

INSTITUTE OF FORESTRY AND  
ENVIRONMENTAL SCIENCES  
UNIVERSITY OF CHITTAGONG

SYLLABUS FOR BACHELOR OF SCIENCE  
WITH HONOURS IN  
ENVIRONMENTAL SCIENCE

SESSION: 2015-2016 AND 2016-2017

**COURSES FOR B.Sc. (Hons.) IN ENVIRONMENTAL SCIENCE**  
**SESSION 2015-2016 AND 2016-2017**

<b><u>First Semester</u></b>	TH	CT/TUPR	FM
ENV 111 Introduction to Environmental Science	50	25 25	100
ENV 112 Functional English	50	25 00	75
ENV 113 Advanced Algebra and Trigonometry	50	25 00	75
ENV 114 Fundamentals of Biological Science	50	25 25	100
ENV 115 Fundamentals of Chemistry	50	25 25	100
ENV 116 Fundamentals of Geography	50	25 25	100
ENV 117 Field Trip and Viva-voce	00	00 00	50
Total Marks			600

<b><u>Second Semester</u></b>	TH	CT/TUPR	FM
ENV 121 Analytical Chemistry	50	25 25	100
ENV 122 Physics	50	25 25	100
ENV 123 Advanced Geometry and Calculus	50	25 00	75
ENV 124 Sociology	50	25 00	75
ENV 125 Geology and Soil Science	50	25 25	100
ENV 126 Survey and Settlement	50	25 25	100
ENV 127 Military Science	00	00 00	25
ENV 128 Field Trip and Viva-voce	00	00 00	25
Total Marks			600

<b><u>Third Semester</u></b>	TH	CT/TUPR	FM
ENV 211 Ecology	50	25 25	100
ENV 212 Coastal Zone, Flood Plain and Disaster Management	50	25 25	100
ENV 213 Fundamentals of Economics	50	25 00	75
ENV 214 Atmospheric and Oceanic Environment	50	25 00	75
ENV 215 Environmental Biochemistry and Toxicology	50	25 25	100
ENV 216 Computer Application in Environmental Science	50	25 25	100
ENV 217 Field Trip and Viva-voce	00	00 00	50
Total Marks			600

<b><u>Fourth Semester</u></b>	TH	CT/TUPR	FM
ENV 221 Ecosystem Management	50	25 00	75
ENV 222 Statistics	50	25 25	100
ENV 223 Aerial Photogrammetry, Remote Sensing and GIS	50	25 25	100
ENV 224 Biodiversity Conservation	50	25 25	100
ENV 225 Environmental Pollution	50	25 25	100
ENV 226 Protected Area Management and Ecotourism	50	25 00	75
ENV 227 Field Trip and Viva-voce	00	00 00	50
Total Marks			600

<b><u>Fifth Semester</u></b>	TH	CT/TUPR	FM
ENV 311 Energy Management	50	25 25	100
ENV 312 Environmental Engineering	50	25 25	100
ENV 313 Microbiology and Environment	50	25 25	100
ENV 314 Environmental Chemistry	50	25 25	100
ENV 315 Environmental Communication and Journalism	50	25 00	75
ENV 316 Environmental Health and Occupational Safety	50	25 00	75
ENV 317 Field Trip and Viva-voce	00	00 00	50
<b>Total Marks</b>			<b>600</b>

<b><u>Sixth Semester</u></b>	TH	CT/TUPR	FM
ENV 321 Soil Pollution	50	25 25	100
ENV 322 Pollution Biology	50	25 25	100
ENV 323 Research Methodology	50	25 25	100
ENV 324 Water Quality Management	50	25 25	100
ENV 325 Hydrology and Water Resources	50	25 00	75
ENV 326 Air Quality Management	50	25 00	75
ENV 327 Field Trip and Viva-voce	00	00 00	50
<b>Total Marks</b>			<b>600</b>

<b><u>Seventh Semester</u></b>	TH	CT/TUPR	FM
ENV 411 Environmental Management	50	25 00	75
ENV 412 Environmental Impact Assessment	50	25 25	100
ENV 413 Environmental Ethics	50	25 00	75
ENV 414 Solid Waste Management	50	25 25	100
ENV 415 Wastewater Engineering	50	25 25	100
ENV 416 Environmental Economics	50	25 25	100
ENV 417 Field Trip and Viva-voce	00	00 00	50
<b>Total Marks</b>			<b>600</b>

<b><u>Eighth Semester</u></b>	TH	CT/TUPR	FM
ENV 421 Industrial Ecology	50	25 00	75
ENV 422 Watershed Management	50	25 25	100
ENV 423 Environmental Policy, Law and Administration	50	25 00	75
ENV 424 Land Use, Urban and Transport Planning	50	25 00	75
ENV 425 Human Dimensions in Environmental Management	50	25 00	75
ENV 426 Project Paper	00	00 00	75
ENV 427 Environmental Management Plan	00	00 00	75
ENV 428 Field Trip and Viva-voce	00	00 00	50
<b>Total Marks</b>			<b>600</b>

**ENV-Environmental Science**

**TH-Theory**

**CT/TU-Class Test/Tutorial**

**PR-Practical**

**FM-Full Marks**

## FIRST SEMESTER

**Course No.** : ENV 111  
**Course title** : INTRODUCTION TO ENVIRONMENTAL SCIENCE  
**Marks** : Theory: 50 (2 cr.); Class Test/Tutorial: 25 (1 cr. : Written-20, Attendance-05); Practical: 25 (1 cr.); Total= 100 (4 cr.)

