# Academic Ordinance for the Bachelor of Science (B.Sc. Honours) in Environmental Sciences (Semester System) 2018

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# Syllabus of Bachelor of Science (B.Sc. Honours) in Environmental Sciences for Academic Sessions: 2017-2018, 2018-2019, 2019-2020 and 2020-2021


Department of Environmental Sciences

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# Department of Environmental Sciences
# Jahangirnagar University

**Academic Ordinance for the**
**Bachelor of Science (B.Sc. Honours) in Environmental Sciences (Semester System) 2018**

## A. Background

In view of the environmental concern, the Department of Environmental Sciences was established at Jahangirnagar University, Bangladesh, in April 1999 as an interdisciplinary undergraduate program by integrating all branches of natural sciences including relevant technological management. Nationally and internationally renowned scientist Professor Dr. Syed Safiullah (1935-2016) was the founder chairman of the department.

"Our Planet, the Earth, has fostered living creatures with solar energy, water and other materials, and these living creatures have in turn transformed the retained its primordial balance over an extended period of time. However, energy consumption and emissions of pollutants and greenhouse gases through human activities seem to exceed the capacity of the earth both in local and global scales. As a result, our earth has lost natural balance causing numerous conflicts, crises and environmental problems. In order to reach a true understanding and fundamental solutions for the environmental problems, it is vital to ask ourselves how the Earth and human beings are to coexist in the future"~ Professor Dr. Syed Safiullah ( 1935-2016).

## B. Vision Statement

The education and research in the Department of Environmental Sciences focuses on two main pillars of vision for the establishment of the Department of Environmental Sciences- "Sustainability" and "Safety of the Earth".

To achieve excellence in environmental leadership, the main goal of the functional entities of the department essentially centers on team-work of environmental studies with a holistic approaches considering human dimension as a significant factor.

## C. Mission Statement

Based on the two pillars of "Sustainability" and "Safety of the Earth", the Department of Environmental Sciences focuses on interdisciplinary studies without the barriers between different fields of sciences, engineering, management as well as social studies addressed on the state of the environment and environmental problems in Bangladesh and the world.

Through a series of academic courses and co-curricular activities, scholars will learn how anthropogenic activities impact the environment and will obtain the critical thinking and problem-solving skills essential to effectively contribute to solutions. We believe that this system will lead us to meaningful solutions for the demands concerning an environmentally sustainable future of our planet.

# D. Regulations

## I. Program

Courses of study for a four year Bachelor Degree in semester and credit system shall extend over a period of four academic years. Each academic year should be divided into two semesters- First Semester and Second Semester. After completion of a particular semester there will be a minimum of 4 weeks transition time to start the next semester. All the pertinent preparation to start a new semester should be finished during this transition time. Each semester will be of duration 20 weeks minimum. A semester will be segmented into Class-weeks, Preparatory leave and Semester-end examination. For a 3 credit course 3 lectures have to be given in a week with a total of 36 lectures; and for a 2 credit course 2 lectures in a week with a total of 24 lectures i.e. one lecture per week for each credit. Time distribution for completing a semester will be as follows.

| SL | Segment | Period | Length |
|---|---|---|---|
| (a) | Class-Weeks | 1st week~15th week | 15 weeks |
| (b) | Preparatory leave before semester-end examination | 16th Week~17th week | 02 Weeks |
| (c) | Semester-end examination | 18th Week~20th Week | 04 Weeks |
| Total | | | 21 Weeks |

## II. Assessment:

For the purpose of assessment shall be assigned to each course. Assessment of a student in a course shall be based on marks obtained in the course-end examination, class assessments and attendance. For theoretical courses at least two tutorials to be taken for a two credit course and three tutorials to be taken for a three credit course. Field work will be assessed according to other courses i.e. 30% for tutorial and field assessment and 70% for Field Report evaluation.

The distribution of marks for each theoretical course will be as follows:

| | | |
|---|---|---|
| 1. | Class attendance | 10% |
| 2. | Class Assessment/tutorials | 20% |
| 3. | Semester-end examination | 70% |
| | Total | 100% |

The distribution of marks for each practical course will be as follows:

| | | |
|---|---|---|
| (a) | Class attendance | 10% |
| (b) | Class Assessment/tutorials | 20% |
| (c) | Lab report and semester-end examination (10%+60%) | 70% |
| | Total | 100% |

## III. Assessment of Project/Internee:

For the purpose of assessment of Project report/Internee report 30 marks shall be allocated for presentation and 70% marks shall be assigned to report evaluation.

## IV. Semester-end Examination

(a) The duration of the course end examinations shall be 4 hours for each three-credit-hours theoretical course and 2.5 hours for each two-credit hours theoretical course. The duration of the course-end practical examination shall be 6 hours.

(b) In the course end examination for theoretical courses, there should be a choice of questions to be answered e.g. 5 questions out of 8.

## V. Grading System

The total numerical marks obtained by a student in each theoretical and practical course will be converted into letter grades. There shall be 11 letter grades that may be assigned to evaluate course-performances and other works. The letter grades and corresponding grade points are as follows:

| Numerical Grade (% of Marks) | Letter Grade | Grade Point |
|---|---|---|
| 80% and 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 |
| Incomplete | I | 0.00 |

## VI. Earned Credits/Qualifying Marks/Repetitions or improvements

(a) The courses in which a student will obtain “D” or a higher grade shall only be counted as credits earned by him/her. Other grades shall not be counted for Grade Point Average (GPA).

(b) If a student obtains “F” grade in any course in any semester, s/he shall have to repeat the course, provided that s/he gets at least 2.75 GPA in that semester. Maximums allowed “F” grades in a particular semester are two. If a student gets more than 2 “F” grades in the same semester, s/he needs to repeat the whole semester.

(c) If a student obtains a grade higher than “F” in a course and also obtains 2.75 GPA in that semester, s/he shall not be allowed to repeat that course for the purpose of grade improvement.

## VII. Calculation of GPA

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

$$GPA = \frac{\sum_{i=1}^{5} C_i G_i}{\sum_{i=1}^{5} Ci}$$

*A numerical example:*

Suppose a student has passed five courses in a semester and obtained the following grades:

| Course Code | Credit | Letter Grade | Grade Points |
|---|---|---|---|
| Env.205 | 3 | A+ | 4.00 |
| Env.205 | 3 | C+ | 2.50 |
| Env.205 | 3 | D | 2.00 |
| Env.205 | 2 | B | 3.00 |
| Env.205 | 2 | B+ | 3.25 |

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

$$GPA = \frac{3(4.00) + 3(2.50) + 3(2.00) + 2(3.00) + 2(3.25)}{(3 + 3 + 3 + 2 + 2)} = 2.92$$

Cumulative Grade Point Average (CGPA) is calculated by averaging the GPAs secured in two or more successive semesters. Total credit in each semester will be used as weights for the calculation as shown in the following example:

| Semester | GPA | Credit |
|---|---|---|
| 1st Year 1st Semester | 4.0 | 17 |
| 1st Year 2nd Semester | 3.0 | 22 |
| 2nd Year 1st Semester | 3.5 | 18 |
| 2nd Year 2nd Semester | 3.0 | 20 |

$$CGPA = \frac{4.00(17) + 3.00(22) + 3.50(18) + 3.00(20)}{(17 + 22 + 18 + 20)} = 3.36$$

## VIII. Qualifying Marks

(a) The qualifying pass grade for a particular course is "D", but for promotion to higher semester a candidate shall have to maintain a minimum CGPA of 2.5 in aggregate at the end of any two successive semesters provided that the last semester is not a probation period.

(b) If a candidate remains absent in a course-end examination for a course for such as serious illness, accident etc., his/her course may be graded "incomplete" subject to the approval of the department and in that case s/he may get a chance to sit for the course-end examination in the next available examination on that course, provided that s/he obtains at least 2.5 GPA in semester. If a student does not avail him/her of the chance then s/he shall be dismissed from the program but may be allowed to continue the courses subject to the provisions of the Section 'Repeater' of this Ordinance.

(c) If a student cross any of his/her examination paper, s/he will be imposed "F" in that course.

(d) The maximum number of incomplete course in one semester cannot be more than one three-credit hours/two credit hours of theoretical/practical course. To avail this "incomplete" grade facility the student has to satisfy that s/he has received not more than one "F" grades in any other course in that semester.

## IX. Class Attendance:

A student must have 60% class attendance to qualify to sit for semester final examination. Basis for awarding marks for class attendance will be as follows:

| Class Attendance | Allocated Marks |
|---|---|
| 90% and above | 100% |
| 85% to less than 90% | 90% |
| 80% to less than 85% | 80% |
| 75% to less than 80% | 70% |
| 70% to less than 75% | 60% |
| 65% to less than 70% | 50% |
| 60% to less than 65% | 40% |
| Less than 60% | 0% |

## X. Promotion to Higher Semester

(a) Normally a student must maintain a minimum CGPA of 2.5 in each semester. For CGPA calculation in each successive semester however the previous grade points achieved by a student will be included. Thus calculated, if a student fails to secure 2.5 CGPA after any two successive semesters but his/her GPA in the previous semester (before this semester) was above or equal to 2.5, s/he will be repeater subject to section 'Repeater' if this ordinance.

(b) If the CGPA of a student is below 2.50 but 2.00 and above in any semester, s/he shall be placed on probation for the next semester. Student who fails to raise his/her CGPA to 2.50 in the next semester shall be dismissed from the program but may be allowed to continue the courses subject to the provision of the section 'Repeater' of this ordinance.

## XI. Repeater

(a) In a semester a student who fails to appear in the course-end examination for some valid reasons may, on recommendation of the Chairperson of the Department be allowed by the Vice-chancellor to continue for one-more Semester and repeat all the courses of that semester. This provision will hold good for a student only once for his/her first semester through the seventh semester.

(b) If any student fails to secure CGPA of 2.5 after probation period in any semester s/he may also be considered for repeating all the courses of that semester. This provision will hold good for a student only twice for his/her first semester through the seventh semester subject to the provision of section "Time Limit".

## XII. Irregular Examination

(a) A student who, on fulfilling the requirements of class attendance and assessment of class work in the 8th Semester fails to secure a minimum of 2.5 CGPA in the aggregate of the semester-end examinations and assessment of class work in the theoretical courses and continuous assessment in practical courses taken together shall cease to be a regular student of this university.

(b) S/he may, however, with the approval of the Chairperson of the Department concerned and fulfilling the specific requirements of the Department, if any, be allowed to sit for the examination in the subsequent semester-end examination of all cease to be a regular student of this university.

(c) The course-end examination for an irregular candidate will be conducted normally according to the syllabus in force in the semester in which s/he presents him/herself for such examination. However, if there are major changes in the syllabus of the course or courses, the relevant Examination Committee may arrange for holding his/her examination according to the old syllabus.

## XIII. Time Limit

No student shall be permitted to continue as a Bachelor's Degree candidate beyond the end of the sixth academic year of his/her first admission into the university.

## XIV. Degree to be awarded

A student who has secured a minimum CGPA of 2.50 after eight semester will be awarded a degree of Bachelor of Science (B.Sc.) (Honours) in Environmental Sciences.

## XV. Year of Degree Awarded

The results of a candidate for four year Bachelor Degree shall be awarded in the year in which s/he fulfils the requirements for the degree.

## XVI. Conducting Examinations and Examination Offences:

Ordinance Pertaining to Rules for Conducting Examinations and Examinations Offences and Discipline 2003 of Jahangirnagar University will be followed in conducting examinations and dealing with examination offences.

## XVII. Resolving Special Issues:

Any case which is not covered or clearly mentioned in this ordinance will be dealt on the basis of Examination Ordinance of Jahangirnagar University.

# Department of Environmental Sciences
# Jahangirnagar University

Syllabus of Bachelor of Science (B.Sc. Honours) in Environmental Sciences for Academic Sessions: 2017-2018, 2018-2019, 2019-2020 and 2020-2021

## A. Summary of the program:

| Description | Part I | | Part II | | Part III | | Part IV | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | **S1** | **S2** | **S1** | **S2** | **S1** | **S2** | **S1** | **S2** | |
| Theoretical 3 Credits Courses | 4 | 3 | 3 | 3 | 3 | 3 | 4 | 3 | **26** |
| Theoretical 2 Credits Courses | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 0 | **19** |
| Practical Related Courses | 2 | 1 | 2 | 1 | 2 | 1 | 0 | 0 | **09** |
| Field Related Courses | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | **03** |
| Project Work/Internship | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | **01** |
| Viva voce | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | **08** |
| **Credits per Semester** | **19** | **20** | **20** | **20** | **20** | **20** | **19** | **13** | **151** |

