentation, Field level assessment.
CLO2	Visual and Auditory	
CLO3	Visual and Auditory	
CLO4	Visual and Auditory	
CLO5	Visual and Auditory	

Learning Materials	
Recommended Readings	*Brady, N.C. and R.R. Weil. 2007. The Nature and Properties of Soils. (14th ed.) Pearson Publ.* *Sehgal, J. 2005. Pedology: Concepts and Applications. Kalayani Publishers, New Delhi, India.* *Hillel, D. 1982. Introduction to soil Physics. Academic Press, INC. London*
Supplementary Readings	*Buol et al. 2005. Soil Genesis and Classification. Iowa State press, USA.*

Visiting hours: 10 am to 12 noon and 3 to 5 pm of the working days *(if available).*

Course Code: SWE 102	**Credits:** 2 (50 Marks)	**Course Status:** Core course

Course Title: Introduction to Soil Chemistry and Soil Fertility

Prerequisite(s): As per University requirements for the admission into the program

Rationale of the Course: This course is designed for undergraduate students of the department so that they can develop an understanding and knowledge of the fundamentals of chemical and biological aspects of soils. The students will also get to appreciate the basics of soil fertility and plant nutrition.

Course Objectives: The objective of this course is to enable undergraduate students to acquire an introductory idea about soil as a new subject. The course will provide an introductory idea of the chemical and biological aspects of soil. The course will also touch on the edaphological aspect of soil, i.e. the role soil plays as a medium of plant growth.

Mapping with SDG: This course is relevant to achieve SDG 4.

Course Learning Outcomes (CLOs) and Mapping with PLOs

Upon completion of this course, the students will be able to:		**PLOs covered**
CLO 1	be familiar with the new subject, understand the importance of the subject and extent, and appreciate as to how the course is related to soil, water and atmospheric sciences.	PLO 1 & 2
CLO 2	know about the composition of soil and its relationship with soil fertility and plant nutrition.	PLO 3
CLO 3	learn the major components of plant tissues and their importance in soil after incorporation into it as soil organic matter.	PLO 1 & 8
CLO 4	learn the composition of soil air and its relationship with atmospheric air and the importance of this phase in different aspects of soils and plant growth.	PLO 2
CLO 5	be familiar with the liquid phase of the soil, and the solvent and solutes present therein; learn the importance of the liquid phase in relation to plant growth.	PLO 1 & 2
CLO 6	be familiar with the pH scale and buffer action and its importance in soil.	PLO 1
CLO 7	be familiar with soil organisms, especially microorganisms, their characteristics, and functions.	PLO 1 & 8
CLO 8	study soil as a source of energy for diverse groups of both macro- and micro-organisms.	PLO 1 & 8

Course Contents

Sl. No	**Topic**	**Class Hours**	**CLOs covered**
1	**Soil Chemistry and Soil Microbiology** - An introduction to the course; Importance; Interrelationship with other branches of Soil Science, Water and Atmospheric studies.	3	CLO 1
2	**Chemical Aspect of three phases of soil** - interrelationship among the three phases of soil and the importance of the phases of soil in relation to plant growth; Chemical nature and properties of soil components; Essential and beneficial elements for plant growth.	4	CLO 2
3	**Soil organic matter-** sources and chemical constituents of soil organic matter. Organic compounds- carbohydrates, protein, amino acids, nucleic acid, amino sugars, lignin, lipids, pectin, chitin, hormones, and enzymes.	5	CLO 3

4	**Soil air-** chemical composition and variations of gaseous components. Impact of gaseous components on soil properties and environmental pollution.	2	CLO 4
5	**Soil solution -** Structure and properties of water molecule; Chemical nature of ions; composition and concentration of soil solution; importance.	6	CLO 5
6	**Soil pH –** pH scale; classification of soil on the basis of pH values; Buffer solution and buffering.	3	CLO 6
7	**Soil organisms:** Scope of Microbiology in relation to the study of soil, water, and atmosphere sciences. Soil Biota: Morphology, function and importance.	5	CLO 7
8	**Soil as a source of energy and nutrients to the biota**. Nutritional division; Temperature and oxygen requirements; Cultivation of microorganisms.	2	CLO 8

Learning Materials	
Recommended Readings	*Weil and Brady, 2017. The Nature and Properties of Soils (15th Edition). Pearson Education Limited. Essex, England* *Plaster, E.J. 2013. Soil Science and Management (6th Edition). Delma Cengage Learning, NY, USA.*
Supplementary Readings	*Tan, K.H. 2011. Principles of Soil Chemistry (4th Edition) CRC Press.* *Killham, K. 1994. Soil Ecology (1st ed.) Cambridge Univ. Press.* *Pelczar et al. 1988. Microbiology (5th ed.) Mc Graw-Hill Book Company.*

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	Teaching- Learning Strategy[a]	Assessment Strategy
CLO 1	[b]Visual and [c]Auditory	Class attendance, In-course Exam, Assignment, Final theory and practical Exam, Field level assessment.
CLO 2	Visual and Auditory	
CLO 3	Visual, Auditory and Kinesthetic[d]	
CLO 4	Visual and Auditory	
CLO 5	Visual and Auditory	
CLO 6	Visual, Auditory and Kinesthetic[d]	
CLO 7	Visual and Auditory	
CLO 8	Visual and Auditory	

Visiting hours: 10 am to 12 noon and 3 to 5 pm of the working days *(if available).*

Course Code: SWE 103	**Credits:** 2 (50 Marks)	**Course Type:** Core course

Course Title: Introduction to Environmental Science

Prerequisite(s): As per University requirements for the admission into the program

Rationale of the Course: Introduction to Environmental Science is an elementary level course, designed to introduce beginners the basic concepts of Environmental Science. It aims to provide fundamental ideas to the undergraduate students about the necessity of studying environmental science encompassing the dynamics of global environmental challenges, environmental processes and issues towards building a more sustainable society for the future generations. This course will teach different segments of environment like Biosphere, Lithosphere, Atmosphere, Hydrosphere; Biological resources, Pollutants and Pollution.

Course Objectives: Providing basic ideas about the concept and importance of environmental science; providing knowledge and awareness pertaining to environmental quality to improve the functions of environmental systems; acquiring preliminary ideas about human-environment interactions, biogeochemical cycles, biosphere, geosphere, atmosphere and hydrosphere that are paramount to gain clear perception about our surrounding environment.

Mapping with SDG: The course is relevant to achieve SDG goal Nos. 4 (Quality Education), 13 (Climate action) and 15 (Life on land).

Course Learning Outcomes (CLOs) and Mapping with PLOs

The students will be able to:		**PLOs covered**
CLO 1	explain concept, importance and scope of environmental science, describe major fields and sub-fields of environmental science, outline major environmental problems and restoration ecology.	PLO 1 & 2
CLO 2	explain human population as a major environmental problem, develop ideas on population change, overpopulation, their factors and global perspective.	PLO 4
CLO 3	outline basic principles, types and nutrient cycling of biogeochemical cycles and demonstrate human interference on these cycles.	PLO 3
CLO 4	understand ecology, ecosystem and biodiversity.	PLO 2
CLO 5	demonstrate relationship between agriculture and environment, describe principles, benefits and limitations of sustainable agriculture, and illustrate soil fertility, erosion, pollution, urbanization and waste management	PLO 5
CLO 6	demonstrate chronological evolution, composition and structure of earth's atmosphere, illustrate indoor and outdoor air pollution, their sources and harmful effects, explain basic concept of global warming and climate change.	PLO 6 & 7
CLO 7	describe sources and effects of water pollution, water quality and treatment.	PLO 6

Course Contents

Sl. No	**Topic**	**Class Hours**	**CLOs covered**
1	**Basic concepts of environmental science:** Basic concept, importance and scope of environmental science; environmental science as an interdisciplinary field; major fields of environmental science; environmental problems; relationship between environment and living	5	CLO 1

	systems; functions of environment; major components; types; factors, Restoration ecology.		
2	**The human population:** Human population as an environmental problem; concept of population change; global perspective of human population change; sustainability; carrying capacity; Gaia hypothesis; population pyramid; factors, consequences and solutions of overpopulation.	5	CLO 2
3	**Biogeochemical cycles:** Principles and aspects of biogeochemical cycles; types; nutrient cycling through these cycles; hydrologic cycle; carbon cycle; nitrogen cycle; human interference on these cycles.	4	CLO 3
4	**Biosphere:** Ecology and its importance; ecosystem; components and types of ecosystem; biomes; ecological community; energy and matter flow in ecosystem; food chain; food web; ecological pyramid; concept and importance of biodiversity.	5	CLO 4
5	**Lithosphere:** Agriculture and environment; sustainable agriculture; global effects of agriculture; soil fertility; soil erosion; soil pollution; making soil sustainable; urbanization; waste management.	5	CLO 5
6	**Atmosphere:** Evolution, composition and structure of atmosphere; air pollution; pollutant; global warming and climate change.	4	CLO 6
7	**Hydrosphere:** Water pollution and its sources; water quality; treatment.	2	CLO 7

Learning Materials	
Recommended Readings	*Botkin, D. B. and E. A. Keller. 2012. Environmental Science- Earth as a living Planet. (8th ed.) John Wiley and Sons, Inc.* *Manahan, S. E. 2000. Environmental Chemistry. (7th ed.) Lewis Publishers.*
Supplementary Readings	*Ken Killham. 2016. Soil Ecology.* *Bert Bolin et al. 1986. The greenhouse effect, climate change and Ecosystems.*

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	Teaching- Learning Strategy[a]	Assessment Strategy
CLOs 1 to 6	[b]Visual and [c]Auditory	Class attendance, In-course Exam, Assignment, Final theory and practical Exam, Field level assessment.
CLO 7	Visual, Auditory and Kinesthetic[d]	

Visiting hours: 10 am to 12 noon and 3 to 5 pm of the working days *(if available)*.

Course Code: SWE 104	**Credit:** 2.0	**Course Status:** Core course

Course Title: Introduction to Water Science

Prerequisite(s): As per University requirements for the admission into the program

Rationale of the Course: This course is designed for undergraduate student of this Department as a basic natural science course aims to provide a basic understanding of water science from climatologic and hydrological perspective.

Course Objectives: The objective of this course is to provide provide students on fundamentals of hydrologic cycle, hydrologic parameters and its some applications, ground water flow, recharge and contamination along with sanitation and human health.

Mapping with SDG: The course is relevant to achieve SDG goal No 4 and 14.

Course Learning Outcomes (CLOs) and Mapping with PLOs

Upon completion of this course the students will be able to:		**PLOs covered**
CLO 1	get a brief idea on water science and different processes entails to hydrologic cycle.	PLO 1 & 2
CLO 2	understand the processes and techniques for measuring precipitation and losses and gains from precipitation, an appreciation of the associated errors and a knowledge of how to analyse rainfall data.	PLO 3 & 4
CLO 3	explain quantitative assessment of hydrologic parameters in well-defined boundaries.	PLO 5 & 6
CLO 4	understand the processes of runoff leading to channel flow; techniques for measuring streamflow and runoff directly.	PLO 2
CLO 5	understand the role of water stored below the ground; techniques used to explore and exploit the amount of ground water.	PLO 8
CLO 6	understand water quality as an issue in hydrology, withdrawal of water using different types of tube wells, contamination of water supply by sanitation systems and its effects on human health.	PLO 4 & 7

Course Contents

Sl. No	**Topic**	**Class Hours**	**CLOs covered**
1	**Water Science**: Hydrology and Climate. Various processes of hydrologic cycle.	2	CLO 1
2	**Precipitation**: Forms, Measurement, Mean precipitation of an area. Losses from precipitation-- Evaporation, Evapotranspiration, Initial loss, Infiltration.	5	CLO 2
3	**Catchment**: Drainage basin, watershed divide, formation of streams, stream pattern, stream orders, drainage density, drainage pattern, works of stream.	3	CLO 3
4	**Runoff**: Overland flow, surface runoff, factors. Hydrograph: Factors, components, hydrograph separation, floods; Application of hydrograph; Stream flow--stage and velocity, discharge measurement, rainfall-runoff relations. Ground water level.	10	CLO 4
5	**Ground water**: Distribution of ground water, aquifers and their characteristics, geologic formation of aquifers, porosity and permeability, movement of groundwater, extraction and recharge of groundwater.	5	CLO 5

6	**Well hydraulics:** Basic ideas on suction mode, force mode tube wells, groundwater contamination, sanitation and health.	5	CLO 6

Learning Materials	
Recommended Readings	*Davie, T. 2003. Fundamentals of Hygrology. (1st ed.) Routledge, London.* *Raphael, V. and G. Kazmann. 2003. Modern Hydrology. (2nd ed.) Harper and Row, New York.* *Reddi, P. J. R. A. 2001. Text Book of Hydrology. (2nd ed.) Laxmi Publ., India.* *Todd, D. K. 2012. Ground Water Hydrology. (4th ed.) John Willey & Sons.*
Supplementary Readings	*Ahmed, M.F. and M. M. Rahman. 2003. Water Supply and Sanitation- Rural and Low Income Urban Communities. (2nd ed.) Progressive Printers Ltd. Bangladesh.*

Mapping CLOs with the Teaching- Learning and Assessment Strategy		
CLOs	Teaching- Learning Strategy[a]	Assessment Strategy
CLO 1	[b]Visual and [c]Auditory	Class attendance, In-Course Assessment Examination, Assignment, Final theory and practical Exam, Field level assessment.
CLO 2	Visual, Auditory and Kinesthetic[d]	
CLO 3	Visual and Auditory	
CLO 4	Visual and Auditory	
CLO 5	Visual and Auditory	
CLO 6	Visual and Auditory	

Visiting hours: 10 am to 12 noon and 3 to 5 pm of the working days (*if available).*

Course Code: SWE 105	**Credits:** 2 (50 Marks)	**Course Type:** Core course

Course Title: Introduction to Natural Hazards and Disaster

Prerequisite(s): As per University requirements for the admission into the program

Rationale of the Course: This course is designed for Under Graduate students of the department so that they get a theoretical as well as practical basis for understanding a general and introductory knowledge about Natural Hazards and Disasters and management through a comprehensive and holistic approach. This course offers the concept and framework of modern disaster management, its key components and terminologies, the knowledge of which will be essential for the advanced courses.

Course Objectives: The objective of this course is to provide students to learn the multidisciplinary approach to the concept of Natural Hazards and Disasters, its evolution, its key components and subcomponents. This course also emphasizes the content in Bangladesh perspective.

Mapping with SDG: This course is relevant to achieve SDG 4.

Course Learning Outcomes (CLOs) and Mapping with PLOs

Upon completion of this course the students will be able to:		**PLOs covered**
CLO 1	gather knowledge about the fundamental components of hazards and knowledge about different Hazard types, causes, effects and analysis.	PLO1, 2, 3, 4 5, 6, 7
CLO 2	learn the concept of modern disaster science and types, causes and effects, Solution to the natural disaster problem.	PLO1, 3 & 4
CLO 3	acquire knowledge about the fundamental components e.g. risk, hazard, vulnerability, exposure, capacity, resilience etc. and their subcomponents.	PLO4, 5, 6 & 8
CLO 4	develop an understanding of the History of Disaster Management,	PLO2, 3, 4, 5 & 8
CLO 5	illustrate the knowledge about the Paradigm shift, and examples,	
CLO 6	develop an understanding of the Disaster management in the context of Bangladesh	

Course Contents

Sl. No	**Topic**	**Class Hours**	**CLOs covered**
1	**Hazards:** Natural Hazards (Meteorological, Hydrological hazards, Hydro-meteorological hazards, Climatic Hazards, Geological hazards and Biological hazards, Technological and Man-made hazards); Types, causes and effects. Hazard analysis.	6	CLO 1
2	**Disaster:** Definitions of Terminology; Sciences of Disaster; Meaning and Impact; types, and causes of Disaster.	5	CLO 2
3	**Disaster Management:** a Four Phase Approach of Disaster Management; disaster management cycle and its components; Disaster Triage, Solution to the natural disaster problem. Historical examples of natural disaster	6	CLO 2 & CLO 3
4	**Vulnerability:** Physical Profile; Social Profile; Environmental Profile; Economic Profile; risk factors influencing vulnerability;	3	CLO 4

5	**Risk:** Definitions and Components of disaster Risk (Likelihood, Consequence and Trends); Disaster Risk reduction and management.	4	CLO 5
6	**Fundamental Approach of Disaster Management in Bangladesh:** History of Disaster Management, Paradigm shift; Policy, framework and Institutions for Disaster Management.	6	CLO 6

Learning Materials	
Recommended Readings	*Pinkowski J. (2008). Disaster Management Handbook. CRC Press. US.* *Paul B.K. (2011). Environmental Hazards and Disasters: Contexts, Perspectives and. Management. Wiley-Blackwell. US.* *Comprehensive Disaster Management Program (CDMP) (2009) Disaster Dictionary. Dhaka, Bangladesh.*
Supplementary Readings	*Coppola D.P. (2007). Introduction to International Disaster Management. Elsevier. UK.* *Cees Westen et al (2011). Multi-hazard Risk Assessment. Public Works* *Smith K. and Petley D.N. (2009). Environmental Hazards: Assessing Risk and Reducing Disaster. Routledge. New York.* *United Nations International Strategy for Disaster Reduction (UNISDR) (2004) Living with Risk: A Global Review of Disaster Reduction Initiatives. Geneva: United Nations.* *Westen (2011). Multi-hazard Risk Assessment Guidebook* *Wisner B. (2004). At Risk: Natural Hazards, People's Vulnerability and Disasters. Routledge. US.*

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	**Teaching- Learning Strategy[a]**	**Assessment Strategy**
CLO 1	[b]Visual and [c]Auditory	Class attendance, In-course Exam, Assignment, Final theory and oral exam and presentation, Field level assessment.
CLO 2	Visual, Auditory and Kinesthetic[d]	
CLO 3	Visual and Auditory	
CLO 4	Visual and Auditory	
CLO 5	Visual and Auditory	
CLO 6	Visual and Auditory	

Visiting hours: 10 am to 12 noon and 3 to 5 pm of the working days (*if available*)

Course Code: SWE 106	**Credits:** 2 (50 Marks)	**Course Type:** Core course

Course Title: Practical

Prerequisite(s): As per University requirements for the admission into the program

Rationale of the Course: This course includes laboratory works related to the theory courses of 1st year and is designed in a way that the students will carry out practical works at the laboratory assigned by the course teacher, with an aim to conduct comprehensive research on Soil physics, Soil chemistry, Hydrology, Water science, Natural Hazards and Disasters.

Course Objectives: The objective of this course is to provide students a comprehensive practical knowledge on different technological parameters of soil, water and environment.

Mapping with SDG: This course is relevant to achieve SDG 4, 6, 13, 14, 15 and 17.

Course Learning Outcomes (CLOs) and Mapping with PLOs		
Upon completion of this course the students will be able to: :		PLOs covered
CLO 1	understand soil sampling techniques to study soil resources, get an idea on geomorphic features; Identify and characterize soil morphological properties in the field.	PLO1, 3
CLO 2	assess and evaluate soil physical properties	PLO2
CLO 3	provide a practical training on the introductory water and environmental sciences so that the students will be able to handle more advanced courses included in the curriculum	PLO1, 2 & 3
CLO 4	learn the concept of protecting building occupants and lessen earthquake/fire-related losses. acquire knowledge about the fundamental components e.g. risk, hazard, vulnerability, exposure, capacity, resilience etc. and their subcomponents. develop an understanding of the Disaster management in the context of Bangladesh.	PLO1, 2, 3, 4 5, 6, 7 & 8

Course Contents			
Course No	**Topic**	**Class Hours**	**CLOs covered**
1	**Related to SWE 101:** Study of soil samples collected from the field; Determination of gravimetric water content, bulk density, particle density of collected soils; Determination of' soil texture (Hydrometer method).	6	CLO 1
2	**Related to SWE 102:** Basic chemical analysis: principles of acid-base titration and oxidation-reduction reactions; preparation of standard solutions and standardization of unknown solutions; determination of soil pH; determination of organic carbon and free carbonates. Handling of Microscope, Preparation of media, Simple staining, Negative staining.	6	CLO 1 &2
3	**Related to SWE 103:** Determination of dissolved Oxygen, dissolved solids, suspended solids, turbidity and hardness of water. Qualitative analysis of inorganic and organic ions.	6	CLO 2 & CLO 3
4	**Related to SWE 104:** Evaluation of measuring river discharge methods and “ground water levels”. Determination of uniformity co-efficient in a monitoring well site.	6	CLO 2 & CLO 3

5	**Related to SWE 105:** Civil defense and the fire service Bangladesh perform fire suppression and prevention system demos to protect building occupants and lessen fire-related losses. Civil defense and the fire service Bangladesh perform earthquake evaquation and prevention system demos to protect building occupants and lessen earthquake-related losses. Additionally, the crew shows how to avoid drowning, what to do in the event of an earthquake and practical knowledge about disaster triage.	03	CLO 4

Learning Materials	
Recommended Readings	Pinkowski J. (2008). Disaster Management Handbook. CRC Press. US. *Killham, K. 1994. Soil Ecology. (1st ed.) Cambridge Univ. Press.* *Pelczar et al. 1988. Microbiology. (5th ed.) Mc Graw-Hill Book Company.* *Davie, T. 2003. Fundamentals of Hygrology. (1st ed.) Routledge, London.* *Tan, K.M. 1993. Principles of Soil Chemistry. (2nd ed.) Marcel Dekker Inc. New York.*
Supplementary Readings	*Comprehensive Disaster Management Program (CDMP) (2009) Disaster Dictionary. Dhaka, Bangladesh.* *Ahmed, M.F. and M. M. Rahman. 2003. Water Supply and Sanitation- Rural and Low Income Urban Communities. (2nd ed.) Progressive Printers Ltd. Bangladesh.* *Manahan, S. E. 2000. Environmental Chemistry. (7th ed.) Lewis Publishers.*

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	Teaching- Learning Strategy[a]	Assessment Strategy
CLO 1	[b]Visual and [c]Auditory	Class attendance, Assignment, Final theory and oral exam and presentation, Field level assessment.
CLO 2	Visual, Auditory and Kinesthetic[d]	
CLO 3	Visual and Auditory	
CLO 4	Visual and Auditory	
CLO 5	Visual and Auditory	
CLO 6	Visual and Auditory	

Visiting hours: 10 am to 12 noon and 3 to 5 pm on the working days (*if available*)

Course Code: SWE 107	**Credits:** 2 (50 Marks)	**Course Type:** GED course

Course Title: Field Work and Community Outreach

Prerequisite(s): As per University requirements for the admission into the program

Rationale of the Course: This course includes Field works related to the theory courses of 1st year and is designed in a way that the students will carry out field works assigned by the course teacher with an aim conducting comprehensive research on Soil physics, Soil chemistry, Hydrology, Water science, Natural Hazards and Disasters.

Course Objectives: The objective of this course is to provide students a comprehensive practical knowledge on different technological parameters of soil, water and environment.

Mapping with SDG: This course is relevant to achieve SDG 4, 6, 13, 14, 15 and 17**.**

Course Learning Outcomes (CLOs) and Mapping with PLOs		
Upon completion of this course the students will be able to: :		PLOs covered
CLO 1	understand soil sampling techniques to study soil resources, get an idea on geomorphic features; Identify and characterize soil morphological properties in the field.	PLO1, 3,
CLO 2	assess and evaluate soil physical properties	PLO2
CLO 3	provide a practical training on the introductory water and environmental sciences so that the students will be able to handle more advanced courses included in the curriculum	PLO1, 2 & 3
CLO 4	learn the concept of protecting building occupants and lessen earthquake/fire-related losses. acquire knowledge about the fundamental components e.g. risk, hazard, vulnerability, exposure, capacity, resilience etc. and their subcomponents. develop an understanding of the Disaster management in the context of Bangladesh.	PLO1, 2, 3, 4 5, 6, 7 & 8

Course Contents			
Sl. No	**Topic**	**Days Required**	**CLOs covered**
1	**Related to SWE 101:** Identify and characterize soil morphological properties in the field; understand soil sampling techniques to study soil resources, get an idea on geomorphic features; assess and evaluate soil physical properties.	01	CLO 1
2	**Related to SWE 101:** Field Study of two ideal soil profile in the field depending on soil catena: Determination of' soil texture by feel method; Determination of' soil color by using soil color chart; Determination of' soil consistency in the field.	01	CLO 1 & 2
3	**Related to SWE 101:** Field soil sample collection for the determination of gravimetric water content, bulk density, particle density of soil and soil texture by Hydrometer method at the laboratory.	01	CLO 1 & 2
4	**Related to SWE 104:** Method of measuring river discharge. Measurement of "ground water level" of a catchment. Determination of uniformity co-efficient in a monitoring well site.	01	CLO 3

5	**Related to SWE 104:** Observation and identification of climatological parameters in a weather station.		
6	**Related to SWE 105:** Fire service and civil defenses performs demonstrations of fire prevention and suppression systems to safeguard building occupants and reduce fire-related damage. The crew also demonstrates drowning prevention techniques and what to do in the event of an earthquake.	02	CLO 4

Learning Materials	
Recommended Readings	*Pinkowski J. (2008). Disaster Management Handbook. CRC Press. US.* *Killham, K. 1994. Soil Ecology. (1st ed.) Cambridge Univ. Press.* *Pelczar et al. 1988. Microbiology. (5th ed.) Mc Graw-Hill Book Company.* *Davie, T. 2003. Fundamentals of Hygrology. (1st ed.) Routledge, London.* *Tan, K.M. 1993. Principles of Soil Chemistry. (2nd ed.) Marcel Dekker Inc. New York.*
Supplementary Readings	*Comprehensive Disaster Management Program (CDMP) (2009) Disaster Dictionary. Dhaka, Bangladesh.* *Ahmed, M.F. and M. M. Rahman. 2003. Water Supply and Sanitation- Rural and Low Income Urban Communities. (2nd ed.) Progressive Printers Ltd. Bangladesh.* *Manahan, S. E. 2000. Environmental Chemistry. (7th ed.) Lewis Publishers.*

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	Teaching- Learning Strategy[a]	Assessment Strategy
CLO 1	[b]Visual and [c]Auditory	Class attendance, Assignment, oral exam and presentation, Field level assessment.
CLO 2	Visual, Auditory and Kinesthetic[d]	
CLO 3	Visual and Auditory	
CLO 4	Visual and Auditory	
CLO 5	Visual and Auditory	
CLO 6	Visual and Auditory	

Visiting hours: 10 am to 12 noon and 3 to 5 pm on the working days (if available)

Course Code: CM 100F	**Credits:** 4 (100 Marks)	**Course Type:** GED course

Course Title: Fundamentals of Chemistry

Prerequisite(s): As per University requirements for the admission into the program

Rationale of the Course: This course is designed to impart theoretical and applied knowledge on analytical, physical, and organic chemistry.

Course Objectives: Fundamental of Chemistry aims to provide undergraduate students of the department of Soil, Water and Environment a basic understanding of chemistry. The course content covers different chemical reactions and processes.

Mapping with SDG: Relevant to achieve SDG 2.