### Theory:

- 1. Introduction:** Common terminologies used in environmental sciences; basic components and broader classifications of environment; understanding of environmental quality; importance of studying environmental science.
- 2. Pollution:** Pollution and major pollutants in environment; causes of environmental pollution in the world and in Bangladesh; importance of forests in maintaining healthy, sound and sustainable environment.
- 3. Pollution in 3 media:** Availability of fresh water in the world and its importance to humans; water quality; water pollution with causes, common impurities, causal effects and sources, common water-borne and viral diseases; air pollution with causes, main pollutants and sources, acid rain; soil pollution - solid and major kinds of chemical pollutants with their sources; noise pollution; all such pollutions discussions with special emphasis to Bangladesh.
- 4. Key global environmental issues:** Greenhouse effect - responsible gases with their contribution to this effect, CFC as a greenhouse gas and its reactions in the high altitude, forms of halocarbons in the atmosphere, CO<sub>2</sub> as a greenhouse gas and its balance in environment, adverse influences and benefits of greenhouse effects, ways and measures to protect greenhouse effect, global warming, climate change; ozone layer depletion - importance of ozone layer in the earth, ozone as a greenhouse gas, its distribution in troposphere and stratosphere; causes, remedial measures and possible threats in Bangladesh.
- 5. Key environmental issues in Bangladesh:** Land degradation - driving forces, causes and impacts on people region wise, land degradation by human activities; water scarcity in dry season and flood; biodiversity - various groups of flora and fauna recorded, major threats to biodiversity; natural disasters, their types and impacts in specific disaster prone areas of Bangladesh.
- 6. Environment related organizations:** Vision and mission of international organization, e.g. Intergovernmental Panel on Climate Change (IPCC), Global Environment Facility (GEF), United Nations Environment Program (UNEP), European Environment Agency (EEA), International Union of Conservation of Nature (IUCN) and Greenpeace, national organizations such as Ministry of Environment and Forests (MoEF), Ministry of Water Resources (MoWR), Department of Environment (DoE), Water Development Board (BWDB), River Research Institute (RRI), WARPO, CEGIS, Arannayk Foundation, Bangladesh Environmental Lawyers Association (BELA), etc. working in the arena of conservation, advocacy and management of environment.
- 7. International treaties, protocols and conventions:** Rationale and background of international treaties, e.g. Comprehensive Nuclear Test Ban Treaty (CTBT), protocols e.g. Cartagena Protocol, Kyoto Protocol and Montreal Protocol and conventions, e.g. Basel Convention, Convention on Biological Diversity (CBD), Convention on the International Trade in Endangered Species of Wild Flora and Fauna (CITES), Convention on the Trans-boundary Effects of Industrial Accidents, Framework Convention on Climate Change (UNFCCC), International Convention for the Prevention of Pollution from Ships, Ramsar Convention, Stockholm Convention etc.

**Practical:**

1. Understanding of common tree species in IFESCU campus and their role in environmental amelioration.
2. Understanding of common Environmental issues in urban and rural areas including their role in environmental amelioration.

**References:**

Bangladesh Paribesh O Paribesh Adidapter (Bengali version), Department of Environment, Dhaka, 1990.

Bangladesh: State of Environment 2001, UNEP and DoE.

Introduction to Environmental Science in Bangladesh Perspective, S. M. Sirajul Haque, M. Mosharraf Hossain and K. M. Nazmul Islam, IFESCU and USDA, 2013.

Understanding our environment – An introduction to environmental chemistry and pollution, (Third edition) Edited by R. M. Harrison, 1999.

Watershed Management Extension and Environmental Conservation in Bangladesh, S. M. Sirajul Haque and Maung Hla Myant, IFESCU and USDA, 2011, 188 pp.

**Course No.** : ENV 112  
**Course title** : FUNCTIONAL ENGLISH  
**Marks** : Theory: 50 (2 cr.); Class Test/Tutorial: 25 (1 cr.: Written-20, Attendance-05); Total = 75 (3 cr.)

**Theory:**

1. **Remedial grammar:** (a) Tense, (b) Parts of speech, (c) Sentence structure, (d) Voice, (e) Correction, (f) Narration, (g) Phrases, (h) Appropriate Preposition.
2. **Vocabulary.** Scientific and communicative (general).
3. **Reading skills:** Comprehension on topics based on scientific subject matter.
4. **Listening and Speaking skills:** Practical use of listening and speaking skills.
5. **Writing:** Writing free and guided composition; Analytical writing.
6. **Communication:** Definition, types and its importance in environmental sciences.
7. **Speech communication:** Introduction to speech communication; speech-communication process; communication model; kinds of speech communication; selection of speech subjects and topics, preparation of speech materials, presentation of speech; speaker-audience interaction.
8. **Written communication:** Description of different types of written communication: Essay, Leaflet, Pamphlets, Books, Booklets, Popular Article, Wall Paper, Poster, Banners, Festoons and Research paper.