## B. List of the courses:

| Year | Semester | Course No. | Course Title | Credits |
|---|---|---|---|---|
| **1st Year** | **S1** | 1111 | Introduction to Environmental Sciences | 3 |
| | | 1113 | Foundation of Earth Sciences | 3 |
| | | 1115 | Foundation of Biotic Environment | 3 |
| | | 1117 | Foundation of Chemistry | 3 |
| | | 1112 | Mathematics for Environmental Sciences | 2 |
| | | 1121 | Laboratory Work on Qualitative and Quantitative Analysis | 2 |
| | | 1122 | Laboratory work on Biotic Component of the Environment | 2 |
| | | | Viva voce | 1 |
| | **S2** | 1211 | Environmental Chemistry | 3 |
| | | 1213 | Soil Science | 3 |
| | | 1215 | Ecology | 3 |
| | | 1212 | Physics for Environment | 2 |
| | | 1214 | Statistics for Environment | 2 |
| | | 1216 | Meteorology and Climatic Processes | 2 |
| | | 1223 | Laboratory work on Earth and Environmental Sciences | 2 |
| | | 1231 | Field Work in Environmental Sciences-I | 2 |
| | | | Viva voce | 1 |
| **2nd Year** | **S1** | 2111 | Biodiversity and Nature Conservation | 3 |
| | | 2113 | Waste management | 3 |
| | | 2115 | Atmospheric Sciences and Pollution | 3 |
| | | 2112 | Environmental Economics and Population Dynamics | 2 |
| | | 2114 | Environment, Society and Culture | 2 |
| | | 2116 | GIS and Remote Sensing | 2 |

| Year | Semester | Course No. | Course Title | Credits |
|---|---|---|---|---|
| | | 2124 | Laboratory work on Environmental Chemistry | 2 |
| | | 2125 | Laboratory work on GIS and Remote Sensing | 2 |
| | | | Viva voce | 1 |
| | | 2211 | Energy and Environment | 3 |
| | | 2213 | Hydrogeochemistry | 3 |
| | | 2215 | Radioactivity and Radiation health physics | 3 |
| | | 2212 | Limnology and Oceanography | 2 |
| | **S2** | 2214 | Hydrology and Water resources | 2 |
| | | 2216 | Environmental Microbiology | 2 |
| | | 2226 | Laboratory work on Environmental Survey and Monitoring | 2 |
| | | 2232 | Field Work in Environmental Sciences-II | 2 |
| | | | Viva voce | 1 |
| **3rd Year** | | 3111 | Environmental Biogeochemistry | 3 |
| | | 3113 | ICZM and Floodplain Management | 3 |
| | | 3115 | Hydrogeomorphology and Climate of Bengal Basin | 3 |
| | | 3112 | Sustainable Development | 2 |
| | **S1** | 3114 | Environmental Analytical Chemistry | 2 |
| | | 3116 | Environmental Biochemistry | 2 |
| | | 3127 | Laboratory work on Ecology and Environmental Microbiology | 2 |
| | | 3128 | Laboratory work on Environmental Data Handling and Simulation | 2 |
| | | | Viva voce | 1 |
| | | 3211 | Industrial Ecology | 3 |
| | | 3213 | Industrial Waste Management | 3 |
| | | 3215 | Environmental Ethics, Policies and Regulations | 3 |
| | | 3212 | Academic Development and Employability | 2 |
| | **S2** | 3216 | Ecotoxicology | 2 |
| | | 3218 | Agriculture and Environment | 2 |
| | | 3229 | Integrated Laboratory Work on Environmental Pollution and Remediation | 2 |
| | | 3233 | Field Work in Environmental Sciences-III | 2 |
| | | | Viva voce | 1 |
| **4th Year** | | 4111 | Instrumentation in Environmental Sciences | 3 |
| | | 4113 | Environmental Assessment and Planning | 3 |
| | | 4115 | Public Health and Sanitation Engineering | 3 |
| | | 4117 | Environmental Modeling | 3 |
| | **S1** | 4112 | Environmental Hazards and Disaster Management | 2 |
| | | 4114 | Occupational Health and Safety | 2 |
| | | 4116 | Emerging Technologies in Environmental Sciences | 2 |
| | | | Viva voce | 1 |
| | | 4211 | Research Methodology, Project Development and Article Writing | 3 |
| | | 4213 | Global Climate Change | 3 |
| | **S2** | 4215 | Environmental Pollution and Mitigation | 3 |
| | | 4244 | Project work and Presentation | 3 |
| | | | Viva voce | 1 |

## C. Detail Syllabus

## FIRST YEAR FIRST SEMESTER

***Course No. Env- 1111***
**Introduction to Environmental Sciences (3 Credits, 100 Marks)**

Summary of Content:

1. Basic concept of Environmental Sciences: History, definition, scope and goal of environmental sciences, it relation to other disciplines of science, state of environmental awareness in society, environmental issues: Greenhouse gases, global warming, acid rain, ozone layer depletion, climate change and sustainable development and action oriented programs in Bangladesh and South Asia
2. Multidisciplinary nature of environmental Sciences: Historical and philosophical basis, concept of Gaia: the interconnectedness of lithosphere, hydrosphere, atmosphere and biosphere, biogeochemical cycles of some important elements
3. Ecosystems, biodiversity and its conservation: Structure and function of an ecosystem, Ecological succession, Food chains, food webs and ecological pyramids, value of biodiversity, biodiversity at local, national and global levels, Conservation of biodiversity
4. Natural Resources and sustainability: Renewable and non-renewable resources, Natural resources and associated problems, Role of an individual in conservation of natural resources, Equitable use of resources for sustainable lifestyles.
5. Environmental Pollution: Causes, effects and control measures of Air Pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution and Nuclear hazards, causes and effects of urban and industrial wastes, Role of an individual in prevention of pollution, Concept of Disaster (Floods, earthquakes, cyclones and landslides).

Learning Outcomes:

1. Knowledge of the general issues of environmental sciences
2. Understanding of the multidisciplinary nature of environmental sciences
3. Understanding of the basic concept of natural resources and sustainability

Recommended books

1. Environmental science earth as a living planet by Daniel B.Botkin, E.A.K., John Wiley and Sons inc., 1998.
2. Environmental science by Miller.Jr., G.T..
3. Environmental Chemistry by S.E. Manahan, 8th Edition, Lewis Publishers, 2000.

***Course No. Env- 1113***
**Foundation of Earth Sciences (3 Credits, 100 Marks)**

Summary of Content:

1. Introduction to Earth Sciences: Definitions of Earth Sciences (Geological Sciences) and Environmental Science. The scope and subdivisions of geography and Geological Sciences. Relationship between geography, geology and Environmental Sciences.

2. The Universe, Solar System and the Planet Earth: Big-Bang theory, solar system, different planets, origin of the solar system, Interior of the earth, compositions and physical properties of different layers, geothermal gradient.
3. Minerals and Rocks: Mineral's chemistry, definition, physical properties, common minerals - silicate minerals, carbonate, phosphate, and sulfate minerals, ore minerals; Classification, formation, origin and characteristics of different types of rocks.
4. Paleoenvironmental study: fossil, types of preservation, preservation conditions of fossils, types of evolution, reasons of extinction and methods of paleoenvironmental analysis (geologic time, absolute vs relative time, radiometric and relative dating techniques, and geologic time scale).
5. Plate Tectonics: Continental drift, plate tectonics, plate margin, continental collision, cause of plate tectonics, relation amongst plate tectonics, continental crust and mountain building.
6. Minerals Resources: Types, amount, and origin of mineral deposits in Bangladesh, prospect and useful mineral substances, natural gas and petroleum reserve in Bengal basin.

Goals and outcomes:

Physical environment of Earth system plays a unique and essential role in today's rapidly changing world. It is an integrated study of the Earth's history, composition, and structure, its atmosphere and oceans, and its environment in space. Knowledge of Physical environment is important because most human activities are related to interaction with the planet Earth. Basic knowledge about the Earth, then, is the key to development of an informed citizenry.

Recommended References:

1. Skinner, B.J. & Porter, S.C., 1995, The Dynamic Earth, 3rd Edn, John Wiley & Sons, Inc., New York.
2. Judson, S. and Kauffman, M.E, 1990, Physical Geology, Prentice-Hall Inc., New Jersey.
3. Miller, R.W. & Donahue, R.L. 1997, Soils in Our Environment, Prentice-Hall Inc.

***Course No. Env- 1115***
**Foundation of Biotic Environment (3 Credits, 100 Marks)**

Summary of Content:

1. Concept of Biotic Environment: Biological structure and function of living organism in natural environment; Understanding of hierarchical biotic organization.
2. Life: Characteristics, Origin of Life, Evolution of Life; Ecosystem people and Biosphere people.
3. Classification of plants: Artificial, Natural and Phylogenetic systems of classification of plants; Outline of Whittaker's system of classification.
4. Taxonomy, Systematic and Herbarium: Taxonomy and Systematic and their objectives, Principles of nomenclature, author citation, conserved name; Herbarium – herbarium techniques, major herbaria of the world; Bangladesh National Herbarium; Species concept and Taxonomic categories.

5. Bacteria and Virus: Archaebacteria and Eubacteria, Gram negative and Gram positive bacteria, Growth of Bacteria, Mycoplasma, Bacteriophage and its multiplication, Economic and Ecological importance of bacteria and virus.
6. Fungi, Algae and Plankton: General characteristics, classification, salient features of different classes, economic and ecological importance of fungi, algae and plankton.
7. Ecological and economic significance of bryophytes and pteridophytes; ecological and economic significance of higher plants and animals.
8. General characteristics and classification of animal phyla.

**Learning Outcomes**: On successful completion of the module, students will be able to:
1. Understand about biotic components of environment.
2. Explain the role and significance of biotic components in environment.

**Recommended References:**


1. Pelezar, M.J. Chan. E.C.S. and Krieg. N.R. 1993. Microbiology. Concepts and Applications. McGaw-Hill Inc.
2. Ashrafuzzaman, H. 1991. A text book of plant pathology. Bangladesh Agricultural Research Council.
3. Storer, T.I & R.L. Usinger, 1979. General Zoology, (3rd Edition), Oxford University Press. Inc. New York.
4. Pandey. B.P, 1985. A text book of Botany. Angiosperms. S. Chand and Campany Ltd. New Delhi.


***Course No. Env- 1117***
**Foundation of Chemistry (3 Credits, 100 Marks)**

Summary of Content:

1. Solutions and Colloids: Types of solutions, concentration units, Henry's law, Nernst distribution law, solvent extraction, solution of non-electrolytes, vapour pressure lowering, boiling point elevation, freezing point depression, osmotic pressure, determination of molecular weight of solute from measurement of these properties, colligative properties of electrolytes, Colloids: Colloidal dispersions, some properties of colloids, colloidal pollutants.
2. The Periodic Law and Modern Periodic Table: Some periodic properties of the elements: metallic behaviour, atomic size, ionization energy, electron affinity and electronegativity, classification of elements.
3. Concepts of Chemical Bonds and Shapes of Molecules: Causes of reactivity of the elements and the octet rule, ionic, covalent and coordination bonds, preliminary treatment of the valence bond theory and the molecular orbital theory, hydrogen bond, metallic bond, van der Waals forces General Concept of Oxidation-Reduction and Acid-Bases: Oxidation number and oxidation-reduction processes, balancing oxidation-reduction reactions, different concepts of acids and bases, relative strengths of acids and bases.
4. Kinetics of Chemical Change: Definition of rate of a reaction, experiment determination of the rate of a reaction, factors affecting the rates of reaction, dependence of rate on concentration: the rate law, units of rate constants, determination of the rate law: determination of order of reactions, some typical reactions, complex reaction, influence of temperature on reaction rates, transition state theory, the rate law and mechanism of

reaction, molecularity and order of reactions, unimolecular reaction: Lindeman's mechanism.

5. Adsorption-filtration: Definition, types of adsorption, adsorption isotherm, adsorption of solutes by solids, hysteresis curves, thermodynamic properties, modes of adsorption by natural and synthetic adsorbents, application of adsorption-filtration process, desorption of solute particles, Mesoporous materials: Porous solids, classification of pore sizes, development of mesoporous supports, preparation of mesoporous materials.
6. Organic Chemistry: General classification of organic compounds, structure, conformation, nomenclature, preparation, physical and chemical properties of different hydrocarbons (alkanes, olefenes, acetylenes, dienes and polymer), A General Concept on Preparation, Physical and Chemical Properties, Reaction Type and Structure of alcohols, aldehydes, ketones, carboxylic acid and amines.

Recommended References:

1. Principles of Physical Chemistry, M.M. Haque and M.A. Nawab (Student Publications).
2. Introduction to Modern Inorganic Chemistry, S.Z. Haider.
3. Organic Chemistry, R.H. Morrison and R.N. Boyd, Prentice-Hall, Inc.

***Course No. Env- 1112***
**Mathematics for Environmental Sciences (2 Credits, 100 Marks)**

Summary of Content:

1. Functions and their graphs for real numbers; limit and continuity; derivatives of elementary functions; chain rule; higher derivatives; partial derivatives; total differential; application to geometry-tangent, normal, maxima and minima, asymptotes.
2. Indefinite integral as inverse of derivatives; techniques of integration; definite integral as limit of a sum, interpretation as areas; determination of length and area of plane curve, beta and gamma functions.
3. Ordinary differential equations; general principles; elementary standard types; linear equation with constant co-efficient.
4. Matrix: Representing linear systems of equations with augmented matrices; matrix operations and transformations and applications.
5. Summation of finite series (both algebraic and trigonometric).

**Learning Outcomes:**

1. To gain the basics of mathematics required for environmental science and engineering.
2. Be prepared for the Laboratory work on Environmental Data Handling and Simulation course (course no. 317).

Recommended References:

1. Introduction to Applied Mathematics for Environmental Science, Parkhurst, David F, 2006, Springer.

***Course No. Env- 1121***

**Laboratory Work on Qualitative and Quantitative Analysis (2 Credits, 100 Marks)**

1. Introduction: Laboratory protocol, code of conduct, laboratory wears, safety rules, laboratory waste disposals, laboratory log book, acquaintance with common laboratory glassware and apparatus, characteristics of corrosive, hazardous and flammable liquids, primary and secondary standard substances, minimisation of parallax, operational and personal errors, representative data, laboratory data interpretation, dimensional analysis (factor-label method), calculation of equivalent weights of oxidizing agents, mass percentage, theoretical and percentage yield, calculation of strengths of standard solution, percentage of error calculation.
2. Preparation of Solutions: Preparation of normal and molar solution of common acid and bases, preparation of normal solution of oxidizing and reducing reagents (e.g, potassium dichromate, sodium thiosulfate, ferrous ammonium sulfate), preparation of dilute solutions, series dilution and strengths calculation of primary standard substances.
3. Acid-Base Reaction: Standardisation of base against standardise acid, standardisation of acid against standardise base.
4. Oxidation-Reduction Reaction: Determination of ferrous iron, ferric iron and total iron by oxidation with standard potassium dichromate solution.
5. Identificaton of cation and radicals by systematic qualitative analysis (group test).
6. Identification of anionic species by systematic qualitative analysis (group test).

***Course No. Env- 1122***

**Laboratory Work on Biotic Component of the Environment (2 Credits, 100 Marks)**

Summary of content:

1. Introduction to laboratory; Microscopic Technique; Preservatives, Stains and Mounting Media.
2. Identification and characterization of fungi, algae and aquatic macrophytes.
3. Study of bryophytes and pteridophytes.
4. Demarcation of phytoplankton and zooplankton.
5. Study of bacterium: Staining technique.
6. Preparation of herbarium sheet and preservation of fauna.
7. Identification and characterization of Chondicthis and Osteicthis.
8. Preparation of field and laboratory note book.

**Viva voce** **(1 Credit)**

## FIRST YEAR SECOND SEMESTER

***Course No. Env- 1211***
**Environmental Chemistry (3 Credits, 100 Marks)**

Summary of Content:

1. Environmental Chemistry: Definition, relationship with other chemical sciences, e.g., inorganic chemistry, organic chemistry, biochemistry, geochemistry and biogeochemistry
2. Redox Processes in Aquatic Environment: Significance, half-reaction, electron activity and pE, Nernst equation and its application, chemical equilibrium, Species diagram of carbon dioxide in water, pE and free energy, pE-pH diagram for iron system, redox reaction and corrosion.
3. Water Pollution: Nature and types of water pollutants, elemental pollution and their determination, heavy metals, Cd, Hg, Cr etc., metalloids e.g. Arsenic in groundwater of Bangladesh, organic pollutants, pesticides in water, polychlorinated biphenyls.
4. Atmospheric Chemistry: Importance of the Atmosphere, Evolution of atmosphere, Inversions and Air pollution, Global climate and Microclimate, Carbon Cycle and Atmospheric Carbon dioxide, Reactions of Atmospheric oxygen and Nitrogen, Aerosols, their direct and indirect effects: Aerosol properties, sources and production mechanisms of atmospheric aerosols, direct and indirect forcing associated with aerosols.
5. Air Pollution: Atmospheric pollutants, Inorganic gasses, Organic and organic sulphites and particulate oxides of sulphur and nitrogen, urban air pollution, Mitigation of urban air pollution.
6. Environmental Soil Chemistry: Soil and agriculture, Nature and composition of soil, Acid-base and Ion-exchange reactions in soils, Wastes and pollutants in soil, Soil loss and degradation.
7. Ocean pollution: Sewage - source and effects of some marine pollution, toxic pollutants - antifouling paints, DDT, dioxins, PCBs; oil on water, marine debris - fishing gears, plastics.