Course Learning Outcomes (CLOs) and Mapping with PLOs

Upon completion of this course, the students will be able to:		**PLOs covered**
CLO 1	acquire an introductory knowledge about the structure of atom, chemical equilibrium, organic macromolecules.	PLO 1
CLO 2	understand the radioactivity and unclear reactions, acids and bases.	PLO 2
CLO 3	understand the periodic classification of elements, electrolysis.	PLO 3
CLO 4	understand the chemical bonds, rates of chemical reactions.	PLO 1
CLO 5	understand the mechanism oxidation and reduction, the organic compounds and organic chemistry.	PLO 2
CLO 6	explain states of aggregation of matter, the concept of acids.	PLO 3
CLO 7	understand the gaseous state, reactions of alkanes, alkenes and alkynes.	PLO 1
CLO 8	understand the vapour pressure of liquids, functional groups.	PLO 2
CLO 9	understand the energy changes in chemical reactions, some important reactions of aromatic compounds.	PLO 3

Course Contents

Sl. No	**Topic**	**Class Hours**	**CLOs covered**
1	The structure of atom: the discovery of electron, proton and neutrons, cathode rays, radioactivity, particle scattering, Rutherford model, fractional atomic masses; isotopes; mass spectroscopy, spectrum of atomic hydrogen; Bohr model; dual nature of matter, wave nature of electrons; atomic orbitals; electron configuration of atoms.	4	CLO 1
2	Radioactivity and unclear reactions. Nuclear binding energy; fission and fusion reactions.	3	CLO 2
3	Periodic classification of elements. Ionization potential, electro-negativity, electron affinity, atomic radius, variation of properties along a period and down a group, diagonal relationship, representative elements, transition elements, chemical properties of s-, p- and d-block elements.	4	CLO 3
4	Chemical bonds: electronic theory, valence bond theory, molecular orbital theory, sigma- and pi-bonds, c-c bonds, catenation, polar molecules, electro-negativity and electron affinity, hydrogen bonding, shapes of molecules, VSEPR theory, hybridization.	4	CLO 4
5	Oxidation and reduction, oxidation number, Analytical reagents.	4	CLO 5
6	States of aggregation of matter, kinetic theory of matter, nature of heat, changes of state.	3	CLO 6

7	The gaseous state: the gas laws, the perfect gas equation, the kinetic theory of gases, the distribution of molecular velocities, intermolecular attraction, liquefaction of gases, the critical state, the critical constants.	4	CLO 7
8	Vapor pressure of liquids, temperature dependence mixtures of liquids, Raoult's law, fractional distillation, solutions of non-volatile solids; celligative properties of solutions. Henry's law, Nernst distribution law.	3	CLO 8
9	Energy changes in chemical reactions, the first law of thermodynamics, the concept of internal energy and enthalpy; measurement of enthalpy changes, enthalpy of formation, Hess's law, lattice enthalpy, Born-Haber cycle; spontaneous processes, concept of entropy.	3	CLO 9
10	Chemical equilibrium, the equilibrium law, the equilibrium constant, homogeneous and heterogeneous equilibrium, the principle of Le chatelier and Brown, the dependence of K on temperature.	3	CLO 1
11	Acids and bases, the Lewis concept, the Bronsted concept, strong and weak acids, acid-base equilibrium in aqueous solutions, Ostwald dilution law, pH, buffer solutions, neutralization curves, indicators for acid-base titrations.	3	CLO 2
12	Electrolysis, galvanic cells, electrodes and electrode reactions, reduction potential, the electrochemical series, the standard hydrogen electrode, measurement of pH.	3	CLO 3
13	Rates of chemical reactions, order and molecularity, zero and 1st order reactions, half life, carbon dating, temperature dependence of rates of reactions.	3	CLO 4
14	The organic compounds and organic chemistry, hydrocarbons, aliphatic hydrocarbons, saturated and unsaturated hydrocarbon, alkanes, alkenes and alkynes, the aromatic hydrocarbons, delocalization in the benzene ring; nomenclature of organic compounds, the IUPAC system, Petroleum, natural gas, refining of petroleum; petrochemicals.	3	CLO 5
15	The concept of acids, bases, nucleophiles, electrophiles, carbocations, carbanions and free radicals.	3	CLO 6
16	Reactions of alkanes, alkenes and alkynes; substitution and hydrogen abstraction reactions in alkanes; hydrogenation, hydrohalogenation, ozonolysis of alkenes and alkynes, homolytic addition of hydrogen halides; geometrical isomers.	3	CLO 7
17	Functional groups, alcohols, aldehydes, ketones, esters, epoxides, amines, amides, typical reactions of the functional groups.	3	CLO 8
18	Some important reactions of aromatic compounds; substitution at the benzene ring, Friedel-Craft's reaction; diazotizaion and coupling sulphonation and nitration.	3	CLO 9
19	Organic macromolecules: polythenes; Teflon; plastic; resin; nylon; peptides, protein, cellulose and starch.	3	CLO 1

Learning Materials	
Recommended Readings	*Ebbing, D. D. and S. D. Gammon. General Chemistry.*

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	Teaching- Learning Strategy[a]	Assessment Strategy
CLOs 1- 4; 6 - 9	[b]Visual and [c]Auditory	Class attendance, In-course Exam, Assignment, Final theory.
CLO 5	Visual, Auditory and Kinesthetic[d]	

Visiting hours: 10 am to 12 noon and 3 to 5 pm on the working days (*if available*)

Course Code: BOT 001	**Credits:** 4 (100 Marks)	**Course Type:** GED course
Course Title: Diversities in Plant Kingdom and Plant Physiology		
Prerequisite(s): As per University requirements for the admission into the program		
Rationale of the Course: This course is designed to provide knowledge on diversities in plant kingdom and plant physiology to the students of the department.		
Course Objectives: The objective of this course aims to provide undergraduate students of the department of Soil, Water and Environment a basic knowledge of Plant Kingdom and its classification; Plant Pathology; Plant Physiology and different processes.		
Mapping with SDG: This course is relevant to achieve SDG goal No **4** and **15**.		

Course Learning Outcomes (CLOs) and Mapping with PLOs

Upon completion of this course the students will be able to:		**PLOs covered**
CLO 1	learn about diversity, plants through geological history; plants of the past and present.	PLO 1
CLO 2	gain knowledge on the classification systems of Plant Kingdom; major characteristic features of the major Plant Divisions.	PLO 1
CLO 3	understand morphology, ecology, distribution, adaptation and methods of reproduction of the following plant groups: (a) Prokaryotes, (b) Algae, (c) Fungi and Lichens, (d) Bryophytes, (e) Pteridophytes, (f) Gymnosperms, (g) Angiosperms with typical examples from each group.	PLO 1
CLO 4	aware of Phytoplankton and benthic algae (freshwater to manure) and their importance.	PLO 5
CLO 5	realize the importance of the microbes (biological and industrial).	PLO 3
CLO 6	acquire knowledge on plants and environments: Plant diversity in relation to environmental factors, e.g., light, temperature, water, habitats, atmospheric gases, seasonal changes and natural catastrophe	PLO 1
CLO 7	learn about plant Pathology: Definition of disease in plants; causes of plant diseases; how do plant pathogens cause disease in plants; kinds and amount of losses owing to plant diseases; Koch's postulates and use of Koch's postulates in the diagnosis of plant diseases; plant disease control through cultural and chemical methods; study of some common plant diseases caused by plant viruses (Tobacco mosaic disease), bacteria (Bacterial blight of rice) and fungi (Late blight of potato, Powdery mildew of cucurbits, Stem rust of wheat).	PLO 4 & 5
CLO 8	explain the mineral nutrition of plants: Role and deficiency, symptoms of essential elements.	PLO 3 & 7
CLO 9	be well known about Photosynthesis: (a) The light reaction phase - transformation of light energy into chemical energy in plastids (b) The chemical reaction phase; Different kinds of chemical reactions: C3, C4 and CAM pathways (c) The importance of photosynthesis for the existence of the biological world.	PLO 1 & 5
CLO 10	learn about Respiration: Mechanism of aerobic and anaerobic respiration, Glycolysis, Kreb's Cycle and electron Transport System (with structural formula and enzymes involved), Fermentation.	PLO 1 & 5
CLO 11	explain Nitrogen Metabolism: (a) The nitrogen fixation - the physical and biological nitrogen fixation, (b) The nitrogen cycle.	PLO 5

CLO 12	know regarding Plant growth regulating substances: Classification, examples and physiological effects; importance of' growth regulators in the growth and development of plants and plant parts.	PLO 5
CLO 13	learn about Physiology of flowering: (a) Photoperiodism: role of phytochrome, light and dark periods (b) Vernalization: role of low temperature with special reference to winter Wheat.	PLO 1 & 5

Course Contents

Diversities in Plant kingdom (Marks: 50)

Sl. No	Topic	Class Hours	CLOs covered
1	What is diversity? Plants through geological history; Plants of the past and present.	3	CLO 1
2	Classification systems of Plant Kingdom; major characteristic features of the major Plant Divisions.	3	CLO 2
3	Morphology, ecology, distribution, adaptation and methods of reproduction of the following plant groups: (a) Prokaryotes, (b) Algae, (c) Fungi and Lichens, (d) Bryophytes, (e) Pteridophytes, (f) Gymnosperms, (g) Angiosperms with typical examples from each group.	10	CLO 3
4	Phytoplankton and benthic algae (freshwater to manure) and their importance.	3	CLO 4
5	Importance of the microbes (biological and industrial).	2	CLO 5
6	Plants and environments: Plant diversity in relation to environmental factors, e.g., light, temperature, water, habitats, atmospheric gases, seasonal changes and natural catastrophe.	5	CLO 6
7	Plant Pathology: Definition of disease in plants; causes of plant diseases; how do plant pathogens cause disease in plants; kinds and amount of losses owing to plant diseases; Koch's postulates and use of Koch's postulates in the diagnosis of plant diseases; plant disease control through cultural and chemical methods; study of some common plant diseases caused by plant viruses (Tobacco mosaic disease), bacteria (Bacterial blight of rice) and fungi (Late blight of potato, Powdery mildew of cucurbits, Stem rust of wheat).	10	CLO 7

Plant Physiology (Marks: 30)

8	Mineral nutrition of plants: Role and deficiency, symptoms of essential elements.	4	CLO 8
9	Photosynthesis: (a) The light reaction phase - transformation of light energy into chemical energy in plastids (b) The chemical reaction phase; Different kinds of chemical reactions: C3, C4 and CAM pathways (c) The importance of photosynthesis for the existence of the biological world.	6	CLO 9
10	Respiration: Mechanism of aerobic and anaerobic respiration, Glycolysis, Kreb's Cycle and electron Transport System (with structural formula and enzymes involved), Fermentation.	4	CLO 10
11	Nitrogen Metabolism: (a) The nitrogen fixation - the physical and biological nitrogen fixation, (b) The nitrogen cycle.	3	CLO 11
12	Plant growth regulating substances: Classification, examples and physiological effects; importance of' growth regulators in the growth and development of plants and plant parts.	3	CLO 12

13	Physiology of flowering: (a) Photoperiodism: role of phytochrome, light and dark periods (b) Vernalization: role of low temperature with special reference to winter Wheat.	4	CLO 13

Learning Materials	
Recommended Readings	*Agrios CN 2002. Plant Pathology, Academic Press, London.* *Bold HC and Wynne MJ 1978, 1985. Introduction to the algae-structure and reproduction, Prentice-Hall, Inc., Englewood Cliffs, New Jersey.* *Bold HC, Alexopoulos CJ and Delevoryas T 1980. Morphology of Plants and Fungi (4th Edition), Harper & Row Publishers, New York.* *Curtis H 1979. Biology 3rd Edition, Worth Publishers, NY.* *Foster AS and Gifford EM 1959. Comparative Morphology of Vascular plants. WH Freeman and Company, San Francisco, California.* *Gupta JS 1972. A Text Book of Botany, Vol. I (Algae, Fungi, Bacteria,Viruses and Lichens). Adarsh Pustak Bhandar Educational Publishers: Agra.* *Jeffries M J 1997. Biodiversity and Conservation. Routledge, New York.* *Lee RE 1992. Phycology (2nd Edition). Cambridge University press, 645 pp.* *Panday SN, SP Misra and PS Trivedi 1997. A Text Book of Botany, Vol. (ii), Vikas Publ. House, New Delhi.*

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	Teaching- Learning Strategy[a]	Assessment Strategy
CLO 1	[b]Visual and [c]Auditory	Class attendance, In-course Exam, Assignment, Final theory and practical Exam.
CLO 2	Visual, Auditory and [d]Kinesthetic	
CLO 3	Visual, Auditory and Kinesthetic	
CLO 4	Visual, Auditory and Kinesthetic	
CLO 5	Visual and Auditory	
CLO 6	Visual and Auditory	
CLO 7	Visual, Auditory and Kinesthetic	
CLO 8	Visual and Auditory	
CLO 9	Visual, Auditory and Kinesthetic	
CLO 10	Visual, Auditory and Kinesthetic	
CLO 11	Visual, Auditory and Kinesthetic	
CLO 12	Visual, Auditory and Kinesthetic	
CLO 13	Visual, Auditory and Kinesthetic	

Practical (20 marks)

Course Learning Outcomes (CLOs) and Mapping with PLOs		
Upon completion of this course the students will be able to:		**PLOs covered**
CLO 1	identify herbs, shrubs, trees, climbers, epiphytes, sub aerial, terrestrial, aquatic plants, etc. in nature, their habitats and adaptations and study in the laboratory to see what organisms are present.	PLO 1 & 5
CLO 2	study phytoplankton (both fresh water and marine) at least one or two examples from Cyanoptyceae, Volvocales, chlorococcales, Desmidiales, Diatoms, Euglenales and dinoflagellates gain practical knowledge on algae: Aquatic - Ulothrin, Oedogonium, Cladophora, Stigeoclonium, Chara/Nitella, Sargassum, Polysiphonia. Terrestrial Fritschiella, Vaucheria/Botrydium, Nostoc. Subacrial Trentipohila, Scytonema. study fungi: Synchyrium, Saprolegania/ Achlya, Saccharaomyces, Penicillium, Aspergillus, Ascobolus, Agaricus/Lepiotd, Ganodermal/ Polyporus.	PLO 1 & 5
CLO 3	identify and compare lichens: Crustose, foliose and fruticose types. study hepatics: Riccia, Marchantia, Anthoceros (habit, details of thallus and sex organs). acquire empirical lesson on ferns: habit and details of the gametophytes (male and female) and sporophytes, a typical fern plant with sori and; its protanllus with sex organs and an aquatic fern. study non-fern ptendopytes: Equisetum, Sclaginella, Mersilea and Isoetes.	PLO 1 & 5
CLO 4	demonstrate Gymnosperms: Cycas, Pinus and Gnetum with cones (I.S.). identify and describe angiosperms: (a) Herbs, shrubs, trees, climbers, epiphytes, sciophytes, heliophytes; (b) differences between dicot and monocot leaves and flowers; stems and leaves; (c) study the families poaceae (Gramineae), Orchidaceae, Nymphaceae, Leguminosae and Compositae.	PLO 1 & 5
CLO 5	gain pragmatic knowledge about plant diseases covered in the theory course and fungi causing damage to food stuff, leather, and cotton fabrics. demonstrate the culturing of fungi and preparation of Bordeaux mixture.	PLO 4, 5, 6 & 8
CLO 6	demonstrate the effect of different' intensities of light on the rate of photosynthesis. demonstrate that starch grains are formed on the chlorophyllous portion of a leaf by using Cassava leaf. prove that light and CO_2 are essential for photosynthesis.	PLO 3, 7 & 8
CLO 7	observe transverse sections of C3 and C4 plant leaves to identify Kraz Anatomy of C4 plant leaves. demonstrate presence of nodules in the roots of leguminous plant; section and maceration of nodules, and to observe nodule forming bacteria and bacteroids. conduct experiment to demonstrate rise in temperature during respiration using germinating seeds and young flower buds. explain evaluation of CO_2 during respiration in germinating seeds.	PLO 3, 4, 7 & 8
CLO 8	exhibit the apical dominance due to auxins, and removal of the same triggering axillary shoot growth using Colens and Tageuan plants. show increase of intemodal length through application of gibberellie acid and suppression of the same by trilodo benzoic acid and Cycocel;	PLO 3, 4, 6 & 8

	demonstrate the herbicidal effect of 2,4 dichlorophenoxy acetic acid on dicotyledonus and monocotyledonous plants.	
CLO 9	observe short day, long day and, day neutral plants at different seasons and to record the name of plants. study the effect of break of dark period on flowering of short-day plants. observe simple starch, compound starch and inulin.	PLO 4, 7 & 8

Course Contents

Diversifies in Plant Kingdom

Sl. No	Topic	Class Hours	CLOs covered
1	At the beginning all the students should be taken outside the department to study the plants in nature (algae to Angiosperms) within/around the Curzon Hall Campus. They will see plants adapted to different habitats and identify herbs, shrubs, trees, climbers, epiphytes, sub aerial, terrestrial, aquatic plants, etc. in the laboratory to see what organisms are present.	2	CLO 1
2	Study of phytoplankton (both fresh water and marine) at least one or two examples from Cyanoptyceae, Volvocales, chlorococcales, Desmidiales, Diatoms, Euglenales and dinoflagellates Study of algae: Aquatic - Ulothrin, Oedogonium, Cladophora, Stigeoclonium, Chara/Nitella, Sargassum, Polysiphonia. Terrestrial Fritschiella, Vaucheria/Botrydium, Nostoc. Subacrial Trentipohila, Scytonema. Study of fungi: Synchyrium, Saprolegania/ Achlya, Saccharaomyces, Penicillium, Aspergillus, Ascobolus, Agaricus/Lepiotd, Ganodermal/ Polyporus	6	CLO 2
3	Study of lichens: Crustose, foliose and fruticose types. Study of hepatics: Riccia, Marchantia, Anthoceros (habit, details of thallus and sex organs). Study of ferns: habit and details of the gametophytes (male and female) and sporophytes Study of ferns: a typical fern plant with sori and. Its protanllus with sex organs and an aquatic fern. Study of non-fern ptendopytes: Equisetum, Sclaginella, Mersilea and Isoetes	5	CLO 3
4	Study of Gymnosperms: Cycas, Pinus and Gnetum with cones (I.S.). Study of angiosperms: (a) Herbs, shrubs, trees, climbers, epiphytes, sciophytes, heliophytes; (b) differences between dicot and monocot leaves and flowers; stems and leaves; (c) study of the families poaceae (Gramineae), Orchidaceae, Nymphaceae, Leguminosae and Compositae.	3	CLO 4
5	Study of plant diseases covered in the theory course and fungi causing damage to food stuff, leather, and cotton fabrics. To demonstrate the culturing of fungi and preparation of Bordeaux mixture.	2	CLO 5

Plant Physiology

6	Experiment to demonstrate the effect of different' intensities of light on the rate of photosynthesis.	6	CLO 6

	Experiment to demonstrate that starch grains are formed on the chlorophyllous portion of a leaf by using Cassava leaf. Experiment of prove light and CO_2 are essential for photosynthesis		
7	Transverse sections of C3 and C4 plant leaves to identify Kraz Anatomy of C4 plant leaves. Experiment to demonstrate presence of nodules in the roots of leguminous plant; section and maceration of nodules, and to observe nodule forming bacteria and bacteroids. Experiment to demonstrate rise in temperature during respiration using germinating seeds and young flower buds. Experiment with germinating seeds to show evaluation of CO_2 during respiration.	6	CLO 7
8	Experiment to show apical dominance due to auxins, and removal of the same triggering axillary shoot growth using Colens and Tageuan plants. Experiment to show increase of intemodal length through application of gibberellie acid and suppression of the same by trilodo benzoic acid and Cycocel; Experiment to demonstrate the herbicidal effect of 2,4 dichlorophenoxy acetic acid on dicotyledonus and monocotyledonous plants.	5	CLO 8
9	Experiment to observe short day, long day and, day neutral plants at different seasons and to record the name of plants. Experiment to observe the effect of break of dark period on flowering of short-day plants. Experiment to observe simple starch, compound starch and inulin.	3	CLO 9

Learning Materials	
Recommended Readings	*Alexopoulos CJ, CW Mims and M Blackwell 1996. Introductory Mycology. (4thediton), John Wiley & Sons, New York.* *Bashar MA and MR Islam MR 2005. Degree Botany, Hassan Book House, Dhaka.* *Hill AF 1951. Economic Botany (Indian reprint 1979), Tata McGraw-Hill Publ. Co., Ltd., New Delhi.* *Panday SN, SP Misra and PS Trivedi 1997. A Text Book of Botany, Vol. (ii), Vikas Publ. House, New Delhi.* *Smith GM 1951. Manual of Phycology – An Introduction to the algae and their biology, Chronica Botanica Company, Waltham, Mass, USA, 375 pp.* *Vashista BR, Sinha AK and Kumar A 2007. Botany for degree students part III Bryophyta. S Chand & Co. Ltd., New Delhi.*

Visiting hours: 10 am to 12 noon and 3 to 5 pm on the working days (if available)

Course Code: GLT 101	**Credits:** 2 (50 Marks)	**Course Type:** GED course

Course Title: Geology

Prerequisite(s): As per University requirements for the admission into the program

Rationale of the Course: This course is designed for undergraduate students of the department so that they get a theoretical basis for understanding the structure and geological processes of Earth, the composition of the Earth's crust, rocks, and minerals which are the materials from which the soil is formed.

Course Objectives: This course aims to provide undergraduate students of the Department of Soil, Water and Environment with a basic concept of geology, and to provide firsthand knowledge of rocks and minerals.

Mapping with SDG: The key sustainable development goals that are best aligned with the program are SDG 4, 13, 14, and 15.

Course Learning Outcomes (CLOs) and Mapping with PLOs

Upon completion of this course, the students will be able to:		**PLOs covered**
CLO 1	acquire an introductory knowledge about the physical structure and chemical makeup of different layers of Earth, various geological processes, and its geologic history as recorded in fossils.	PLO 1, PLO 2 & PLO 3
CLO 2	acquire a primary understanding of the physical and chemical properties of rock-forming minerals and their classifications.	PLO 1, PLO 2 & PLO 3
CLO 3	learn the genesis, physical, and chemical makeup of igneous, metamorphic, and sedimentary rocks with emphasis on the geology of Bangladesh.	PLO 1, PLO 2 & PLO 3

Course Contents

Sl. No	**Topic**	**Class Hours**	**CLOs covered**
1	**Concepts of Geology:** The Earth - its internal structure and composition; geological processes, external and internal geological time scale and evolution of life from the fossil record. A brief introduction to paleontology.	10	CLO 1
2	**Mineralogy:** Study of the physical properties, chemistry, and classification of common rock-forming and ore minerals.	10	CLO 2
3	**Petrology:** Study of the origin, mode of occurrence, texture, structure, composition, and classification of igneous, sedimentary, and metamorphic rocks with emphasis on the rock types of Bangladesh.	10	CLO 3

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)

CLOs	Teaching- Learning Strategy[a]	Assessment Strategy
CLOs 1 - 3	[b]Visual and [c]Auditory	Class attendance, In-course Exam, Assignment, Final Theory Exam.

Visiting hours: 10 am to 12 noon and 3 to 5 pm on the working days (*if available*)

Course Code: GLP 102	**Credits:** 2 (50 Marks)	**Course Type:** GED course

Course Title: Petrology and Mineralogy Lab

Prerequisite(s): As per University requirements for the admission into the program

Rationale of the Course: The rationale of this laboratory course is to apply the theoretical concepts of rocks and minerals through hand specimen.

Course Objectives: Study of common rocks and minerals

Mapping with SDG: This course is relevant to achieve SDG 4 (Quality Education)

Course Learning Outcomes (CLOs) and Mapping with PLOs		
Upon completion of this course the students will be able to:		**PLOs covered**
CLO 1	Study common rock forming and ore minerals in hand specimen.	PLO 1
CLO 2	Study common igneous, sedimentary, and metamorphic rocks in hand specimen.	PLO 1

Course Contents			
Sl. No	**Topic**	**Class Hours**	**CLOs covered**
1	Study of common rock forming and ore minerals in hand specimen.	Fifteen	CLO 1
2	Study of common igneous, sedimentary and metamorphic rocks in hand specimen.	Fifteen	CLO 1

Learning Materials	
Recommended Readings	*W. A. Deer, R. Howie and J. Zussman, Introduction to the Rock Forming Minerals.*

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	Teaching- Learning Strategy[a]	Assessment Strategy
CLO 1	[b]Visual and [c]Auditory, and Kinesthetic	Class attendance, Assignment, practical Exam, Field level assessment.

Visiting hours: *10 am to 12 noon and 3 to 5 pm on the working days (if available).*

Courses for 2nd Year

Course Code: SWE 201	**Credits:** 2 (50 Marks)	**Course Type:** Core course

Course Title: Soil Mineralogy and Soil Colloids

Prerequisite(s): Needs to be promoted from 1st year

Rationale of the Course: This course is designed for Under Graduate students of the department so that they get a theoretical basis for understanding of clay mineralogy and soil colloids. This course deals with the mineralogical organization in the clay fraction of the soils. It also focuses on colloidal systems and sorption –desorption properties of soil colloids.

Course Objectives: This course is designed to provide students the knowledge and understanding on the composition and classification of rocks and minerals, and the importance, genesis, structure, classification, and mineralogical organization of layer silicates in soils. The objective also includes knowledge development on the preparation and purification of colloids and sorption –desorption properties of soil colloids.

Mapping with SDG: This course is relevant to achieve SDG 4 and 15

Course Learning Outcomes (CLOs) and Mapping with PLOs

Upon completion of this course the students will be able to:		**PLOs covered**
CLO 1	acquire knowledge about rocks and minerals and their behavior in soil, understand the general distribution of minerals in soils and how it is influenced by environmental conditions.	PLO 1 & 2
CLO 2	understand the behavior, structure and composition of clay minerals in soils and their impact on soil formation.	PLO 3
CLO 3	understand the methods of identification of clay minerals and explain the importance of clay minerals in agriculture and environment.	PLO 1 & 7
CLO 4	develop knowledge on preparation and purification of sols; describe the colloidal systems and sorption –desorption properties of soil colloids	PLO 2
CLO 5	explain different adsorption isotherms and equations.	PLO 1 & 2

Course Contents

Sl. No	**Topic**	**Class Hours**	**CLOs covered**
1	**Rocks and minerals:** Kinds of rocks; essential and accessory minerals; primary and secondary minerals; silicate and non-silicate minerals; stability of minerals; time sequence of mineral occurrence; common minerals in different size fractions of soils.	10	CLO 1
2	**Clay minerals:** General properties; classification; structure; genesis; sources of charges; identification; oxide and hydroxide minerals in soils; factors affecting types of clay minerals; amorphous materials in soils; distribution of clay minerals in major soil groups of the world and major soils of Bangladesh.	10	CLO 2 CLO 3
3	**General study of colloids:** Characteristics of coarse dispersion, colloidal system and solution; classification of colloidal systems; preparation and purification of sols; optical and kinetic properties of sols; structure of colloidal systems - electrical double-layer and	10	CLO 4 CLO 5

	triple-layer theory; Donnan's theory of membrane equilibrium; surface behaviour of colloids; adsorption-desorption phenomenon; adsorption capacities of various soil components; different adsorption equations.		

Learning Materials	
Recommended Readings	Grim, R. E. Clay Mineralogy. McGraw-Hill Book Company, Inc. New York, USA. *Bahl et al. 2009. Essentials of Physical Chemistry. S. Chand & Company Ltd.*, India. *Tan, K. H. 1993. Principles of Soil Chemistry. (2nd ed.) Marcel Dekker, Inc.* *Sehgal, J. 2014. A Textbook of Pedology: Concepts and Applications. (2nd ed.) Kalyani. India.*
Supplementary Readings	*Brady, N.C. and R.R. Weil. 2002. The Nature and Properties of Soil. (13th ed.) Pearson Education, Singapore.*

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	Teaching- Learning Strategy[a]	Assessment Strategy
CLO 1	[b]Visual and [c]Auditory	Class attendance, In-course Exam, Assignment, Final theory and practical Exam, Field level assessment.
CLO 2	Visual, Auditory and Kinesthetic[d]	
CLO 3	Visual and Auditory	
CLO 4	Visual and Auditory	
CLO 5	Visual and Auditory	

Visiting hours: 10 am to 12 noon and 3 to 5 pm on the working days (if available)

Course Code: SWE 202	**Credits:** 4 (100 Marks)	**Course Type:** Core course

Course Title: Soil Physics

Prerequisite(s): Needs to be promoted from 1st year

Rationale of the Course: This course is designed for Under Graduate students of the department so that they get a theoretical basis for understanding physical and hydrological properties of soils. This course focuses on solid, liquid, and gaseous phases of soil. In addition, Soil temperature and Soil color will also be discussed.