**References:**

- Ehninger, D.; Monroe, A.H. and Gronbeck, D.E. 1978, Principles and types of Speech Communication (8th ed.), Scott, Foresman and Company, London.
- Kapp, R.O. 1973. Representation of Technical Information (2nd ed). The Anchor press Ltd., Britain.
- Kumar, S and Lata, P. 2011. Communication Skills.1st edition. Oxford University Press.
- Pyle, M. A. 1986. Test of English as a Foreign Language. Cliffs Notes, Inc. U.S.A.
- Raman, R. A. and Sharma, S. 2011. Technical Communication- principles and practice. 2<sup>nd</sup> edition. Oxford University Press
- Taylor, C. 1978. Advancing Language Skills. The University Press Ltd. Bangladesh.
- Verderber, R. F. 1982. 5<sup>th</sup> edition. Wadsworth Publishing Company, California, USA

**Course No. : ENV 113**  
**Course title : ADVANCED ALGEBRA AND TRIGONOMETRY**  
**Marks : Theory: 50 (2 cr.); Class Test/Tutorial: 25 (1 cr. : Written-20, Attendance-05); Total = 75 (3 cr.)**

**Theory:**

**1. Algebra:**

- a. Importance of Mathematics in Environmental Science.
- b. Theory of equations
- c. Summation of series
- d. Determinant, Cramer's rule to solve equations
- e. Matrices [Rank of matrices is not included]
- f. Application of Algebra in Env. Sci.

**2. Higher Trigonometry:**

- a. De Moivre's theorem and its applications to solve equations
- b. Summation series
- c. Simple application of all the chapters in Env. Sci.

**3. Linear Programming:**

- a. Introduction, Constraints, Maximization and minimization, Graphical solutions
- b. Application of Linear Programming in Env. Sci.

**References:**

Aufmann R.N., Barker, V.C. and Nation, R.D. College Algebra and Trigonometry. Brooks Cole; 7 edition 1080 p.

Gass, S.I. 2010. Linear Programming: Methods and Applications: Fifth edition Dover Books on Computer Science, 544 p.

Hall, H.S. and Knight, S.R. Higher Algebra, Macmillan and Co. Ltd. New York.

Ray, G.C. and Hossain, M.E. Linear Programming, Titas Publications, 38 Bangla Bazar, Dhaka.

Shahidullah, A.M.M. and Bhattacharjee, P.K. A Text Book on Algebra and Trigonometry. Gonith Prokashon, Dhaka.

Sultan, A. Linear Programming: An Introduction With Applications (Second edition) Create Space Independent Publishing Platform. 660 p.

Theson, G. L. . Algebra and Trigonometry. Words Worth publication Company, Belmont, California. 613 p

**Course No.** : ENV 114  
**Course title** : FUNDAMENTALS OF BIOLOGICAL SCIENCE  
**Marks** : Theory: 50 (2 cr.); Class Test/Tutorial: 25 (1 cr. : Written-20, Attendance-05); Practical: 25 (1 cr.); Total= 100 (4 cr.)

### Theory:

- 1. Introduction:** General introduction of biological science; Introduction of plants and animals and their relationship in nature; Environmental perspective of biological science.
- 2. Classification:** Principles of classification; major groups of plants and animals; nomenclature and its principal; Characteristics of plants and animals and their identification
- 3. Physiology:** Introduction of plants and animals physiology including human being; Environmental perspective of plants and animals physiology; Absorption, transpiration in plants and water use efficiency; Water stress and plant growth and productivity; Role of nutrients, absorption of mineral nutrients diagnosis of nutrient deficiency- visual symptoms.
- 4. Reproductive biology:** Reproduction of plants and animals; process of reproduction, regeneration, importance of reproduction in environment.
- 5. Ecology:** Ecology of plants and animals; ecological significance of plants and animals in environment; Adaptation to environment.
- 6. Origin and evolution:** Plants and animals origin and their evolution; Change in plants and animals kingdom in nature; Environmental perspective of evolution.
- 7. Inheritance:** Law of inheritance; physical basis of heredity; linkage and crossing over.
- 8. Importance:** Significance of plants and animals in environmental conservation.

### Practical:

1. Collection, identification and preservation of plants and animal samples.
2. Study on plants and animals organ.
3. Demonstration of morphological and anatomical structure of root, stem and leaf;
4. Demonstration of digestive and nervous system of small animals
5. Study of physiological systems of Frog, Lizard and Fish.
6. Study of skeletal systems of Amphibia, Reptilia, Aves and Mammalia

### References:

- Cobley, L. S. and Steele, W.M. 1976. An Introduction to the Botany of Tropical crops. Second edition, The English language Book Society and Longman, London, U.K.
- Dutta, A.C. 1972. A Class Book of Botany, Fourteenth edition, Oxford University Press, Fanadany House, Calcutta-13, India.
- Kershaw, R.D. 1983. Animal Diversity, University Class Test Press, U.K.
- Pandey. B.P. 1985. A text book of Botany, Angiosperms S. Chand and Company Ltd. New Delhi.
- Porter. C.L. 1969. Taxonomy of Flowering Plants. Eurasia Publishing House, New Delhi, India.
- Ricki Lewis. 1992. Life. WMC Brown Pub. Ltd.
- Sharma, O.P. 1980. A manual of Practical Botany. Vol 1. Pragati Prakashani, Begum Bridge, Neerut-25001, India.
- Storer, T.I. & R.L. Uninger, 1979. General Zoology, (3rd edition), Oxford University Press. Inc. New York.