Recommended References:

1. Environmental Chemistry, S.E. Manahan, 7th Edn, Lewis Publishers, 2000.
2. Environmental Chemistry of Soil, M. McBride.
3. A Guide to the study of Environmental Pollution, William Andrews (Edn).

***Course No. Env- 1213***
**Soil Science (3 Credits, 100 Marks)**

Summary of Content:

1. Introduction, function, formation and horizon of soils; soil clay minerals, organic matter (humic substances) and ion exchanges.
2. Major soil nutrients: Nitrogen, Potassium & Phosphate; soil acidity and alkalinity and 'Redox' reactions in soil; trace element in soils.
3. Soil texture and structure; soil water content and soil water potential
4. Soil aeration and soil water movement; soil erosion and soil compaction
5. Introduction to life in the soil, soil biological processes; soil bioremediation & reclamation, soils of Bangladesh.

Learning Outcomes:

On successful completion of the module, students will be able to:

1. Explain the processes governing nutrient transformations and dynamics in soils.
2. Describe the role of soil texture and structure in governing soil physical processes.
3. Discuss the functions of soil biota in soil as a medium for plant growth"

Reference books

1. Brady N.C., and Weil, R. R. 2002. The nature and properties of soils. 13th Ed, prentice Hall, USA.
2. White, R.E. 2006. Principles and Practice of Soil Science (4th Edition, ebook), Blackwell Science, Cambridge.
3. In addition, lecture notes will be enriched with materials from a number of sources and recently published paper and.

***Course No. Env- 1215***

**Ecology** **(3 Credits, 100 Marks)**

Summary of content:

1. Introduction: Definition of Ecology, Scopes and Subdivisions of Ecology.
2. Ecosystem ecology: Concept of ecosystem, components – biotic and abiotic components, structure and functions of ecosystem, ecosystem services, classification of ecosystem, ecosystem dynamics; nutrient and energy flow in ecosystem – flux of matter and energy through ecosystem; Limiting factors; Carrying capacity.

3. Population Ecology: Population, Outlines of autecology, significance of autecological study, Population dynamics, population structure, population growth, factors regulating population size; Meta-population; Modelling population dynamics.
4. Community Ecology: Characteristics and composition of community, community types, life-form, biological spectrum, physiognomy, succession, community development, community dynamics; Concept of meta-community ecology; Basic patterns and elementary processes, interspecific interactions in communities, Competition: Mechanisms, Models and Niches – Models of community composition and dynamics; Assessment of Diversity Index.
5. Species Interactions: Direct and indirect effects of species interactions in communities; Factors influencing interactions among species; Models of predation in communities-Simple predator-prey models, Models of predation on more than one prey; Understanding of interaction strength; Models of mutualistic interactions; Factors influencing interactions among species.

**Learning Outcomes**: On successful completion of the module, students will be able to:
1. Understand the principles and fundamental concepts of ecology, ecosystems, population and community.
2. Analyse the concepts of energy flow and strength of species interaction
3. Explain ecological factors and the impacts of anthropogenic activities on environment.

**Textbook**
1. William G. Hopkins. 2002. Introduction to Plant Physiology, 2nd edition, John Wiley and Sons. Inc. New York.

***Course No. Env- 1212***
**Physics for Environment (2 Credits, 100 Marks)**

Summary of content:

1. Introduction: scope and applications of physics in environmental sciences, measurement-physical quantities, standards and units, international systems of units, dimensional analysis.
2. Introductory concepts of electricity, magnetism, gravity and relevant basic laws.
3. Sound and Noise: Basic acoustics, human perceptions and noise criteria, transmission of noise, reducing the transmission of noise.
4. Heat transfer: Mode of heat transfer, conduction, convection; heat transfer and change of state; Radiation-emission power and absorption power, different laws of radiation, black body radiation.
5. Thermodynamics: First and second law of thermodynamics, internal energy, antrophy, enthalphy, Carnot's cycle, thermal efficiency, third law of thermodynamics.
6. Fundamental concepts of hydrostatics and hydrodynamics: hydrostatic change of pressure with elevation, equilibrium of floating bodies, forces against a dam, equation of continuity, Bernoulli's equation, viscosity and coefficient of viscosity.

Learning outcomes:

1. To provide an understanding and appreciation of physical laws and theories in evaluating environmental process.
2. Acquire knowledge on hydrostatics and hydrodynamics, transfer of heat and radiations and their application in environmental systems.
3. Acquire knowledge on thermodynamics and its application in interpreting environmental processes.

Recommended References:

1. E. Boeker, R. van Grondelle, Environmental Physics, John Wiley and Sons., 1996.
2. Halliday, Resnick, Krane, Physics Vol I and II 4th Edition, 1994.

***Course No. Env- 1214***
**Statistics for Environment** **(2 Credits, 100 Marks)**

Summary of Content:

1. Basic Concepts: Variable – quantitative, qualitative, random, discrete and continuous random; Sample; Population; Error – relative error and absolute error; Data – quantitative and qualitative; Frequency distribution; Presentation of quantitative data – histogram, frequency polygon, frequency curve, line chart, cumulative frequency diagram, scatter diagram; Presentation of qualitative data – bar diagram, pie diagram, picture diagram, map diagram
2. Measures of location: Definition of measures of central tendency averages – mean, mode, median; Definition of percentiles; Exercises
3. Measures of dispersion: Definition of range, quartile deviation, mean deviation, variance, standard deviation, co-efficient of variation; Exercises
4. Relationship between variables: Regression analysis – concept of linear regression, equation of linear regression, definition of regression coefficient (β), familiarize with curvilinear regression graphs and their equations; Correlation analysis – concept of correlation analysis; Exercises.
5. Probability distribution and hypothesis testing: Definition of normal distribution and skewness, properties of normal distribution; Introduction to hypothesis testing – concepts of null hypothesis, alternative hypothesis, one-tailed test, two-tailed test, type I error, type II error, degree of freedom, level of significance, *p*-value, *t*-test, *F*-test, *Z*-test; Exercises.

References:

1. Agarwal B.L., 1991, Basic Statistics, 2nd edition, Wiley Eastern Ltd., New Delhi, India.
2. Mostafa M.G., 1989, Methods of Statistics, 4th edition, Karim Press and Publications, Dhaka, Bangladesh.
3. Mahajan B. K., 2002, Methods in Biostatistics, 7th edition, Jaypee Brothers, Medical Publishers (P) Ltd., New Delhi, India.

Learning Outcomes:

On the successful completion of the Course, students will be able to:

1. Know the preliminary knowledge of the statistics to understand published data
2. Explain and represent the personal research data at the initial stage
3. Be prepared for the Laboratory work on Environmental Data Handling and Simulation course (course no. 317).

***Course No. Env- 1216***
**Meteorology and Climatic Processes (2 Credits, 100 Marks)**

Summary of Content:

1. Meteorology: Definition, Scope and Sub-classifications, History of meteorology, Nature, origin and composition of the atmosphere, Vertical divisions of the atmosphere; Meteorological equipment and Weather forecasting: Surface measurements, Application of remote sensing, Satellite observation.
2. Heating Earth's Surface and Atmosphere: Solar Insolation of the earth and heat budget, Variability of insolation, World distribution of insolation, Vertical distribution of temperature
3. Water balance of the atmosphere: Humidity, Physical changes of state of water Processes of cooling to produce condensation and sublimation, Clouds formation and classification, Fog formation and type, Precipitation, causes, forms and types.
4. Air Pressure and Winds: Pressure, vertical distribution of pressure, Pressure gradient and wind, Factors affecting wind speed and direction; General atmospheric circulation, Seasonal changes in the general circulation, Oceanic circulation, Monsoon, local winds, mountain and valley breeze; Stability and instability, air masses sources region and classification, Extra tropical cyclone, anti-cyclone, Thunderstorms.
5. Climate controls and Climate: Definition, production of climates, Climatic classification of the world and Worlds climatic regions, the role of oceans, El Nino-Southern Oscillation (ENSO) events, La Nina events, preliminary concepts of climate change.

**Learning outcomes:**

Meteorology and Climate Science help us to understand and predict changes in the Earth’s atmosphere. Climate change, air pollution and severe meteorological events are crucial environmental issues. The demand for knowledge and practical skills in atmospheric science is increasing. Climate studies and meteorology is an interdisciplinary study that focuses on the activity and changes of the atmosphere as well as weather patterns, on the other side. Meteorology and climate studies can be applied in military, energy production, agriculture, transport or constructions, among other fields, resulting in vast employment opportunities. Graduates can become weather forecasters in the public or private sector, forensic or broadcast meteorologists or even teachers.

Recommended References:

1. Franklyn W. Cole, Introduction to Meteorology, 3rd Edition, John Wiley and Sons.
2. Atmosphere, weather and climate, 7th Edition, Roger G. Barry and R. J. Chorley.
3. Edward Bryant, Climate Process and Change, Cambridge University Press, 1997.
4. Trewartha and Horn, An Introduction to Climate, 5th Edition.

5. IPCC report (recent edition)

***Course No. Env- 1223***
**Laboratory Work on Earth and Environmental Sciences (2 Credits, 100 Marks)**

1. Identification of rocks and minerals on hand specimen
2. Environmental surveying, Topo-sheet and map reading.
3. Subsurface geologic data interpretation.
4. Identification of physical components of environment in Jahangirnagar University campus.

***Course No. Env- 1231***
**Field Work in Environmental Sciences-1 (2 Credits, 100 Marks)**

Field visit is to document the aspects of environment and evaluate its interactions in the ecosystem.

**General observations:** To know the different aspects of environment and understanding its interactions in the ecosystem through the field visit, so, following observations can be conducted in the study area. To understand different ecosystems and identify its characteristic. Its biotic and a-biotic aspects of the ecosystem and documenting what we see. To observe the geomorphology and physiographic condition, geology and structure, climate, soil, water body, biodiversity of the study area. How does an ecosystem function? What are the links between different species with each other's and with their habitat? Observe its food chains. Ecosystem user and its sustainability. Associate component of field visit: To learn how to use GPS for location identification, how to measure the field distance and plotting on base map, how to collect and preserve water, soil and biological sample and its documentations (labeling, storing and writing descriptions of the in situ condition), how to interact with the local people and acquires the information's or data from them, how to select the sample person or group in the field, what would be the sampling method and frequency? etc.

**Study area:** To understand the natural phenomena of environment, the study area should be such an area where we can meet our all aspects as much as possible. In these considerations, it can be Sitakundo, Chittagong district; Teknaf, Cox's bazaar; Jaflong, Sylhet; Rangamati, Chittagong hilltracts etc.

**Duration of field work:** 5 to 15 days

***Viva voce*** ***(1 Credit)***

## SECOND YEAR FIRST SEMESTER

***Course No. Env- 2111***
**Biodiversity and Nature Conservation (3 Credits, 100 Marks)**

Summary of Content:

1. History of conservation biology, Fields with which conservation biology interfaces; conservation and law, Characters of effective conservation law, Problems of conservation law in application. Conserving genetic diversity, protecting endangered species, Designing biodiversity preserves, Conserving and society, conservation economics and public policy. Management categories for conservation: Techniques and methods of biodiversity conservation; management categories for conservation. International geosphere - biosphere program (IGBP); World Conservation strategy; IBP and MAB Programs.
2. Global Biodiversity: Components of biodiversity; Richness of life on the earth; Measures of diversity; A framework for managing biodiversity; Defining priorities for conservation and sustainable use; Protecting and restoring ecosystems, species, populations and genetic diversity; Legal measures for sustainable use and protection of biodiversity; Building capacity for biodiversity management, Biodiversity prospecting.
3. Forest, Wildlife and wetland resources of Bangladesh and their conservation: Forest resources of Bangladesh as resource base and their conservation. (a) Wildlife management in Bangladesh (b) Wildlife management principles: Ecological basis, hunting refuges, predator control, artificial stocking, carrying capacity, habitat improvement, interspersion, territories, diseases (c) List of extinct wildlife of Bangladesh. Protected areas of Bangladesh. Wetlands of Bangladesh as resource base and their management practices.
4. Application of biotechnology for utilization of biodiversity: Improve production and sustainability, Molecular marker for rapid selection, Disease screening. Study on qualitative, Quantitative and Synthetic characters of plant.
5. Using biodiversity for environmental remediation: Limiting factors of bioremediation, Different types of environmental contaminants, BTEX, PCB degradation, Niche adjustment to accommodate cc4l Chlororespiration, bioremediation technologies.

Recommended References:


1. Global Biodiversity Assessment, V.H. Heywood 1995, UNEP
2. Conservation Biology, 1997, George W. Cox., Wm. C. Brown Publishers, Londo
3. Conservation Biology.-Fred Van Dyhe.


***Course No. Env- 2113***
**Waste Management (3 Credits, 100 Marks)**

Summary of Content:

1. Introduction: Definition, classification of waste, Characteristic of solid waste, impacts and environmental consideration.

2. Solid waste management: collection system, solid waste collection estimate and cost, waste transfer, maximum and economic haul time, disposal techniques, modes of operation, utilization of waste to energy production, resource conservation and recovery, low, high and medium technology.
3. Hazardous waste management: Types of hazardous waste, risk perception and risk assessment, toxicity consideration, one-hit mode, reasonable maximum exposure, risk characterization and risk management, transport regulations, disposal protocols.
4. Municipal and household wastes management: Disposal design, recovery and recycling of household wastes, domestic garbage, bulk treatment on commercial scale, recycling of paper.
5. Emerging Technologies for waste Management : (A) Power generation through incineration technology from waste (B) Recycling technologies of plastics and thermo-plastics

Learning Outcomes

1. To be able to understand the implications of the production, resource management and environmental impact of solid waste management.
2. To be able to understand components of solid waste management infrastructure systems to minimize the above effects.
3. To be aware of the significance of recycling, reuse and reclamation of solid wastes.
4. To be familiar with relationships between inappropriate waste management practices and impacts on water, soil and sediment quality.