Course Objectives: The objective of this course is to provide students a basic but comprehensive knowledge on physical properties of soil, detail study of the solid, liquid and gaseous phases of soil, water movement within the soil profile, thermal regime of soil and importance of soil color.

Mapping with SDG: This course is relevant to achieve SDG 4.

Course Learning Outcomes (CLOs) and Mapping with PLOs

Upon completion of this course the students will be able to:		**PLOs covered**
CLO 1	acquire an introductory knowledge of soil physical properties and chronological development of the study of Soil Physics, three phases of soil and their interrelationships.	PLO 1 & 2
CLO 2	explain basic physical properties of soil related to its solid phase, describe textural and structural behavior of soil, determine soil textural class, and to understand causes and consequences of soil compaction.	PLO 3
CLO 3	understand basic properties of water, contents and energy state and retention of water in soil, explain water flow equations and measure water movement in the soil.	PLO 1 & 7
CLO 4	compare soil and atmospheric air, explain aeration mechanisms in soil and atmosphere.	PLO 2
CLO 5	explain thermal properties of soil.	PLO 1 & 2
CLO 6	determine and describe color of soil, understand importance of soil color.	PLO 1

Course Contents

Sl. No	**Topic**	**Class Hours**	**CLOs covered**
1	**Soil Physics in Perspective:** definition of Soil Physics, history of Soil Physics, Soil Physical properties.	3	CLO 1
2	**Phases of soil:** Soil – a three phase disperse system, description of the three phases, mass and volume relations of soil constituents.	5	CLO 1
3	**The Solid Phase:** Texture- definition, primary particles, specific surface of soil particles, particle size analysis and expression of results, sedimentation equation (Stokes' law), assumptions and limitations of Stokes' law, determination of Textural class of a soil. Structure- definition, classification, and agricultural significance of soil structure; Genesis, Evaluation and management of soil structure. Soil Consistence- definition, classification, Atterberg's constants and their practical significance. Soil Compaction- occurrence of soil compaction in agricultural fields, consequences of soil compaction, control of soil compaction.	20	CLO 2

4	**The Liquid Phase:** Properties of water- structure, H-bonding, states of water, surface tension, capillarity, viscosity, density, derivation of capillary rise equation. Soil water contents- definition and measurements. Soil water potential- definition, components, measurement. Water retention in soil- water release curve, hysteresis. Water movement in soil- saturated flow, Darcy's law, Poiseuille's equation, water flux through a uniform homogeneous soil profile and through a layered soil profile, hydraulic conductivity, determination of saturated hydraulic conductivity in the laboratory.	20	CLO 3
5	**The Gaseous Phase:** Composition of soil air and atmospheric air, aeration, mechanisms of soil gas exchange.	5	CLO 4
6	**Soil Temperature:** Introduction, Temperature based classification in the Soil Taxonomy, heat capacity, thermal conductivity, thermal diffusivity, factors affecting soil temperature.	5	CLO 5
7	**Soil Color:** Causes and significance of soil color, Munsell's Colour Chart.	2	CLO 6

Learning Materials	
Recommended Readings	*Hillel, D. 1998. Environmental Soil Physics. Academic Press. London, UK* *Kohnke, H. 1979. Soil Physics. Tata McGraw-Hill Publishing Company Ltd., New Delhi, India.* *Baver et al. 1972. Soil Physics. Jhon Wiley & Sons Inc. NY, USA.*
Supplementary Readings	*Scott, H. D. 2000. Soil Physics: Agricultural and Environmental Applications. C State Univ. Press, Ames, Iowa, USA.*

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	Teaching- Learning Strategy[a]	Assessment Strategy
CLO 1	[b]Visual and [c]Auditory	Class attendance, In-course Exam, Assignment, Final theory and practical Exam, Field level assessment.
CLO 2	Visual, Auditory and Kinesthetic[d]	
CLO 3	Visual and Auditory	
CLO 4	Visual and Auditory	
CLO 5	Visual and Auditory	
CLO 6	Visual and Auditory	

Visiting hours: 10 am to 12 noon and 3 to 5 pm on the working days (if available)

Course Code: SWE 203	**Credits:** 2 (50 Marks)	**Course Type:** Core course

Course Title: General Microbiology

Prerequisite(s): Needs to be promoted from 1st year

Rationale of the Course: This course is designed for Under Graduate students of the department so that they get a theoretical as well as practical basis for understanding a general knowledge in microbiology, different types of micro-organisms and their factors of abundance, aerobic and fermentative metabolic processes, enzyme activity, protein synthesis, microbial importance in agriculture, industry and medicine. In addition, principles, types and functions of microscope will also be discussed.

Course Objectives: The objective of this course is to provide students a basic but comprehensive knowledge about different characteristic study of micro-organisms and their abundance in soil and environment mentioning their importance in agriculture, industry and medicine considering enzymes and various metabolic processes involved. From this course students will acquire an introductory knowledge about media preparation, sterilization, microbial growth study by using microscope.

Mapping with SDG: This course is relevant to achieve SDG 4.

Course Learning Outcomes (CLOs) and Mapping with PLOs

Upon completion of this course the students will be able to:		**PLOs covered**
CLO1	learn the historical and fundamental development of Microbiology, acquire knowledge about the place of micro-organisms in the living world i.e. classification of microorganisms.	PLO1&6
CLO2	gather knowledge about characteristic study of five major groups of microorganisms.	PLO1&5
CLO3	develop an understanding of the factors affecting the growth and abundance of various microorganisms in soil and environment.	PLO7&8
CLO4	illustrate their knowledge about the agricultural, industrial and medicinal importance of microorganisms.	PLO4,5&7
CLO5	acquire knowledge about the pure, mixed and contaminated culture; Culture media- types, preparation and dispensation; Pure culture techniques- isolation, maintenance and preservation of pure culture; Type culture collections.	PLO5,7&8
CLO6	develop an understanding of the source of energy and nutrients for the soil-biota and	PLO5&7
CLO7	illustrate their knowledge about light spectrum, resolving power and magnification power; Microscopes- light and electron microscopes; Microscopy- bright-field, dark-field, fluorescence, phase-contrast, differential interference contrast, transmission electron, scanning, scanning tunnelling and atomic force microscopy.	PLO1

Course Contents

Sl. No	**Topic**	**Class Hours**	**CLOs covered**
1	**Historical development of Microbiology**: Discovery of microorganisms; Origin of life; Spontaneous generation vs biogenesis; Germ theory of disease; Development of laboratory techniques, fermentation, vaccination, antisepsis and chemotherapy; The golden age of and contributions in historical development of microbiology, The tree of life.	5	CLO1

2	**General characteristics** of bacteria, fungi and algae: their classification, morphology, growth and reproduction; Protozoa and earthworm: their habitat, distribution in the nature, subdivisions, mode of reproductions and importance.	6	CLO2
3	**Factors affecting the growth and abundance of various microorganisms in soil, environment and laboratory**; Growth and growth curve; Growth measurement- direct and indirect methods; Environmental growth requirements; categorization of microbes based on nutritional and environmental growth factors.	2	CLO3
4	**Importance** of microorganisms in agriculture, industry and medicine; microbial involvement in- biogeochemical cycles, production of acids, enzymes, antibiotics, vitamins and probiotics.	6	CLO4
5	**Microbiological Culture:** Culture types; Culture media- types, preparation and dispensation; Pure culture techniques- isolation, maintenance and preservation of pure culture; Type culture collections.	5	CLO5
6	**Methods of Microbial Control;** Physical and chemical Agents- Temperature, Desiccation, Osmotic Pressure, Radiation, Filtration, sterilization, disinfection, decontamination, static, and cidal.	2	CLO5&6
7	**Soil as a source** of energy and nutrients for the biota -minerals, organic matter and living biomass; soil biotic activity and factors, role of soil biota, soil forming factors biota,	2	CLO6
8	**Microscope**- principles, types and functions of microscope.	4	CLO7

Learning Materials	
Recommended Readings	*Michael J . Pelczar, Jr. E. C. S. Chan Noel K. Krieg 1988. Microbiology. (5th ed.) McGraw-Hill Book Co., Singapore.* *Microbiology: An Introduction- G.J.Tortora, B.R.Funke and C.L.Case; Pearson, Boston* *Brock Biology of Microorganisms- M.T. Madigan, J.M. Martinko, P.V. Dunlap, D.P. Clark,Pearson Prentice Hall* *Talaro and Chess. 2014. Foundations In Microbiology. Published by McGraw-Hill Education, **2** Penn Plaza, New York,*
Supplementary Readings	*Alexander, M. 1977. Introduction to soil microbiology. (2nd ed.) Wiley, USA.* *Kathleen, P. T. and B. Chess. 2014. Foundations in Microbiology. (9th ed.) McGraw-Hill Book Co. Singapore.* *Jeffrey C. Pommerville. 2011. Alcamo's Fundamentals of Microbiology. (7th ed.) Jones and Bartlett Publishers, USA.*

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	**Teaching- Learning Strategy[a]**	**Assessment Strategy**
CLO 1	[b]Visual and [c]Auditory	Class attendance, Continuous assessment, Incourse Exam, assignment, Final theory and practical Exam, oral exam and presentation, Field level assessment.
CLO 2	Visual, Auditory and Kinesthetic[d]	
CLO 3 to 6	Visual and Auditory	
CLO7	Visual and Auditory and Kinesthetic[d]	

Visiting hours: 10 am to 12 noon and 3 to 5 pm on the working days (if available)

Course Code: SWE 204	**Credits:** 2 (50 Marks)	**Course Type:** GED course
Course Title: Calculus		
Prerequisite(s): Needs to be promoted from 1st year		
Rationale of the Course: This course is designed to provide knowledge on differential and integral calculus to the students of the department other than Mathematics calculus.		
Course Objectives: The objective of this course is to familiarize the students with differentiation and integration methods so that they will be able to better understand and handle models and equations used in different courses on Soil, Water and Environment.		
Mapping with SDG: This course is relevant to achieve SDG goal No 4 (Quality Education).		

Course Learning Outcomes (CLOs) and Mapping with PLOs		
Upon completion of this course the students will be able to:		**PLOs covered**
CLO 1	know techniques of differentiation and solve different problems by using differential calculus.	PLO 6 & 10
CLO 2	gain knowledge on integration processes, and apply integral calculus.	PLO 6 & 10

Course Contents			
Sl. No	**Topic**	**Class Hours**	**CLOs covered**
1	**Differential Calculus:** Relations and Functions, Domain and range of functions, Graphs of functions, Even and Odd functions. Limit, Continuity and Differentiability of Functions. Various Techniques of differentiation, Chain Rule, logarithmic, Implicit and Parametric Differentiation. Rule's theorem, Mean-value theorem and Taylor's theorem. Applications of Differential Calculus: Maxima and Minima of Functions, Applied Maxima and Minima Problems.	15	CLO 1
2	**Integral Calculus:** Anti Derivatives, Indefinite Integrals; Integration by substitution, Standard integrations, Integration by parts, Integration of rational and Trigonometric functions. Definite Integrals: Elementary definite integrals, Properties of definite integrals, Standard formulas for definite integrals, Gamma and Beta functions. Applications of integral Calculus: Arc length, Area and Volume by definite integrals.	15	CLO 2

Learning Materials	
Recommended Readings	*Anton et al. 2015. Calculus (Early Transcendental). (10th ed.) Johns Wiley and Sons, Inc.* *Matin, A. and B. Chakrabarty. 2012. Differential Calculus. (6th ed.) Standard Book Mart* *Matin, A. and B. Chakrabarty. 2012. Integral Calculus. (6th ed.) Standard Book Mart*

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	Teaching- Learning Strategy[a]	Assessment Strategy
CLO 1	[b]Visual and [c]Auditory	Class attendance, In-course Exam, Assignment, Final theory and practical Exam.
CLO 2	Visual and Auditory	

Visiting hours: 10 am to 12 noon and 3 to 5 pm on the working days (if available)

Course Code: SWE 205	**Credits:** 2 (50 Marks)	**Course Type:** GED course

Course Title: Biostatistics

Prerequisite(s): Needs to be promoted from 1st year

Rationale of the Course: This course is designed to acquaint the under graduate students with the statistical theories and methods and their application in biological sciences and agriculture which will enable them to understand the concept involved in data presentation, analysis and interpretation.

Course Objectives: The objective of this course is to introduce fundamental statistical theories and methods in presentation and analysis of biological, agricultural and environmental data as well as **t**o prepare the students to handle research data for appropriate analysis and interpretations.

Mapping with SDG: This course is relevant to achieve SDG 4.

Course Learning Outcomes (CLOs) and Mapping with PLOs

Upon completion of this course the students will be able to:		**PLOs covered**
CLO 1	assemble and summarize the raw data using different statistical measures.	PLO 1, 6 & 8
CLO 2	apply probability concepts and appropriate sampling techniques.	PLO 8 & 9
CLO 3	analyze and interpret correlation between variables and regression measures as well as test of hypothesis	PLO 8 & 10
CLO 4	design an experiment with statistical analysis and draw valid inferences	PLO 8, 9 & 10

Course Contents

Sl. No	Topic	Class Hours	CLOs covered
1	**Introductory Statistics:** Definition, Characteristics and Importance. Data Collection, Classification and Summarization. Tabular and Graphical representation of Data. Stem and Leaf Diagram, Frequency distribution –Ungrouped and Grouped, Frequency Polygon, Histogram and Ogive.	5	CLO 1
2	**Summary Measures:** Measures of Central Tendency –Mean, Median and Mode and their Empirical Relations. Quantiles. Absolute and Relative Measures of Dispersion –Mean Deviation, Standard Deviation and Co-efficient of Variation. Normal Distribution and Skewness.	5	CLO 1
3	**Probability and Sampling:** Concept of Probability Measures, Probability Rules –Addition and Multiplication Law. Population and Sampling, Sample size and Design, Errors in Sample Survey, Probability and Purposive Sampling –Techniques, advantages and Limitations.	5	CLO 2
4	**Relationship between Variables:** Simple Correlation Analysis, their Testing and Interpretation. Scatter plot and rank correlation. Regression Analysis –Simple Linear Regression Analysis, Regression coefficients and Equations. Coefficient of Determination.	5	CLO 3
5	**Test of Hypothesis:** Null and Alternative Hypotheses, Confidence Limit, degree of freedom, Student's t-Test, Chi-Square Test, F-Test, ANOVA and Test of Significance.	5	CLO 3
6	**Experimental Design:** Basic Concepts and Principles, Completely Randomized Design, Randomized Block Design and Latin Square Design –their Field Lay-out, Analysis of Variance and Significance Testing as well as drawing inferences	5	CLO 4

Learning Materials

Recommended Readings	*Bluman, A. G. 2014. Elementary Statistics: A Step by Step Approach. McGraw-Hill Education.* *Rangaswamy, R. 1995. A text book of Agricultural Statistics. New Age International.* *Mahajan, B. K. 2010. Methods in Biostatistics. (7th ed.) Jaypee Brothers Medical Publishers.*
Supplementary Readings	*Zaman et al. 1982. Simple Lessons from Biometry. Bangladesh Rice Res. Ins. Joydebpur.*

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	**Teaching- Learning Strategy[a]**	**Assessment Strategy**
CLO 1	[b]Visual and [c]Auditory	Class attendance, In-course Exam, Assignment, Final theory and practical Exam, Field level assessment.
CLO 2	Visual, Auditory and Kinesthetic[d]	
CLO 3	Visual and Auditory	
CLO 4	Visual and Auditory	

Visiting hours: 10 am to 12 noon and 3 to 5 pm on the working days (if available)

Course Code: SWE 206	**Credits:** 2 (50 Marks)	**Course Type:** Core course

Course Title: Plant Biochemistry

Prerequisite(s): Needs to be promoted from 1st year

Rationale of the Course: The course is designed to provide fundamental ideas about biochemistry of plant system to the undergraduate students. This course will provide students with specific knowledge of biomolecules and biochemical pathways that occur in plants, mechanism of metabolic processes and their interaction with environment, basis of molecular biology.

Course Objectives: The objective of this course is to provide students a basic but comprehensive knowledge regarding the structure, chemical and physical properties of biomolecules; the relationship between structure and function of macromolecules; how light energy is captured and converted to chemical forms of energy to power functions of cells and whole plants; the principles of enzyme kinetics and how enzyme properties contribute to metabolic processes; molecular biochemistry of stress tolerance mechanism in plants.

Mapping with SDG: This course is relevant to achieve SDG 4 and SDG 15.

Course Learning Outcomes (CLOs) and Mapping with PLOs

Upon completion of this course the students will be able to:		**PLOs covered**
CLO 1	describe protein structure, function, biosynthesis and biodegradation.	PLO 1 & 6
CLO 2	gain an understanding of nucleic acid, nucleotides leading to DNA based information technology.	PLO 1
CLO 3	explain role of enzymes in plant, their structure, synthesis and kinetics.	PLO 1
CLO 4	learn mechanism involved in conversion of light energy to chemical energy to power functions of plant cell.	PLO 1& 6
CLO 5	acquire knowledge on identification of Carbohydrate structure, biosynthesis and biodegradation	PLO 1 & 6
CLO 6	explain mechanism involved in adaptation of environmental stress tolerance.	PLO 2

Course Contents

Sl. No	**Topic**	**Class Hours**	**CLOs covered**
1	**Protein:** Amino acids-classification, function, amino acid activating enzymes; Peptides, Protein biosynthesis in plants; Tertiary and Quaternary protein structure	5	CLO 1
2	**Nucleic acid:** Nucleic acid-classification, functions, synthesis of nucleotides, replication of DNA, RNA characteristics and functions.	5	CLO 2
3	**Enzymes:** Enzymes-definition, classification, characteristics, mode of action, Michaelis–Menten kinetics, basics of protein-ligand interaction, Plant hormone-structure, function	6	CLO 3
4	**Energy flow:** light reaction of photosynthesis-pigments, photosystem, ATP synthesis; photosynthetic C assimilation-Calvin cycle, C3, C4, CAM pathways, photo-respiration, glycolysis	6	CLO 4

5	**Carbohydrate**- structure, classification, synthesis and breakdown of sucrose and starch.	5	CLO 5
6.	**Biochemistry of stress tolerance**: drought, salinity, heat stress and their tolerance mechanism in plant.	3	CLO 6

Learning Materials	
Recommended Readings	1. David L. Nelson, Michael M. Cox (2013). ***Lehninger Principles of Biochemistry,*** 6th Edition, Macmillan Learning. 2. Pratt, C.W. and Cornely, K. (2014). ***Essential Biochemistry,*** 5th edition**,** John Wiley & Sons.
Supplementary Readings	1. Buchanan, B., Gruissem, W., Jones, R. (2000). ***Biochemistry and Molecular Biology of Plants***. 2nd edition, John Wiley & Sons. 2. Heldt H-W (2011). ***Plant Biochemistry***, 4th Edition. Elsevier Academic Press.

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	Teaching- Learning Strategy[a]	Assessment Strategy
CLO 1	Visual[b], Auditory[c] and Practical[d]	Class attendance, In-course Exam, Assignment, Final theory and practical Exam, Field level assessment.
CLO 2	Visual and Auditory	
CLO 3	Visual and Auditory	
CLO 4	Visual and Auditory	
CLO 5	Visual, Auditory and Practical	
CLO 6	Visual and Auditory	

Visiting hours: 10 am to 12 noon and 3 to 5 pm on the working days (if available)

Course Code: SWE 207	**Credits:** 2 (50 Marks)	**Course Type:** Core course

Course Title: Water Chemistry

Prerequisite(s): Needs to be promoted to 1st year

Rationale of the Course: The course is designed for undergraduate students of the Department of Soil, Water, and Environment with a focus on the processes occurring in natural and polluted waters. This course covers the basics of aqueous chemistry, the chemical reactivity, and equilibrium in aqueous solution, the reaction kinetics, the aqueous solution chemistry of acid-base reactions, complex formation, precipitation, and dissolution reactions, and oxidation-reduction reactions.

Course Objectives: The objective of this course is to arm the students with a fundamental understanding of water chemistry building on their high-school chemistry. This understanding will aid them when they work in water and wastewater treatment plants, in different research organizations, and academia, for that matter. The laboratory part will complement the theoretical part and is likely to provide students with hands-on experience.

Mapping with SDG: This course is relevant to achieve SDG 4, 6 & 14.

Course Learning Outcomes (CLOs) and Mapping with PLOs

Upon completion of this course, the students will be able to:		**PLOs covered**
CLO 1	Understand the basic properties of water and how these properties influence its behavior in the environment; and know different approaches for expressing concentrations, including molar concentration, equivalents, etc.	PLO 1
CLO 2	Understand the concept and approaches for quantifying the reactivity of chemicals; define activity coefficients and the chemical equilibrium constant; and distinguish between concentrations and chemical activities.	PLO 6
CLO 3	Appreciate what reaction kinetics are, what is the rate law, and how temperature affects reaction rate constants.	PLO 1 & PLO 8
CLO 4	Solve acid-base equilibrium problems and construct log concentration diagrams for acids and bases.	PLO 1 & PLO 8
CLO 5	Describe the distribution of CO_2, H_2CO_3, HCO_3^- and CO_3^{2-} in natural waters and understand the significance of carbonate species reactions in regulating the pH and the composition of natural waters.	PLO 1 & PLO 8
CLO 6	Use MINTEQ Software for solving water chemistry problems.	PLO 10
CLO 7	Interpret quantitatively the titration data.	PLO 1 & PLO 7
CLO 8	Know the basic concepts and terminology for gas/liquid equilibrium, and be familiar with Henry's law which describes the equilibria between CO_2(aq) and CO_2(g), H_2S(aq) and H_2S(g), and NH_3(aq) and NH_3(g).	PLO 1
CLO 9	Understand the role of coordination chemistry in reactions including complexation and complex stability and metal ion hydrolysis.	PLO 1
CLO 10	Perform solubility calculations.	PLO 1 & PLO 8
CLO 11	Understand redox reactions including stoichiometry and equilibria and be able to balance these redox reactions.	PLO 1 & PLO 8

Course Contents			
Sl. No	**Topic**	**Class Hours**	**CLOs covered**
1	**Basics of Aquatic Chemistry**: Scope of aquatic chemistry, Structure of water molecules, Behavior of solutes in water, Dissolution of salts, Common approaches for expressing concentrations in environmental chemistry	3	CLO 1
2	**Chemical Reactivity and Equilibrium**: Characterizing chemical reactivity, Predicting activity coefficients from knowledge of the solution composition, The activity of solids dispersed in water, Models of Chemical Equilibrium, Effects of temperature on equilibrium constant, Combining chemical reactions	3	CLO 2
3	**Reaction Kinetics**: Reaction rate constant, Effect of temperature on reaction rate constants, Experimental evaluation of reaction kinetics	2	CLO 3
4	**Acids and Bases**: The pH and p(x) concept, Solving acid-base equilibrium problems, Logarithmic concentration diagrams, Open versus closed systems	3	CLO 4
5	**Dissolved carbon dioxide**: Dissolved carbonate equilibria (closed system), Aqueous carbonate system open to the atmosphere, Alkalinity	3	CLO 5
6	Using MINTEQ Software for Solving Chemical Equilibrium Problems	2	CLO 6
7	**Titration and Buffers**: Quantitative interpretation of titration data, Alkalinity and Acidity, Buffers, Buffer intensity	2	CLO 7
8	**Gas-Liquid Equilibrium**: Basic concepts and terminology for gas/liquid equilibrium, Effect of gas/liquid equilibration on gas-phase composition, Factors affecting volatility, and Henry's constant	3	CLO 8
9	**Chemistry of metals in aqueous systems**: Complex formation-mononuclear complexes and mixed ligand complexes	3	CLO 9
10	**Precipitation and Dissolution Reactions**: Solubility calculations, Solubility of oxides and hydroxides, Solubility of carbonates	3	CLO 10
11	**Redox Chemistry**: Oxidation numbers, Balancing redox reactions, Redox half reactions, Activity of free electrons, Equilibrium constants for redox half reactions, Computing pe from species activities, The Nernst equation	3	CLO 11

Learning Materials	
Recommended Readings	Benjamin, M.M. 2015. Water Chemistry (Second Edition). Waveland Press, Inc., Long Grove, Illinois Faure, G. 1998. Principles and Applications of Geochemistry (Second Edition). Prentice-Hall, Inc., Upper Saddle River, New Jersey
Supplementary Readings	Sawyer et al., 2003. Chemistry for Environmental Engineering (Fifth Edition) The McGraw-Hill Companies Inc., New York

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	Teaching- Learning Strategy[a]	Assessment Strategy
CLO 1	[b]Visual, [c]Auditory and Kinesthetic[d]	Class attendance, In-course Exam, Assignment, Final theory and practical Exam, Field level assessment.
CLO 2	Visual and Auditory	
CLO 3	Visual and Auditory	
CLO 4	Visual and Auditory	
CLO 5	Visual, Auditory and Kinesthetic	
CLO 6	Kinesthetic	
CLO 7	Visual, Auditory and Kinesthetic	
CLO 8	Visual and Auditory	
CLO 9	Visual and Auditory	
CLO 10	Visual and Auditory	
CLO 11	Visual and Auditory	

Visiting hours: 10 am to 12 noon and 3 to 5 pm on the working days (if available)

Course Code: SWE 208	**Credits:** 2 (50 Marks)	**Course Type:** Core course

Course Title: Introduction to Ecosystem Services

Prerequisite(s): Needs to be promoted from 1st year.

Rationale of the Course: The lesson plans were designed to introduce students to the concepts of ecosystem services, especially on the monitoring, valuation, characterization of human well-being, conservation of ecosystem resources, possible solutions to meet the criteria and constraints of the problems of ecosystem services, etc.

Course Objectives: To train up the undergraduates regarding ecosystem services; their functions, processes and impacts; to monitor and valuation of ecosystem services; classification and assessment of ecosystems and their services; management and protection strategies of ecosystem services; contribution of ecosystem services to human resilience and well-beings.

Mapping with SDG: The course is relevant to achieve SDG 2 (Zero Hunger), 4 (Quality Education) and 13 (Climate Action).