**Course No. :** ENV 115  
**Course title :** FUNDAMENTALS OF CHEMISTRY  
**Marks :** Theory: 50 (2 cr.); Class Test/Tutorial: 25 (1 cr. : Written-20, Attendance-05); Practical : 25 (1 cr.); Total = 100 (4 cr.)

### Theory:

- 1. Introduction:** Introduction to Chemistry, scope & importance of studying chemistry in relation to Environmental Science.
- 2. Solutions and Colloids:** Types of solutions concentration units, Henry's law, Nernst distribution law, solvent extraction, solution of non-electrolytes, vapor 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.
- 3. Chemical Kinetics & Equilibrium:** First and Second order reactions and their simple treatment, determination of order of reactions, simple theories of reaction rate (only outline of Arrhenius and Collision theory).  
Laws of mass action, its enunciation and mathematical formulation, its application to chemical reactions; principles of mobile equilibrium and its application to industrial reaction.
- 4. The Periodic Law and Modern Periodic Table:** Some periodic properties of the elements: metallic behavior, atomic size, ionization energy, electron affinity and electronegativity, classification of elements.
- 5. 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.
- 6. Structure Theory of Organic Chemistry:** A knowledge of the structure of C-C, C=C, C≡C, Alcohol, Aldehyde, Ketone, Amine, Amide & Carboxylic acid group, Benzene, Glucose and Carbohydrate.
- 7. Survey of Organic Functional Groups:** Reactions with special reference to functional groups and characteristic reactions of Alkane, Alkyl, Alkenes, Alcohol, Aldehyde, Ketone, Amine, monobasic and substituted monobasic acids and its esters, Anhydrides and Amides.

### Practical:

- Inorganic Qualitative Analysis (Semi-micro method):  
A. Basic radicals: Lead, copper, cadmium, antimony, iron, aluminium, nickel, calcium magnesium  
B. Acid radicals: Carbonate, chloride, sulphate, nitrate, iodide
- Inorganic Quantitative Analysis:  
A. Volumetric analysis:  
(1) Acid base titrations,  
(2) Oxidation reduction titrations: (i) with  $\text{KMnO}_4$  solutions (ii) with  $\text{K}_2\text{Cr}_2\text{O}_7$  solutions
- Water and other soluble plant extracts.

### References:

- Ahmed, M. and Mian, A.J. 1972. A Text Book of Organic Chemistry, Third edition. Ghani Art Press, Bangla Bazar. Dhaka.
- K.Kundu, Atomic Structure and the Periodic Table.
- S. Glasstone and D. Kews, Elements of Physical Chemistry, (McMillan & Co. Ltd.)
- Finar, I L. 1973. Organic Chemistry. Vol. I. English Language Book Society. 6th ed.
- General Chemistry, D.D. Ebbing.
- Haider, S.Z. 1977. Introduction to Modern Inorganic Chemistry. 5th Ed. Students Publications, P.K. Roy Lane, Dhaka.
- Hoque, M.M. and Nawab, M.A. 1974. Principles of Physical Chemistry. 3rd ed. Students Publications, Dhaka.
- Khalique, A. 1971. Organic Chemistry. Ideal Library, Bangla Bazar, Dhaka.
- Morrison and Boyd, 1988. Organic Chemistry. 7th ed. Allyn and Bacon, Inc. New Delhi.
- K. Kundu, Oxidation-Reduction and Acid-Base Reaction,
- P.W. Atkins, Physical Chemistry,

**Course No.** : ENV 116  
**Course title** : FUNDAMENTALS OF GEOGRAPHY  
**Marks** : Theory: 50 (2 cr.); Class Test/Tutorial: 25 (1 cr. : Written-20, Attendance-05); Practical: 25 (1 cr.); Total= 100 (4 cr.)

### **Theory:**

- 1. Introduction:** Geography and its branches with scope and importance in studying in environmental science.
- 2. Universe and earth:** History and description of the universe; galaxies and their types; Milky ways, solar system and other important components of the universe; origin, spheres and interior of the earth.
- 3. Atmosphere:** Composition of lower and upper sky atmosphere with main features and occurrences in each; imaginary lines such as latitude, longitude etc. of the world with terminologies used and their significance in relation to climate and time; Temperature zones of the earth.
- 4. Important earth features:** Geographically important features of the earth, such as - continents, oceans, seas, lakes, mountain, plateaus, plain land; earth extremes and some numerical facts about the earth.
- 5. Geographical regions:** Natural regions and sub-regions of the world; continents, oceans and seas and their distribution; locations of the currently discussed countries of the world region wise in different continents; sub-regions with countries, different climate conditions and physiographic regions of Asia.
- 6. Geography of Bangladesh:** Major physiographic regions, river systems, other water bodies such as haor, baor, beel, canal, lake, etc.; mineral, fuel and power resources in Bangladesh.
- 7. Cartography:** Scales and maps with their types and uses; international conventional signs used in maps; map reading; preliminary concept of GIS application on data representation in maps, presentation of qualitative information in maps and quantitative data by graphs.