Recommended References:

1. Introduction to Environmental Engineering, M. L.. Davis, D. A. Cornwell, 3rd edn, McGrawHill, 1998.
2. Environmental Chemistry, S. E. Manahan, 7th end, Lewis Publishers, 2000.
3. Introduction to Environmental Engineering and Science, G. M. Masters, Prentice-Hall Inc., 1991.

***Course No. Env- 2115***
**Atmospheric sciences and pollution (3 Credits, 100 Marks)**

Summary of Content:

1. Introductory overview of atmospheric science, the earth system and atmospheric thermodynamics, Radiative transfer, cloud microphysics, atmospheric dynamics.
2. Air quality: Nitrogen oxides, sulfur dioxide, Volatile organic compounds, Ozone, aerosols, greenhouse gases, air quality criteria and standards, International air pollution issues, effects of air pollution on health, living systems, and environments
3. Physical and chemical characteristics of gaseous and particulate air pollutants: Chemical compositions, chemical cycles and mass balance, Chemical reactions, aerosols, Radiation, atmospheric transport, atmospheric mass balance.

4. Classification, pathways and atmospheric reactions of air pollutants, air pollution meteorology, air quality information systems, Impacts of air pollutants on living and non-living environments. Sources of air pollution (natural, anthropogenic, mobile, stationary),
5. Measurement/monitoring/sampling, air pollution chemistry, photochemistry, deposition, transport and dispersion of air pollution, Engineering control of pollutant sources, airshed planning (regulatory and land use controls).

Learning Outcomes

Upon completion of this course, you will be able to do the following:

1. Describe the layers of the atmosphere and understand the chemical cycles that occur in them.
2. Describe the physical process and chemical reactions by which chemicals move from one position to another and photo chemically processed to another compound.
3. Understand current issues in stratospheric chemistry, particularly dealing with the ozone layer and aerosols in the upper atmosphere.
4. Gain a systematic understanding of air pollution, including: sources, emissions, health, and environmental effects, chemistry, engineering and legislative controls.
5. This course is intended to serve as a pre-requisite for the Course No: 422 (Global climate change)

Reference books:


1. Earth's Climate: Past and Future: 2nd (second) Edition, William F. Ruddiman, 2008
2. Atmospheric science: an introductory survey (second edition). John Wallace and Peter B. Hobbs, University of Washington, Elsevier.
3. Atmospheric science: an introductory survey (second edition). John Wallace and Peter B. Hobbs, University of Washington, Elsevier.
4. Fundamentals of Air Pollution, Elsevier, 5th Edition, SanDiego, Daniel Vallero, 2014


***Course No. Env- 2112***
**Environmental Economics and Population Dynamics (3 Credits, 100 Marks)**

Summary of Content:

1. Introduction to the key concepts from environmental economics: The environment as a social asset; GDP concepts; Environment and Growth, Economic Efficiency: Markets; Market failures; Government regulation; Economics of Environmental Quality; Framework of Analysis, Benefit-Cost Analysis: Benefits; Benefit-Cost Analysis: Costs.

2. Strategic interactions: Coase Theorem; Tragedy of the Commons; Transactions costs and institutions; Natural Resource Economics, Types of pollutants; Short run and long-run Choices.

3. Valuing the environment: Welfare economics; efficiency and optimality in allocation; approaches to environmental evaluation.

4. Environmental policy instruments and implementation: Criteria for Evaluating Environmental Policies; Decentralized Policies: Liability Laws, Property Rights, Moral Suasion; Command-and-Control Strategies: The Case of Standards; Incentive-Based

Strategies: Emission Charges and Subsidies; Incentive-Based Strategies: Transferable Discharge Permits; Common and control policies in different areas e.g. water policy design and implementation; biodiversity; trade, deforestation; tropical deforestation and poverty; preservation and conservation; climate change; carbon trading; international co-operation; Kyoto Protocol

5. Population Dynamics: Fertility; Measures and Determinants, an Economic Model of Family Size, Fertility Trend in Bangladesh, Mortality Measures, Determinants and consequences, Malthus-Optimum Concept of Population Growth:, Theory of Demographic Transition, Harris-Todaro Model of Migration, Population and Environment, population policy and programme in Bangladesh.

Learning Outcomes

1. To apply essential concepts, such as market failure, household behavior, transaction costs and willingness to pay to the learning of environmental economics
2. To be acquainted with the main tools used to value environmental goods and services and to critically evaluate alternative environmental policy instruments.
3. To develop written and verbal skills in communicating interdisciplinary nature of environmental problems from an analytical and an environmental economic perspective.

Reference books:

1. Field, Barry C. and Martha K. Field Environmental Economics, 5th Edition (San Francisco, CA: McGraw-Hill, 2009).
2. Titenberg T. and Lewis L. Environmental & Natural Resource Economics 8th Edition. (Prentice Hall; 8 edition (July 31, 2008)
3. Weeks, R. 2007. POPULATION: An Introduction to Concepts and Issues Tenth Edition

***Course No. Env- 2114***
**Environment, Society and Culture (3 Credits, 100 Marks)**

Summary of Content:

1. Environmental sociology: Concepts-Existential dualism, Neo-Malthusianism , New Ecological Paradigm, Eco-Marxism, Ecological modernization and reflexive modernization , Social construction of the environment, Modern environmentalism, Historical studies
2. Basic concepts on environment, society and culture, Social variables and environment, what is meant by "culture"? Operationalizing the concept of culture, relations between environment-behavior, culture-environment, the environment as a cultural landscape, organization of space, time, meaning and communication, a system of settings, culture, environment and time, environmental citizenship
3. Environmental thought: past and present, valuing the environment , knowledges and knowing, Political economy of environmental change, Environmental technologies, Redesigning natures, Institutions and policies for influencing
4. Mobility, Society & Change: Multiple motilities of people, objects, messages and ideas – and the complex interconnections, Environmental contexts and current issues, problems and change in the human environment, Introduction to Environmental Politics: Race, Class

and Gender, The Rights of Peoples: Indigenous peoples and the environment, national and ethnic tensions capitalism and crisis, perspectives on environment and development

5. Climate Change and Society, policy and politics of climate change, theoretical perspectives on a range of climate change debates and present alternative arguments.
6. Eco-socialism: Green anarchism, Indigenous rights, Democratic confederalism, Ecological civilization, Red–green alliance, Red–red–green coalition, Socialist Resistance, Eco-capitalism, Ecopreneurship, Enviro-Capitalists: Doing Good While Doing Well, Natural Capitalism, Rural community development
7. Eco modernism: Bright green environmentalism, Pro-nuclear movement, Viridian design movement, Whole Earth Discipline, Green politics, Environmental education , Environmentalism, Environmental awards.

Course outcomes:

Students will acquire new skills to address urgent environmental challenges across environmental policy, conservation, education, public consultation and the arts. In this course, students will gain the ability to answer critical environmental challenges ranging from air quality, food production safety and distribution, loss of critical habitats, issues related to urban growth, climate change, water pollution, and the spread and prevalence of disease. These areas of focus require students to apply and integrate concepts and tools of multiple disciples from across the campus and the community.

References:


1. Jules Pretty, Andy Ball, Ted Benton, Julia Guivant, David R Lee, David Orr, Max Pfeffer, Hugh Ward. Handbook on Environment and Society, SAGE Publishing
2. Hannigan, John, "Environmental Sociology", Routledge, 2014
3. Harper, Charles. 2004. Environment and Society: Human Perspectives on Environmental Issues. Upper Saddle River, New Jersey: Pearson Education, Inc. ISBN 0-13-111341-0


***Course No. Env- 2116***

**GIS and Remote Sensing** **(2 Credits, 100 Marks)**

1. Introduction to different branches of Geographic Information Sciences (Global Positioning System (GPS), Remote Sensing (RS) and Geographical Information Systems (GIS)): Definition, history, functions and uses.
2. Remote Sensing: Fundamentals of RS, Types, Data acquisition techniques (Applications of Multispectral data, Geodetic, Acoustic and near-acoustic), Aerial photographs; various types of satellite, sensors and their characteristics and functions, Data processing and Image analysis, Remote Sensing software, Potentials of remote sensing for agriculture, environment and resource monitoring and management.
3. Geographic Information System (GIS): Techniques used in GIS, Data creation, Relating information from different sources, Data representation (Raster, Vector, Advantages and disadvantages, Voxel, Non-spatial data), Data capture, Raster-to-vector translation, Projections, coordinate systems and registration, Spatial analysis with GIS (Data modelling, Topological modelling, Networks, Cartographic modelling, Map overlay, Automated cartography), GIS software, GIS and Society, Database management systems (DBMS), data quality and errors in GIS, software (Arc-View and IDRISI)
4. Global Positioning System (GPS): Simplified method of operation, System segmentation (Space segment, Control segment, User segment), Calculating positions, Accuracy and error sources (Atmospheric effects, Multi-path effects, Ephemeris and clock

errors, Selective availability, Relativity), and Applications (Military, Navigation, Target tracking, Missile and projectile guidance, Search and Rescue, Reconnaissance and Map Creation, others), DGPS.

5. Application of GIS: Knowledge-based approaches in GIS, information management and environmental research, application of GIS in socio-economic and environmental science, ecological models and GIS, hazard model and GIS, Digital Elevation Model (DEM) and its Applications.

**Recommended References:**


1. Martin, D. 1994. Geographic Information Systems and their Applications, London:Routledge.
2. Peuquet, D.J. and Marble, D.F. 1993 Introductory Readings in Geographic Information Systems, London: Taylor and Francis.
3. Text Book on Remote Sensing, C.S. Agorwal, 1st edition 2000, Wheeler Publishing.


***Course No. Env- 2124***

**Laboratory Work on Environmental Chemistry (2 Credits, 100 Marks)**

1. Preparation and standardization of acid and base solution.
2. Determination of major physical and chemical properties of water and wastewater (pH, EC, turbidity, TDS, TSS, total solids, total hardness, total alkalinity, total acidity, DO, BOD, COD).
3. Determination of the concentration of major metal ions in water and wastewater (Fe, Cu, Pb, Cr, Ni, Ca, Al, N, P, K).
4. Complexometric titration with EDTA as primary standard substance (using Murexide and Solochrome Black/Eriochrome Black T indicator).
5. Gravimetric analysis of some major anions (chloride, carbonate, sulphate, phosphate).

***Course No. Env- 2125***

**Laboratory Work on GIS and Remote Sensing (2 Credits, 100 Marks)**

1. Application of GIS and ArcInfo Software for Agriculture, Landuse, and Forestry.
2. Interpretation of Aerial Photography and Satellite Images for Environmental Applications including Coastal, Fluvial, and Urban Preparation & geoenvironmental map from imaging.
3. Environmental Change Detection using Integrating GIS, Remote Sensing and Topo Map Information.
4. Geohazard and Risk Assessment using Remote Sensing and GIS data.
5. Fields observation of specific sites which are interpreted on respective image.
6. Submission of Field Report, based on satellite imagery and Aerial photograph data analysis and interpretation.

**Viva voce (1 Credit)**

## SECOND YEAR SECOND SEMESTER

***Course No. Env- 2211***
**Energy and Environment** **(3 Credits, 100 Marks)**

Summary of Content:

1. Energy: Definition, forms and classification of energy; Units of energy; Energy usage in past civilisations; role of energy use in the evolution of human civilization; Energy scenario and utilization pattern in Bangladesh.
2. Renewable energy sources (solar energy, hydropower, wind energy, bio-mass, bio-gas, tidal, geo-thermal etc.); advantages and disadvantages of renewable energy; future prospects.
3. Energy use and Environmental Pollution; Impacts of fossil fuel burning at local, regional and global levels; air pollution, climate change, global warming etc.
4. Energy conservation and Efficiency: Energy conversion process and Efficiency; importance of energy conservation, techniques of energy saving in house hold, industrial and transport sector; energy saving initiatives in Bangladesh; improved stove, energy saving bulb, cogeneration etc. and National energy policy of Bangladesh.
5. Energy and Sustainable Development: Concept of sustainable development; Energy resources and estimation of energy reserves and resources: Energy security and crisis Demand for energy services; Energy trade patterns and globalization; Energy prices and taxes; Energy investment; Global and regional energy needs.
6. Economic and Social Issues for Sustainable Energy Development: Energy and economic prosperity: energy consumption and economic well-being; Disparities in Income and energy consumption, Energy intensities.
7. Energy and socio-political issues: Energy and poverty Energy and women Energy and population Energy and urbanization and Energy and life styles;
8. Energy, Environment and Health: Rural energy in the developing countries and impacts; Energy environment and health issues in house hold, workplace, community.
9. Energy and Geopolitical Issues: Politics regarding fossil fuel (oil, coal, gas) at National, Regional and International regarding.

Learning outcomes

This course will provide students with a scientific understanding of energy, energy choices, and their implications for sustaining environment and Earth's living systems. In addition, the course will present different conceptual approaches to the on-going energy problems that confronts human society. Energy conservation, energy efficiency, and the transition to renewable and alternative energy sources will be discussed sufficiently. An important goal for the course is to enable students to evaluate energy choices for a sustainable future

Recommended References:

1. Joseph Priest, Energy Principles, Problems and Alternatives, 3rd Edition, Addision-Wesley Publishing Company.

2. Devid Reed, Editor, Structural Adjustment, the Environment, and Sustainable Development, Earthscan Eastern Publications Ltd. London.
3. K. Srivastava, Sustainable Development. Dragana Pilipovic, Energy Risk, McGraw-Hill.

***Course No. Env- 2213***
**Hydrogeochemistry** **(3 Credits, 100 Marks)**

Summary of Content:

1. Basic concept: Definition, scope and goal of hydrogeochemistry, its relation to Environmental sciences, The hydrologic cycle, residence times and water fluxes, the role of geology, vegetation and anthropogenic impacts on water chemistry, global water budget, water: a unique substance.
2. Physical and chemical properties of water: pH and Buffers, DO, BOD and COD determination, nature of BOD reaction, COD demand, BOD-COD interrelationship, application of BOD and COD data, carboneous and nitrogenous biochemical oxygen demand (C BOD, N BOD), water quality and chemical changes in natural water, Optical properties of water.
3. General chemistry of surface and groundwater: Rain water to groundwater: The saturated zone – groundwater chemistry,
4. Humic and fulvic acids in soils, rivers and lakes: surface chemistry and mobility heavy metal, Metal–ligand interaction in water, solubility and stability of metal ions, adsorption mechanisms on geocolloids and adsorption isotherms.
5. Ionic Equilibrium and precipitation and dissolution: redox equilibrium and electron activity, Redox process and stability diagram, Solutions, clay mineral solubility and equilibria – thermodynamic concepts, the solubility and stability of oxides, hydroxides and carbonates, Silicate weathering process- rates of reaction - chemical kinetics.