Course Learning Outcomes (CLOs) and Mapping with PLOs		
Fruitful accomplishment of the course will lead the undergraduates to:		**PLOs covered**
CLO 1	recognize major ecosystem services, processes, functions, impacts of natural events and human activities on environments and ecosystems.	PLO 1 & 2
CLO 2	use of tools to monitor and valuation of ecosystem services; principal services and services supplied by major biomes.	PLO 8
CLO 3	characterize the well-being in the context of service flows; linking services to well-being; differences in well-being by respondent or community type; and ecosystem services to well-being and public health.	PLO 3 & 4
CLO 4	distinguish agricultural and ecosystem services, impacts of inputs associated with intensification, agriculture and food system structure and social consequences of food system and understand the ways to conserve ecosystem resources.	PLO 5, 6 & 8
CLO 5	illustrate the patterns of Earth's features of ecosystems**;** the solutions to reduce impacts of natural Earth processes of ecosystem on humans; the criteria for success and constraints, and their possible solutions.	PLO 7 & 8
CLO 6	classify and evaluate the ecosystem services: manage and protect the strategies of ecosystem services; 'Cut off' of ecosystem services and to contribute on ecosystem services for human resilience.	PLO 1 & 3
CLO 7	understand the well-beings of human through the incorporation of biodiversity.	PLO 7

Course Contents			
Sl. No	**Topic**	**Class Hours**	**CLOs covered**
1	**Ecosystem services:** meaning, importance, examples and major ecosystem services. Ecosystem processes and functions; Impacts of natural events and human activities on environments and ecosystems (e.g., fire, floods, pollution, dams).	5	CLO 1
2	**Cultural ecosystem services and Biodiversity:** Biodiversity and Ecosystem Services; Key ecosystem service concepts; Monitoring ecosystem services; Community monitoring of ecosystem Services; Tools to monitor ecosystem services; Valuation of ecosystem services; Principal services and services supplied by major biomes.	5	CLO 2

3	**Ecology and ecosystem services:** characterizing well-being in the context of service flows; linking services to well-being; differences in well-being by respondent or community type; examples of linking ecosystem services to well-being and public health.	3	CLO 3
4	**Agricultural and Ecosystem services:** Impacts of intensive cropping; impacts of inputs associated with intensification; impacts of intensive rice systems; agriculture and food system structure and social consequences of food system. Ways to conserve ecosystem resources (e.g., by reducing, reusing, recycling, finding substitutes).	5	CLO 4
5	**Patterns of Earth's features of ecosystems:** Energy and fuels from natural resources. Solutions to reduce impacts of natural Earth processes of ecosystem on humans. Criteria for success and constraints on materials, time, or cost, possible solutions to meet the criteria and constraints of the problems of ecosystems.	5	CLO 5
6	**Classification and Assessment of Ecosystem Services:** Classification, Assessment of Ecosystems and their Services – Indicators for ecosystem assessments; measurement, management and protection strategies of ecosystem services. Contribution of ecosystem services to human resilience. 'Cut off' of ecosystem services.	5	CLO 6
7	**Ecosystems and human well-beings:** biodiversity synthesis.	2	CLO 7

Learning Materials	
Recommended Readings	*Nature's Services, Societal Dependence on Natural Ecosystems. Gretchen C. Daily Ed., Island Press, USA.* *The greenhouse effect, climate change and ecosystems – Bolin et al. 1986.*
Supplementary Readings	*Global Biodiversity Assessment. Heywood V., Ed., Cambridge University Press, Cambridge, England.* *Issues in Ecology, 1997(2): Ecosystem Services. Ecological Society of America.* *The contribution of ecosystem services to human resilience, 2015. Elizabeth C. Ed., Shaping policy for development – odi.org* *Dictionary of Environmental Science and Technology 3rd edn., Andrew Porteous.* *Climate change and Agriculture – ASA Spec. Publ. No 59.*

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	Teaching- Learning Strategy[a]	Assessment Strategy
CLO 1	[b]Visual and [c]Auditory	Class attendance, In-course Exam, Assignment, Final theory and practical Exam, Field level assessment.
CLO 2	Visual, Auditory and Kinesthetic[d]	
CLOs 3 to 7	Visual and Auditory	

Visiting hours: 10 am to 12 noon and 3 to 5 pm on the working days (if available)

Course Code: SWE 209	**Credits:** 2 (50 Marks)	**Course Type:** Core course

Course Title: Practical.

Prerequisite(s): Needs to be promoted from 1st year

Rationale of the Course: This course includes laboratory works related to the theory courses of 2nd year and is designed in a way that the students will carry out practical research assigned by the course teacher with an aim conducting a comprehensive study and research on soil mineralogy and soil colloids, Environmental Microbiology, soil, physics, soil chemistry, water chemistry, ecology and ecosystem services and GIS.

Course Objectives: The objective of this course is to provide students a comprehensive practical knowledge on different parameters of soil, water and environment, ecology and ecosystem services and GIS,

Mapping with SDG: This course is relevant to achieve SDG 4, 6, 13, 14, 15 and 17.

Course Learning Outcomes (CLOs) and Mapping with PLOs		
Upon completion of this course the students will be able to:		PLOs covered
CLO 1	provide a practical training on the Identification of soil forming minerals; Separation of clay fraction from soil; identification of clay minerals.	PLO1, 2, 3, 4 5, 6, 7
CLO 2	acquire knowledge about different characteristic study of micro-organisms.	PLO1 - 7
CLO 3	gather practical knowledge about the principles, types and functions of microscope.	PLO 5, 7
CLO 4	provide knowledge about statistical data analysis and experimental design.	PLO1, 2, 3, 4
CLO 5	provide specific knowledge of biomolecules and biochemical pathways that occur in plants, mechanism of metabolic processes and their interaction with environment, basis of molecular biology.	PLO1, 2, 3
CLO 6	introduce students to the concepts of ecosystem services, especially on the monitoring, valuation, characterization of human well-being, conservation of ecosystem resources, possible solutions to meet the criteria and constraints of the problems of ecosystem services, etc.	PLO1, 2, 3, 4
CLO 7	arm the students with a fundamental understanding of water chemistry building on their high-school chemistry. This understanding will aid them when they work in water and wastewater treatment plants, in different research organizations, and academia, for that matter.	PLO 5, 7
CLO 8	emphasize the understanding of GIS theory, technology, and applications: produce effective maps of analytical results which adhere to established cartographic standards; gain proficiency in spatial data analysis and 3D data analysis.	PLO1, 2, 3, 4 5, 6, 7

Course Contents			
Sl. No	**Topic**	**Class Hours**	**CLOs covered**
1	**Related to SWE 201:** Identification of soil forming minerals; Separation of clay fraction from soil; identification of clay minerals by CEC method; Experimental verification of Fruendlich's adsorption equation.	5	CLO 1
2	**Related to SWE 202:** Collection and storing of soil samples for studying physical properties; Detailed particle size analysis of soil by combination of	10	CLO 2

	hydrometer and sieving methods, and presentation of data by particle size distribution curve; Determination of liquid limit and plastic limit; Dry an wet sieving methods of soil aggregate analyses; Penetration resistance analysis of soils.		
3	**Related to SWE 203:** Microscope; Microbiological tools and techniques; preparation of media, cultivation of bacteria, simple and negative staining techniques used in microbiology; Isolation of bacteria and fungi from soil; Purification and preservation of culture; Gram staining; Motility test of bacteria; and morphology of bacterial colony.	5	CLO 2 & CLO 3
4	**Related to SWE 205:** Field data collection and Statistical Analysis for Correlation, Regression, and Experimental Design and Data Interpretation of Results. Use of Modern Statistical Softwares in Experimental Data Analysis.	5	CLO 4
5	**Related to SWE 206:** Role of enzymes and protein in plant, their structure, synthesis and kinetics.	5	CLO 5
6	**Related to SWE 207:** Determination of total solids (TS), TDS, SS, Hardness, alkalinity, DO, BOD, COD, Ammonia, Nitrates, Nitrites and Phosphates contents in collected water samples;	5	CLO 7
7	**Related to SWE 208:** Monitoring and evaluation of ecosystem services: Determination of selected parameters	5	CLO 6
8	**Related to GML 202:** Introductory Lesson: Instrumental set up of a GIS laboratory; Uses of different kinds of base maps, thematic maps, aerial photos, topographic maps and other base materials; Developing spatial database: data input systems; spatial data capturing methodology, Identification and characterization of coverage/layer features/ data capturing terminology (arc, node, vertex, pseudo node, dangling node, label point, polygon, user ID, RMS error, Tic, Annotations etc.); editing of digitized cover/layer, projection and geo-referencing, presentation and display of vector data and raster data modules, topology constructions, annotations and symbolizations; final digital output; GIS Map and Database: Joining database with map; attribute and spatial query, summarization, overlaying techniques etc. Spatial analysis: Interpolation, IDW, Kriging, spline; 3D Analysis: Creating and managing 3D GIS data. 3D Data Visualization, DEM, 3D Terrain and Surface Analysis, GPS in Field: GPS working procedures and data capturing methodology; Use of GPS in the identification of spatial datasets and their attributes and formulation of vector data model with necessary cartographic features.	12	CLO 4, 5, 6

Learning Materials

Recommended Readings	*Sehgal, J. 2014. A Textbook of Pedology: Concepts and Applications. (2nd ed.) Kalyani.* *Bahl et al. 2009. Essentials of Physical Chemistry. S. Chand & Company Ltd.* *Michael J .* Pelczar*, Jr. E. C. S. Chan Noel K. Krieg 1988. Microbiology. (5th ed.) McGraw-Hill Book Co., Singapore.* *Talaro and Chess. 2014. Foundations In* Microbiology. *Published by McGraw-Hill Education,* **2** *Penn Plaza, New York,*
Supplementary Readings	*Alexander, M. 1977. Introduction to soil microbiology. (2nd ed.) Wiley, USA.*

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	Teaching- Learning Strategy[a]	Assessment Strategy
CLO 1	[b]Visual and [c]Auditory	Class attendance, Continuous assessment, assignment, practical Exam, oral exam and presentation, Field level assessment.
CLO 2	Visual and Auditory and Kinesthetic[d]	
CLO 3	Visual and Auditory	
CLO 4	Visual and Auditory	
CLO 5	Visual and Auditory	
CLO 6	Visual and Auditory	
CLO 7	Visual and Auditory and Kinesthetic[d]	

Visiting hours: 10 am to 12 noon and 3 to 5 pm on the working days (if available)

Course Code: SWE 210	**Credits:** 2 (50 Marks)	**Course Type:** GED course

Course Title: Field Work and Community Outreach

Prerequisite(s): Needs to be promoted from 1st year

Rationale of the Course: This course includes Field works related to the theory courses of 2nd year and is designed in a way that the students will carry out field research assigned by the course teacher.

Course Objectives: The objective of this course is to provide students a comprehensive practical knowledge at the field level on different parameters of soil, water and environment, ecology and ecosystem services and GIS,

Mapping with SDG: This course is relevant to achieve SDG 4, 6, 13, 14, 15 and 17.

Course Learning Outcomes (CLOs) and Mapping with PLOs		
Upon completion of this course the students will be able to:		PLOs covered
CLO 1	Provide a practical training on the Identification of soil forming minerals; Separation of clay fraction from soil; identification of clay minerals.	PLO1, 2, 3, 4 5, 6, 7
CLO 2	Acquire knowledge about different characteristic study of micro-organisms.	PLO1- 7
CLO 3	Gather practical knowledge about the Principles, types and functions of microscope.	PLO 5, 7
CLO 4	provide knowledge about statistical data analysis and experimental design.	PLO1, 2, 3, 4
CLO 5	provide specific knowledge of biomolecules and biochemical pathways that occur in plants, mechanism of metabolic processes and their interaction with environment, basis of molecular biology.	PLO1, 2, 3
CLO 6	introduce students to the concepts of ecosystem services, especially on the monitoring, valuation, characterization of human well-being, conservation of ecosystem resources, possible solutions to meet the criteria and constraints of the problems of ecosystem services, etc.	PLO1, 2, 3, 4
CLO 7	arm the students with a fundamental understanding of water chemistry building on their high-school chemistry. This understanding will aid them when they work in water and wastewater treatment plants, in different research organizations, and academia, for that matter.	PLO 5, 7
CLO 8	emphasize the understanding of GIS theory, technology, and applications: produce effective maps of analytical results which adhere to established cartographic standards; gain proficiency in spatial data analysis and 3D data analysis.	PLO1, 2, 3, 4 5, 6, 7

Course Contents			
Sl. No	**Topic**	**Class Hours**	**CLOs covered**
1	**Related to SWE 207:** Water sample collection from Haor area under the course SWE-207 (Water Chemistry).	5	CLO 1
2	**Related to SWE 202, SWE 203, SWE 206:** Plant sample collection: Tea, rubber growing soils and tea leaves samples collection for physical, bioachemical and microbiological studies under the	10	CLO 2

	course SWE- 202 (Soil Physics), SWE-203 (General Microbiology) and SWE-206 (Plant Biochemistry)		
3	**Related to SWE 208:** Biodiversity and Eco-system services monitoring in the north-eastern art of Bangladesh under the course SWE-208 (Introduction to Ecosystem Services)	5	CLO 2 & CLO 3
4	**Related to GML 202:** Map preparation using GPS and GIS technology: concept o precision farming under the course GML-202 (Fundamentals of GIS): GPS in Field: GPS working procedures and data capturing methodology; Use of GPS in the identification of spatial datasets and their attributes and formulation of vector data model with necessary cartographic features.	5	CLO 4
5	**Related to GML 202:** Introductory Lesson: Instrumental set up of a GIS laboratory; Uses of different kinds of base maps, thematic maps, aerial photos, topographic maps and other base materials; Developing spatial database: data input systems; spatial data capturing methodology, Identification and characterization of coverage/layer features/ data capturing terminology (arc, node, vertex, pseudo node, dangling node, label point, polygon, user ID, RMS error, Tic, Annotations etc.); editing of digitized cover/layer, projection and geo-referencing, presentation and display of vector data and raster data modules, topology constructions, annotations and symbolizations; final digital output; GIS Map and Database: Joining database with map; attribute and spatial query, summarization, overlaying techniques etc. Spatial analysis: Interpolation, IDW, Kriging, spline; 3D Analysis: Creating and managing 3D GIS data. 3D Data Visualization, DEM, 3D Terrain and Surface Analysis, GPS in Field: GPS working procedures and data capturing methodology; Use of GPS in the identification of spatial datasets and their attributes and formulation of vector data model with necessary cartographic features.	12	CLO 4, 5, 6

Learning Materials	
Recommended Readings	*Sehgal, J. 2014. A Textbook of Pedology: Concepts and Applications. (2nd ed.) Kalyani.* *Bahl et al. 2009. Essentials of Physical Chemistry. S. Chand & Company Ltd.* *Michael J* . Pelczar, *Jr. E. C. S. Chan Noel K. Krieg 1988. Microbiology. (5th ed.) McGraw-Hill Book Co., Singapore.* *Talaro and Chess. 2014. Foundations In* Microbiology. *Published by McGraw-Hill Education,* **2** *Penn Plaza, New York,*
Supplementary Readings	*Alexander, M. 1977. Introduction to soil microbiology. (2nd ed.) Wiley, USA.*

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	Teaching- Learning Strategy[a]	Assessment Strategy
CLO 1	[b]Visual and [c]Auditory	Class attendance, Continuous assessment, assignment, practical Exam, oral exam and presentation, Field level assessment.
CLO 2	Visual and Auditory and Kinesthetic[d]	
CLO 3 to 6	Visual and Auditory	
CLO 7	Visual and Auditory and Kinesthetic[d]	

Visiting hours: 10 am to 12 noon and 3 to 5 pm on the working days (if available)

Course Code: FC 2	**Credits:** 2 (50 Marks)	**Course Type:** GED course

Course Title: Functional and Communicative English

Prerequisite(s): Needs to be promoted from 1st year

Rationale of the Course: This course is designed to acquire knowledge on the appropriate methods of reading, writing, speaking and listening etc. which are pre condition of the higher education in the areas of Soil, Water and Environment.

Course Objectives: The objective of this course is to increase oral and writing skills of the students. After successful completion of this course the participants will be able to: answer test questions of their major subjects with less grammatical mistakes. Since the medium of instruction in the Department of Soil, Water and Environment is English, this course will help the students to follow the class lectures better.

Mapping with SDG: This course is relevant to achieve SDG goal No 4 (Quality Education).

Course Learning Outcomes (CLOs) and Mapping with PLOs

Upon completion of this course the students will be able to:		**PLOs covered**
CLO 1	acquire knowledge on the reading, writing, listening and speaking in an appropriate manner	PLO 6 & 8
CLO 2	gain knowledge based on the grammatical norms	PLO 8 & 10

Course Contents

Sl. No	**Topic**	**Class Hours**	**CLOs covered**
1	**Reading:** Reading passages would include extracts from different genres – academic articles, business correspondence, biographies, newspaper reports, editorials, short stories, interviews, travel writings, etc. Students will identify the discourse patterns and different features of the given genre. Students will learn to read for different purposes. As well as learning to skim and scan for obtaining information they will learn to read critically to identify the writer's stance, point of view, attitude, etc. Through reading, they will develop awareness of the context in interpreting the text and then exploit this knowledge in their own writing.	10	CLO 1
2	**Writing:** Paragraphs: Narrative, descriptive, compare and contrast, classification, cause and effect, definition, etc. Essays: Arguments, Expository, Narrative, Biographies, etc. Business Correspondence: Job application, CV, Joining letter, Resignation letter, Leave of Absence, Memos, Reports, etc.	8	CLO 2
3	**Grammar:** Active and passive voice, direct and indirect speech, modal auxiliaries, conditional sentences, prepositions, conjunctions, Wh questions, Yes-No questions, tense, error correction, joining sentences and transformation of sentences.	6	

4	**Listening and Speaking:** Oral presentations in groups: Students will select topics for presentation in consultation with the course teacher. Pronunciation: Students will be made familiar with the IPA so that they can use the dictionary as a guide for pronunciation. Listening would involve understanding class lectures delivered in English. Students would be encouraged to listen to the BBC world service, read English newspapers, and watch English news channels.	6	

Learning Materials	
Recommended Readings	*New Headway Pre-Intermediate Students Book - John and Liz Soars* *English Grammar In Use – Raymond Murphy*

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	Teaching- Learning Strategy[a]	Assessment Strategy
CLO 1	[b]Visual and [c]Auditory	Class attendance, In-course Exam, Assignment, Final theory and practical Exam.
CLO 2	Visual and Auditory	

Visiting hours: 10 am to 12 noon and 3 to 5 pm on the working days (if available)

Course Code: CM 241H	**Credits:** 2 (50 Marks)	**Course Type:** GED course

Course Title: Chemistry of the Elements

Prerequisite(s): Needs to be promoted from 1st year

Rationale of the Course: This course aims to give a comprehensive introduction to concepts used by (inorganic) chemistry to describe the structure, properties and reactivity of compounds of the main group elements.

Course Objectives: The course aims to introduce inorganic chemistry. It covers the chemical elements and their properties with respect to position in the Periodic Table. Particular attention is paid to periodic trends and relationships among the elements and their respective compounds. The course furthermore covers bonding theory and the structure of molecules, metals, salts and minerals. The course also describes the environmental, biological and industrial role of inorganic compounds.

Mapping with SDG: The key sustainable development goals that are best aligned with the program is: SDG 4.

Course Learning Outcomes (CLOs) and Mapping with PLOs

Upon completion of this course, the students will be able to:		**PLOs covered**
CLO 1	acquire an introductory knowledge about the chemistry of the representative elements.	PLO 1
CLO 2	understand the metallurgy of some selected elements.	PLO 2
CLO 3	understand the the First Transition series and the Lanthanides.	PLO 3
CLO 4	understand the coordination chemistry.	PLO 1
CLO 5	explain states of inert gases.	PLO 2
CLO 6	understand the elements of radiochemistry.	PLO 3

Course Contents

Sl. No	**Topic**	**Class Hours**	**CLOs covered**
1	**Chemistry of the representative elements:** Chemistry of alkali and alkaline earth metals; chemistry of representative elements of Gr 3A-7A with particular reference to B and Al, C and Si, N and P, O and S and the chemistry of the halogens.	4	CLO 1
2	**Metallurgy of some selected elements:** Occurrence and extraction of Mg, Al, Cr, Fe, Ni, Cu, Au, Zn, Sn and Pb.	3	CLO 2
3	**The First Transition series and the Lanthanides:** The metals and their oxidation states; aqueous chemistry; chemistry of oxides and halides; the lanthanides and actinides – their general features, oxidation states occurrence and isolation; oxides and hydroxides; aquo ions and oxo salts.	4	CLO 3
4	**Coordination chemistry:** synthesis of coordination compounds; nomenclature and structures of complex compounds; Werner's primary and secondary valency concepts; Sidwick's electronic concept; valency bond theory; stability of coordination compounds; isomerism in coordination compounds; coordination compounds in biological systems.	5	CLO 4
5	**Inert gases:** occurrence, isolation and application; chemistry of xenon, other noble gases.	4	CLO 5

6	**Elements of radiochemistry:** discovery of radioactivity; concept of half life and mean life of radioelements; radioactive decay; isotopes and their uses; artificial radioactivity and nuclear reactions; nuclear reactors – principles and uses.	4	CLO 6

Learning Materials	
Recommended Readings	*1. Greenwood, N. N., & Earnshaw, A. (2012). Chemistry of the Elements. Elsevier.* *2. Goldsby, K., & Chang, R. (2015). Chemistry. McGraw-Hill Higher Education.*

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	Teaching- Learning Strategy[a]	Assessment Strategy
CLOs 1- 4; 6 – 9	[b]Visual and [c]Auditory	Class attendance, In-course Exam, Assignment, Final theory.
CLO 5	Visual, Auditory and Kinesthetic[d]	

Visiting hours: 10 am to 12 noon and 3 to 5 pm on the working days (if available)

Course Code: CMGL 101H	**Credits:** 2 (50 Marks)	**Course Type:** GED course

Course Title: General Chemistry Laboratory

Prerequisite(s): Needs to be promoted from 1st year

Rationale of the Course: This course aims to give laboratory idea and knowledge on organic and inorganic chemistry.

Course Objectives: The course aims to introduce to the undergrad students of the Department of Soil, Water and Environment on the analytical knowledge of organic and inorganic chemistry.

Mapping with SDG: This course is best aligned with SDG 4 (Quality Education)

Course Learning Outcomes (CLOs) and Mapping with PLOs

Upon completion of this course, the students will be able to:		**PLOs covered**
CLO 1	acquire a practical knowledge on the inorganic and organic compounds	PLO 1
CLO 2	investigation, identification and standardization of organic and inorganic compounds	PLO 6

Course Contents

Sl. No	**Topic**	**Class Hours**	**CLOs covered**
1	Preliminary investigation action of heat on-selected inorganic compounds such as NH_4Cl, $NaNO_2$, $NaNO_3$, $Pb(NO_3)_2$, Zn-salts, metal carbonates, halides, sulphides, sulphites; action of dilute and concentrated sulphuric acid on inorganic compounds and action of acids in presence of Cu turnings and MnO_2; action of sodium hydroxide; flame colouration and borax bead reactions.	4	CLO 1 & CLO 2
2	The identification of acid radicals (anions) in solution.	2	CLO 2
3	The identification of metal ions (cations) in solution; the analytical classification of the metal ions; analysis of the silver group (Group I), copper group (Group IIA); test for interfering radicals such as phosphates, borates and their removal; analysis of the iron group (Group IIIA), zinc group (Group IIIB), calcium group (Group IV), and the alkali group.	4	CLO 2 & CLO 3
4	Standardization of a given HC1 solution with standard Na_2CO_3 solution and determination of sodium carbonate and sodium hydrogen carbonate in a sample of washing soda; Standardization of given thiosulphate solution with $K_2Cr_2O_7$ solution and determination of copper content of a supplied solution.	4	CLO3 & CLO 4
5	Preparation of Mohr's salt and determination of its content by titration against standard $K_2Cr_2O_7$.	2	CLO 2
6	Determination of the enthalpy of neutralization of an acid calorimetrically; Determination of the partition coefficient of I_2 between water and CH_2Cl_2; Determination of the presence of nitrogen, halogen and sulphur in organic compounds.	4	CLO3
7	Investigation of the effect of reactant concentration on the rate of a chemical reaction; Investigation of the effect of temperature on the rate of a chemical reaction; Investigation of the variation of conductance of a weak electrolyte with concentration.	4	CLO3 & CLO 4

8	Construction of a chemical cell and measurement of its e.m.f. and determination of the redox potential of an electrode.	2	CLO 4 & CLO 5
9	Determination of the molar mass of a volatile liquid by the Duma's method.	2	CLO 5
10	Purification of a given organic compound by recrystallization/distillation and termination of its m.p/b.p and refractive index; Preparation of organic compound using substitution elimination and oxidation reactions.	2	CLO5 & CLO 6
11	Identification of the functional groups in organic compound (unsaturation; alcohol; phenol; carbonyl; aldehydde, ketone; carboylic acid; aromatic amine and nitro-groups).	2	CLO 6

Learning Materials	
Recommended Readings	*Vogel's Textbook of Quantitative Inorganic Analysis,* *Vogel's Textbook of Practical Organic Chemistry*

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	Teaching- Learning Strategy[a]	Assessment Strategy
CLOs 1- 4; 6 – 9	[b]Visual and [c]Auditory	Class attendance, In-course Exam, Assignment, Final theory.
CLO 5	Visual, Auditory and Kinesthetic[d]	

Visiting hours: 10 am to 12 noon and 3 to 5 pm on the working days (if available)

Course Code: GMT 201	**Credits:** 2 (50 Marks)	**Course Type:** GED course

Course Title: Introduction to Geography and Environment

Prerequisite(s): Needs to be promoted from 1st year

Rationale of the Course: This course aims to give a comprehensive idea on the physical geography of the Undergrad students of the Department of Soil, Water and Environment. This knowledge on physical geography will enhance their in depth knowledge on the area of Environmental Sciences.

Course Objectives: The course aims to train the Undergrad students on the physical geography and the related issues of geomorphic processes.

Mapping with SDG: This course is associated with the SDG 4 (Quality Education)

Course Learning Outcomes (CLOs) and Mapping with PLOs

Upon completion of this course, the students will be able to:		**PLOs covered**
CLO 1	acquire knowledge on physical geography and environmental sciences; earth crust and its nature of composition	PLO 1
CLO 2	gain knowledge on earth movement and geomorphic processes	PLO 2
CLO 3	get an idea on the climatic indices and their impacts on vegetation	PLO 3
CLO 4	know on the human geography and habitats	PLO 1
CLO 5	explore knowledge on the economic aspects of geography	PLO 6

Course Contents

Sl. No	**Topic**	**Class Hours**	**CLOs covered**
1	Introduction to Physical Geography and Environmental Science: Physical Geography: Its relation to Environmental Science	4	CLO 1
2	The Earth's crust and Lithosphere Composition of Earth's crust (Sial, Sima, Rocks and Minerals).	3	CLO 2
3	Earth Movement and Geomorphic processes: Changes in the crust: exogenic and endogenic; aggradational and degradational; Earth quakes and volcanism.	4	CLO 3
4	Factors and Elements of Climatic indices: altitude, latitude, vegetation, ocean, land, etc. Elements: rainfall, temperature, humidity, pressure etc. ; Vegetation Types and Distribution	5	CLO 4
5	Human Geography and Human Environment: scope and subject matter; Population: Factors and Distribution; Settlement types (urban and rural) and characteristics.	4	CLO 5
6	Economic Activities: Classification (Primary activities, Secondary activities, Tertiary activities); Settlement types	4	CLO 6

Learning Materials

Recommended Readings	*Introduction to Physical Geography- Strahler*

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	Teaching- Learning Strategy[a]	Assessment Strategy
CLOs 1- 6	[b]Visual and [c]Auditory	Class attendance, In-course Exam, Assignment, Final theory.
CLO 5	Visual, Auditory and Kinesthetic[d]	

Visiting hours: 10 am to 12 noon and 3 to 5 pm on the working days (if available)

Course Code: GMl 202	**Credits:** 2 (50 Marks)	**Course Type:** GED course

Course Title: Fundamentals of GIS and Remote Sensing

Prerequisite(s): Needs to be promoted from 1st year

Rationale of the Course: Acquisition of primary ideas on the principles and operations of GIS, GPS and RS technology. Able to use the above technologies with a multi-disciplinary approach.