### **Practical:**

1. Study of essential parts of various kinds of local, national and international maps.
2. Prepare and study different kinds of scales used in maps.
3. Determination and calculation of representative fraction from a given problems.
4. Drawing of map of Bangladesh
5. Presentation of statistical data by different forms of graphs.

### **References:**

- Bhuiyan, R. H. and Enam, M. K. 2006. Physical Geology.  
Professor Muazzem Hossain Chawdhury, Chawdhury, M. H. 2004. Ucchya Madyamic Vugul (Prothom Potra)  
Rashid, H.E., Geography of Bangladesh, 1991 by University Press Limited, Dhaka.  
K. Siddhartha and S. Mukherjee, Geography, 2002, Vol. (editors) Kisalaya Publications Pvt. Ltd, India.

**Course No. : ENV 117**  
**Course title : FIELD TRIP AND VIVA- VOCE**  
**Marks : Field Trip-25 (1cr.); Viva- voce-25 (1 cr.); Total = 50 (2cr.)**

**Field Trip: 25**

Environmental activities and reporting	-	07	
Tour report	-	05	
Tour examination	-	08	
Tree planting, nursing and reporting			-
05			

**Viva- voce: 25**

A plot of minimum 25 seedlings must be maintained by each student in the selected Plantation sites throughout the duration of his/her B.Sc. (Honours) course.

**The distribution of marks for the program for class attendance will be as follows:**

Attendance (%)	Marks
96 and above	5.0
91 - 95	4.5
86 - 90	4.0
81 - 85	3.5
76 - 80	3.0
71 - 75	2.5
66 - 70	2.0
60 - 65	1.5
Less than 60	00

## SECOND SEMESTER

**Course No.** : ENV 121

**Course title** : ANALYTICAL CHEMISTRY

**Marks** : Theory: 50 (2 cr.); Class Test/Tutorial: 25 (1 cr. : Written-20, Attendance-05); Practical: 25 (1 cr.); Total= 100 (4 cr.)

### Theory:

**1. Introduction:** Chemical analysis –types and application; Analytical techniques and methods; Factors affecting the choice of analytical methods; Common apparatus and glassware for analytical chemistry.

**2. Background in fundamental chemistry:** Chemical equilibrium; Law of mass action; Factors affecting chemical reactions in solution; Solution, solubility and concentration; Acid-base equilibria in water; Common-ion effect; The ionic product of water; Buffer solutions.

**3. Sampling:** Population and Sample; Sampling and its importance; Sampling procedure; Sampling and physical state; Crushing and grinding; Hazards in sampling; Sampling of environmental samples – Air sampling, Water sampling, Soil sampling, Biological sampling, Solid waste sampling.

### 4. Separative techniques

**Solvent extraction:** Fundamentals and factors; Synergistic extraction; Extraction reagents; **Chromatography:** Basics; History of development; Types of chromatographic techniques: (a) **Ion exchange:** Fundamentals, Ion exchange resins; Ion exchange in organic and aqueous-organic solvents; Liquid ion exchangers; Experimental techniques; (b) **Thin layer, column and liquid chromatography:** Thin-layer chromatography (TLC); Elution technique; Liquid chromatography (LC) and its types; Derivatisation; High performance liquid chromatography (HPLC) and High performance thin-layer chromatography (HPTLC); (c) **Gas chromatography:** Fundamentals; Apparatus; Types and applications; Analysis of a mixture using the internal; normalization method; (d) **Electrophoresis and electrochromatography:** Principles and instrumentation; Procedures and applications

### 5. Titrimetric analysis

Titrimetric analysis; Classification of reactions in titrimetric analysis; Preparation of standard solutions; Primary and secondary standards; Standard solutions; Equivalents, normalities and oxidation numbers; **Neutralisation titrations:** Indicators and their preparation; Mixed and universal/multiple range indicators; Neutralisation curves; Titrations in non-aqueous solvents; **Complexation titrations:** Complex ions; Complexation; Stability of complexes; Metal ion buffers; Complexones; Standard EDTA solutions; Types of EDTA titrations and EDTA complexes; Titration curves; Titration of mixtures, selectivity, Metal ion indicators. **Precipitation titration:** Precipitation reactions; Determination of end points in precipitation reactions: **Oxidation-reduction titrations:** Change of the electrode potential during the titration of as reductant with an oxidant; Formal potentials; Detection of the end point in oxidation-reduction titrations

### 6. Gravimetric Analysis

Fundamentals; Precipitation; Effect of acids, temperature, solvent on the solubility of a precipitate; Supersaturation and precipitate formation; Co-precipitation; Fractional precipitation; Precipitation from homogeneous solution; Washing and ignition of precipitate; Thermogravimetric and electrogravimetric methods of analysis; Fractional precipitation; Organic precipitants; Volatilization or evolution method

## **7. Electrochemical analysis:**

Electrode/Redox potentials; Electrochemical/Oxidation-reduction cells; Calculation of the standard redox potential; Electrode systems; Electrochemical analysis methods: Coulometry, Potentiometry, Voltammetry, Amperometry.