Learning Outcomes:

1. Knowledge of the hydrologic cycle and processes
2. Understanding of the physical and chemical properties of water
3. Understanding of the basic concept of water resource planning & management

Reference books

1. Appelo C.A.J. & Postma D. (2006) Geochemistry, groundwater and pollution. Balkema, 2nd Ed
2. Kiely, G., 1998, Environmental Engineering, McGraw-Hill.
3. Raghunath, H.M., Hydrology: Principles, Analysis and Design

***Course No. Env- 2215***
**Radioactivity and Radiation Bio-Physics (3 Credits, 100 Marks)**

Summary of Content:

1. Basics of radioactivity: Ionizing radiation; origin of radioactivity; natural and artificial radioactivity; alpha, beta and gamma-ray radiation; radioactive series, differential equation of radioactive series, applications of radiation.
2. Radiation detection: Interaction of radiation with matter; radiation detection principles, different types of radiation detectors; units of radioactivity.
3. Effects of radiation: Effects of radiation on human body; routes of entry of radiation; syndrome associated with radiation exposure, radiation damage, treatment of radiation exposure.
4. Radiation protection: basics of radiation protection, radiation absorber, radiation dosimetry, maximum permissible dose (MPD) relative biological effectiveness (RBE), annual limit of intake (ALI); personal protective devices.
5. Handling of radioactive waste: Radioactive waste, principles of handling of radioactive waste; storage and disposal of radioactive waste; radiological emergency.

Learning Outcomes:

1. On successful completion of the Course, students will be able to:
2. Describe the origin, nature and theoretical aspects of radiation.
3. Explain interaction of radiation with matter and biological systems and discuss associated risks
4. Describe different radiation protection technique and handling of radioactive waste.

Reference books:


1. Herman Cember, Introduction to Health Physics, McGRAW-HILL, INC.
2. Martine and S.A., Harbison, An Introduction to Radiation Protection, London, Chapman and Hall.
3. Huges. W. T. ,Notes on Ionizing Radiation, Quantities, Units, Biological effects and permissible doses.


***Course No. Env- 2212***
**Limnology and Oceanography (3 Credits, 100 Marks)**

Summary of Content:

Limnology

1. Introduction: Definition, history and scope of limnology.
2. Physical features of inland water environments: Density, viscosity, surface film, surface tension, surface radiation, turbidity, effect of light and temperature on the growth of aquatic organisms, thermal stratification and circulation.
3. Chemical features of inland water environment: pH, DO, BOD, heavy metals.

4. Productivity of aquatic habitat: Primary productivity and measurement of primary productivity in aquatic habitats; factors affecting primary production.
5. Classification of lakes and special type of world lakes; Factors affecting growth and distribution of planktonic organisms.

Oceanography

1. Marine ecosystems: Introduction, features of the oceans; Classification of marine environment (habitat).
2. Physico-chemical characteristics of marine environment: surface currents, waves, tides, continuity, light, temperature, pressure, viscosity and surface tension, density -temperature relationship, heat capacity, dissolved salts, major and minor ions in sea water, salinity-temperature relationship, dissolved gases and acid/base buffering.
3. Biota of marine ecosystem and their adaptations: General natures of marine life, Classification of biota of marine ecosystem - marine producers, shore communities, coral reefs - reef forming corals, zonation on coral reefs, symbiotic relationships in coral reef fish, coloration in coral reef fish, classification of marine plankton, migration of plankton, salinity effects on life, temperature effects.
4. Global marine primary production: Effects of light, photosynthetic pigments, nutrient requirements, nutrient regeneration and grazing on primary production.
5. Marine Pollution: sources, causes and control of marine chemical and biological pollution.
6. Maritime boundary of Bangladesh, disputed areas, International law and protocols of maritime boundaries.

Recommended References:


1. Sumich, J.L. 1992. In Introduction to the Biology of Marine Life, Wm. C. Brown Publishers, 3rd edition.
2. Ragothaman, G. 2002. Aquatic Ecology, Trivedy, Agrobios, India.
3. Subrahmanyam, N.S. and Sambamurty, A.V.S.S. 2000. Ecology, Narasa Publishing House, NewDelhi, India.


***Course No. Env- 2214***
**Hydrology and Water Resources (2 Credits, 100 Marks)**

Summary of Content:

1. Introduction: Hydrologic Cycle, Importance of Hydrology, Water Balance, Energy Budget.
2. Precipitation and Water losses: Types and forms, causes and measurements of precipitation and its analysis; types of water losses, Infiltration, methods determining Infiltration, Factors affecting evaporation, methods determining evaporation and evapotranspiration.
3. Runoff: Sources, Catchment characteristics, Factor affecting runoff and runoff estimation Hydrologic Instrumentation, Remote Sensing in Hydrology.
4. Hydrograph: Definition, Hydrograph separation, Unit Hydrograph, Preposition and application of unit hydrograph, Catchment modelling.

5. Groundwater: Definition, origin and depth of GW, springs and wells, Aquifers and Aquifers properties, Water yield, Groundwater flow, Groundwater investigations, Well tests, Steady state well Hydraulics, Methods of Groundwater exploration.
6. Hydrological Environments: Hydrogeological environments of Bangladesh, Sea-water intrusion in coastal aquifers, Hydrogeological models and their use in resource assessments.
7. Water Resources planning & management: criteria of water quality and its impurities, characteristics of domestic, industrial & Irrigation water, Sources of fresh water. Estimation & Collection system of surface & ground water, abuse & reuse of water, Basic concept of water resource planning & management, Wetlands & water resources, Soil water relationship,
8. Human impacts on water resources: Irrigation & flood control system, strategic planning
9. Conceptual frame work & models, Watershed management of urban ( Municipal ) & Rural area emphasis on drinking water (urban) & Irrigation water (Rural), Economic considerations, Business response, water and conflict

Learning outcomes

Hydrology is the scientific study of the movement, distribution, and quality of water on Earth and other planets, including the water cycle, water resources and environmental watershed sustainability. Goals and objectives: Hydrology and water resources deals with surface and ground-water processes, hydrometeorology and hydroclimatology, watershed response to disturbance, hydrologic and parameter estimation, multiobjective resources planning and management, numerical modeling of solute transport in groundwater, and optimization of conjunctive use of surface water and groundwater.

Recommended References:

1. Kiely, G., 1998, Environmental Engineering, McGraw-Hill.
2. Raghunath, H.M., Hydrology: Principles, Analysis and Design.
3. Abdel-Aziz, I.K., 1986; Groundwater Engineering. McGraw-Hill Book Co., New York.

***Course No. Env- 2216***
**Environmental Microbiology** **(2 Credits, 100 Marks)**

Summary of Content:

1. Introduction to Environmental Microbiology: Introduction, Historical perspective, Branches of Environmental Microbiology, Scope of Environmental Microbiology, Modern Environmental Microbiology.
2. Aquatic Microbiology: Distribution of microorganism in fresh water environments, estuaries and oceans. Domestic and drinking water: pollution, purification, microorganism as indicator of water quality, bacteriological examination of water. Wastewater: characteristics and treatment processes.
3. Air Microbiology: Microorganisms in air, survival of microorganisms in air, techniques of the study of microorganisms in air, origin of microorganisms in air, control of microorganisms in air.

4. Soil Microbiology: Porous media, Characteristics of microorganism in porous media, Microbial activities in porous media, Microorganisms in surface soils, Methods of studying soil microorganisms.
5. Microorganisms in extreme environments: Psychrophiles, Thermophiles, Acidophiles, Alkalophiles, Halophiles and biotechnological applications of Extremophiles and Extremozymes.
6. Role of microorganisms in biogeochemical cycles: carbon cycle, nitrogen cycle, sulfur cycle and phosphorus cycle.
7. Role of microorganisms in the degradation of hydrocarbons, other organic pollutants and remediation of heavy metals.
8. Interaction among microorganisms: Mutualism, Commensalism, Antagonism, Competition, Parasitism, Predation.
9. Mathonogenesis and Acetogenesis: Importance, Habitats; Characteristics of microbes, biochemistry and mechanism.

Recommended References:


1. Microbiology: An Introduction. 8th ed. G.J. Tortora, B.R. Funke and C.L. Case. Pearson Education Inc, Singapore, 2007.
2. Microbiology. 5th ed. M.J. Pelczar Jr., E.C.S. Chan and N.R. Krieg. Tata McGraw-Hill Publishing Co.Ltd., New Delhi, India, 2000.
3. Environmental Microbiology. R.M. Maier, I.L. Pepper and C.P. Gerba. Academic Press, Elsevier, 2006.
4. Microbial Ecology- Fundamentals and Applications, 4th ed., R.M. Atlas and R. Bartha. Benjamin/ Cummings Publishing Co., Inc., 2000.


***Course No. Env- 2226***

**Laboratory Work on Environmental Survey and Monitoring (2 Credits, 100 Marks)**

Summary of content:

Part-A

1. Identification and characterization of 15 phytoplankton and 10 zooplankton and monitoring of bloom.
2. Study of the adaptive characteristics (anatomical modifications) of hydrophytes, xerophytes, mesophytes and halophytes.
3. Study of the reproductive behaviour of plant and animal species.
4. Assessment of community by Quadrat method.
5. Study of ecosystem composition at J.U. Campus and surrounding areas.
6. Calculation of ecological footprint

Part-B

1. Study of rainwater harvesting systems( methods, design)
2. Design and calculation of municipal storm water discharge.
3. Calculation of carbon footprint.
4. Analysis and interpretation of watershed data.

5. Determination of Soil texture by Particle-size analysis-hydrometer method
6. Determination of Soil density by Bulk and Particle density measurement.
7. Determination of engineering properties of soil and aquifer materials.

***Course No. Env- 2232***
**Field Work in Environmental Sciences-II**

**(2 Credits, 100 Marks)**

Field work on evaluation of environmental processes, hazards, resources, land use and socioeconomic conditions of an area.

**General observations:**
1. To evaluate the natural and artificial processes of the study area and finding its role on environment.
2. To list the natural and artificial resources of the study area: Forest resources, River based resources, Soil resources, Water resources, Mineral and hydrocarbon resources: Solar energy and wind energy resources; and artificial resources.
3. Identify the possible hazard (natural and anthropogenic) of the study area and evaluate its existing management system.
4. To evaluate the socioeconomic conditions of the study area and find out the factors which are controlling it.

**Study area:** Sundarban coastal area,Khulna; coastal and hill area of Chittagong district; St. martin, Teknaf, Cox's bazaar; Jaflong, Sylhet; Rangamati, Chitagong hiltracts, Panchogar, Dinajpur, etc.

**Duration of field work:** 5 to 15 days

***Viva voce*** ***(1 Credit)***

## THIRD YEAR FIRST SEMESTER

***Course No. Env- 3111***
**Environmental Biogeochemistry** **(3 Credits, 100 Marks)**

Summary of Content:

1. Definition, scope and goal of biogeochemistry, its relation to environmental sciences
2. Carbon, the Earth and life: Carbon and the basic requirements of life, chemical elements, simple compound and their origin, the origin of life, the raw materials of life, evolution of life and the atmosphere, Miller experiments.
3. Photosynthesis and evolution of life: Atmospheric oxygen, photosynthesis and the first organisms, evolution of marine life, evolution of terrestrial life, The carbon cycle and Atmospheric carbon dioxide: Terrestrial and ocean biogeochemical carbon cycle, Paleo $CO_2$ and Natural changes in the carbon cycle, anthropogenic source of $CO_2$, Carbon cycle model evaluation, Projection of $CO_2$ concentration and their implications.
4. Chemical composition of biogenic materials: structure of natural products, occurrence of carbohydrates, proteins, lipids, waxes, lignin and tannin, biogeochemical implications of natural compounds, production degradation and preservation of organic compounds, sedimentary organic matter and final fate or biogenic materials in the natural environment,
5. Biogeochemical tools for environmental study: Biogeochemical signatures in natural archives, application of isotope for studying biogeochemical and climatic process in natural environment, application of biomarker as a biogeochemical tool for studying material cycling, transportation of terrestrial biogenic materials to the ocean and paleovegetation and climate reconstructions.
6. Biogeochemical aspects of world major River: Carbon and Mineral Transport in Major North American, Russian Arctic, and Siberian Rivers: The St Lawrence, the Mackenzie, the Yukon, the Arctic Alaskan Rivers, the Arctic Basin Rivers in the Soviet Union, and the Yenisei, Carbon Transport by the Himalayan Rivers, Fate of Riverine Particulate Organic Matter, Dissolved Organic Carbon in Rivers.

Recommended References:


1. Biogeochemistry of Major World Rivers by *E. T. Degens, S. Kempe and J. E. Richey*
2. Organic geochemistry S. D Killops and V J Killops, 1993, Longman Scientific and Technical.


***Course No. Env- 3113***
**ICZM and Floodplain Management** **(3 Credits, 100 Marks)**

Summary of Content:

1. Introduction: Characteristics of Bangladesh coastal zone, Topographical changes, climate of coastal zone, soils of coastal zones and floodplain, Coastal embankment project, sea level rise and its implication for Bangladesh
2. Floodplain: Introduction location & climate of flood plain, geomorphology, hydrology, biological agents, physiographic Units of the flood plains, Soil formation of seasonally flooded land (e.g. Ganges & Meghna floodplain) & non flooded land, Agriculture development on flood plains and its effect on environment. Human settlement & plantation management on floodplain and Char land.

3. Environmental management of floodplain soil: Soil in natural & man made environment, Soils as a medium for plant growth, sorption properties of soil, soil in relation to environment, soil acidification, erosion & conservation problems in Bangladesh floodplain and coastal areas.
4. Coastal environment & Management: Introduction, definition & importance, classification of coastal system: estuaries, tidal wetlands, coral reefs, beaches and shoreline, Description & categorisation of coastal ecosystem: Anthropogenic & natural disturbances of coast, environmental perturbation of coastal aquatic habitat: Impact of coastal aquaculture on environment (e.g. shrimp culture),
5. Coastal resource and livelihood: Evaluation of vital area, resource capability use allocation, Diversification, Livelihood groups: Salt farmer, Fisher man and Small farmer, Poverty, Vulnerability to environmental changes: regional and global perspectives
6. Coast protection: Multistructure embankment, groans etc, their problems & remedies, Development options in the coast: tourism and recreation (Cox's Bazar & Kuakata) fisheries resources, Nature conservation, Infrastructure development. Guidelines for coast development & management; Policy analysis & case studies.
7. Mangroves: Sunderbones and other mangroves of the world; problem and prospects

Goals and outcomes:

ICZM is a dynamic, multidisciplinary and iterative process to promote sustainable management of coastal zones. It covers the full cycle of information collection, planning, decision making, management and monitoring of implementation. ICZM uses the informed participation and cooperation of all stakeholders to assess the societal goals in a given coastal area, and to take actions towards meeting these objectives. It means integration of the terrestrial and marine components of the target territory, in both time and space. On the other hand, floodplain management is a decision-making process that aims to achieve the wise use of the county's floodplains. "Wise use" means both reduced flood losses and protection of the natural resources and function of floodplains. Floodplain management utilizes corrective and preventive measures for reducing flood damage, including but not limited to emergency preparedness plans, flood control works and floodplain management regulations. As an environmental sciences is a multidisciplinary subjects, students of environmental sciences will be benefited by acquiring knowledge in this course content.