Course Objectives: The objective of the course is to acquire knowledge on GIS, GPS and Remote sensing technologies in relation to precision farming.

Mapping with SDG: The course is relevant to achieve SDG goal No 4 (Quality education)

Course Learning Outcomes (CLOs) and Mapping with PLOs

Upon completion of this course, the students will be able to:		**PLOs covered**
CLO 1	gain knowledge on GIS software, cartographic features and maps	7, 8
CLO 2	acquire proper concepts on data model and overlay operations	8, 9
CLO 3	produce effective maps of analytical results which adhere to established cartographic standards;	8, 10
CLO 4	expertise on utilization of GIS, GPS, RS facilities for precision farming through spatial data analysis.	8, 9, 10

Sl. No	**Course Contents**	**Class Hours**	**CLOs**
1	**Introduction:** Definition and concept of GIS and Geo-informatics; history of GIS, components of a GIS, GIS related special hardware and software, purpose of GIS, GIS as a planning tools, major functions of GIS, how does a GIS work; GIS and LIS, areas of GIS applications; instrumental setup of a GIS laboratory. GIS activities in Bangladesh; GIS applications areas regarding soil, water and environment related issues.	8	1
2	**Cartographic features and Maps:** Ideas on base maps and thematic maps; purpose of a map and map scale; map features and map characteristics; map projections: importance of map projection, kinds of map projection, advantages and limitations of map projection, map projection used in Bangladesh; mapping agencies and sources of map resources in Bangladesh; cartography, digital cartography and manual cartography; contour map, spot height, soil map, land use map etc.	8	2, 3
3	**Data types and data models:** Importance of data in GIS; primary data and secondary data. data acquisition, preprocessing, data processing and metadata, sources of data error, remedies of data error, data quality and management; advantages of data management, concept on spatial data and attribute data; data layers and layer concept and GIS; AEZ in the GIS data layer and overlay operations, presentation of geographic data, topology, raster and vector data structures.	8	3, 4
4	**GPS:** Components of GPS; Working procedures of GPS; sources of errors in GPS; uses or application areas of GPS; relationships between GPS and GIS.	1	4, 5
5	**RS:** definition, principles of remote sensing (RS), components of RS systems, advantages of RS, application areas of RS, Relationship	2	4, 5

	between RS, GIS and GPS. RS activities related to organizations SPARRSO, ICIMOD etc.		
6	**Precision farming:** Definition, basic concepts of precision farming; precision farming in the developed countries; why precision farming is needed specifically for Bangladesh; Role of GPS-GIS-RS technologies in precision farming; Spatial variability of soils; spatial variability models;	3	5, 6, 7

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	Teaching- Learning Strategy[a]	Assessment Strategy
CLO 1	[b]Visual and [c]Auditory	Class attendance, In-course Exam, Assignment, Final theory and practical Exam, Field level assessment.
CLO 2	Visual and Auditory	
CLO 3	Visual, Auditory and Kinesthetic[d]	
CLO 4	Visual and Auditory	

Learning Materials	
Recommended Readings	*Demers, M. N. Fundamentals of GIS, 2000. John Wiley and Sons Inc. Singapore. Star, J. and J. Estes. 1990. An introduction of GIS. Prentice Hall Inc. New Jersey, USA.*

Visiting hours: 10 am to 12 noon and 3 to 5 pm on the working days (if available)

Courses for 3rd Year

Course Code: SWE 301	**Credits:** 4 (100 Marks)	**Course Type:** Core course

Course Title: Pedology

Prerequisite(s): Needs to be promoted from 2nd year

Rationale of the Course: This course deals with the study of the soils in the landscapes as they occur in their natural environment. This course is also designed to develop an understanding and knowledge of morphogenesis, characteristics and classification of the soils of the world.

Course Objectives: The aim of this course is to study the soils of the world as they occur in their natural environment. At the end of this course, students should be able to have a basic understanding of how soils form and the patterns in which they occur on landscapes; to investigate morphogenetic properties of soils in the field; and to have a working knowledge of Soil Taxonomy.

Mapping with SDG: This course is relevant to achieve SDG 4 and 15.

Course Learning Outcomes (CLOs) and Mapping with PLOs

Upon completion of this course the students will be able to:		**PLOs covered**
CLO 1	have a basic understanding of how soils form and the patterns in which they occur on landscapes	PLO 1 & 2
CLO 2	understand the basic principles of weathering and relationships between soil development and weathering processes.	PLO 1
CLO 3	discuss how soil forming factors influence the rate and intensity of soil formation and describe soil as a component of the global ecosystems, describe soil formation concepts as related to biogeochemical (pedogenetic) processes, and describe and apply the basic concepts of soil morphology, genesis and classification.	PLO 1 & 7
CLO 4	investigate morphogenetic properties of soils in the field; and to have a working knowledge of Soil Taxonomy, to study the soils of the world as they occur in their natural environment in relation to genetic processes, properties and management implications.	PLO 2 & 7

Course Contents

Sl. No	**Topic**	**Class Hours**	**CLOs covered**
1	**Concepts of pedology and soil development:** Pedological and edaphological concepts and approaches in the study of soils; concepts of soil in natural and anthropic system; concepts of soil development; chemistry of soil development; genetic soil horizons and soil profiles; pedon as a soil individual; master and diagnostic horizons in soils.	10	CLO 1
2	**Weathering:** types and factors of weathering; geochemical and pedochemical weathering processes; stability indices and weathering sequences of minerals; weathering and soil formation.	10	CLO 2

3	**Factors and processes of soil formation**: detailed study of the factors of soil formation-climate, parent material, relief, organism, time; biogeochemical processes in soil formation; specific soil forming processes; soil-landscape relationships and catenary sequence.	20	CLO 3
4	**Geographical distribution of major soils on the earth's surface**: zonality concepts of soils; study of the orders of soil taxonomy-their environmental settings, genetic processes, properties and use potentials; classification of soil orders up to suborder level.	20	CLO 4

Learning Materials	
Recommended Readings	*Buol et al. 2005. Soil Genesis and Classification. Iowa State Press, USA.* *FAO. 2006. Guidelines for Soil Description (4th ed.). FAO, Rome.* *Jenny, H. 1941. Factors of Soil Formation. McGraw Hill Book Co., New York.* *Jenny, H. 1980. The Soil Resource: Origin and Behavior. Springer-Verlag, New York Inc.*
Supplementary Readings	*Sehga, J. 2005. Pedology-Concepts and Applications. Kalayani Publishers, New Delhi, India.*

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	Teaching- Learning Strategy[a]	Assessment Strategy
CLO 1	[b]Visual, [c]Auditory and Kinesthetic[d]	Class attendance, In-course Exam, Assignment, Final theory and practical Exam, Field level assessment.
CLO 2	Visual and Auditory	
CLO 3	Visual, Auditory and Kinesthetic	
CLO 4	Visual, Auditory and Kinesthetic	

Visiting hours: 10 am to 12 noon and 3 to 5 pm on the working days (if available)

Course Code: SWE 302	**Credits:** 4 (100 Marks)	**Course Type:** Core course

Course Title: Soil Chemistry

Prerequisite(s): Needs to be promoted from 2nd Year

Rationale of the Course: The course is designed for undergraduate students of the Department of Soil, Water, and Environment with a focus on the species and reaction processes of chemicals in soils, with applications to agricultural and environmental issues.

Course Objectives: The objective of this course is to provide the students with information regarding the reaction processes of chemicals, which are continuously going on in soil in relation to plant growth and the fate of contaminants. This understanding will aid them when they work for different research organizations and academia. The laboratory part will complement the theoretical part and is likely to provide students with hands-on experience.

Mapping with SDG: This course is relevant to achieve SDG 2, 4, 6, 11 and 15.

Course Learning Outcomes (CLOs) and Mapping with PLOs

	Upon completion of this course, the students will be able to:	**PLOs covered**
CLO 1	learn about the importance and extent of soil chemistry. As it is the backbone of soil science, this course will help students to learn about different branches of soil science.	PLO 1, PLO 2 & PLO 3
CLO 2	know about the dynamism of soil solution; learn about the chemical nature of soil solution; conceptualize the role of the liquid phase of the soil, mechanisms of the movement of salts in the soil, and also its roles on all aspects of the environment.	PLO 1 & PLO 2
CLO 3	will give detail information about the transformation and fate of organic matter in soil which is very important for controlling physical, chemical and biological properties of soils.	PLO 1 & PLO 2
CLO 4	explain the ion exchange phenomenon, a very basic property of soil, and understand the retention and release of nutrients as well as pollutants, buffer capacity of soil, and nutrient buffering.	PLO 2, PLO 3 & PLO 9
CLO 5	illustrate their ideas about the causes of acidification and alkalization of soils, different aspects of pH (the single electrochemical property that influence almost all the properties of soils), its importance in soil ecosystems.	PLO 9 & PLO 10
CLO 6	will learn about the mechanisms for the reclamation of different problem soils to revert soil productivity. This chapter will help to know the liming materials, amounts to be added to achieve certain pH values etc.	PLO 9 & PLO 10
CLO 7	learn different aspects of the transformation of different nutrients; their retention and release, and the partitioning of chemical elements in soil constituents.	PLO 1, PLO 4 & PLO 8

Course Contents

Sl. No	**Topic**	**Class Hours**	**CLOs covered**
1	**Introduction to soil chemistry**: The soil chemistry discipline, Historical background, The soil environment, Chemical reactions in soils, Soil	4	CLO 1

	biogeochemical cycling, Soil chemical influences on food production, soils, and environmental health.		
2	**Soil water chemistry:** Ionic radius; Nature of water and hydration of ions; Ligands and metal bonds; Thermodynamic approach to aqueous soil chemistry; Calculation of ion activity; Precipitation, and dissolution reactions; Cation hydrolysis; Movement of salts in soil and factors affecting salt movement.	8	CLO 2
3	**Soil reaction:** Types of acidities in soil. Soil acidification- sources of hydrogen ion in soil; Soil alkalization –sources of hydroxyl ion in soil. Importance of pH on soil properties and plant growth.	8	CLO 2
4	**Colloidal fraction and adsorption processes in soils**: General properties and types of soil colloids, Pauling's rules, Determination of mineral formula, Genesis and geographic distribution of soil colloids, Sources of charges on soil colloids, Adsorption of cations and anions, Cation exchange reactions, Cation exchange capacity, Cation exchange selectivity, Cation exchange equations, Methods of measuring cation exchange capacity, Anion exchange.	8	CLO 4
5	**Soil Organic matter:** Composition and source. Humus – Chemical composition; classification and properties; theories of humus formation; Extraction and fractionation. Importance of organic matter on soil properties and in relation to pollution	8	CLO 1
6	**Chemistry of soil amendments**: Buffer components of soil and mechanism of buffering; amelioration of soil acidity and alkalinity. **Liming materials** –their reactions in soil; determination of lime requirement and factors controlling the liming program; Acid forming materials- sulphur and sulphate containing materials, their reactions in soil and factors controlling the acidification programme.	10	CLO 3
7	**Plant nutrients:** Forms and labile pool of plant nutrients in soil; Availability of plant nutrients; Nutrient fixation mechanisms and factors controlling the non-biological fixation of N, P and K in soil; Sulphate retention by soil; Nutrient buffering capacity of soil-mechanism and importance; Quantity-intensity relationship; Fractionation of N, P, K, S, and micronutrients; Transformations of N, P, K, S and micronutrients in soil under varied conditions.	10	CLO 7

Learning Materials	
Recommended Readings	*Strawn, D. G., Bohn, H. L., & O'Connor, G. A. (2019). Soil chemistry. John Wiley & Sons.* *Weil and Brady (2017). The nature and properties of soils (15th Edition). Pearson Education Limited. Essex, England* *Essington, M. E. (2015). Soil and water chemistry: an integrative approach. CRC press.* *Stevensen, F. J. 1986. Cycles of Soil. (1st ed.) John Wiley and Sons*

Mapping CLOs with the Teaching-Learning and Assessment Strategy (*VAK)		
CLOs	**Teaching- Learning Strategy[a]**	**Assessment Strategy**
CLO 1 to 7	[b]Visual, [c]Auditory, and Kinesthetic[d]	Class attendance, In-course Exam, Assignment, Final theory and practical Exam, Field level assessment.

Visiting hours: 10 am to 12 noon and 3 to 5 pm on the working days (if available)

Course Code: SWE 303	**Credits:** 2 (50 Marks)	**Course Type:** Core course

Course Title: Soil Biochemistry

Prerequisite(s): Needs to be promoted from 2nd Year

Rationale of the Course: This course is designed for Under Graduate students of the department for introducing soil biochemistry by looking at the catalysis in soil, fundamentals of soil biochemical reactions, enzyme activities in soil, soil-enzyme interactions, chemistry of soil organic compounds and their biodegradation, nitrogen transformation mechanisms, and biodegradation of xenobiotic compounds in the environment.

Course Objectives: The objective of this course is to provide students a basic understanding of different biochemical interactions in soil, preliminary concepts on soil-enzyme interactions, biotic and abiotic transformation reactions, chemistry and biodegradation of natural and xenobiotic organic compounds within the soil environment, transformations of soil nitrogen compounds and their environmental implications.

Mapping with SDG: This course is relevant to achieve SDG 4 and 15.

Course Learning Outcomes (CLOs) and Mapping with PLOs

Upon completion of this course the students will be able to:		**PLOs covered**
CLO 1	Acquire knowledge and understanding of different aspects of soil biochemistry, particularly of biotic and abiotic reactions in the soil.	PLO 1 & 3
CLO 2	Understand the activities of enzymes as catalysts in soil, the role of enzymes in soil biochemical transformations, types and properties of soil enzymes, interactions of enzymes with different soil components, factors affecting enzyme activities in soil, classification of soil enzymes, and problems related to study of soil enzyme activity.	PLO 3 & 6
CLO 3	Gain an understanding of the chemistry, existence, properties and biodegradation of major organic polymers from plant, microbial and animal residues in soil, different transformation reactions in soil, the mechanism of release of nutrients in soil through decomposition of organic matter, and the biochemical processes responsible for the metabolism of carbohydrates present in soil.	PLO 3
CLO 4	Explain the processes involved in the biodegradation of different compounds in the soil and factors affecting their decomposition.	PLO 3
CLO 5	Learn the processes involved in the microbial breakdown of different organic compounds in soil, microbial transformations of nitrogen containing compounds in soil and their environmental implications.	PLO 5 & 6

Course Contents

Sl. No	**Topic**	**Class Hours**	**CLOs covered**
1	**Soil as a medium for biochemical reactions**: Biotic and abiotic reactions – hydrolysis, oxidation-reduction, formation of free radicals, condensation and polymerization, photo-transformation.	2	CLO 1
2	**Soil as a catalytic system**: General principles of catalysis, catalysis in soil – enzymes as catalysts in soil, types of enzymes - extracellular, intracellular, constitutive and inducible enzymes. properties of soil enzymes, factors influencing enzyme activities in soil – pH effects, resistance to proteolysis and thermal denaturation, activation energy and temperature coefficient, effects of salinity, trace elements, pesticides, addition of fertilizers, organic amendments. classification of soil enzymes (by location and function), functional classification of	9	CLO 2

	enzymatic activities in soil, methods of identifying soil enzymes, humus-enzyme complexes, clay-enzyme complexes, problems related to study of enzyme activity.		
3	**Transformation and decomposition of organic polymers:** Major organic polymers from plant, microbial and animal residues in soil, transformation reactions involving both natural and xenobiotic organic compounds in soil, decomposition of organic matter and release of nutrients, soil respiration, carbohydrate metabolism – aerobic and anaerobic.	5	CLO 3
4	**Biodegradation of organic polymers:** Chemistry, existence, and properties of cellulose, hemicelluloses, lignin, starch, pectin, chitin, gums, polyphenols and amino sugars and their bio-degradation in soil, factors affecting their decomposition in soil, impact of C/N ratio on decomposition.	9	CLO 4
5	**Microbial transformation of nutrients:** Microbial breakdown of protein, amino acids, nucleic acids in soil and release of ammonium and nitrate, fate of ammonium and nitrate in soil, ammonia volatilization, denitrification and nitrate pollution and their impact on soil, water and environment as well as on the economy of N-fertilization, biological oxidation, priming action, catabolic repression, fermentation and putrefaction, soil reducing power, mineralization, humification and dehumification, biodegradation of pesticides.	5	CLO 5

Learning Materials	
Recommended Readings	*Stevensen, F. J. 1986. Cycles of Soil. John Wiley and Sons.* *Alexander, M. 1977. Introduction to soil microbiology. Wiley, USA.*
Supplementary Readings	*Brady, N.C. and R.R. Weil. 2002. The Nature and Properties of Soil. (13th ed.) Pearson Education, Singapore.* *Killham, K. 1994. Soil Ecology. Cambridge University Press, UK.* *Rao, N. S. S. Soil Microorganisms and Plant Growth. Science Publishers, New Hampshire, USA.*

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	Teaching- Learning Strategy[a]	Assessment Strategy
CLO 1	[b]Visual and [c]Auditory	Class attendance, In-course Exam, Assignment, Final theory and practical Exam, Field level assessment.
CLO 2	Visual and Auditory	
CLO 3	Visual and Auditory	
CLO 4	Visual and Auditory	
CLO 5	Visual and Auditory	

Visiting hours: 10 am to 12 noon and 3 to 5 pm on the working days (if available)

Course Code: SWE 304	**Credits:** 2 (50 Marks)	**Course Type:** Core course

Course Title: Soil Microbiology

Prerequisite(s): Needs to be promoted from 2nd year

Rationale of the Course: This course is aimed to guide the students to gain knowledge on microbes living in the environment, specifically in the soil. It also discuss about extremophiles and various mechanisms undertaken by microbes to withstand extreme environment. It deals with different processes where microorganisms play vital and active role along with basic understanding of microbial genetics.

Course Objectives: The objective is to focus on microbial habitat, their succession and symbiotic relationship with nature. It also deals with utilization of microbes in crop production combined with Eco-friendly environment having opportunities of a wide range of industry and business development.

MMapping with SDG: This course is relevant to achieve SDG 4 and 15

Course Learning Outcomes (CLOs) and Mapping with PLOs

Upon completion of this course the students will be able to:		**PLOs covered**
CLO 1	Understand importance and application of Microbiology in different fields, especially in Soil. (Historical perspective)	**PLO1, PLO6**
CLO 2	Describe microbial communities in soil, especially in rhizosphere and their effect under different environmental condition.	**PLO2, PLO8**
CLO 3	Explain role of microorganisms in soil fertility and plant growth.	**PLO7, PLO8**
CLO 4	Gain detail knowledge on biological nitrogen fixation and bio fertilizers with its impact.	**PLO4, PLO5, PLO7**
CLO 5	Acquire knowledge on Mycorrhiza and their role in crop production.	**PLO5, PLO7, PLO8**
CLO 6	Describe Azolla-Anabena symbiosis and its role in Agriculture.	**PLO5, PLO7**
CLO 7	Understating mutation, basic microbial genetics and genetic transfer mechanism in microbes	**PLO 6, PLO7**

Course Contents

Sl. No	**Topic**	**Class Hours**	**CLOs covered**
1	Application of microbiology in various fields including soil.	3	CLO 1
2	Microorganisms in their natural environment; environmental stress various extreme environments; microbial communities and their adoptions.	6	CLO 2
3	Soil as a medium for microbial growth. Rhizosphere its effects on microorganisms and plant growth. Role of microorganisms in soil fertility and plant growth.	3	CLO 3

4	Biological nitrogen fixation (BNF): microbiology and bio chemistry of nitrogen fixation. Nitrogen fixation under different environmental conditions. Preparation and use of inoculums; adaptation and success of bio-fertilizers; impact of bio-fertilizer on agriculture. Measurement of BNF.	4	CLO 4
5	Mycorrhiza: definition and classification of mycorrhiza; role of ecto and endo micorrhiza in crop production.	2	CLO 5
6	Azolla Anabena symbiosis its physiology and multi-purpose use in tropical agriculture**.**	3	CLO 6
7	Microbial genetics. Mutation and mutation rate; types of mutations, Detection of mutations; mutagenic agents, Screening chemicals for mutagenicity Molecular basis of mutagenesis, Mutation induced by chemical and physical agents, Effects of mutation on multicellular organisms and microorganisms	9	CLO 7

Learning Materials	
Recommended Readings	*Michael J . Pelczar, Jr. E. C. S. Chan Noel K. Krieg 1988. Microbiology. (5th ed.) McGraw-Hill Book Co., Singapore.* *Microbiology: An Introduction- G.J.Tortora, B.R.Funke and C.L.Case; Pearson, Boston* *Brock Biology of Microorganisms- M.T. Madigan, J.M. Martinko, P.V. Dunlap, D.P. Clark,Pearson Prentice Hall* *Bergersen, F. J. Methods for Evaluating Biological Nitrogen Fixation. Jhon Willy & Sons.* *Rahman et al. Biological Nitrogen Fixation associated with Rice Production. Kluver Acad. Pub.* *Rao, N. S. S. Soil Microbiology. Oxford & Ibh Publishing Co. Pvt Ltd.* *Stanier, R. Y. General Microbiology. The Macmillan Press Ltd.* *Stewart, W D P. Nitrogen Fixation in Plants. The Athlone Press.* *Van Elsas et al. Modern Soil Microbiology. Marcel Dekker,Inc.*
Supplementary Readings	*Alexander, M. 1977. Introduction to soil microbiology. (2nd ed.) Wiley, USA.* *Kathleen, P. T. and B. Chess. 2014. Foundations in Microbiology. (9th ed.) McGraw-Hill Book Co. Singapore.* *Jeffrey C. Pommerville. 2011. Alcamo's Fundamentals of Microbiology. (7th ed.) Jones and Bartlett Publishers, USA.*

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)

CLOs	Teaching- Learning Strategy[a]	**Assessment Strategy**
CLO1	[b]Visual and [c]Auditory	Class attendance, Continuous assessment, Incourse Exam, assignment, Final theory and practical Exam, oral exam and presentation, Field level assessment.
CLO2	Visual and Auditory and Kinesthetic[d]	
CLO3 to 6	Visual and Auditory	
CLO7	Visual and Auditory and Kinesthetic[d]	

Visiting hours: 10 am to 12 noon and 3 to 5 pm.

Course Code: SWE 305	**Credits:** 4 (100 Marks)	**Course Type:** Core course

Course Title: Soil Fertility and Plant Nutrition

Prerequisite(s): Needs to be promoted from 2nd year.

Rationale of the Course: Soil Fertility and Plant Nutrition is a basic course regarding Agriculture, Food security and Environment. Efficient and sustainable management of soil, plant, water and their relationships deserve special attention to study this course for the sustainably food supply globally. Accordingly, student will guide to acquire knowledge on recent advances in soil fertility and plant nutrition, physiological roles of plant nutrients, their interactions and growth responses, fertilizers and environment, soil resilience, organic and modern farming, and nutrient status of Bangladesh soils.

Course Objectives: Aim this course is to guide the students to gain knowledge and tackle problems on i) Recent advances in soil fertility and plant nutrition, ii) nutrient uptake and physiological roles of plant nutrients, iii) Fertilizer needs and methods of application, and nutrient interactions, iv), plant growth and growth responses, and mathematical models, v) Soil resilience, fertilizers and environment, organic and modern farming, and nutrient status of Bangladesh soils.

Mapping with SDG: The course is relevant to achieve SDG goal Nos. **1** (No Poverty), **2** (Zero Hunger), **4** (Quality Education) and **13** (Climate Action).

Course Learning Outcomes (CLOs) and Mapping with PLOs

Upon completion of this course the students will be able to:		**PLOs covered**
CLO 1	Students will be able to compare the past and recent advances for the development of soil fertility and plant nutrition and accordingly make their future plan.	PLO 7
CLO 2	Students will be able to know the essential plant nutrients, their categories, plant uptake mechanisms and physiological roles.	PLO 1
CLO 3	Students will be able to recognize the different types of fertilizers, their sources, manufacturing, fertilizers law, grades, ratios, organic and bio-fertilizers.	PLO 4 & 7
CLO 4	Students will be able to evaluate the nutrient status of soils and plants through visual symptoms, soil and plant analyses, biological methods, and laboratory, greenhouse and field experiments.	PLO 2 & 7
CLO 5	Student will be able to understand that in the future, interactions and their recognition will be the key to significant progress toward optimum yields and efficient utilization of inputs in the limited land area.	PLO 7 & 8
CLO 6	Student will be aware of fertilizer types, balanced fertilization, their placement options considering the fate of soil, salt index, soil quality and environmental conditions.	PLO 3
CLO 7	Students will be able to choose the right factors for right crops and be able to use mathematical models for future directions.	PLO 8
CLO 8	Student will be able to know the merits and demerits of fertilizers and the techniques to make the soil resilient under variable environments.	PLO 10
CLO 9	Students will be able to recognize the different AEZs all over Bangladesh, their fertility status, crop sequence and be able to predict for future through the use of crop models.	PLO 8 & 10

Course Contents			
Sl. No	**Topic**	**Class Hours**	**CLOs covered**
1	**Past and recent advances** in the field of soil fertility and plant nutrition; factors affecting plant growth and development.	6	CLO 1
2	**Plant nutrient elements**: essentiality of nutrient elements; categories of nutrients; mechanisms of nutrient uptake in plants; physiological roles of various plant nutrient elements.	10	CLO 2
3	**Fertilizer materials**: sources and manufacture of major fertilizer materials; single, compound and mixed fertilizer; fertilizer grades, and fertilizer ratios; fertilizer law; organic fertilizer and bio-fertilizers.	5	CLO 3
4	**Diagnosis of fertilizer needs**: different approaches to diagnosis; visual symptoms; soil and plant analysis, biological methods and laboratory; greenhouse and field experimentation.	9	CLO 4
5	**Nutrient interactions**: antagonistic- synergistic activity; response of crops to fertilizer application; various equations and curves; calculation of fertilizer needs of soil.	6	CLO 5
6	**Methods of fertilizer application**: reasons and rationale of various methods; fertilizer movement in soil; fate of added nutrient in soil; residual effects of fertilizers; salt index; balanced fertilization; impact of fertilizer application on soil quality and environment.	9	CLO 6
7	**Plant growth and growth responses** to factors affecting plant growth; mathematical models to express fertilizer response.	4	CLO 7
8	**Soil resilience**, impacts of inorganic fertilizers on environment; organic farming and modern farming.	5	CLO 8
9	**Nutrient status of Bangladesh soils**; AEZ and fertilizer requirements; fertilizer application in a single crop and in a crop sequence; crop modeling.	6	CLO 9

Learning Materials	
Recommended Readings	Tisdale, S. L., W. L.Nelson, J.D. Beaton. 2013. Soil Fertility and Fertilizer. (8th ed.) Mengel and Kirkby. 2001. Principles of Plant Nutrition. (5th ed.) Springer.
Supplementary Readings	Hassan et al. 2012. Fertilizers Recommendation Guide. Bangladesh Agric. Res. Council, Dhaka. Russel, E. W. 2015. Soil Condition and Plant Growth. Longmans, Green and Co.

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	Teaching- Learning Strategy[a]	Assessment Strategy
CLOs 1 to 2	[b]Visual and [c]Auditory	Class attendance, In-course Exam, Assignment, Final theory and practical Exam, Field level assessment.
CLOs 3 to 4	Visual, Auditory and Kinesthetic[d]	
CLOs 5 to 9	Visual and Auditory	

Visiting hours: 10 am to 12 noon and 3 to 5 pm on the working days (if available)

Course Code: SWE 306	**Credits:** 4 (100 Marks)	**Course Type:** Core course

Course Title: Water Resources and Water Quality

Prerequisite (s): Needs to be admitted in 3rd year

Rationale of the Course: This course will guide the students to gain knowledge on the origin and sources of water, distribution of surface and ground water, aquatic ecosystem, water quality, use and purification, and water resource management.