## **8. Colorimetry and spectrophotometry:**

Fundamentals and Theory; Classification of methods of 'colour' measurement or comparison; Wavelength selection; Radiation sources; Cells, The Beer-Lambert relationship in quantitative spectrophotometry; Data presentation; Layout of instruments; Derivative spectrophotometry; The origins of absorption spectra; Elementary theory; Instrumentation; Flames; The nebuliser-burner system; Resonance line sources; Monochromator; Detectors; IO Interferences; Chemical interferences; Background correction methods; Atomic absorption spectrophotometers;

Apparatus and instruments and Applications of **Infrared spectroscopy, Atomic emission spectroscopy, Plasma emission spectroscopy** -Direct current plasma (DCP); Inductively coupled plasma (ICP), **Atomic absorption and flame emission spectroscopy, Atomic fluorescence spectroscopy**

## **9. Statistics for Analytical Chemistry**

Errors; Accuracy and precision; Significance testing; Calibration and linear regression; Quality control and chemometrics; Using excel for data analysis

### **Practical:**

1. Identification of apparatus and glassware used in analytical chemistry
2. Use of gravimetric and titrimetric method
3. Construction of calibration curve
4. Use of Chromatography for determination of selected analyte
5. Use of spectroscopy for determination of selected analyte

### **References:**

David, G. L. 2001. *Analytical Chemistry*. Sangam Books Limited  
Vogel, 2009. *Quantitative Chemical Analysis*, 6/E. Pearson Education  
Kealey, D. & Haines, P. J. 2002 *BIOS Instant Notes in Analytical Chemistry*. Taylor & Francis

**Course No. : ENV 122**

**Course title : PHYSICS**

**Marks : Theory: 50 (2 cr.); Class Test/Tutorial: 25 (1 cr. : Written-20, Attendance-05); Practical : 25 (1 cr.); Total = 100 (4cr.)**

### **Theory:**

1. **Introduction:** General considerations of physics and its relevance to environmental science; Relationship of physics to other branches of environmental science.
2. **Mechanics:** Newton's law of motion, Newton's law of universal gravitation; Kepler's law, acceleration due to planets and satellites; Momentum; Work, Power and Energy; Conservation of momentum and energy; Energy in a gravitational field; Simple harmonic oscillator problems; **Renewable and non-renewable energy resources** - Hydropower, Biomass, Wind; Environmental context of energy sources; Physical perspective of global climate change;
3. **Elasticity:** Stress and strain; Hooke's Law; Modulus of elasticity; elastic and plastic substances;
4. **Fluid mechanics:** Rise of liquid in a capillary tube; angle of contacts; theory of capillary; capillary fundamentals and soil water; Hydrostatic equation; viscous field; Poiseuille's equation; Dispersion of pollutants in water and air
5. **Soil physics:** Types of soil water movement; salivated flow through soils; unstated flow in soils; water movement in stratified soils; retention of soil moisture in the field; capillarity and root extension and its relevance to soil pollution
6. **Sound:** Sound and sound waves; Propagation of sound wave; Intensity of sound and its measurement; Noise; Sound abatement.
7. **Heat and Thermodynamics:** Absolute temperature; specific heat; conduction, convection, and radiation of heat; mechanical equivalent of heat; first law of thermodynamics; thermodynamics processes, Thermal pollution; Heat and environment; Thermodynamics and global warming.
8. **Light:** Reflection, Refraction, Transmission, Emission and Absorption of light; Laws of reflection, Refraction; Mirrors, Lens, Prism; Electromagnetic radiation, solar spectrum; solar constant; Fluorescence; Fundamentals of spectroscopy.
9. **Electricity:** Coulomb's law; Ohm's law; Capacitance and resistance and their combinations, Kirchoff's law; D.C. and A.C. Power and their applications; Consumption and wastage calculation for electrical energy; Carbon footprint calculation in relation to electricity consumption.
10. **Electronics:** Diode and triode valves; transmitter, receiver, transistors and microprocessors; Application of electronics in environmental science; Environmental sensors based on physical properties of matter; Data loggers.
11. **Modern Physics Radioactivity** and its application, Properties of rays, principal facts, laws, application of radio-isotopes, Hazards related to radioactivity.
12. **Theory of Relativity:** Postulates of special theory of relativity; Implications and importance of the theory in environmental science.

### **Practical:**

1. Compound pendulum;
2. Young's modulus;
3. Surface tension of water;
4. Calorimetric experiment;
5. Specific heat;
6. Measurement of resistances.
7. Melde's experiment
8. Newton rings experiment.