Recommended References:

1. Soil and Water conservation by FR Troch (1991) Prentice Hall. NJ.
2. Water & Waste water by My Hammer (1996) Prentice Hall inc.
3. Soils & the Environment by A Wild (1996) Cambridge Uviv. Press.
4. Environmental Soil chemistry by DL sparks (1996) Academic press.

***Course No. Env- 3115***
**Hydrogeomorphology and Climate of Bengal Basin (3 Credits, 100 Marks)**

Summary of Content:

1. Geographical position of the Bengal Basin: Boundary of Bengal Basin, Characteristics of boundaries, morphological characteristics, Bengal Basin comparing to other basins and delta (e.g., Indus Basin, Nyle Delta)
2. Physiography of the Bengal Basin: major physiographic subdivisions, delta, types and characteristics of delta, development of Bengal Delta through time
3. Geological and structural setting of Bengal Basin: Himalayan Foredeep, Tectonic folded belt, Basinalforedeep
4. Hydrography: Definition of rivers, lakes, hoars, and beels; Ox-bow lakes, components of flood plain geomorphology, major classification of rivers and streams, characteristics of braided, straight and meandering rivers, swamps and tidal creeks, coastal geomorphological components
5. Stratigraphy, structure, and geological history of the Bengal Basin, relationship of Bengal Basin with its neighbouring sedimentary basins.
6. Climate of Bengal Delta: Global classification of climate zone, Bengal delta and global climate classification, regional climatic condition, koppen classification, monsoonal climate, atmospheric circulation, influence of atmospheric circulation in Bay of Bengal, ocean circulation,

Goals and outcomes:

Ongoing climate change is a major forcing factor on Earth's ecological services including agricultural production, biodiversity, and carbon cycle. Climatic regime and climate change is also a major driver of the dynamics of Earth's geomorphological systems, including its glaciers, rivers, floodplain, mountains and coasts (short term) that correspond to climate forcing by orbital cycles. Many studies have considered how geomorphological systems have responded to climate forcing over long time scales, where system responses are approximately in phase with forcing. As Bangladesh is a part of Bengal delta and its floodplain is formed by the sediments of large river systems of Himalaya, it is very important to study the changing characteristics of its morphology by climate change effects.

Recommended References:

1. Curray, J.R. & Moore, D.G., 1974, Sedimentary and Tectonic Processes in the Bengal Deep-Sea Fan and
2. Khan, F.H., 1991, Geology of Bangladesh; The University Press Ltd., Dhaka.
3. Reimann, K.U., 1993, Geology of Bangladesh; Gebrueder Borntraeger, Berlin.

***Course No. Env- 3112***
**Sustainable Development (2 Credits, 100 Marks)**

Summary of Content:

1. The Concept and Principles of sustainable development: origins of the concept of sustainable development and the core ideas that underpin it; barriers to sustainable development; the role of science and technology in contributing to key sustainable development challenges

2. Economic Development and Sustainability: challenges at local, regional and global level
3. Social development and Sustainability: Identification of challenges and solution initiatives at different levels.
4. The environmental challenge of sustainability: Challenges and national and global initiatives; contemporary case studies
5. Sustainable Development Goals(SDGs) and Future Perspectives on the prosperity of humankind

**Learning Outcomes:** On successful completion of the Course, students will be able to:

1. Describe competing conceptions of sustainable development
2. Recognize the positive and negative roles of science and technology in delivering sustainability
3. Identify key questions that policy processes seeking to deliver sustainability must address

Reference books


1. World Commission on Environment and Development (1987) Our Common Future, Oxford University Press, Oxford.
2. Jennifer A. Elliott, An introduction to sustainable development, 4th Ed. 2012, Routledge Publications, London.
3. Simon Dresner, The principles of sustainability-Simon, 2nd Ed. 2008, Earthscan Publisher, London.
4. Michael Jacobs, The green economy: environment, sustainable development and the politics of the future, Pluto Publications, London, 1991.


***Course No. Env- 3114***

**Environmental Analytical Chemistry (2 Credits, 100 Marks)**

Summary of Content:

1. Analytical Chemistry: Definition, analytical process, review of fundamental concepts, expressions of analytical results.
2. Analytical data handling: Limitations of analytical methods, classification of errors, accuracy and precision, minimization of errors, significant figures, mean and standard deviation, statistical treatment of analytical data.
3. Analytical sampling: Solid, liquid and gaseous samples, sampling procedure and sample population, operations of drying and preparing a solution of the analyses.
4. Titrimetric analysis: Titrimetric analysis, classification of reactions in titrimetric analysis, Standard solutions, preparation of primary and standards. principles of neutralisation titrations, titration curves, detection of the end point, indicators, oxidation reduction reactions, normality, molarity and equivalent weight calculations of some common oxidizing and reducing agents.
5. Complexometric titration: Principles of complexometric titration, important complexing reagents with emphasis EDTA, EDTA titration curves and detection of end points.
6. Gravimetric analysis: Introduction to gravimetric analysis, precipitation methods, unit operations in gravimetric analysis, impurities in precipitates, Gravimetric calculation.
7. Ion exchange methods: Principles of chromatography, classification of chromatography, Principles of Ion exchange chromatography, cation and anion exchange resins, action of ion exchange chromatography, exchange of complexing agents- separation of metal ion on anion exchange columns, application of ion exchange chromatography.

8. Solvent extraction: General discussion, factors favoring solvent extraction, the distribution coefficient, the distribution ratio, the percent extracted, solvent extraction of metals, analytical separations.

Recommended References:


1. Fundamentals of Analytical Chemistry, D. A. Skoog, D. M. West, F. J. Holler, 7th edn, Saunders College Publishing, 1996.
2. Environmental Sampling and Analysis for Metals, M. Csuros, C. Csuros, Lewis Publishers, 2000.


***Course No. Env- 3116***

**Environmental Biochemistry (2 Credits, 100 Marks)**

Summary of Content:

1. Environmental Biochemistry: Definition, the composition of living matter.
2. Cell Biology: Cell as a basic unit of life, Cell organization of prokaryotic and eukaryotic cells, Structural and functional capitalization of cell.
3. Carbohydrates: General introduction and basic biochemical aspects.
4. Nitrogen and nitrogenous compounds in the environments: amino acids, peptides, proteins and their biochemical description.
5. Nucleic acids, enzymes, co-enzymes, lipids, hormones, vitamins and their significance in the biological system.

**Textbook**


1. Principles of Biochemistry. 2nd Ed. Albert L. Lehninger. CBS Publishers & Distributors. New Delhi, India, 1993.


***Course No. Env- 3127***

**Laboratory Work on Ecology and Environmental Microbiology (2 Credits, 100 Marks)**

Summary of Content:

1. Determination of productivity of aquatic ecosystem.
2. Quantification of bloom forming plankton (phytoplankton + zooplankton).
3. Determination of the biomass of producers in the given area.
4. Assessment of biodiversity index.
5. Study of the biotic component of a pond ecosystem of J.U. Campus.
6. Determinations of moisture content, water holding capacity, pH, organic carbon and organic matter of soil.
7. Basic Rules and Requirements of a Microbiology Laboratory.
8. Preparation of culture media.
9. Technique of serial dilution.
10. Water quality test through faecal coliform counts by streak plate method / pour plate method / spread plate method and enumeration of coliform bacteria.
11. Study of root nodules in legume plants.
12. Sampling of bacteria from air, water and soil.
13. Bacterial culture and its antimicrobial sensitivity test.
14. Determination of bacterial growth.
15. Preparation of field and laboratory note book.

*Course No. Env- 3128*

**Laboratory Work on Environmental Data Handling and Simulation (2 Credits, 100 Marks)**

This course provides students with an understanding of basic data science concepts critical to the proper use and understanding of experimental and modeled environmental data.

1. Environmental data input and analysis by using Excel.
2. The lab introduces the statistical computing language R and provides hands-on experience using R to conduct basic statistic procedures, including data screening and adjustments, sample tests and stochastic simulations.
3. Introduction to AquaChem and data input procedure, plotting Piper diagram and interpretation.
4. Input and interpretation of bore log data by using Rockworks.
5. Fundamentals of MATLAB: Overview of linear algebra and matrix manipulation using MATLAB; problem-solving methodology; arrays; use of files, functions and data structures; plotting; numerical methods for calculus and differential equations; 2D and 3D visualization of scientific data.

***Viva voce*** ***(1 Credit)***

## THIRD YEAR SECOND SEMESTER

***Course No. Env- 3211***
**Industrial Ecology** **(3 Credits, 100 Marks)**

Summary of Content:

1. Introduction: Goals and definitions, Historical development of IE, Metaphor- Food Webs and Industrial Ecoparks and Biomimicry, Limits of Technology and Concepts of technosphere or Biosphere.
2. Key Concepts of IE: System Analysis, Material and Energy Flows and Transformations; Analogies to Natural Systems; Open- vs. Closed-Loop Systems; Industrial Metabolism,
3. System Tools to support IE: Life Cycle Assessment (LCA), Components and Applications; Process Level LCA vs Economic Input-Output (EIO) LCA; Life Cycle Inventory Analysis (LCI); Life Cycle Impact Assessment (LCIA); Life Cycle Interpretation; Functional unit of analysis: Energy and Transportation Modules, Materials Production Phase, Use Phase; End-of-Life Management Phase.
4. Life Cycle Design and Management: Needs analysis, design requirements, Design-Process, Selection and Synthesis of Design Strategies, Design Evaluation
5. Environmental Accounting: Internal costs-conventional, hidden, liability, less tangible costs; external costs; Cost allocation; Life-Cycle Costing: Purchase, ownership, disposition, Private and social costs.
6. Case study- Industrial Symbiosis at Kalundborg.

**Learning Outcomes:** On successful completion of the Course, students will be able to:

1. Analyze systematically the global, regional and local material and energy flows associated with products, processes, industrial sectors, and economies.
2. Describe the ecological, economic, social, political, and technological factors that influence the life cycle of a product system.
3. Discuss the analytical tools and methods for implementing principles of industrial ecology.

Reference books


1. Industrial Ecology. Graedel, T.E. and Allenby, B., Prentice Hall: Englewood Cliffs, NJ, 1995.
2. The Greening of Industrial Ecosystems. National Academy Press: Washington, DC, 1994.
3. Benyus, J. M. Biomimicry: Innovation Inspired by Nature Quill: New York, 1998.


***Course No. Env- 3213***
**Industrial Waste Management** **(3 Credits, 100 Marks)**

Summary of Content:

1. Industrial Pollution Emissions and Standards: Industrial Emissions- Liquids, Industrial Emissions- gases, Criteria and Standards, Air pollution Quality Standards, Water Quality Criteria and Standards for Industrial Effluents, Water quality Management.

2. Industrial Waste: Social, Economic, Technological and environmental perspectives of Industrial waste, Physical, Chemical and Biological characteristics of wastewater, methods of waste water analysis, Principal constituents of concern in wastewater treatment, Reuse of treated wastewater, Reducing quantity and toxicity of wastewater.
3. Pollution Control for specific pollutants: Removal of BOD, Removal of Chromium, Mercury and Lead, Removal of particulate matter, Removal of sulphur Dioxide, Removal of oxides of nitrogen, Removal of organic vapor from effluent gases.
4. Pollution control in Tanning Industries: Introduction, Tanning processes, Chemicals used in the Tanning industries, Desired limits of pollutants, Origin and Characteristics of the effluents, Polluting effects of waste water in the environment, Methods of pollution abatement.
5. Pollution control in Pulp and Paper Industries: Introduction, Manufacture processes and characteristics of liquid effluents, Pollution control for liquid effluents, Pollution control of gaseous effluents.
6. Pollution control in Fertilizer industries: Introduction, Classification of fertilizer plants, Nature, sources, concentration, adverse effects and tolerance limits of effluents from fertilizer industries, Effluent separation and treatment of liquid effluents, Pollution control of gaseous effluents.
7. Pollution control in Textile dyeing Industries: Introduction, Manufacture processes and sources of effluents, Quantities of effluents, Characteristics of effluents from different sections, Harmful effects of textile effluent, Pollution control in textile effluents.
8. Pollution control in Petroleum refineries and Petrochemical Industries: Introduction, Characteristics of liquid effluents of refineries and petrochemical industries, Treatment of liquid effluents from refinery industries, Treatment of liquid effluents from petrochemical industries.
9. Pollution control in Food and Beverage Processing Industries: Introduction, Characteristics of liquid effluents of food and beverage processing industries, Pollution control in Food and beverage processing Industries.

Recommended References:


1. Industrial Pollution Control Hand book, Herbert F. Lund., McGraw Hill
2. Pollution Control in Process Industries, S. P. Mahayals, Tata McGraw Hill Publishing Company Limited, New Delhi.
3. Industrial Pollution Privation Handbook, Harry M. Freeman, McGraw-Hill Professional, New York
4. Analytical Toxicology of Industrial Inorganic Pollution, Morris B. Jacobs, John Wiley and Son, Inc., New York.
5. Understanding Environmental Pollution, Mereuita K-Hill, Cambridge University Press.
6. Industrial and Hazardous Wastes, Rajiv K, Sinha and Sunil Herat, Pointer Publishers Jaipur, India.

***Course No. Env- 3215***
**Environmental Ethics, Regulations and Policies (3 Credits, 100 Marks)**

Summary of Content:

1. Relation of environmental laws to ethics and ethical issues in environment. Role of classical and contemporary ethical theories to the suggestive measures for protecting environmental degradation both at local and global levels.
2. Definition of law, protocols, treaties and convention; classification of laws, environmental law, environmental rights, environmental justice, principles of environmental law, historical evolution of environmental legislation.
3. Major UN conferences regarding environment: Stockholm declaration, 1972, Agenda 21, Rio-declaration, Kyoto protocol, CDM and Carbon credit, Convention of biological diversity, Ramser convention, Basel convention, UN convention on the laws of the sea; Convention of Biological Diversity(CBD), MDG and SDG and other recent conventions.
4. Environmental regulatory regime in Bangladesh; constitutional provision, role of NGOs in the legal activism in Bangladesh; Environmental and related policies.
5. Sectoral environmental legislation's in Bangladesh: laws regarding Biodiversity conservation, Forestry, Fishery, Mineral exploration, Groundwater management, Climate Change Adaptation, Brick Kiln, Urban Development etc.