Course Objectives: The objective of this course is to provide -

- knowledge of the origin and sources of water, distribution of surface and ground water.
- knowledge about aquatic ecosystems and aquatic biology, water quality parameters.
- an understanding of the sources and processes of surface and ground water pollution.
- knowledge of climate change and water resources in Bangladesh.
- an understanding of the biogeochemical aspects of major rivers of the world with special reference to the rivers of Bangladesh, and on water resource management.

Mapping with SDG: This course is relevant to achieve SDG 4 and 14.

Course Learning Outcomes (CLOs) and Mapping with PLOs

Upon completion of this course, the students will be able to:		**PLOs covered**
CLO 1	know the origin and sources of water; water movement in the ecosystem; types of water bodies/storage systems.	PLO 1 & 2
CLO 2	illustrate their ideas about global geographic distribution, quantification of water resources and measurement/prediction tools. gather knowledge about the structure of ecosystems: their types, factors and functions.	PLO 1 & 3
CLO 3	develop an understanding of the domestic, agricultural and industrial uses of water. illustrate their knowledge about the physical and chemical processes of surface water.	PLO 1 & 7
CLO 4	acquire knowledge about the water quality parameters for drinking, irrigation, inland surface water and effluents.	PLO 2
CLO 5	describe the interaction between soil processes, water quality and water pollutants: types, sources, impacts on the aquatic environment as well as human health.	PLO 1 & 2
CLO 6	develop an understanding of the sources and processes of surface and ground water pollution.	PLO 3 & 4
CLO 7	illustrate their knowledge about the climate change and water resources in Bangladesh.	PLO 6 & 8

Course Contents

Sl. No	**Topic**	**Class Hours**	**CLOs covered**
1	**Sources and Properties of water:** Hydrologic cycle; Physical, Chemical and Biological properties of water;	3	CLO 1
2	**Distribution of surface and ground water:** Introduction to surface and ground water; Types of water bodies/storage systems (river, haors, baors, beels); Global geographic distribution; Quantification of water resources, measurement/prediction tools; water table; vertical distribution	12	CLO 1

	of water; formation and properties of aquifers; techniques for ground water recharge; river structure and patterns; watershed and drainage basins; importance of watershed and watershed management; rain water harvesting.		
3	**Water quality and Uses of water:** Different water quality parameters (physical, chemical, biological), water quality standards and water quality requirements; Physical and chemical processes in surface water; Interaction between water quality and soil processes; Needs vs. Supply, allocation of water among competing demands. **Water pollutants and pollution:** Surface and ground water pollution; causes (Aquatic toxicology, Heavy minerals, Organic contaminants, PCBs and other Halogens materials, PAH, Pesticides, Waterborne Pathogens and Microbes) and effects; Eutrophication.	15	CLO 2
4	**Water availability assessment:** Surface water and ground water demand assessment; Municipal, industrial, agricultural and environmental allocation - Principles and policies-Case studies. Biogeochemical aspects of major rivers of the world with special reference to the rivers of Bangladesh.	10	CLO 3
5	**Aquatic ecosystems and aquatic biology:** ecosystem processes and their linkages to biogeochemical cycles and global environmental change, biodiversity and its regulation and connection to ecosystem function and ecosystem services, the structure, function, dynamics and role of food webs in aquatic ecosystems. **Marine resources:** commercial use of marine resources; threats to marine ecosystems and resources; marine ecosystem and resource management (planning approach, construction techniques and monitoring of coastal zones).	8	CLO 4
6	**Climate change and water resources in Bangladesh:** special emphasis on agriculture, fisheries, forestry, sea level rise, thermal shifts and storm intensity/frequency; Some likely impacts include increased stormwater runoff/pollution, increased floodplain areas, loss of drinking water supplies and migration of wetlands.	6	CLO 5
7	**Water purification processes and water resource management:** Primary, Secondary and Tertiary treatment processes; Water resource management scenario in Bangladesh (National water policy, ground water availability, arsenic contamination, conservation of water).	6	CLO 6

Learning Materials	
Recommended Readings	*Fundamentals of Environmental Studies - S.N. Tripathy and Sunakar Panda* *Environmental Science and Technology - Stanley E. Manahan* *The Environment - Chris Park* *Water Pollution (Causes, Effects and Control) - P.K. Goel*
Supplementary Readings	*Soil and Groundwater Pollution - Alexander J.B. Zehnder* *Environmental Chemistry - B.K. Sharma* *Water quality handbook - McGraw-Hill.* *Water resources handbook - McGraw-Hill.*

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	Teaching- Learning Strategy[a]	Assessment Strategy
CLO 1	[b]Visual and [c]Auditory	Class attendance, In-course Exam, Assignment, Final theory and practical Exam, Field level assessment.
CLO 2	Visual and Auditory	
CLO 3	Visual and Auditory	
CLO 4	Visual and Auditory and Kinesthetic[d]	
CLO 5	Visual and Auditory	
CLO 6	Visual and Auditory	

Visiting hours: 10 am to 12 noon and 3 to 5 pm on the working days (if available)

Course Code: SWE 307	**Credits:** 4 (100 Marks)	**Course Type:** Core course

Course Title: Atmospheric Science

Prerequisite(s): Needs to be promoted from 2nd year

Rationale of the Course: Atmospheric Science course (SWE 307) is designed for undergraduate students to provide students a basic knowledge and understanding of the atmosphere as a part of the environmental control system. This course focuses to develop the students' capacity to analyze atmospheric elements and conditions concerning climate, climate change and air pollution.

Course Objectives: The objective of this course is to give an understanding of the composition and structure of the atmosphere, global energy budget, atmospheric moisture budget, global air circulation, air pollution, climate change and its overall impact on humans and environment.

Mapping with SDG: This course is relevant to achieve SDG 4 and SDG 13.

Course Learning Outcomes (CLOs) and Mapping with PLOs

Upon completion of this course the students will be able to:		**PLOs covered**
CLO 1	describe the basic composition and structure of the atmosphere	PLO 1
CLO 2	know the distribution of solar radiation and global energy budget (i.e., energy of the atmosphere); as well as the variation of heat energy on the earth's surface	PLO 2
CLO 3	explain the atmospheric moisture budget; air stability and instability, and daily weather	PLO2
CLO 4	identify forces affecting wind and to understand winds that have effects on local and regional biophysical environment	PLO 3
CLO 5	understand global air circulation that has influences on weather and climatic pattern of an area; and to understand climate of different regions of the world.	PLO 6
CLO 6	outline the influence of atmospheric processes on atmospheric chemistry and to understand atmospheric chemical and photochemical reactions which have effects air pollutants	PLO 7
CLO 7	understand local, regional and global pollution of the atmosphere; and to illustrate some atmospheric effects of air pollution.	PLO 8
CLO 8	explain air borne particulate matter formation, transportation and sink as well as their effects on air pollution and global albedo.	PLO 2
CLO 9	understand global warming and its impacts on climate change and sea level rise, and students will be able develop an informed and critical attitude towards mitigating climate change.	PLO 10

Course Contents

Sl. No	Topic	Class Hours	CLOs covered
1	**Description of the atmosphere**: Composition of the atmosphere; variation of atmospheric composition with height; vertical profiles of the atmospheric pressure, temperature and air density.	4	CLO 1
2	**Solar radiation and the global energy budget**: Solar energy and principles of electromagnetic radiation; radiation laws; solar constant and energy balance of the earth; global energy balance of the earth- atmosphere system.	5	CLO 2
3	**Variation of heat energy on the earth's surface**: Insolation, factors affecting incoming solar radiation on the earth; factors affecting variation of temperature on the earth's surface.	4	CLO 2

4	**Atmospheric moisture budget**: Atmospheric components of the global hydrological cycles; changes of state of water; evaporation, humidity and condensation; cloud types.	4	CLO 3
5	**Adiabatic processes**: Adiabatic temperature change, air stability and instability, condensation level, cloud formation, formation of precipitation, air stability and daily weather.	2	CLO 3
6	**Atmospheric motion**: Air pressure and winds; forces affecting winds; horizontal and vertical transport of winds.	4	CLO 4
7	**Global air circulation**: Global pressure belts; global wind belts; Jet Stream.	3	CLO 5
8	**Winds:** Wind classification, monsoon circulation; tropical cyclones; EI Niño-Southern Oscillation (ENSO) events.	3	COL 4
9	**Weather and climate**: Parameters of weather and climate, factors controls the climate of a region, climate classification system	2	COL 5
10	**Atmospheric chemistry related to atmospheric processes**: Effects of atmospheric motions on atmospheric chemistry; half-life, residence time and renewal time of chemicals in the atmosphere.	2	COL 6
11	**Chemical and photochemical reactions in the atmosphere**: Atmospheric chemical species and their classes; photochemical reactions, electronically excited species, ions and free radicals in the atmosphere; formation of hydroxyl, hydroperoxyl and nitrate radicals in the atmosphere and their effects on air pollutants; acid-base reactions in the atmosphere.	5	COL 6
12	**Air pollution:** Types and sources of air pollution; criteria of air pollutants; hazardous air pollutants; ambient air quality standards; and indoor air quality.	6	COL 7
13	**Some atmospheric effects of air pollution**: Ground level ozone formation; photochemical and industrial smog formation and their effects on urban and industrial regions; ozone layer depletion; acid deposition- formation of acidic components in the atmosphere and effects on terrestrial and aquatic ecosystem.	6	COL 7
14.	**Atmospheric aerosols**: Air borne particulate matter; aerosols; chemical composition of aerosol particles; transformations of aerosols; residence time, transportation and sink of aerosol particles.	5	COL 8
15.	**Greenhouse gases and global warming**: Greenhouse gases; terrestrial infra-red radiation and the greenhouse effect; global warming and sea level changes; effects of global warming and sea level rise on the natural resources and socio-economic conditions of Bangladesh.	5	COL 9

Learning Materials	
Recommended Readings	*Barry, R. G. and R. J. Chorley. 2003. Atmosphere. Weather and Climate. (8th ed.) Routledge Taylor and Francis Group. London.* *Hobbs, P. V. 2000. Introduction to Atmospheric Chemistry. Cambridge University Press.* *Jacob, D. J. 1999. Introduction to Atmospheric Chemistry. Princeton Univ. Press, Princeton, NJ.* *Lutgens, F. K. and E.J. Tarbuck. 1982. The Atmosphere: An Introduction to Meteorology. (2nd ed.) Prentice-Hall Inc. NJ*
Supplementary Readings	*Miller, G. T. 2000. Living in the Environment – Principles, Connections and Solutions. (11th ed.) Brooks/Cole Publ. Company.*

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	Teaching- Learning Strategy[a]	Assessment Strategy
CLO 1, & 6-9	[b]Visual and [c]Auditory	Class attendance, In-course Exam, Assignment, Final theory and Practical Exam, Field level assessment.
CLO 2	Visual, Auditory and Kinesthetic[d]	

Visiting hours: 10 am to 12 noon and 3 to 5 pm on the working days (if available)

Course Code: SWE 308	**Credits:** 4 (100 Marks)	**Course Type:** Core course

Course Title: Ecology and Environment

Prerequisite(s): Needs to be promoted from 2nd year

Rationale of the Course: This course is designed for Undergraduate students of the department so that they get a theoretical basis for understanding fundamental knowledge on complex natural ecosystems which are very much vulnerable due to anthropogenic warming, climate change and pollution.

Course Objectives: This multidisciplinary course aims to provide knowledge on the interactions between organisms and their environments, balance in ecosystem processes and on environmental conservation. Students will learn to predict what will happen to an organism, a population or a community under a particular set of circumstances. Based on these predictions, the students will be able to control and exploit the organisms.

Mapping with SDG: This course is relevant to achieve SDG 4, 13 and 15

Course Learning Outcomes (CLOs) and Mapping with PLOs		
Upon completion of this course the students will be able to:		**PLOs covered**
CLO 1	to gain knowledge about the chronological advancement of ecology and basic ideas on organisms and their environment.	PLO 1 & 2
CLO 2	recognize structure, components, and energy exchange of an ecosystem.	PLO 1, 2, 7
CLO 3	to know the universal trends of changes in vegetation and organisms during ecosystem development.	PLO 1 & 4
CLO 4	to acquire knowledge on soil/ plant/microbe interactions with their environment.	PLO 1 & 3
CLO 5	to learn the ecology of soil nutrient (CNSP) cycling.	PLO 1 & 7
CLO 6	to know the status of biodiversity of Bangladesh and the mechanism of conservation of biodiversity.	PLO 1, 2 & 6
CLO 7	to achieve knowledge on the genetic modification of plants to improve crop yields and increase efficiency of agriculture.	PLO 4, 6 & 7
CLO 8	to evaluate the forest floor and trees those will be affected due to climate change.	PLO 4, 5 & 7
CLO 9	to understand the results of imbalanced ecosystem induced by human race.	PLO 2 & 7

Course Contents

Sl. No	**Topic**	**Class Hours**	**CLOs covered**
1	**Ecology and its domain:** Organisms- match between organisms and their environments; Conditions, Resources, Unitary and modular organisms; Principles of thermodynamics in relation to ecology.	6	CLO 1
2	**Communities and Ecosystems:** Interactions of biological and environmental factors, structure, different components, energy flow, food chain, food web, energy exchange in ecosystem, ecosystem modeling.	6	CLO 1 & 4
3	**Succession:** Causes, trends, types, and general process of succession, model of succession.	6	CLO 4
4	**Ecological Interactions:** Neutralism, competition, mutualism, commensalism, ammensalism, parasitism, disease, predators, plant/ microbe, animal/ microbe, animal/ animal, plant/ animal and microbe/ microbe.	9	CLO 2
5	**Bio-geochemical Cycles:** Carbon, nitrogen, sulphur, and phosphorus cycles.	9	CLO 1

6	**Biodiversity:** Biomass, microbial biomass, biodiversity, factors responsible for determination of biodiversity, levels of biodiversity, types of biodiversity, global biodiversity crisis, losses and conservation of biodiversity with special reference to Bangladesh.	7	CLO 1 & CLO 5
7	**Genetically modified plants and microbes**: use in the environment, food, agriculture, and technology transfer.	6	CLO 6
8	**Forest Ecosystem:** Total territory of forest land, species diversity, conservation of tree genetic resources, types of species to be affected by global climate change.	6	CLO 1
9	**Anthropogenic Effects on Ecosystem:** Factors affecting human population change, world population growth pattern, urbanization and industrialization, population growth pattern vs. resources of Bangladesh, human impacts on ecosystem.	5	CLO 2

Learning Materials	
Recommended Readings	*Begon et al. 1996. Ecology. (3rd ed.) Blackwell Science Ltd.* *Fisher, R.F. and D. Binkley. 2000. Ecology and Management of Forest Soils. John Wiley & Sons Inc., Canada.* *Molles, M. C. 2002. Ecology: Concepts and Applications. (2nd ed.) McGraw-Hill Higher Education.*
Supplementary Readings	*Killham, K. 1994. Soil Ecology. Cambridge University Press, UK.*

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	Teaching- Learning Strategy[a]	Assessment Strategy
CLO 1	[b]Visual and [c]Auditory	Class attendance, In-course Exam, Assignment, Final theory and practical Exam, Field level assessment.
CLO 2	Visual and Auditory	
CLO 3	Visual and Auditory	
CLO 4	Visual and Auditory	
CLO 5	Visual, Auditory and Kinesthetic[d]	
CLO 6	Visual and Auditory	
CLO 7	[b]Visual and [c]Auditory	
CLO 8	[b]Visual and [c]Auditory	
CLO 9	[b]Visual and [c]Auditory	

Visiting hours: 10 am to 12 noon and 3 to 5 pm on the working days (if available)

Course Code: SWE 309	**Credits:** 6 (150 Marks)	**Course Type:** Core course
Course Title: Practical		
Prerequisite(s): Needs to be promoted from 2nd year		
Rationale of the Course: This course is designed for students to get a laboratory training on Pedology, Soil Chemistry, Soil Bio-chemistry, Soil Microbiology, Soil Fertility and Plant Nutrition, Water Resources and Water Quality, Atmospheric Sciences, Ecology and Environment, and others aspects of this entity.		
Course Objectives: This course aims to provide knowledge on the laboratory in the thematic areas of Pedology, Soil Chemistry, Soil Biochemistry, Soil Microbiology, Soil Fertility and Plant Nutrition, Water Resources and Water Quality, Atmospheric Sciences, Ecology and Environment, etc.		
Mapping with SDG: The course is relevant to achieve SDG **2**, **4,** 6, **13,** 14, and 15.		

Course Contents			
SL No	**Topic/ Courses**	**Hours**	**CLOs covered**
1	Study of collected soil samples: Determination of free iron oxides; calculation of free iron/total iron ratio to study the development of soil in the course pedology.	5	CLO 1
2	Determination of active and reserve acidities of soil. Determination of lime requirements of soil for amelioration and effects of these amendments on soil properties. Fractionation of Humus. Determination of total NPKS and micronutrients in soil. Determination of EC. Determination of CEC and exchangeable bases, percent base saturation and ESP etc. in the course soil chemistry.	12	CLO 2
3	Incubation studies on the evolution CO_2, nitrogen mineralization and potential denitrification in soil using different energetic resources and at varying moisture level etc. in the course soil biochemistry.	5	CLO 2 & CLO 3
4	Identification of bacteria by biochemical tests and similarity matrix; MTU tests, KIA tests and IMVIC tests; determination of ammonification and nitrification potential of soil; study of nitrogen fixation by free living bacteria; preparation of inoculum and it application; measurement of BNF; sterilization of seed and soil etc. in the course soil microbiology	5	CLO 4
5	Preparation of culture solution; sand culture experiment to observe the effects of missing elements on some common crops; acquaintance with different fertilizers and methods of their use; choice of extraction methods to assess the availability of N, P, K, S, Ca, Mg, Fe and Zn analysis of plants for different nutrients in the course soil fertility and plant nutrition.	6	CLO 5
6	Determination of water quality for drinking and irrigation purposes in the course water resources and water quality.	12	CLO 6
7	Measurement of physical parameters of atmosphere; collection of air sample and determination of nature and concentration of pollutants in the course atmospheric sciences.	12	CLO 7
8	Estimation of microbial biomass, carbon, nitrogen and phosphorus; measurement of gas fluxes. Determination of Soil Organic carbon by Walkley and Black's wet oxidation method in the course ecology and environment.	12	CLO 8

Course Code: SWE 310	**Credits:** 2 (50 Marks)	**Course Type:** GED course

Course Title: Field Work and Community Outreach

Prerequisite(s): Needs to be promoted from 2nd year

Rationale of the Course: This course is designed for Undergraduate students of the department so that they get a hand on experience in the field for understanding the knowledge on pedogenesis, soil and water chemistry, terrestrial ecosystems, climate resilient technologies etc.

Course Objectives: This multidisciplinary course aims to provide knowledge on the soil-water-ecosystem resources and their sustainable technologies to achieve the goals of SDGs.

Mapping with SDG: The course is relevant to achieve SDG goal Nos. **2** (Zero Hunger), **4** (Quality Education), 6 (Clean water and sanitation), **13** (Climate Action), 14 (Life below water), and 15 (life on land).

SL No	Topic/Courses covered	Days Required	CLOs covered
1	study of the soils in the landscapes as they occur in their natural environment; develop an understanding and knowledge of morphogenesis, characteristics and classification of the soils of Bangladesh under the course pedology.	02 days	**CLO 1**
2	Collection of in-situ humus rich soils from the coastal belt of Khulna regions for the study of the fractionation of soil humus under the soil chemistry.	01 day	**CLOs**
3	Collection of in-situ saline soils from the coastal belt for the study of the effects of salinity on enzymatic activities as part of the course soil biochemistry. In addition, the samples will be used to evaluate the stress of increasing salinity on the microbial population under the course soil microbiology, and on indigenous plants under the course soil fertility and plant nutrition.	02 days	**CLOs**
4	Assessment and monitoring of water quality in the saline regions and subsequent comparison with the fresh water wetlands of the south-western part of Bangladesh under the course water resources and water quality.	04 days	**CLOs**
5	Observation and study of the Sundarban mangrove ecosystem for the purpose of better understanding the ecological succession, biodiversity levels, and forest genetic resources under the course ecology and environment.		**CLOs**

Courses for 4th Year

Course Code: SWE 401	**Credits:** 2 (50 Marks)	**Course Type:** Core course
Course Title: Soil Survey and Remote Sensing		
Prerequisite(s): Needs to be promoted from 3rd year		
Rationale of the Course: This course is intended to expose the students with the basic concepts and techniques in conducting modern soil survey and land evaluation. Course also introduces principles and fundamentals of remote sensing in soil survey and land use planning.		
Course Objectives: The objectives of this course are- to introduce the techniques and steps in planning and conducting modern soil survey of various orders and scales, and to acquaint with the associated applied aspects like field morphological study, stereoscopic photo/image analysis map construction, land evaluation and data interpretation, etc.		
Mapping with SDG: This course is relevant to achieve SDG 4.		

Course Learning Outcomes (CLOs) and Mapping with PLOs

Upon completion of this course the students will be able to:		**PLOs covered**
CLO 1	Demonstrate modern soil survey and understand mapping techniques and associated aspects.	PLO 1, 7 & 8
CLO 2	Identify, analyze and rectify aerial photos and other base maps needed in soil survey work.	PLO 8 & 9
CLO 3	Apply the principles and acquisition of RS data in the field of soil survey, agriculture and environment with proper interpretation	PLO 8 & 10
CLO 4	Evaluate land for sustainable resource management and planning	PLO 8, 9 & 10

Course Contents

Sl. No	**Topic**	**Class Hours**	**CLOs covered**
1	**Soil Survey:** Definition and Aspects, Principal types, Importance and Agricultural uses of Survey data, Modern Orders of Soil Survey –their Specifications, techniques and uses with advantages and limitations. Soil Survey Work Plan, Traverse Plan. Examination and Description of soil in the field. Tools and Techniques of Soil Sampling for Different Purposes.	6	CLO 1
2	**Soil Mapping:** Map Projection, Scale, and Legend, Digital Map Construction using GIS, Plotting of Soil Boundaries, Different Types of Soil Map, Soil Taxonomic and Mapping Units –consociation, association, complex etc. USDA Soil Classification and Soil Correlation Studies.	5	CLO 1
3	**Base Materials:** Principal type of Base Maps –Vertical and Oblique Aerial Photograph, Aerial Mosaic, Topographic Map, Mouza Map, Satellite Images etc. with their Merits and Demerits. Background of Aerial Platform, Photo Scale and Distortion, Flight Planning, Aerial Camera and Filter.	5	CLO 2

4	**Photogrammetry:** Definition and Basic Principles; Height, Relief Displacement and Area Measurement and Correction. Definition and Principles of Aerial Photo-Interpretation (API). Theory of Stereovision, Parallactic Angle and 3D View. Use of Stereoscope in analysis and Interpretation of Aerial Photos.	5	CLO 2
5	**Remote Sensing (RS):** Background and Basic Principles, Electromagnetic Energy, Satellite System and Orbital Characteristics, Sensors and Resolution Types; Passive and Active RS System, Basic Components –Data Acquisition, Processing, Interpretation and Analysis. Spectral Reflectance Equation. Spectral Signatures of Soil, Vegetation and Water. RS and GIS. Use of RS Data in Soil Survey and Land Use Planning.	6	CLO 3
6	**Land Evaluation:** Definition, Purpose and Principles. Land Use and Land Cover. Land Evaluation Procedure, Land Capability and Crop Suitability Classification in Bangladesh, Storie Index. Sustainable Land Use Planning. Soil Survey Interpretations and report preparation. Soil Survey Database in Bangladesh –District Reconnaissance Report and Upazila Nirdeshika.	6	CLO 4

Learning Materials	
Recommended Readings	*Soil Survey Division Staff. 1993. Soil Survey Manual. Soil Conservation Service. USDA* *Lillesand et al. 2008. Remote Sensing and Image Interpretation. John Wiley and Sons* *Jensen, J. R. 2006. Remote sensing of the Environment. Pearson Education Inc.* *Sehgal, J. L. Introductory Pedology: Soil Genesis, Survey and Classification. Kalyani Publishers, New Delhi, India.*
Supplementary Readings	*Buol et al. 2003. Soil Genesis and Classification. Iowa State University Press, Iowa, USA.* *Brady, N.C. and Weil, R.R. 2013. The nature and properties of soils. Pearson Education Inc.*

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	**Teaching- Learning Strategy[a]**	**Assessment Strategy**
CLO 1	[b]Visual and [c]Auditory	Class attendance, In-course Exam, Assignment, Final theory and practical Exam, Field level assessment.
CLO 2	Visual, Auditory and Kinesthetic[d]	
CLO 3	Visual and Auditory	
CLO 4	Visual and Auditory	

Visiting hours: 10 am to 12 noon and 3 to 5 pm on the working days (if available)

Course Code: SWE 402	**Credit:** 2.0	**Course Type:** Core Course

Course Title: Soil Conservation and Sustainable Land use

Prerequisite(s): Needs to be promoted from 3rd year.

Rationale of the Course: This course is designed for undergraduate students to provide ideas on the processes of soil and water degradation, development of control practices and soil quality enhancement, mechanisms of erosion processes and its control, sustainable agriculture and the ways in which technology and social influences have and will shape soil erosion and conservation processes.

Course Objectives: The objective of this course is to train students so that they will be able to explain types, processes, extent and effects of soil degradation and soil erosion, and its controlling measures for soil conservation for sustainable agriculture.

Mapping with SDG: The course is relevant to achieve SDG goal No 4.