### **References:**

- Holiday and Resnick. Physics for Students of Science and Engineering, Part I and Part II. Wiley, N.Y.
- Hossain, T. 1975. A Text Book of Heat 2nd ed. Barnamala Press & Publications Ltd. 31/32, P.K. Roy Road, Bangla Bazar, Dhaka.
- Kalimuddin, M. 1974. A Text Book of Magnetism, Electricity and Modern Physics. 2nd ed., Mullick Brothers, 3/1, Bangla Bazar, Dhaka.
- Mason, N. and Hughes, P. 2001. Introduction to Environmental Physics: Planet Earth, Life and Climate, Taylor and Francis.
- Mathur, D.S. 1983. Elements of Properties of Matter. 10th ed., S. Chand & Company Ltd. Ram Nagar, New Delhi-110055.
- Seely, S. Electron Tube circuits.

**Course No. : ENV 123**

**Course Title : ADVANCED GEOMETRY AND CALCULUS**

**Marks: : Theory :50 (2Cr): Class Test/Tutorial 25 (1 Cr; Written :20, Attendance :5 ;Total= 75 (3 cr.).**

**Course contents:**

**1. Advanced Geometry:**

The straight line;  
Changes of axes;  
Pairs of straight line;  
General equation of second degree;  
Circles;  
Parabola;  
Ellipse;  
Hyperbola;

**2. Differential Calculus:**

Functions;  
Continuity;  
Differential co-efficients;  
Successive differentiation;  
Partial differentiation;  
Tangents and normal;  
Maxima and minima;

**3. Integral Calculus:**

Integrations of functions of single variable;  
Methods of integration;  
Integration by parts;  
Special integration;  
Definite integrals;

**4. Application of Geometry and calculus in Environmental Sciences.**

**References:**

- Anton, H., Bivens, I. and Davis, S. 2002. *Calculus: early transcendentals (7th edition)* Wiley.
- Barnett R.A., Ziegler M.R. and Byleen, K.E. 2010. *Calculus for Business, Economics, Life Sciences and Social Sciences (12th edition)*, Pearson. 704 p.
- Larson, R., and Edwards, B.H. 2013. *Calculus*. Brooks Cole; 10 edition. 1280 p.
- Mc.Dougal Little. 2007. *Holt McDougal Larson Geometry: Student edition Geometry 2008*, Mc.Dougal Little. 1st edition. 1176 p.
- Mohammad, K. and Bhattacharjee, P.K. 1988. *A Text Book on Differential Calculus*. S. Tripaty, 124 Chandanpura, Chittagong.
- Mohammad, K. and Bhattacharjee, P.K. and Latif, M.A. 2003. *A Text Book on Integral Calculus (With Differential Equations)*. Kanta Bhattacharjee, 28/A Joinagar, Chittagong.
- Rahman, A. and Bhattacharjee, P.K. 2003. *A Text Book on Co-ordinate Geometry with Vector Analysis*. S. Bhattacharjee, 28/A Joinagar, Chittagong. .
- Ruby, T.L., Sellers, J., Korf, L., VanHorn, J. and Munn, M. 2013. *Kaplan AP Calculus AB & BC 2014 (Kaplan Ap Calculus Ab and Bc)*, Kaplan Publishing, 624 p.

**Course No. : ENV 124**

**Course title : SOCIOLOGY**

**Marks : Theory: 50 (1 cr.); Class Test/Tutorial: 25 (1 cr. : Written-20, Attendance-05);Total = 75 (3 cr.)**

**Theory:**

- 1. Introduction:** Subject matter of sociology; sociology as a science; social sciences and sociological research; basic methods of sociological research.
- 2. Society:** Definition, social structure, status, role, group, institutions; types of society- hunter and gatherer societies, pastoral societies, horticultural societies, agricultural societies, industrial societies, post-industrial and modern societies.
- 3. Culture:** Human nature and elements of culture, norms, values; cultural variation and language; characteristics of Bangladesh society and its culture.
- 4. Social groups:** Types of social group, primary and secondary groups, ethnic groups, minority groups; associations and organizations; formal organizations- bureaucracy, functions and dysfunctions of bureaucracy.
- 5. Social institutions:** Major types of social institutions- family, religious, economic, political and educational institutions; Institutions in Bangladesh, their structure and functions, ethnicity and ethnic community institutions.
- 6. Social stratification:** Social class and social status and their components - property, power, prestige; social stratification in Bangladesh society and its implication in natural resource management.
- 7. Population and ecology:** Human population characteristics - birth and death rates, population density, growth and migration; ecological aspects of human survival in relation to land, water, energy, minerals etc.; Population and the environment –relationship between ecology, population and resource depletion.
- 8. Application:** Application of sociological knowledge for forest and environmental resources development and management in Bangladesh.