Recommended References:


1. Mohanty S.K., Universal's Environment & Pollution Law Manual, Universal Law publishing Co. Pvt. Ltd., 1999.
2. Laws Regulating the Environment in Bangladesh, M. Farooque and R. Hassan, published by BELA.
3. Rahman A.A., Haq S., Haither R., Jansen E.G. (eds), Environment & Development in
4. Bangladesh, voll 1&2, UPL, 1994.
5. Pojman P.L., Global Environmental Ethics, Mayfield Publishing Company, 2000
6. Rolston-3 H., Environmental Ethics, Temple University press, Philadelpfia, 1998.


***Course No. Env- 3212***
**Academic Development and Employability (2 Credits, 100 Marks)**

Summary of Content:

1. Basic of academic development: Networking, Outreach, and Science Communication and Effective Criticism,
2. Keys of academic development: Self-Management, Team working, Problem solving, Application of IT, awareness, importance of academic development
3. Effective Presentation: Presentation of project plans and results and feedback, revision of project plans according to feedback/comments/suggestions
4. Proposal writing: outline of research proposal, keys of proposal, and limitations of proposal.
5. Research activities of the prospective researchers/faculty of the department of Environmental sciences.

**Learning Outcomes:**

1. Enhance your comprehension of the academic environment by understanding the key drivers that can effect decision making, behaviour and advancement as an employee
2. Develop your ability to gather skills and knowledge for solving specific environmental problem.
3. Provide a solid foundation in the professional research from the diversified faculty research capacities.

***Course No. Env- 3216***
**Ecotoxicology (2 Credits, 100 Marks)**

Summary of Content:

1. Environmental toxicology: Introduction, Principles and concepts, classification and sources of toxic substances, dose- response relationship, relative toxicities, reversibility and sensitivity, Xenobiotics and endogenous substances, toxicological chemistry, kinetic phase and dynamic phase, principles and methods of studying toxins in an ecosystem.
2. Environmental changes and health: Changes in environmental and health effects, environmental diseases, e.g. Cancer, birth defects, reproductive damage, respiratory diseases, and heavy metal induced diseases.
3. Mutagenic pollutants and Environmental cancer: types of mutation, effects of mutation, induction of mutation. Causes of cancer, stages in the development of cancer, classification of carcinogens, and metabolism of chemical carcinogens.
4. Uses, sources of exposure, metabolism, toxicity and biochemical effects of Environmental metals, Pesticides and related materials (insecticides, herbicides, PCBs, Dioxin etc.), volatile organic compounds, fluorides and air pollutants (inorganic gases and particulate maters)
5. Environmental Allergens: What are allergens, Some specific allergens- Fish & meat Allergy, Milk Allergy, Peanut Allergy, Cold Allergy, Dust Allergy, Pollen Allergy, Stress Allergy, mechanisms of allergenecity, Effects on health, Control and management of allergy.

**Textbook**

1. Fundamentals of Environmental Chemistry, S. E. Manahan. Lewis Publishers, 2000.

***Course No. Env- 3218***
**Agriculture and Environment (3 Credits, 100 Marks)**

1. Introduction - Shifting cultivation, settled cultivation, agricultural revolution, agricultural growth pattern and its implication; environmental changes and food security.
2. Pest and disease epidemics: Diseases and their development in crops; Controlling of diseases, IPM.
3. Production of biofertilizer and its ecofriendly application in agriculture.
4. Production of disease resistant and HYVs using micro-propagation and genetic engineering.

5. Agro-ecological regions of Bangladesh; Cropping pattern; Crop diversification; Agro-forestry.
6. Agricultural pollution and its effects; Effect of agrochemicals on soil, freshwater and biota; Agrochemical residues and their effects; Utilization of organic waste and treated wastewater for crop production.
7. Conservation of crop germplasm; Major constraints for slow growth of agriculture sector of Bangladesh; Policy and program of agricultural development in Bangladesh; Impact of genetically modified food and biosafety; National biosafety guideline of Bangladesh.
8. Climate vulnerability on crops; Effects of flooding, drought and salinization on agriculture.

**Recommended References:**


1. Brammer, H. 1999. Agricultural Disaster Management in Bangladesh, University Press Ltd., Dhaka.
2. Hossain, M. 1991. Agriculture in Bangladesh, University Press Ltd., Dhaka.
3. Merrington, M. 2002. Agricultural Pollution, Taylor and Francis.
4. Karim, Z., Hussain, S. G., Ahmed, A.U. 1999. Climate change vulnerability of crop agriculture, In: Vulnerability and Adaptation to climate Change for Bangladesh, (Eds.) Huq, S., Karim, Z., Asaduzzaman, M., and Mahtab, F., Kluwer Academic Publishers.


***Course No. Env- 3229***

**Integrated Laboratory Work on Environmental Pollution and Remediation (2 Credits, 100 Marks)**

Part-A

1. Monitoring and measurement of air quality of urban, and rural area.
2. Microscopic examination of particulate matter (Morphological Studies).
3. Determination of ammonium, nitrate, and phosphate ions by strip.
4. Chemical identification of Inorganic Components of particulate matter (Pb, Fe, Ni, Cu).
5. Determination of $SO_2$ / $CO_2$ in air of an Urban & Rural area.
6. Determination of total acid in air of an Urban & Rural area.

Part-B

1. Treatment of textile wastewater by traditional industrial processes.
2. Calculation and design of different types of wastewater treatment plant.
3. Monitoring of sound level and design for remediation of sound pollution.
4. Design and monitoring of solid waste management plant in Jahangirnagar University campus.
5. Arsenic determination in groundwater by Low-cost kit and Laboratory.
6. Disaster risk calculation.

*Course No. Env- 3233*

**Field Work in Environmental Sciences-III (2 Credits, 100 Marks)**

To evaluate the pollution aspects (its source, type, cause, effects, extent etc.) and its existing management system from the field observation and understanding of a particular site through a case study.

**General observation:** The following aspects need to be observed and documented regarding the evaluation of pollution and its management system.

- The type of land or water use in the polluted area, its geographic and geological characteristics, who use the area and who owns it.
- Identifying the affected sectors of the environment that is 'what is being polluted-air, water, soil etc.
- To identify the pollution sources of an area; and have to be know its quantity and quality of the pollutions.
- To determine the causes of pollution and the polluting agents.
- Assess the extent of pollution severe/moderate/slight/nil, to: the air, water, soil, biodiversity.
- Map the area to be studied.
- Evaluate the social and health aspects associated with the pollutants.
- Assess the exiting management system of pollution site and evaluate its positive or negative impacts towards environment.

**Study area:** Dhaka city and its surrounding fringes area, Cittagong and its surrounding area, Cox's Bazaar, Teaknaf, St. martin island, Khulna city and its surrounding area, Sylhet city and surrounding area etc.

**Duration of field work:** 5 to 15 days

***Viva voce*** ***(1 Credit)***

## FOURTH YEAR FIRST SEMESTER

***Course No. Env- 4111***
**Instrumentation in Environmental Sciences (3 Credits, 100 Marks)**

Summary of Content:

1. Concepts of Instrumental Analysis and Analytical process
2. Analytical Methods and their classification: Qualitative and Quantitative Methods, Classical and Instrumental Methods, Classification based on concentration range; Analytical Process and its subdivisions; Physical and chemical properties used in instrumental analysis, Analyse concentration and instrumental response relationship; Performance Characteristics of Instrumental Methods: precision, accuracy, bias, sensitivity, dynamic range, selectivity. Environmental Analysis: idea about commonly encountered samples and major analyses.
3. Introduction to Spectroscopy: The nature of radiant energy, wave concept and photon concept of electromagnetic (EM) radiation, electromagnetic spectrum, interaction of EM energy with matter: absorption, emission, fluorescence, phosphorescence and scattering, energy states in various species of matter, atomic and molecular spectroscopy, Production of EM radiation, Basic components of an optical instrument.
4. Ultraviolet / Visible Spectroscopy: Origin of molecular electronic spectroscopy: types of electrons in molecular species and their transition probabilities, absorption spectra of functional groups, spectra of metal ions and other non-absorbing species, spectra-structure correlation, principles of quantitative determination: absorbance and transmittance, Beer's law and its limitations, instrumentation, sample preparation techniques, applications.
5. Infrared Spectroscopy: Molecular motion and vibrational modes of molecules, theory of absorption of infrared energy by molecules, vibrational coupling and interpretation of IR spectra, sample preparation techniques, types of IR instruments, advantages of FTIR spectrometer.
6. Atomic Absorption Spectrometry: Theory of AAS, various techniques of atomization, methods of calibration in AAS, sample preparation for AAS measurement, interferences encountered in AAS determination of metal ions, sensitivity considerations, applications of AAS in environmental analysis.
7. Chromatographic Methods: Principles of chromatographic separation: migration, separation and elution phenomena, chromatographic parameters and their interrelation, peak broadening and its theoretical explanation, Classification of chromatographic methods, sample preparation techniques, mechanisms of separation, Basic idea of HPLC, GC, fluorescence spectroscopy and TOC analyser, and typical applications of them in various fields.
8. Environmental Analysis and laboratory Management: Sampling and sampling error, Quality control and quality assurance.

Recommended References:

1. Principles of instrumental analysis (6th Edn.), D. A. Skoog, F. J. Holler and T. A. Nieman, Thomas Asia Pte. Ltd., Singapore, 2005.

2. Vogel's textbook of quantitative chemical analysis (6th Edn.), J Mendham, R C Denney, J D Barnes and M J K Thomas (Editors), Pearson Education (Singapore) Pvt. Ltd., Delhi, India, 2006.
3. Analytical chemistry (5th Edn.), G. D. Christian, John Wiley & Sons, Inc., Newyork / Singapore, 1994.
4. Laboratoy experiments in environmental chemistry, D. N. Boehnke and R. D. Delumyea, Prentice Hall Publishers, N. Y., 2000.
5. A laboratory manual for environmental chemistry, R. Gopalan, A. Anand, and R. W. Sugumar, Transatlantic Publisher Group, London, 2009.
6. Environmental laboratory exercises for instrumental analysis and environmental chemistry, Frank M. Dunnivant, John Wiley & Sons Inc., New Jersy, 2004.
7. Standard methods for the examination of water and wastewater (21st Edn.), L. S. Clesceri, A. E. Greenberg, and A. E. Eaton(Editors), American Public Health association, New York, 2001.

***Course No. Env- 4113***

**Environmental Assessment and Planning (3 Credits, 100 Marks)**

Summary of Content:

1. Introduction, definition, scope and goal of Environmental assessment (EA): International and national aspects of Environmental Impact Assessment (EIA); Background and legal framework, baseline studies, capacity building, Project cycle- IEE and EIA; EIA characteristics and function of EIA, Methodologies (Adhoc, checklist, matrices, network diagram, overlays and mathematical modelling); Cumulative impact assessment; Role of DoE in and application of EIA in Bangladesh.
2. Social impact assessment and public involvement: Required skills of persons for conducting EIA; Training provisions for EIA, Impact Assessment costs; EIA reporting and review, Practical learning from case studies (water quality impact, Large dam construction, tourism development; industrial development, afforestation)
3. Environment Risk Assessment (ERA): Definition, legal framework, risk evaluation, risk characterization, public perception of risk Major steps in ERA , Risk characterization and comparative risk assessment, risk analysis, accident analyses; industrial issues and health risk, case studies.
4. Introducing Strategic Environmental Assessment (SEA) and Planning:
5. Overview; SEA in plan making; Three SEA systems from USA, Europe and China; Application of SEA in different policies of Bangladesh. The SEA Process: Setting the Context for SEA; Identifying environmental baselines and links to other strategic actions; Identifying alternatives; Predicting impacts; Evaluating and mitigating impacts; Documentation, implementation and monitoring; Ensuring SEA effectiveness and Resourcing it with practical works.
6. Cross-cutting issues: Environmental management planning (EMP); monitoring and mitigation of environmental problems, Ecological Assessment, Benefits of integrating sustainability with a consolidated EIA/EMS; Integrating EIA, EMS, and sustainable development, etc.

**Learning Outcomes:** On successful completion of the Course, students will be able to:

1. Be familiar with EIA legislation, steps; methods; instruments and key processes.
2. Understand the importance of Social Impact Assessments and public participation in EIA process.
3. Thinking and linking strategically for planning and policies to improve collaborative skills.

Reference books


1. Eccleston, Charles H. 2011. *Environmental impact assessment*: a guide to best professional practices. CRC press
2. Bram, F. Noble. 2015. Introduction to Environmental Impact Assessment: A Guide to Principles and Practice, 3rd Edition
3. Riki Therivel. 2010. 2nd edition. Strategic Environmental Assessment in Action. Routledge & Resources from World Bank, ADB and Published SCI articles etc.


***Course No. Env- 4115***
**Public Health, Sanitation and Environmental Engineering (3 Credits, 100 Marks)**

Summary of Content:

1. Definition of health, health and development, health problems in Bangladesh and developing countries and developed countries, Health and Sanitation in SDG's and status of MDG's.
2. Water borne disease, Structure and design for safe water and supply in rural and urban areas, Structure and design for proper sanitation and fecal sludge management, Disease due to poor sanitation, personal hygiene and cleanliness.
3. Infectious/communicable (Diarrhoeal, STD, AIDS) and non-communicable disease (Cancer, cardiovascular), emerging and non-emerging disease, tropical disease, population growth and control, nutrition and health.
4. Public health services, private for profit and non-profit health services, public and out of pocket health expenditures, economic impact on health, safety net for the health care of poor. National health policy, role of UN (e.g. WHO, UNICEF, UNFPA and world bank) and other international agencies in public health, curative and preventive health care system and services, primary health care.

Learning outcomes

1. Understand and interpret public health data;
2. Select appropriate engineering and associated responses to address prevailing public health problems;
3. Understand the requirements for designing public health responses taking into account technical, social, institutional and financial issues;
4. Assess outcomes and evaluate progress.

Recommended References:


1. Textbook of preventive and social medicine, JE park and K Park, Banarsidas Bhanot publishers, India

2. Fundamental of community medicine, Sufi M Anawarul Islam and quazi Emadadual Haq, Dhaka
3. Drinking Water Treatment: Focusing on Appropriate Technology and Sustainability, Chittaranjan Ray and Ravi Jain, Springer Dordrecht Heidelberg London New York, 2011.

***Course No. Env- 4117***
**Environmental Modelling (3 Credits, 100 Marks)**

Summary of Content:

1. Introduction: Definition, forms of models (computational and conceptual models), types of computational models, the role of modelling, model vs reality.
2. The model life-cycle: the stages of model life-cycle (elements and steps of modelling); model uncertainty, methods of and uncertainty and sensitivity analysis, model calibration and validation.
3. Model implementation for natural environment-air, water, land, and climate,
4. Model simulation: processes, simple computational model development and solution techniques.
5. Basic concept of data assimilation and analysis; use of software.