Course Learning Outcomes (CLOs) and Mapping with PLOs

Upon completion of this course the students will be able to:		**PLOs covered**
CLO 1	Explain how does a soil can be considered as a basic and irreplaceable resource, population effects on this resource and improvement of its quality with respect to conservation needs.	PLO 1 & 2
CLO 2	Understand types, processes, factors and its assessment with some ideas on degradation in this subcontinent.	PLO 3 & 4
CLO 3	Acquire knowledge on qualitative and quantitative measurement of soil erosion as well as its effect on crop productivity.	PLO 5 & 6
CLO 4	Gain an understanding to conserve the soil especially mechanical field practices from erosion, suitability to crop production on the basis of land capability classification.	PLO 2
CLO 5	Know background of some of the issues involved in implementing soil conservation proposals.	PLO 7 & 8

Course Contents

Sl. No	**Topic**	**Class Hours**	**CLOs covered**
1	Soil as a basic and irreplaceable resource. Population versus resource base of the world; Soil quality concept; Physical, chemical and biological indicators of soil quality.	5	CLO 1
2	Soil Degradation, Types and processes of soil degradation; Factors affecting soil degradation; Assessment of degradation processes on world scale; Soil degradation in South Asia and South-East Asia.	6	CLO 2
3	Soil Erosion, Classification of erosion; harmful effects of erosion; factors affecting water and wind erosion; quantifying the impact of erosion; field measurements of erosion; predicting erosion potential erosion models; monitoring soil erosion impact on crop productivity	5	CLO 3

4	Soil Conservation, Principles of soil conservation; planning soil conservation for a given area; land capability classification in relation to soil degradation; problems of implementing soil conservation practices in the field; Socio-economic aspects of soil conservation.	7	CLO 4
5	Land sustainability, sustainable land use system and soil resilience; assessment of soil sustainability; Functions of soil management techniques for soil and water conservation; future approaches of soil conservation. Impact of land degradation on food security.	7	CLO 5

Learning Materials	
Recommended Readings	*Blum et al. 1998. Methods for Assessment of Soil Degradation. CRC Press, New York.* *Khan, T. H. 1999. Soil Conservation and Sustainable Land Use, Dept of Soil, Water and Environment, Univ. of Dhaka, Bangladesh.* *Lal, R. and B. A. Stewart. 1990. Advances in Soil Science. Vol.II. Soil Degradation. Springer- Verlag, New York.* *Morgan, R. P. C. 1995. Soil Erosion and Water Conservation. (2nd ed.) Longman Group UK Limited.* *Pierce, F. J. and W. W. Fyre. 1998. Advances in Soil and Water Conservation. (1st ed.) Sleeping Beer Press, USA.*
Supplementary Readings	*Scherr, S.J. 1999. Soil Degradation: A threat to developing country, food security by 2020. Int. Food Policy Res. Inst. Washington, USA*

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	Teaching- Learning Strategy[a]	Assessment Strategy
CLO 1	[b]Visual and [c]Auditory	Class attendance, In-course Exam, Assignment, Final theory and practical Exam, Field level assessment.
CLO 2	Visual, Auditory and Kinesthetic[d]	
CLO 3	Visual and Auditory	
CLO 4	Visual and Auditory	
CLO 5	Visual and Auditory	

Visiting hours: 10 am to 12 noon and 3 to 5 pm on the working days (if available)

Course Code: SWE 403	**Credits:** 4 (100 Marks)	**Course Type:** Core course

Course Title: Soil Water Management

Prerequisite(s): Needs to be promoted from 3rd year

Rationale of the Course: This course is designed to teach senior undergraduate students the management of soil water for better crop production. The course will provide the theoretical basis for understanding soil water regime and the relationships among soil water, plant and atmosphere. This course will also focus on irrigation and drainage practices.

Course Objectives: The objective of this course to focus on all process involved with the management of water regime of soil to enhance crop growth. Students will be trained with a comprehensive knowledge on Soil-Plant-Atmosphere-Continuum (SPAC) and on the process of irrigation and drainage.

Mapping with SDG: This course is relevant to achieve SDG 4 and 15

Course Learning Outcomes (CLOs) and Mapping with PLOs

Upon completion of this course the students will be able to:		**PLOs covered**
CLO 1	explain field water balance and availability of water to plants; measure infiltration rates in the field and by using models; explain evaporation from bare soil surface.	PLO 1, 2, 5 &7
CLO 2	describe role of water in plants, water absorption by plants, soil-plant-atmosphere continuum (SPAC); measure water potentials in soil and in plants; and explain ET and crop water requirement.	PLO 1, 2, 5 &7
CLO 3	acquire knowledge about the details of irrigation, encompassing its source, quality, classifications, techniques, and the irrigation requirement of crops.	PLO 1, 2, 5 &7
CLO 4	explain drainage as a practice with an emphasis on waterlogged soil.	PLO 1, 2, 5 & 7

Course Contents

Sl. No	**Topic**	**Class Hours**	**CLOs covered**
1	**Soil water regime:** Field capacity concept, available water, factors affecting water storage in the soil profile, field water balance. Infiltration, factors affecting infiltration, profile moisture distribution during infiltration, infiltration models, methods of measuring infiltration rates. Evaporation, factors affecting evaporation, reduction of evaporation from bare soil surface.	10	CLO 1
2	**Soil water - plant relations:** Role of water in plants, processes of water absorption by plants, energy concept of water absorption, pathway of water in soil-plant-atmosphere system, factors affecting water absorption. Plant responses to soil moisture conditions- the water relations in the soil-plant-atmosphere continuum (SPAC); Resistances in the movement of water within the plants and from soil to the roots.	14	CLO 2

	The free energy concepts of soil and plant water potentials; Determination of moisture changes in the soil-plant system; determination of soil and plant water potentials by Thermocouple Psychrometer and Pressure bomb techniques. Transpiration, factors affecting transpiration. Water requirement of crops, evapotranspiration (ET) and consumptive use (CU), classification of CU of water by crops, factors affecting ET, methods of estimating ET.		
3	**Irrigation**: Sources and Quality of Irrigation water; Selection of land for irrigation; Frequency of irrigation / irrigation cycle; Irrigation units, Duty of water. Design of irrigation systems-their suitability for different soils and crops; Field irrigation efficiency, Performance Evaluation of Irrigation Projects, Irrigation needs of major crops in Bangladesh.	12	CLO 3
4	**Drainage:** Theory of Water Movement Through Soil and Toward Drain, Concepts and Benefits of Drainage, Types of drainage- their merits and demerits; Drainage of coastal planes and swampy lands. Waterlogged soil; Types of water logging; Constrains associated with excess water; Management of waterlogged soil in coastal areas of Bangladesh; Tidal river management.	12	CLO 4

Learning Materials	
Recommended Readings	*Hillel, D. 1998. Environmental Soil Physics. Academic Press. London, UK* *Majumdar, D. K. (2001). Irrigation water management: principles and practice*. PHI Learning Pvt. Ltd. *Ali, H. (2011). Practices of Irrigation and On-farm Water Management: Volume 2* (Vol. 2). Springer Science & Business Media.

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	Teaching- Learning Strategy[a]	Assessment Strategy
CLO 1, 2	[b]Visual and [c]Auditory	Class attendance, In-course Exam, Assignment, Final theory and practical Exam, Field level assessment.
CLO 2, 3.4	[b]Visual and [c]Auditory	
CLO 3, 4, 5,6	Visual and Auditory	
CLO 5, 6. 7.8	Visual and Auditory	

Visiting hours: 10 am to 12 noon and 3 to 5 pm on the working days (if available)

Course Code: SWE 404	**Credits:** 2 (50 Marks)	**Course Type:** Core course
Course Title: Soil and Ecosystem Management		
Prerequisite(s): Needs to be promoted from 3rd year		
Rationale of the Course: The rationale of this course is to identify the land and soil related problems in various vulnerable ecosystems which are environmentally distressed and hinders crop production and to demonstrate sustainable management technologies to restore soil health..		
Course Objectives: The objective of this course is to identify the vulnerable land and soil ecosystem which hinders crop production and to demonstrate sustainable management technologies to restore soil health.		
Mapping with SDG: This course is relevant to achieve SDG 4 and 15		

Course Learning Outcomes (CLOs) and Mapping with PLOs

Upon completion of this course the students will be able to:		**PLOs covered**
CLO 1	guidelines on sustainable soil management and ecosystem vulnerability; soil quality indicators (SQI), climate change and food security issues;	2, 6, 5
CLO 2	get an idea on the vulnerable soil ecosystem and their management;	4,7, 8
CLO 3	soil ecosystem restoration and policy development	5, 6 ,7

Sl. No	Course Contents	Class Hours	CLOs
1	**Introduction**: Introductory lecture on Sustainable soil management (SSM), Characteristics or guidelines for SSM, Importance of SSM in promoting the goals of SDGs. Challenges for achieving SSM. Vulnerable soil ecosystems: their occurrences and major constraints regarding agricultural and environmental issues.	5	1
2	**Soil quality Indicators (SQI), climate change and Food security issues:** Definition of soil quality (SQ), principles of SQ, SQ indicators: physical, chemical and biological; SQI and soil function; soil resistance and resilience related to soil quality, SQ index preparation of any AEZ of Bangladesh, AEZ grading based on soil organic matter, C sequestration mechanisms, C sink, C trading, Soil and ecosystem services, Climate-smart agriculture, Soil C budget, '4 per 1000 initiative' regarding climate change and food security issues. Sustainable management of carbon deficient soils with special reference to Bangladesh or similar climatic zones.	5	1, 2
3	**Vulnerable Soil Ecosystem and their management:** Saline soil ecosystem: Nature of salt affected soils causes of salinity intrusion, Management of salty soils; Acid soil ecosystem: Causes of acidification, Impacts of soil systems, management of acid soils, liming materials; Acid sulphate soil ecosystem: Characteristics, formation, and accumulation of acid sulphate soils, Management of acid sulphate soils; Waterlogged soil ecosystem: Severity and extent of waterlogged soils, Impacts of waterlogging on soil properties, Management of waterlogged soils; Sandy soil ecosystem: Characteristics of sandy soil, Constraints to crop production, Management strategies of sandy soils due to recent climate change issues; Drought prone soil ecosystem: Effects of drought on the soil	15	3, 4, 5

	system, Management and long-term policy development in drought prone ecosystem, Rainwater harvesting and storage models; Char land soil ecosystem: formation and genesis of char land soils, characteristics, management strategies of unstable sandbars, Agriculture development models; Sloppy land ecosystem: Characteristics of sloppy land, watershed management principles, Important features of watershed management: hedgerow plantation, jute geotextiles, multi-slot divider, bench terrace, Gabin check dam, Integrated watershed approaches, SALT: Its features, characteristics and benefits; Peat land Ecosystem: Nature and characteristics of peat lands, Stages of the development of tropical peat swamp forest, causes of peat land biodiversity loss and degradation, values of peat land in ecosystem restoration, Conservation strategies of peat land biodiversity.		
4	**Climate resilient Agriculture (CRA) and ecosystem restoration:** Climate resilient agriculture, principles, benefits, Organic agriculture (OA) and food security issues, Conversion procedures of OA from traditional farming, organic standards and certification, factors for the conversion to OA, IFOAM, bio-fertilizer, vermicomposting, practices of conservation agriculture, precision farming, OA and ecosystem restoration practices, A new steps of C farming, a model of smart village.	5	6,7,8

Learning Materials	
Recommended Readings	*Malcolm, E. S. (ed.). 2000. Handbook of Soil Science. CRC Press.* *Khan, et al., (eds.). 2008. Research Experiences with Problem Soils of Bangladesh. Bangladesh Agricultural Research Institute, Bangladesh.*

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	Teaching- Learning Strategy[a]	Assessment Strategy
CLO 1, 2	[b]Visual and [c]Auditory	Class attendance, In-course Exam, Assignment, Final theory and practical Exam, Field level assessment.
CLO 2, 3.4	[b]Visual and [c]Auditory	
CLO 3, 4, 5,6	Visual and Auditory	
CLO 5, 6. 7.8	Visual and Auditory	

Visiting hours: 10 am to 12 noon and 3 to 5 pm on the working days (if available)

Course Code: SWE 405	**Credits:** 2 (50 Marks)	**Course Type:** Core course

Course Title: Agronomy

Prerequisite(s): Needs to be promoted from 3rd year

Rationale of the Course: SWE 405 (Agronomy) is an applied multidisciplinary course and designed to provide all basics and applied principles and practices of crop production systems. The course includes utilization of most relevant basics and applied sciences and technologies for the production of crops and cropping system.

Course Objectives: The objectives are- acquisition and building of knowledge of sciences and technologies of producing crops and using crops and crop products for foods, fuels, fibers, edible oils, medicines and all commodities originating from plants; preparatory planning, programming, executing and monitoring of complete crop production systems from field preparations and seeding to post harvest technologies, and maximizing economical yields of crops.

Mapping with SDG: This course is relevant to achieve SDG 2, 4 and 15.

Course Learning Outcomes (CLOs) and Mapping with PLOs

Upon completion of this course the students will be able to-		**PLOs covered**
CLO 1	learn principles of Agronomy, basics of Bangladesh agriculture, and agronomic classification of crops.	PLO 3
CLO 2	understand climate of a region, basics and applied crop-climate interactions for the protection of crops in field vis-à-vis minimal crop damage under unforeseen disaster.	PLO 2
CLO 3	gain knowledge on effective soil-water-environment management and appropriate tillage and cultural practices, and learn farm machineries.	PLO 4 and 8
CLO 4	learn basics and applied knowledge of seed technology, including seed certification systems, international and national seed law and regulations.	PLO 3 and 4
CLO 5	acquire knowledge of integrated weed management	PLO 5

Course Contents

Sl. No	**Topic**	**Class Hours**	**CLOs covered**
1	**Principles of Agronomy:** Origin and importance of agriculture; Agronomy and duties of an agronomist; Location, area, climate, rivers and agricultural seasons of Bangladesh; Agronomic classification of plants; Crop propagation.	6	CLO 1
2	**Agricultural climatology:** Weather and climatological elements; Influence of weather and climate on vegetation and crop production; Factors affecting climate of a region.	4	CLO 2
3	**Soil tillage:** Purposes of tillage practices; Soil tilth; Types and methods of tillage operations; Tillage equipment and implements - their classification and suitability of their use to different soils and crops; Farm machinery.	8	CLO 3

4	**Seed:** Definition and importance of seed; Seed germination; Seed dormancy; Quality of good seeds and seedlings; Factors affecting quality of seeds and seedlings; Evaluation of seed quality; Seed testing and seed treatment; Seed certification; Seed rate; Seed law; Maximum economic yield of crop.	7	CLO 4
5	**Weeds:** Classification of weeds; Harmful and beneficial effects of weeds; Crop – weed association; Weed management and control. Herbicides - classification, use and methods of application; Weed control environmental concerns; Common weeds of Bangladesh.	5	CLO 5

Learning Materials	
Recommended Readings	*Gopal, C. D. 1989. Fundamentals of Agronomy. Oxford and IBH Publ. Co. Ltd.* *Kakde, J. R. 1985. Agricultural Climatology. (2nd ed.) Metropolitan Books, New Delhi.* *Pearson, L.C. 1967. Principles of Agronomy. (1st ed.) Prindle Weber and Schmidt.* *Rao, V. S. 2000. Principles of Weed Science. (2nd ed.) CRC Press.*
Supplementary Readings	*Chandrasekaran, B., Annadurai, K., And Somasundaram, E. 2010.* *A Textbook of Agronomy New Age International (P) Ltd. New Delhi*

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	Teaching- Learning Strategy[a]	Assessment Strategy
CLO 1	Visual[b] and Auditory[c]	Class attendance, In-course Exam, Assignment, Final theory and practical Exam, Field level assessment.
CLO 2	Visual and Auditory	
CLO 3	Visual, Auditory and Kinesthetic[d]	
CLO 4	Visual, Auditory and Kinesthetic	
CLO 5	Visual and Auditory	

Visiting hours: 10 am to 12 noon and 3 to 5 pm on the working days (if available)

Course Code: SWE 406	**Credits:** 2 (50 Marks)	**Course Type:** Core course

Course Title: Crops of Bangladesh

Prerequisite(s): Needs to be promoted from 3rd year

Rationale of the Course: The course is designed to provide fundamental ideas to the undergraduate students about different types of cropping systems, production methods of various types of crops along with development and application of advanced technology leading to improved production of quality crops that ultimately ensure food security in Bangladesh.

Course Objectives: The objective of this course is to provide students basic ideas about ecology, agronomy, physiology, physical environment, production systems and research needs of important agricultural crops of Bangladesh, acquire preliminary knowledge on pests, insects and diseases affecting crop production and provide knowledge on cropping systems commonly practiced in Bangladesh.

Mapping with SDG: This course is relevant to achieve SDG 4 and 15.

Course Learning Outcomes (CLOs) and Mapping with PLOs

Upon completion of this course the students will be able to:		**PLOs covered**
CLO 1	Acquire generalized idea about field crops of Bangladesh, their classification system and socio-economic importance.	PLO 1 & 3
CLO 2	Describe cultivation processes, production technology, soil and climatic requirements, problems and prospects of cereal crops of Bangladesh.	PLO 3 & 6
CLO 3	Discuss past and present status of production technology, cultivation processes of fiber crops of Bangladesh.	PLO 3 & 6
CLO 4	Explain distribution of minor crops of Bangladesh, their cultivation processes and processing technologies.	PLO 3
CLO 5	Illustrate principles and practices involved in the cultivation processes of tea, rubber, jackfruit, mango, and coconut.	PLO 3
CLO 6	Describe various types of agronomic practices, cropping patterns, crop rotations and their benefits and limitations, concept of sustainable soil-crop management system.	PLO 2 & 7
CLO 7	Collect data from the fields about current and past cropping systems at a specific location, devise a plan to solve a specific problem of that region based on the provided information.	PLO 7

Course Contents

Sl. No	**Topic**	**Class Hours**	**CLOs covered**
1	**Agronomy of arable crops of Bangladesh:** Importance of studying crop production systems of Bangladesh, crop production for ensuring food security, concept of arable crops, classification of arable crops.	2	CLO 1
2	**Cereal crops of Bangladesh:** Concept of cereal crops, importance of cereal crops, agro-climatic requirements, soil, origin, cultural practices, fertilization, irrigation, harvesting, pests and diseases, post-harvest technologies of rice, wheat, maize and other cereal crops.	6	CLO 2
3	**Fiber crops of Bangladesh:** Concept of fiber crops, importance of fiber crops, agro-climatic requirements, soil, origin, cultural practices, fertilization, irrigation, harvesting, pests and diseases, post-harvest technologies of jute, cotton and other fiber crops.	5	CLO 3

4	**Other important crops of Bangladesh:** Importance of other major crops, agro-climatic requirements, soil, origin, cultural practices, fertilization, irrigation, harvesting, pests and diseases, post-harvest technologies of potato, tobacco, pulse and oilseed.	6	CLO 4
5	**Agronomy of perennial crops:** Concept of perennial crops; importance of perennial crops; agro-climatic requirements, soil, origin, cultural practices, fertilization, irrigation, harvesting, pests and diseases, post-harvest technologies of tea, rubber, jackfruit, mango and coconut.	6	CLO 5
6	**Cropping systems in Bangladesh:** Different types of farming, cropping and agro-forestry systems of Bangladesh; cropping intensity; intensity index; cropping pattern; mono cropping; mixed cropping; multiple cropping; alley cropping; sequential cropping; parallel cropping; relay cropping; inter-cropping; advantages and disadvantages of different cropping systems; principles of crop rotation; factors of crop rotation; advantages and disadvantages of crop rotation.	3	CLO 6
7	**General survey of agricultural data:** Field data collection on cropping patterns and farmers' perceptions; research investigation for crop science related problem.	2	CLO 7

Learning Materials	
Recommended Readings	*Duncan, G. H. and W. A. Ross. 1957. Growing Field Crops. Mc Graw-Hill, NY.* *Singth, C. 1989. Modern Techniques of Raising Field Crops. Oxford and IBH Publishing, New Delhi.*
Supplementary Readings	*Radha, T. and L. Mathew. 2007. Fruit Crops. New India Publishing, New Delhi, India.* *Hamjah, M. A. and Chowdhury, M. A. K. 2014. Determinants of Crop Production in Bangladesh: Measuring Climatic and Hydrological Effects on Agricultural Production in Bangladesh. Lap Lambert Academic Publishing, Germany.*

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	Teaching- Learning Strategy[a]	Assessment Strategy
CLO 1	[b]Visual and [c]Auditory	Class attendance, In-course Exam, Assignment, Final theory and practical Exam, Field level assessment.
CLO 2	Visual and Auditory	
CLO 3	Visual and Auditory	
CLO 4	Visual and Auditory	
CLO 5	Visual and Auditory	
CLO 6	Visual and Auditory	
CLO 7	Visual, Auditory and Kinesthetic[d]	

Visiting hours: 10 am to 12 noon and 3 to 5 pm on the working days (if available)

Course Code: SWE 407	**Credits:** 4 (100 Marks)	**Course Type:** Core course

Course Title: Soil Pollution and Waste Management

Prerequisite(s): Needs to be promoted from 3rd year

Rationale of the Course: Soil Pollution and Waste Management (SWE 407) is designed to extend knowledge about environmental awareness, sources and management of soil and environmental pollution by heavy metals, agrochemicals, radioactive materials, solid wastes, waste water, etc. This course is also concerned with sources of natural and artificial radioactivity and its hazards

Course Objectives: Objective of this course is to develop students' capacity to understand environmental pollution through hazardous wastes, sewage sludge, atmospheric dry and wet deposition, solid wastes, municipal and industrial wastewater, health-care wastes; and to apply principles and techniques of waste management. It also aims to provide knowledge on radioactivity: hazards, transfer into food chain, after effects of radioactive accidents as well as effects on human and disposal of radioactive wastes.

Mapping with SDG: This course is relevant to achieve SDG 4.

Course Learning Outcomes (CLOs) and Mapping with PLOs

Upon completion of this course the students will be able to:		**PLOs covered**
CLO 1	Know the meaning of soil environment, sources of pollution and its effects, and how to develop awareness.	PLO 1 & 2
CLO 2	gather knowledge about contents of heavy metals in soil, water and plants; chemical toxicology and impact of heavy metals on ecology, LD50 values, and remediation of heavy metal toxicity.	PLO 3
CLO 3	describe the impacts of pesticides, herbicides and fungicides on soil, plant and water ecosystem, degradation processes of pesticides, herbicides and fungicides.	PLO 1 & 7
CLO 4	acquire knowledge about sources and causes of natural and artificial radioactivity, about the different types and modes of radioactive decay, the hazards caused by radioactivity transfer of radioactivity into food chain; gather knowledge about after effects of reactor accidents and nuclear weapon tests, and develop an understanding of the impact of radioactivity on human and animal, and the disposal of radioactive wastes.	PLO 2
CLO 5	know the basic concept of environmental pollution and environmental awareness.	PLO 1 & 2
CLO 6	understand hazardous and toxic wastes, risk factor analysis and management.	PLO 1
COL 7	describe the effect of fossil fuels on the environmental setting and how coal resources mining in Bangladesh have impact on biophysical environment.	PLO 1, 2 & 8
COL 8	develop understanding about environmental pollution through solid wastes.	PLO 1 and 2
COL 9	apply principles and techniques for solid waste management.	PLO 1, 2 & 8

COL 10	know different categories and sources of health-care wastes and their management.	PLO 1 and 2
COL 11	understand the characteristics of wastewater and their effects on surface water and underground water.	PLO 1 and 2
COL 12	get acquainted with characterizing municipal wastewater and applying principles and techniques of wastewater treatment towards surface- and groundwater safety.	PLO 1, 2, 10
COL 13	characterize different types of industrial wastewater and manage them through effluent treatment plants (ETPs).	PLO 1, 2 & 7
COL 14	explain the effects of atmospheric dry and wet deposition on plants as well as on terrestrial and aquatic ecosystem.	PLO 1 and 2

Course Contents

Sl. No	Topic	Class Hours	CLOs covered
1	**Soil environment:** Meaning of soil environment; sources of soil pollution; Concept of environmental pollution; effects of environmental pollution; environmental awareness.	3	CLO 5
2	**Heavy metals:** Sources and world production; contents of heavy metals in normal soil, water and plants, permissible limits of heavy metals in soils, water and corps; biochemistry, chemical toxicology and impact of heavy metals on soil ecology, crops and humans; LD50 values; remediation of heavy metal toxicity.	8	CLO 2
3	**Pesticides, herbicides and fungicides:** Definition, classification, uses and impact on soil and water ecosystem; biodegradation of pesticides, herbicides and fungicides; lethal doses, health hazards.	7	CLO 3
4	**Radioactivity:** Radioactive materials, sources of natural and artificial radioactivity; hazards caused by radioactivity; transfer of radioactivity into food chain; after effects of reactor accidents and nuclear weapon tests; permissible limits of radioactivity in soil and foods; impact of radioactivity on human and animal management and disposal of radioactive wastes.	12	CLO 4
5	**Environment pollution**: Concept of environmental pollution; effects of environmental pollution upon humans and environment; environmental awareness.	2	CLO 5
6	**Hazardous and toxic wastes**: Hazard, hazardous waste, toxic waste and risk analysis; factors affecting dose and response of toxic chemicals; hazardous waste management; PCBs – properties, uses, human and environmental health contamination.	3	CLO 6
7	**Fossil fuels**: Energy, power and energy carrier; fossil fuels and the environment; coal resources in Bangladesh and their effects on the biophysical environmental upon opencast and underground coal mining.	4	CLO 7
8	**Solid waste**: Sources, classification and physical composition of solid waste; physical, chemical, energy and biological properties of solid waste.	3	COL 8
9	**Solid waste management system**: Solid waste management hierarchy, collection, handling, storage and transportation of municipal solid	3	COL 9

	wastes; waste minimization design- reuse, recovery (resources and energy), recycling, physical transformation / processing techniques for material recovery from solid wastes, thermal and biological treatment processes; ultimate disposal of municipal solid wastes and sanitary landfill site management.		
10	**Health-care waste management**: Categories and sources of health-care wastes; risks associated with health- care wastes; handling, storage and transportation of health-care wastes; treatment and disposal of hazardous health-care wastes.	3	COL 10
11	**Wastewater**: Uses of water and water pollution; Major water pollutants that impair water quality; physical, chemical and biological characteristics of wastewater; storm water and sanitary sewer system; effects of wastewater on the surface water and underground water.	2	COL 11
12	**Municipal wastewater treatment**: Municipal wastewater; wastewater characteristics; effluent standards; wastewater treatment processes; sludge treatment and disposal.	4	COL 12
13	**Industrial wastewater and effluent treatment plant (ETP)**: Industrial wastewater; characteristics and harmful effects; industrial wastewater treatment processes in tanneries, diary plant, pharmaceuticals, textile units, petrochemicals and paper industry; special processes for the removal of chromium, phenol, mercury, nitrogen and dissolved salts from industrial wastewater.	4	COL 13
14	**Atmospheric dry and wet deposition**: Gaseous pollutants and their effects on plants.	2	COL 14

Learning Materials	
Recommended Readings	*B. K. Sharma. 2007. Environmental Chemistry. Krishna Prakashan Media (P) Ltd. Delhi.* *Kabata-Pendias. 2010. Trace Elements in Soils and Plants. 4th edition. Boca Raton, FL, USA: CRC Press/Taylor & Francis Group.* *Ronald A. Baily; Herbert M. Clark; James P.Ferris; Sonja Krause and Robert L. Strong. 2002. Chemistry of the Environment. Academic Press. New York.* *Kiely, G. 1998. Environmental engineering. Irwin McGraw-Hill, Boston, USA* *Peavy, et al. 1985. Environmental engineering. McGraw-Hill Book Company, NY, USA.* *Arcadio, P.A and A.S. Gregoria. 2008. Environmental Engineering. Prentice-Hall, Inc, USA*
Supplementary Readings	*H. B. Bradl. 2005. Heavy metals in the Environment. Elsevier Academic Press.* *Stanley E Manahan. 2022. Environmental Chemistry: Eleventh Edition. CRC Press,* *J. Severa, J. Bár · 1991. Handbook of Radioactive Contamination and Decontamination.* *Bob Burton · 2002.Nuclear Power, Pollution and Politics.* *Forrest E. Knowles · 1973. Radioactive Pollutants.*

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	Teaching- Learning Strategy[a]	Assessment Strategy
CLO 1	[b]Visual and [c]Auditory	Class attendance, In-course Exam, Assignment, Final theory and practical Exam, Field level assessment.
CLO 2	Visual, Auditory and Kinesthetic[d]	
CLO 3 to 6	Visual and Auditory	

Visiting hours: 10 am to 12 noon and 3 to 5 pm on the working days (if available)

Course Code: SWE 408	**Credits:** 4 (100 Marks)	**Course Type:** Core course

Course Title: Climate Change, Mitigation and Adaptation

Prerequisite(s): Needs to be promoted from 3rd year.