**Learning Outcomes:** On successful completion of the Course, students will be able to:

1. Understand the role and nature of modelling environmental systems,
2. Understand the basic principles of model building, implementation, and application,
3. Have a clearer understanding of the challenges and decisions associated with model implementation and validation of model outputs.

Recommended References


1. Environmental Modelling, Jerald L. Schnoor, John Willey & Sons, 1996.
2. Transport Modelling for Environmental Engineers and Scientists, Mark M. Clark, John Willey & Sons, 1996.
3. Environmental Modelling Training Modules USEPA. https://www.epa.gov/measurements/environmental-modeling-training-modules#file-168089
4. Suggested journal: Environmental Modelling & Software (Elsevier)
5. Environmental Modelling by using MATLAB.


***Course No. Env- 4112***
**Environmental Hazards and Disaster Management (2 Credits, 100 Marks)**

Summary of Content:

1. Risk Assessment: Concept of risk, hazard, disaster and vulnerability, factors of risk, types of risk, point of risk analysis, risk management goals, strategies, principles of risk management framework, risk management methods, principles of decision making, and public perception of risk.

2. Geoenvironmental problems identification and risk management, framework for risk-based site management, defining goals, regulatory and societal issues, site assessment for risk-based site management.
3. Hazard in the environment: definition of event, hazard and disaster, common feature of disaster, classification of disaster, factor related to damage, potential hazardous process or agencies, hazard caused stages and sequences, dimension of disaster.
4. Formation process, exposure and impact of various national hazard: Cyclones, storm surges, thunderstorms, (kalboishakhi), lightening, tornadoes, flooding, drought, landslides, subsidence, tsunamis, volcanic activity.
5. Earthquake engineering: seismological aspects, earthquake occurrences, wave type, earthquake stations, source zones, magnitude, probability of occurrence, mode of wave propagation, designed ground motions, seismic soil structure interactions, and seismic design of retaining structures, liquefaction, and seismic risk in geotechnical earthquake engineering.
6. Coastal hazard and disaster Management: Types and causes of coastal hazard, Adjustment of hazard, Warning and forecasting system, case study in Bangladesh.
7. Hazard assessment: technique, uncertainty, warning system, types and levels, natural resources maps, hazard related maps, use of hazard information in the development and planning process, stage of development planning, integrated flood hazard assessment in to development planning process.
8. Disaster and hazard reduction: Scope of mitigation of environmental disaster and hazards, methods of mitigation, livelihood adaptation, risks reduction model, institution (flood action program, FAP), early warning information and GIS based disaster technology.

Goals and outcomes:

A disaster is the effect of a naturally or anthropogenically occurring hazard taking place in a populated area and resulting in severe damage to the environment and often loss of lives. These types of events have environmental, social and economic consequences. So it is important to minimize the losses and damage by indigenous knowledge and technological development. This course will help to make understand the student the origin, effects, consequences and mitigation measures of hazard.

Recommended References:

1. Smith, 1995, Environmental Hazard, 2nd edition.
2. Paul, B.K., 2011, Environmental Hazards and Disasters: Contexts, Perspectives and Management, Copyright © 2011 John Wiley & Sons, Ltd. DOI: 10.1002/9781119979616

***Course No. Env- 4114***
**Occupational Health and Safety (2 Credits, 100 Marks)**

Summary of Content:

1. Introduction: Need for integration of safety, health and environment; Fundamentals of safety; overview of industrial safety management; role of top management and Government in safety management, Legal aspects of safety.

2. Steps of industrial safety management: Security Management of Industrial plants; Safe working practices; Personal protective equipment's; Storage and handling of Material and equipment; Safety in transportation and automotive equipment's; Electrical safety; Mechanical Hazards; Chemical Hazards; Building design and Fire protection; Safety in Hazardous area, safety in power plants.
3. Occupational Health and Safety Assessment Series (OHSAS), Scope of OHSAS 18001.
4. Industrial safety analysis: Introduction, locating and defining injury sources, causes of injury, sources of data, safety analysis techniques, fault tree calculations, risk tolerability.
5. Implementation and operation, Structure and responsibility, Training, awareness and competence, Consultation and communication, Documentation, Operational control, Emergency preparedness and response, Social security inside the industries, Insurance.

Learning Outcome

1. To be able to evaluate hazards, including environmental pollution/health hazards, and show how the assimilation and application of knowledge can be used to generate possible options for controlling risks.
2. To be able to demonstrate the complexity of the interaction of the determinants of health, and how the use of evidence based practice and reflective practice supports an effective approach.
3. Clear understanding of the importance of partnerships, planning and organizing, professional conduct and business awareness via project management and soft skills training.

Recommended References:

4. "Occupational health and safety management systems-Specification", Occupational health and safety assessment series, OHSAS 18001:1999.
5. "American national Standard, Quality Management Systems-Requirements" published by American Society for Quality, December, 2000.

***Course No. Env- 4116***

**Emerging Technologies in Environmental Sciences (2 Credits, 100 Marks)**

Summary of Content:

1. Climate engineering: definition, prospect and problems in climate engineering, critical global discussions, climate engineering technologies: Carbon dioxide removal and solar radiation management.
2. Wastewater Treatment with Concomitant Bioenergy Production Using Microbial Fuel Cells: Bioanode MFCs for Waste and Wastewater Treatment, Biocathode MFCs for Wastes and Wastewater Treatment.
3. Alternative environmental friendly fuels: Hydrogen fuel cell, Ocean thermal energy conversion, Harness waves and Tides, Energy from Algal biomass.
4. Application of Nanomaterial's in Environmental Protection: Environmental benefits of nanotechnology, Risk assessment of Nanomaterial's, Human Exposures and their measurement and control.
5. Recent development and new technology for environmental Protection.

Recommended References:

1. Geo-engineering: Governance and technology Policy.
   Source: https://fas.org/sgp/crs/misc/R41371.pdf
2. “Advances in Water Treatment and Pollution Prevention” Editors: Sanjay K. Sharma • Rashmi Sanghi; Springer, Dordrecht Heidelberg. New York London.
3. U.S. Environmental Protection Agency “Nanotechnology White Paper”
   Source: https://www.epa.gov/sites/production/files/2015-01/documents/nanotechnology_whitepaper.pdf

***Viva voce*** ***(1 Credit)***

## FOURTH YEAR SECOND SEMESTER

***Course No. Env- 4211***
**Research Methodology and Article Writing** **(3 Credits, 100 Marks)**

Summary of Content:

### Part A: Research Methodology

1. Concept of research planning - comprehensive research plan; Hypothesis-framing of a hypothesis and importance of a hypothesis in research.
2. Objectives and importance of research methodology; Research design; Sampling design - sample survey; Tools and techniques for data collection; Methods of data collection; Data processing and analysis.
3. Case Studies

### Part B: 2 Art of Scientific Writing

4. Scientific Writing; Writing the Scientific Proposal, Report and Thesis; The Author's procedure.
5. Preparation of Title; List the Author's & Addresses, Preparation of the Abstract; Introduction; Materials & Methods; Results and Discussion; Acknowledgement; References.
6. Design Effective Tables, Graphs & Illustrations: When to use tables and graphs; arrangement of tabular material; titles, footnote and abbreviations; when to illustrate and to use graphs, preparation of graphs, symbols and legends; photographs and micrographs.
7. The review Process (deal with editors) and the publishing process (deal with Proofs).
8. Writing a review paper, a conference report, a book review; Present a paper orally; Preparation of a poster.

### Recommended References:


1. Cochran, W. G. and Cox, G. M. (1957): Experimental Designs; John Wiley and Sons nc, London.
2. Cochran, W. G. (1963). Sampling Techniques (second edition), John Wiley & Sons, NY
3. Islam, M. Nurul. (2009). An Introduction to Research Methods. Mullick and Brothers. New Market, Dhaka.


***Course No. Env- 4213***
**Global Climate Change** **(3 Credits, 100 Marks)**

### Summary of Content:

1. Cosmic Solar Radiation Basics, Solar Radiation below and Above the Atmosphere, Trends in Surface Solar Radiation, or Global Dimming and Brightening, The Causes of Dimming and Brightening, Influence of Solar Radiation Changes, Observed Changes in the State of Arctic Sea Ice, Classifying and Comprehending the Observed Changes, Solar Activity,
2. Rays and Climate Change, The Influence of Molecular-dust Galactic Clouds on the Earth's Climate, The Influence of Interplanetary Dust Sources on the Earth's Climate, Space

Factors and Global Warming, The Influence of Asteroids on the Earth's Climate, The Influence of Nearby Supernova on the Earth's Climate, Land ice: indicator and integrator of climate change, Mass Balance of Glaciers and Ice Sheets, Observations of Recent Changes

3. Myths, Facts, Lies and Opinions About the Greenhouse Effect, Origin of the Greenhouse Effect: 'Primary' and 'Secondary' Effects, The Physical Chemistry Properties of Greenhouse Gases, Orbital-induced Climate Change, Aerosol Loading, Spatial Distribution and Radiative Effect, Volcanoes and Climate
4. Climate change through earth history, Global surface temperatures (land surface, sea surface), Characterization of Extremes and Variability, Uncertainty Quantification, Sea Level Rise and Coastal Systems, Climate Change and Global/Relative Sea Level Rise, Recent Impacts of Sea Level Rise, Global Warming and Coasts at Latitudinal Extremes, The Challenge to Understand Contemporary Impacts
5. The Life Cycle of Tropospheric Aerosols, Aerosol-Radiation Interactions, Aerosol-Cloud Interactions, The Net Radiative Forcing of Aerosols, The Role of Aerosols in Climate Feedback Mechanisms, The Role of Aerosols in Potential Climate Engineering Schemes
6. Agriculture and Climate Change, Accelerated Soil Erosion, Mitigation Potential of Agriculture
7. Societal adaptation to climate change, Risk and Vulnerability, Disease Occurrence and Transmission, Ocean and Large-scale Surface Water Changes, Shifting Biomes and Resilience, Extreme Events, Food and Water Supply
8. Present Climates and Human Activity, Future Climates—The Great Uncertainty, carbon cycle, Sustainable Development and Climate Change: How can sustainable development be achieved for all while addressing global climate change? UN Framework Convention on Climate Change, Climate Justice and Equity, Global Warming, Spin and Media, Reactions to Climate Change Negotiations and Action, COP3— COP20.

**Goals and outcomes:**

The climate of the planet has changed tremendously over the last few decades, mostly due to pollution, greenhouse gases and depletion of the ozone layer that protects the earth. Global warming is one of the main factors of climate change, leading to excessive flooding, forest fires and rise in global temperatures. Scientists have analyzed climate change and identified some main features that work like early warning signs such as heat waves, periods of unusually warm weather, sea level rising, coastal flooding, ocean warming, and melting of glaciers. In some areas, excessive and unprecedented rise in temperature causes heat-related illness and death, especially in urban areas and among the elderly, the young, the ill, and the poor.

**References:**

1. Trevor M. Letcher, 2016, Climate Change Observed Impacts on Planet Earth, Second Edition, Elsevier Radarweg 29, PO Box 211, 1000 AE Amsterdam, Netherlands

2. David G. Anderson, Kirk A. Maasch and Daniel H. Sandweiss 2007, Climate Change and Cultural Dynamics: A Global Perspective on Mid-Holocene Transitions (Editors), Elsevier
3. Fifth Assessment Report - Climate Change 2013, IPCC: The Physical Science Basis. ... Copies of the printed report are available from Cambridge University Press.

***Course No. Env- 4215***
**Environmental Pollution and Mitigation (3 Credits, 100 Marks)**

Summary of Content:

1. Introduction: Types of pollution and their fate in Environment: Major categories of environmental pollution; Concepts of biological pollution; Entry of Pollutants in the environment; Transfer, transport and dilution of pollutants; Carrying capacity.
2. Biomanipulation: The Biomanipulation concept; Biomanipulation studies on reduction of fish abundance; Biomanipulation studies on phytoplanktivorus fish; Biological control of macrophytes; Relationship between biomanipulation in the limnetic and littoral zones; Future trends; Biomanipulation by introduction of herbivorous zooplankton; Applicability of planktonic biomanipulation for managing eutrophication; Conditions for effective biomanipulation; The first biomanipulation conference; ecosystem stability; Biomanipulation and ecosystem research.
3. Indicator Organism and Environmental Health: Indicator Organism to determine biological pollution; Monitoring of environmental health by using biological indicator.
4. Biosensor detection of pollutants; Bioremediation; Bioremediation of various ecosystems.
5. Algal Nuisances: Blooms, Nuissance blooms of Cyanobacteria in tropical fresh water system, Red tides.
6. Eutrophication: Sources of nutrients: Urban sources and Rural sources; General effects of eutrophication on the biota of freshwater: Plankton, Macrophytes, Benthos, Fish; Community interactions and eutrophication; Eutrophication as Problems for man: Water purification, Nitrates, Amenity values, Algal and Cyanobacterial toxins; Controlling eutrophication.
7. Intrusive Microorganisms and Bioassays: Intrusive Microorganisms: Bacteria, Viruses; Bioaccumulators: Bryophytes, Bivalves, Fish; Biomarkers; Bioassay: Biostimulation, Toxicity tests, Automated biomonitors.
8. Emerging Technologies: Bioreporters, Biosensors and Microprobes.
9. Wastewater treatment with aquatic macrophytes: Aquatic macrophytes in wastewater treatment systems; Suitability, mechanisms of action, design considerations, economics and environmental impact.
10. Biotechnological methods in pollution abatement: Biotechnology in the reduction of $CO_2$ emission; Algal photosynthesis in waste treatment; Eutrophication in biological phosphorus removal; Metal pollution and its bioabetement; cell immobilization as a tool in waste treatment.

## Recommended References:


1. Environmental Microbiology. Christon J. Hurst et al. Second Edition, 2002, ASM Press, Washington, D.C.
2. Biology of Freshwater Pollution. C.F. Mason, Third Edition, 1996, Longman Group Ltd. England.
3. Biomanipulation Tool for Water Management. Proceedings of an International Conference held in Amsterdam, The Netherlands, 8-11 August, 1989. Edited by R.D. Gulati, E.U.R.R. Lammens, M.L. Meijer and E.Van Donk. Kluwer Academic Publ. London.


***Course No. Env- 4244***
**Project Work/Internee (3 Credits, 100 Marks, 100 Marks)**

A project on environmental issues under the supervision of any faculty of the department or an internship in any reputed organization can be undertaken as assigned by the department. A report should be submitted and would be evaluated by an internal and an external as assigned by the department. 70 Marks is allocated for Project/Internee Report and 30 Marks is allocated for Presentation.

***Viva voce*** ***(1 Credit)***