Rationale of the Course: Climate change and adaptation is a vibrant course regarding the present day's environment. Consequences of climate change on the soil and associated environments are leading to increasing number of extreme weather events, destroying infrastructure, having impacts on soil health, agriculture and forest, water supply and threatening the biodiversity and environment. Moreover, increase in the mean temperature of our planet will have catastrophic consequences around the world. To study this course, the students will gain knowledge and able to take challenges to overcome the problems on climate change and environment, adaptation/mitigation technologies, Carbon capture and trading, clean development mechanism, and promote international and regional cooperation**.**

Course Objectives: Guide the students to gain knowledge and tackle problems on i) Climate change, ii) Effects/evidences of changes in climate and environment, iii) Impacts/uncertainties/risk of climate change and adaptation/mitigation technologies, iv) Carbon -capture, -economy, -trading, clean development mechanism, v) Support science, research and innovation, vi) promote climate resilience/risk management, well-built communities, international and regional cooperation.

Mapping with SDG: The course is relevant to achieve SDG goal Nos. **3** (Good Health and Well Being), **13** (Climate Action), **15** (Life on Land) and **17** (Partnerships for the Goals).

Course Learning Outcomes (CLOs) and Mapping with PLOs

Upon completion of this course the students will be able to:		**PLOs covered**
CLO 1	Students will be able to understand global climate, greenhouse effects, global warming, and their relationships and consequences.	PLO 1
CLO 2	Students will be able to realize the effects and evidences of changes in climate and environment, changes in patterns of temperature, precipitation and sea level rise, drivers of climate change and climate sensitivity.	PLO 2 & 3
CLO 3	Students will be able to recognize and solve the problems regarding the impacts of climate change on various sectors such as Agriculture, Forestry and Ecosystem, Industry, Human health and Society, Projected impacts for different regions and uncertainties in the projected impacts of climate change	PLO 3, 4 & 5
CLO 4	Students will be able to know the techniques or strategies for the adaptation in various sectors such as Industry, Agriculture, Coastal Zones, Human Health, and Key mitigation technologies and practices for Industry, Agriculture, carbon capture and storage.	PLO 6
CLO 5	Student will be able to understand the principles of low carbon economy, price of carbon, carbon trading, clean development mechanism for future clean technology.	PLO 4 & 6
CLO 6	Student will be conscious for economic growth, support science and technology, research and innovation, promote climate resilience and risk management, well-built communities, international and regional cooperation.	PLO 8 & 10

Course Contents

Sl. No	**Topic**	**Class Hours**	**CLOs covered**
1	**Earth's Climate System** – Climate in the spotlight, climate classification, the earth's natural greenhouse effects and global warming.	3	CLO 1
2	**Observed changes and its causes** – Observation of effects and evidences of changes in climate and environment, changes in patterns of	5	CLO 2

	temperature, precipitation and sea level rise, drivers of climate change, climate sensitivity and feedbacks.		
3	**Impacts of climate change** - Impacts of climate change and possible solutions on various sectors: Agriculture, Forestry and Ecosystem, Industry, Human health and Society. Projected impacts for different regions, uncertainties in the projected impacts of climate change, risk of irreversible changes.	20	CLO 3
4	**Climate change adaptation and mitigation measures** – Adaptation strategy/options in various sectors: Industry, Agriculture, Coastal Zones, Human Health. Key mitigation technologies and practices: Industry, Agriculture, carbon capture and storage.	20	CLO 4
5	**Clean technology** – Principles of low carbon economy, price of carbon, carbon trading, clean development mechanism, examples of future clean technology.	5	CLO 5
6	**Goal of climate change** - Economic growth, support science and technology, research and innovation, promote climate resilience and risk management, well-built communities, international and regional cooperation.	5	CLO 6

Learning Materials	
Recommended Readings	*Pachauri, R. K. and A. Reisinger, A. (Eds.). 2007. IPCC Fourth Assessment Report - The AR4 Synthesis Report, IPCC, Geneva, Switzerland.* *Johnston, T. and Q. Chiotti. 2000. Climate change and the adaptability of Agriculture, ASA Spec. Publ. No 59, Madison, USA.*
Supplementary Readings	*van Dam, J. C. 2003. Impacts of climate change and climate variability on hydrological regimes. Cambridge Univ. Press, Cambridge, UK.* *Dash, S.K. 2007. Climate Change – An Indian Perspective, Cambridge Univ. Press India Pvt. Ltd. India.*

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	Teaching- Learning Strategy[a]	Assessment Strategy
CLO 1	[b]Visual and [c]Auditory	Class attendance, In-course Exam, Assignment, Final theory and practical Exam, Field level assessment.
CLOs 2 to 3	Visual, Auditory and Kinesthetic[d]	
CLOs 4 to 6	Visual and Auditory	

Visiting hours: 10 am to 12 noon and 3 to 5 pm on the working days (if available)

Course Code: SWE 409	**Credits:** 2 (50 Marks)	**Course Type:** Core course

Course Title: Soils of Bangladesh

Prerequisite(s): Needs to be promoted from 3rd year

Rationale of the Course: This course deals with the environmental settings, origin, behavior, characteristics and classification of the soils of Bangladesh.

Course Objectives: The aim of this course is the study of the origin and behavior of soil resources of Bangladesh. At the end of this course, students should be able to understand the genesis, characteristics, classification and use potentials of the soils of Bangladesh.

Mapping with SDG: This course is relevant to achieve SDG 4 and 15.

Course Learning Outcomes (CLOs) and Mapping with PLOs

Upon completion of this course the students will be able to:		**PLOs covered**
CLO 1	acquire an introductory knowledge on the environmental settings and soil resources of Bangladesh.	PLO 1 & 2
CLO 2	describe soil formation concepts as related to biogeochemical processes under seasonally flooded conditions, and develop an understanding of the morphological, physical and chemical properties of soils formed on different physiographic units of Bangladesh.	PLO 2 & 3
CLO 3	classify soils according to soil classification systems in Bangladesh and correlate them with the US Soil Taxonomy and FAO-Unesco Legend.	PLO 1 & 7
CLO 4	describe AEZs of Bangladesh in the context of agricultural development possibilities.	PLO 2& 5

Course Contents

Sl. No	**Topic**	**Class Hours**	**CLOs covered**
1	**Soils and Soil conditions in Bangladesh**: Environmental conditions and pedogenic factors in Bangladesh; dominant soil forming processes in Bangladesh; stages of soil formation under seasonally flooded conditions- ripening, homogenization, reduction, ferrolysis, decalcification, formation of gleyans, formation of subsoil structure, acidification, formation of mottles, formation of plough pan etc.; inundation land types; soils on physiographic units of Bangladesh.	12	CLO 1 CLO 2
2	**Development of Soil Classification in Bangladesh**: Major soils of Bangladesh; 7-soil tracts; general soil types of Bangladesh; classification of the soils of Bangladesh on the basis of Soil Taxonomy and FAO-UNESCO Legend; soil series and soil families in Bangladesh; Morphological description of some important soil series of Bangladesh.	10	CLO 3
3	**Agroecological Zones (AEZ) of Bangladesh**: concepts of AEZ, and brief description of different AEZs of Bangladesh. Development constraints and agricultural development possibilities in AEZ.	8	CLO 4

Learning Materials	
Recommended Readings	*Brammer, H. 1996. The Geography of the Soils of Bangladesh. The Univ. Press Ltd., Dhaka.* *FAO-UNDP. 1988. Land Resources Appraisal of Bangladesh for Agricultural Development. Agroecological Regions of Bangladesh. Report-2. FAO report. FAO, Rome.* *Hassan, M. M. 1999. Soils of Bangladesh- Their Genesis, Classification and Use Potential. Consultant and Allied Agro Industries, Dhaka.* *Huq, S.M.I. and J. U. M. Shoaib. 2013. The Soils of Bangladesh. Springer-Verlag, New York Inc.*
Supplementary Readings	*Hussain, M. S. 2020. Soil Classification. Dhaka Univ. Press, Dhaka.*

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	Teaching- Learning Strategy[a]	Assessment Strategy
CLO 1	[b]Visual and [c]Auditory	Class attendance, In-course Exam, Assignment, Final theory and practical Exam, Field level assessment.
CLO 2	Visual, Auditory and Kinesthetic[d]	
CLO 3	Visual, Auditory and Kinesthetic[d]	
CLO 4	Visual and Auditory	

Visiting hours: 10 am to 12 noon and 3 to 5 pm on the working days (if available)

Course Code: SWE 410	**Credits:** 2 (50 Marks)	**Course Type:** Core course

Course Title: Chemistry of Submerged Soils

Prerequisite(s): Needs to be promoted from 3rd year.

Rationale of the Course: The course is designed to provide fundamental understanding of the scope and importance of soil chemistry emphasizing soil chemical characteristics along with processes, reactions and transformations occurring in the submerged soil which will help to gain in-depth knowledge and better understand the strategies related to soil chemistry and rice production.

Course Objectives: The objective of this course is to provide student with knowledge regarding the principles of soil chemistry in agricultural and environmental sciences; developing both analytical and quantitative skills in soil chemistry; accessing chemistry of waterlogged soil and chemical potential of cations and anions through the knowledge of terminology and concepts in soil chemistry; understanding mechanisms of soil chemical reactions and processes, transformation of nutrients, soil organic matter, characteristics of paddy and non-paddy soil, chemical equilibrium and solubility of compounds that contribute to soil health, rice production and environmental sustainability.

Mapping with SDG: This course is relevant to achieve SDG 4, SDG 14 and SDG 15.

Course Learning Outcomes (CLOs) and Mapping with PLOs

Upon completion of this course the students will be able to:		**PLOs covered**
CLO 1	identify and explain the importance, classification and chemistry of waterlogged soil	PLO 1 & 2
CLO 2	know the mechanism of chemical, electrochemical changes in nutrient cycling under submerged condition	PLO 2 &4
CLO 3	understand the relation between organic matter and soil physical, chemical and biological properties	PLO 2 & 4
CLO 4	gain an understanding of paddy soil and its limitation	PLO 2 & 6
CLO 5	understand major environmental issues related to waterlogging	PLO 6 & 8
CLO 6	understand chemical equilibrium, solubility of salts in soil solution.	PLO 1 & 6

Course Contents

Sl. No	**Topic**	**Class Hours**	**CLOs covered**
1.	**Importance and Classification of waterlogged soil:** Definition of waterlogged soil and it's classification, scope and applications of soil chemistry in waterlogged soil, importance of waterlogged soil in plant growth and environmental sustainability	2	CLO 1
2.	**Chemistry of waterlogged soil:** electrochemical (pH, Eh, EC) changes due to submergence; transformations of N, P, S, Fe, Mn and other minor nutrients; chemical changes and reactions occurring during drying of waterlogged soil;	15	CLO 2
3.	**Influence of organic matter on the properties of waterlogged soil**: Decomposition of soil organic matter; its mechanisms; its effects on soil properties; factors affecting organic matter decomposition; soil properties under alternate wetting drying cycle.	3	CLO 3
4.	**Potential and limitation of Paddy soil:** Morphonology and characteristics of paddy soil, descriptions of physical, chemical,	5	CLO 4

	biological conditions prevailing in paddy soil; basic difference between paddy and non-paddy soil; adaptation of plants to waterlogged soil		
5.	**Major environmental and fertility issues rising from waterlogging:** Nutrient toxicity and deficiency level under different stages of submergence, formation of acid sulphate soil and saline soil, green house gas emission from submerged soil.	2	CLO 5
6.	**Chemical potential of soil cations and anions:** Concept and basic principles of chemical equilibrium in soil; its properties and significance; pH and solubility of different chemical compounds; equilibrium involving sparingly soluble crystalline solids – calcium phosphate, calcium carbonate	3	CLO 6

Learning Materials	
Recommended Readings	*Ponampurema, F. N. 1972.* ***Chemistry of Submerged Soil****. Advances in Agronomy. Am. Soc. Agron, Madison, USA.* *IRRI. 1964.* ***Mineral Nutrition of Rice****. Johns Hopkins Press, Baltimore, Maryland, USA* *Bohn et al. 1979.* ***Soil Chemistry****. (2nd ed.) A. Wiley-Interscience Publication*
Supplementary Readings	*IRRI. 1985.* ***Wetland Soils: Characterization, Classification and Utilization.*** *International Rice Research Institute, Los Baños, Philippines.* *Brady, N.C. and R.R. Weil. 2002.* ***The Nature and Properties of Soil****. (13th ed.) Pearson Education, Singapore* *Tan, K. H. 1993.* ***Principles of Soil Chemistry****. (2nd ed.) Marcel Dekker, Inc.*

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	Teaching- Learning Strategy[a]	Assessment Strategy
CLO 1	Visual[b] and Auditoryc	Class attendance, In-course Exam, Assignment, Final theory and practical Exam, Field level assessment.
CLO 2	Visual, Auditory and Practical[d]	
CLO 3	Visual and Auditory	
CLO 4	Visual, Auditory and Practical	
CLO 5	Visual, Auditory and Practical	
CLO 6	Visual and Auditory	

Visiting hours: 10 am to 12 noon and 3 to 5 pm on working days (if available).

Course Code: SWE 411	**Credit:** 2.0	**Course Status:** Core Course

Course Title: Advanced Hydrology

Prerequisite(s): Needs to be promoted from 3rd year.

Rationale of the Course: Hydrology course is designed for senior Under Graduate students to provide advanced knowledge on surface and ground water hydrology, fundamentals of well hydraulics, and on ground water resources of Bangladesh.

Course Objectives: The objective of this course is to describe the movement of water through the hydrologic cycle and the factors that affect its flow, measurement of the flow of water at various points of the hydrologic cycle and to explain ground water dynamics and well hydraulics.

Mapping with SDG: The course is relevant to achieve SDG goal Nos. 4, 14 and 15.

Course Learning Outcomes (CLOs) and Mapping with PLOs

Upon completion of this course the students will be able to:		**PLOs covered**
CLO 1	This unit of lectures will deliver to students an idea on river water discharge measurement and floodplain mapping'	PLO 1 & 2
CLO 2	This unit will provide the students an understanding the processes and techniques of ground water flow in aquifers.	PLO 3 & 4
CLO 3	This unit will provide quantitative assessment of different technologies for the withdrawal of water in different aquifer conditions and economic consideration of these technologies	PLO 5 & 6
CLO 4	An understanding of the processes of getting a safe drinking water.	PLO
CLO 5	An understanding of the role of ground water utilization in Bangladesh;	PLO 8
CLO 6	Brief idea on ground water quality, intrusion and contamination in Bangladesh.	PLO 4 & 7
CLO 7	Application of computational approach in hydrological research	PLO 10

Course Contents

Sl. No	**Topic**	**Class Hours**	**CLOs covered**
1	**Surface water hydrology:** Runoff and Flooding; Flood Plain Mapping; Hydrograph Calculation; Drainage basins and Drainage patterns; River flow and Discharge measurements.	3	CLO 1
2	**Ground water hydrology:** Rock properties affecting ground water; Sub-surface distribution of ground water; Ground water flow equations; Ground water levels and environmental influences,	4	CLO 2
3	**Well hydraulics**: Hand, shallow, deep set shallow and deep Tube wells- types, design, drilling, construction and maintenance. Low cost water supply technologies Rainwater harvesting:	7	CLO 3
4	**Fundamentals of ground water resources evaluation:** Ground water exploration, pumping test, presentation and interpretation of results; Water mining and land subsidence.	4	CLO 4
5	**Ground water resources of Bangladesh:** hydrological background; Regional ground water conditions; Ground water utilization; Ground water development potential, planning, and management	5	CLO 5

6	Ground water pollution and contaminant transport; Saline water intrusion in aquifers; management of aquifers; Basin-wide ground water development.	3	CLO 6
7	Application of telemetry and remote sensing in hydrologic data acquisition. Ground water depletion in Bangladesh.	4	CLO 7

Learning Materials	
Recommended Readings	*Michael Kasena.2001. Applied ground water hydrology and well hydraulics. Water Resources Publication, USA.* *Nazeen Ahmed, Stewart W Taylor and Zhuping Sheng. 2014. Hyddraulics of wells: Design, construction, testing and maintainance of water well systems American Society of Civil Engineers, USA.* *Davie, T. 2003. Fundamentals of Hygrology. (1st ed.) Routledge, London.* *Raphael, V. and G. Kazmann. 2003. Modern Hydrology. (2nd ed.) Harper and Row, New York.* *Reddi, P. J. R. A. 2001. Text Book of Hydrology. (2nd ed.) Laxmi Publ., India.* *Todd, D. K. 2012. Ground Water Hydrology. (4th ed.) John Willey & Sons.*
Supplementary Readings	*Ahmed, M.F. and M. M. Rahman. 2003. Water Supply and Sanitation- Rural and Low Income Urban Communities. (2nd ed.) Progressive Printers Ltd. Bangladesh.*

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	**Teaching- Learning Strategy[a]**	**Assessment Strategy**
CLO1	[b]Visual and [c]Auditory	Class attendance, Continuous assessment, assignment, practical Exam, oral exam and presentation, Field level assessment.
CLO2	Visual and Auditory and Kinesthetic[d]	
CLO3	Visual and Auditory	
CLO4	Visual and Auditory	
CLO5	Visual and Auditory	
CLO6	Visual and Auditory and Kinesthetic[d]	

Visiting hours: 10 am to 12 noon and 3 to 5 pm on the working days (if available)

Course Code: SWE 412	**Credits:** 2 (50 Marks)	**Course Type:** GED course

Course Title: Seminar

Prerequisite(s): Needs to be promoted from 3rd year

Rationale of the Course: This course is designed for Under Graduate students of the department so that they can perform an oral presentation on any topic covering the focal areas: Soil, Water and Environment.

Course Objectives: The objective of this course is to train the students in preparing seminar paper on a given topic, preparation and use of presentation materials - slides, multimedia projectors, etc. At the end of the course, students will be required to prepare a seminar paper on a given topic and present it before an audience.

Course Contents			
SL No	**Topic/ Courses covered**	**Class Hours**	**CLOs covered**
1	Topic of the Seminar report will be selected by the student after consultation with the assigned supervisor. The student will prepare a report and will deliver a oral presentation.	2	CLO 6 & CLO 7

Visiting hours: 10 am to 12 noon and 3 to 5 pm on the working days (if available)

Course Code: SWE 413	**Credits:** 6 (150 Marks)	**Course Type:** Core course

Course Title: Practical

Prerequisite(s): Needs to be promoted from 3rd year.

Rationale of the Course: This course is designed in a way that the students will carry out practical experiments assigned by the course teacher with an aim conducting a comprehensive survey and research on soil survey and remote sensing, soil conservation and sustainable land use, soil water management, agronomy, crops of Bangladesh, soil pollution and waste management, climate change mitigation and adaptation, soils of Bangladesh, chemistry of submerged soil, hydrology,

Course Objectives: The objective of this course is to provide students a comprehensive practical knowledge on different technological parameters of soil, water and environment,

Mapping with SDG: This course is relevant to achieve SDG 4, 6, 13, 14, 15 and 17.

Course Learning Outcomes (CLOs) and Mapping with PLOs		
Upon completion of this course the students will be able to:		PLOs covered
CLO 1	expose the students with the basic concepts and techniques in conducting modern soil survey and land evaluation, fundamentals of remote sensing in soil survey and land use planning.	PLO1, 2, 3, 4, 5, 6, 7
CLO 2	acquaint with the associated applied aspects like field morphological study, stereoscopic photo/image analysis map construction, land evaluation and data interpretation, etc.	PLO1, 2, 3, 4, 5, 6, 7
CLO 3	provide ideas on the processes of soil and water degradation, development of control practices and soil quality enhancement, mechanisms of erosion processes and its control, sustainable agriculture and the ways in which technology and social influences have and will shape soil erosion and conservation processes.	PLO1, 2, 3, 4, 5,
CLO 4	identify the land and soil related problems which hinders crop production and to demonstrate sustainable management technologies to restore soil health.	PLO1, 2, 3, 4, 5,
CLO 5	A field study will be carried out in the vulnerable ecosystem sites of Bangladesh to find out the problem related to soil and ecosystem management; Sustainable land management technologies through questionnaire survey.	PLO1, 2, 3, 4, 5,
CLO 6	collect data from the fields about current and past cropping systems at a specific location, devise a plan to solve a specific problem of that region based on the provided information.	PLO1, 2, 3, 4, 5,
CLO 7	extend knowledge about environmental awareness, sources and management of soil and environmental pollution by heavy metals, agrochemicals, radioactive materials, solid wastes, waste water, etc.	PLO1, 2, 3, 4, 5, 8, 9

Course Contents			
Course Code	**Topic**	**Class Hours**	**CLOs covered**
1	**Related to SWE 401:** Study of Base Materials, Stereoscopic Study and Interpretation of aerial photograph.		CLO 1, 2
2	**Related to SWE 402:** Collection of soil samples and determination of Bulk density, Percentage of different sized particles, Dispersion ratio, and Erosion ratio. Calculation of Universal Soil Loss by using USLE and recommendation of conservation practices.	8	CLO 2
3	**Related to SWE 403:** Determination of saturated hydraulic conductivity of soil. Evaluation of irrigation water quality standard of studied project.	12	CLO 3

4	**Related to SWE 404:** Field visit based on ecosystem vulnerable areas; identify the soil quality indicators; In situ recommendation and farmers advisory services to enhance soil health and ecosystem services	8	CLO 5
5	**Related to SWE 405 and SWE 406:** Pot/Field/Laboratory experiment: students will jointly carry out a pot/field/laboratory experiment to study a given problem. The objectives of the experiment will be (a) training of the students in determining the objectives of an experiment; (b) preparation of experimental design; (c) setting up of the experiment; (d) cultural practices; (e) analysis of soil and plant samples; (f) interpretation of data; and (g) preparation of report and recommendation. Evaluation of seed quality in the laboratory. Seed testing and treatments.	12	CLO 2, 3, 4, 5, 6
6	**Related to SWE 407:** Determination of heavy metals in collected waste, sewage sludge, soil, water and plant samples; determination of water quality; determination of DO, BOD and COD; preparation of report and recommendation.	12	CLO 6, 7
7	**Related to SWE 408 and SWE 409:** Collection and analysis of different parameters of samples collected from field.	20	CLO 1, 2, 3, 4, 5, 6
8	**Related to SWE 410:** Chemical and electrochemical changes due to flooding – changes in pH and redox potential; transformation of N, S, Fe, Mn and P.	10	CLO 2, 3,

Learning Materials	
Recommended Readings	*Buol et al. 2003. Soil Genesis and Classification. (5th ed.) Iowa State University Press, Iowa, USA.* *Jensen, J. R. 2006. Remote sensing of the Environment. Pearson Education Inc.* *Hillel, D. 1998. Environmental Soil Physics. Academic Press. London, UK* *Khan, et al., (eds.). 2008. Research Experiences with Problem Soils of Bangladesh. Bangladesh Agricultural Research Institute, Bangladesh.*
Supplementary Readings	*Pierce, F. J. and W. W. Fyre. 1998. Advances in Soil and Water Conservation. (1st ed.) Sleeping Beer Press, USA.* *Gopal, C. D. 1989. Fundamentals of Agronomy. Oxford and IBH Publ. Co. Ltd.* *Arcadio, P.A and A.S. Gregoria. 2008. Environmental Engineering. Prentice-Hall, Inc, USA.*

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	**Teaching- Learning Strategy[a]**	**Assessment Strategy**
CLO1 & 3 - 6	[b]Visual and [c]Auditory	Class attendance, Continuous assessment, assignment, practical Exam, oral exam and presentation, Field level assessment.
CLO2& 7	Visual and Auditory and Kinesthetic[d]	

Visiting hours: 10 am to 12 noon and 3 to 5 pm on the working days (if available)

Course Code: SWE 414	**Credits:** 2 (50 Marks)	**Course Type:** GED course

Course Title: Field Work and Community Outreach

Prerequisite(s): Needs to be promoted from 3rd year.

Rationale of the Course: This course is designed in a way that the students will carry out field level experiments assigned by the course teacher with an aim conducting a comprehensive survey and research on soil survey and remote sensing, soil conservation and sustainable land use, soil water management, agronomy, crops of Bangladesh, soil pollution and waste management, climate change mitigation and adaptation, soils of Bangladesh, chemistry of submerged soil, hydrology,

Course Objectives: The objective of this course is to provide students a comprehensive practical knowledge on different technological parameters of soil, water and environment,

Mapping with SDG: This course is relevant to achieve SDG 4, 6, 13, 14, 15 and 17.

Course Contents

Sl. No	Topic	Days Required	CLOs covered
1	**Related to SWE 401:** Soil Survey: Field visit and collection of Soil Survey data and other agricultural information. Examination and Description of soil in the field. Study of Base Materials, Stereoscopic Study and Interpretation of aerial photograph. Study and Identification of Soils in the Field, Demarcation of Soil Boundaries on Base Map. Construction of Final Soil Map etc. using GPS and GIS. Preparation of Soil Survey Report with Data Interpretations and Recommendations	3	CLO 1
2	**Related to SWE 402, and SWE 408:** Field visit to observe- Soil conservation practices, Water conservation in hill area; Watershed management practices. Visit to different soil conservation related laboratories and research stations. Field visit and report submission on lands most prone to climate change. Collection of soil samples and determination of Bulk density, Percentage of different sized particles, Dispersion ratio, and Erosion ratio.	2	CLO 2,3,4
3	**Related to SWE 403:** Performance evaluation of Dhaka-Narayangonj-Demra flood control, drainage, and irrigation project and coastal embankment project of Cox's Bazar.	2	
4	**Related to SWE 404 and SWE 405:** SALT concept, mulching, conservation tillage, other innovative techniques regarding land and soil management. Visit of Problem soils and their sustainable management strategies for better crop production in hilly areas.	1	CLO 4, 5
5	**Related to SWE 405 and SWE 406:** General survey of field agricultural data: Field data collection on cropping patterns and farmers‟ perceptions; research investigation for crop science related problem.	2	

6	**Related to SWE 407:** Collection of waste effluent, soil, and plant sample; determination of heavy metals in waste, sewage sludge, soil and plant sample; determination of water quality; determination of DO, BOD and COD; preparation of report and recommendation. Visit to the polluted areas around Dhaka city and collection of waste effluent, soil, and plant sample; Collection of soil/sediment, sea water, seaweed/plant samples for determination of heavy metals for assessing pollution load.	2	CLO 5, 6, 7
7	**Related to SWE 408:** Collection of samples for analyses of different parameters of samples collected from field.	1	CLO 5, 6, 7
8	**Related to SWE 409:** Field trips to different Agro-Ecological Zones of' Bangladesh. Soils in the landscape; study of the catenary sequences of soils in the field.	3	CLO 5, 6, 7

Learning Materials	
Recommended Readings	*Buol et al. 2003. Soil Genesis and Classification. (5th ed.) Iowa State University Press, Iowa, USA.* *Jensen, J. R. 2006. Remote sensing of the Environment. Pearson Education Inc.* *Hillel, D. 1998. Environmental Soil Physics. Academic Press. London, UK* *Khan, et al., (eds.). 2008. Research Experiences with Problem Soils of Bangladesh. Bangladesh Agricultural Research Institute, Bangladesh*
Supplementary Readings	*Pierce, F. J. and W. W. Fyre. 1998. Advances in Soil and Water Conservation. (1st ed.) Sleeping Beer Press, USA.* *Gopal, C. D. 1989. Fundamentals of Agronomy. Oxford and IBH Publ. Co. Ltd.* *Arcadio, P.A and A.S. Gregoria. 2008. Environmental Engineering. Prentice-Hall, Inc, USA.*

Mapping CLOs with the Teaching- Learning and Assessment Strategy (*VAK)		
CLOs	**Teaching- Learning Strategy[a]**	**Assessment Strategy**
CLO 1 to CLO 7	Visual and Auditory and Kinesthetic[d]	Class attendance, Continuous assessment, assignment, practical Exam, oral exam and presentation, Field level assessment.

Visiting hours: 10 am to 12 noon and 3 to 5 pm on the working days (if available)