**References:**

- Anderson, C.H. 1971. *Towards a New Sociology-A critical view.* Ircoin-Dorsey Limited, Illinois.
- Bertocci, P. 1970. *Elusive Villages: Social Structure and Community Organization in rural East Pakistan.* Michigan State University.
- Biesanz, M.H. and Biesanz, J. 1973. *Introduction to Sociology.* New Jersey, Englewood Cliffs: Prentice Hall, Inc.
- Bottomore, T.B. 1972. *Sociology—A guide to problem and literature.* Second impression. George Allen and Uncoin Ltd, London.
- Chowdhury; Anwarullah *et al.* (eds.). 1986. *Sociology of Bangladesh: Problems and Prospects.* Bangladesh Sociology Association, Dept. of Sociology, D.U., Dhaka.
- Frederico, R.C. 1979. *Sociology.* Addison Wesley Publishing Company, Philippine.
- Koenig, S. 1968. *An Introduction to the Science of Society.* Barnes & Noble, Inc. New York.
- Rahman, A. 1986. *Peasant and Classes—A study in Differentiation in Bangladesh.* Dhaka University Press Limited.
- Schendel, W. V. *Peasant Mobility: The Odds of Life in Rural Bangladesh.* Van Gercum. Assen.
- Sen, R. (ed.). 1975. *Social Science (2nd ed.).* Franklin Book Programmes.



**Course No. : ENV 125**

**Course title : GEOLOGY AND SOIL SCIENCE**

**Marks : Theory: 50 (2 cr.); Class Test/Tutorial: 25 (1 cr. : Written-20, Attendance-05); Practical : 25 (1 cr.); Total = 100 (4 cr.)**

**Theory:**

1. **Introduction:** Scope of geology and soil science in environmental sciences; elemental, mineralogical and rock composition of the earth crust.
2. **Mineralogy:** Definition, physical characteristics and classification of minerals; common rocks and soil forming minerals.
3. **Petrology:** Major rock types and their formation, classification and description; kinds of soils developed from different rocks.
4. **Fossils:** Forms and uses of fossils, geological time scale.
5. **Geology** of Bangladesh.
6. **Weathering** agents of rocks and minerals, soil forming processes and factors of soil formation.
7. **Soils:** Concepts of soil, approaches of soil studies; physical, chemical and biological properties of soils; significance of important soil properties in tree growth, availability of nutrients and dominance of microorganisms.
8. **Soil water:** Soil water constants and their relationships with plant growth.
9. **Soil profile:** Soil profile and horizons with their sub-divisions with dominant characteristics.
10. **Organic matter:** Humus formation and its influence on physical, chemical and biological properties of soils.
11. **Soil classification:** Need for soil classification; kinds of classification; modern system of classifications in the world; classification of Bangladesh soils and their correlation with international systems.
12. **Soil organisms:** Morphological description, classification and functions of organisms living in soil.

**Practical:**

1. Identification of important physical properties of rock and mineral specimens in the laboratory.
2. Demonstration of major geological features in the field.
3. Differentiation of land materials into rock, parent materials and soils, along with collection of common rocks, minerals and fossils.
4. Study of soil profile in the field based on physical properties and methods of soil sampling.
5. Determination of soil organic matter by wet oxidation method.
6. Determination of soil bulk density, water holding capacity and pH.

**References:**

- Bangar, M.M, A Text Book of Geology. 1981. Standard Publishers Distributors, Delhi.
- S. M. Sirajul Haque, Geology and Soil Science IFESCU and USDA, 2013, ---- pp.
- Hussain, M.S. Soil Classification (with special reference to the soils of Bangladesh), 1992. University of Dhaka.
- Brammer, H. Soil Survey Project Bangladesh. 1971. Soil Resources, AGL; SF/ PAK
- Brady, N.C. The Nature and Properties of Soil, 1996. Prentice Hall of India India, New Delhi.

**Course No.** : ENV 126  
**Course title** : SURVEY AND SETTLEMENT  
**Marks** : Theory: 50 (2 cr.); Class Test/Tutorial: 25 (1 cr. : Written-20, Attendance-05); Practical : 25 (1 cr.); Total = 100 (4 cr.)

**Theory:**

**Part A: Survey**

1. **Introduction:** Definition, classification, scope and importance of surveying in forestry, useful data and formulae, general rules for calculation of areas and volumes.
2. **Scales:** Different expressions, representative fractions, types of scale (plain, diagonal and vernier scales), construction of different types of scales.
3. **Map and map reading:** Classification of maps, orientation, location of point (s).
4. **Chain survey:** Instruments and procedures, errors and corrections in chain survey, recording and plotting, advantages and disadvantages of chain survey, linear measurements, conventional signs.
5. **Traverse survey:** Useful terms, angular instruments, types of traverse, bearings, field procedure, plotting closing errors and adjustments, theodolites-measurement of horizontal and vertical angles, measurement of bearings, azimuth.
6. **Plane table survey:** General instrumentation and principle, methods and procedure-setting up the table, radiation, intersection, traversing, and resection.
7. **Levelling:** Definitions, Important terms related to leveling, instrumentation, principles of levelling, Purposes of leveling, procedures of leveling, Methods of calculating reduced level, classification of leveling-direct and indirect levelling, profile levelling, common errors in levelling.
8. **Topographical survey:** Contouring- contour and contour lines; Characteristics of contours, methods of contouring, contour drawing, interpolation of contours, GPS.
9. **Area computation:** Computation of area by planimeter and squares method.
10. **Copying plans and maps:** Copying of plans of map by tracing, graphical and mechanical methods, enlargement and reduction by proportional compass, photographic and photo copying methods.

**Part B: Settlement**

1. General concepts of records of rights, khatian, parcha, deed, maps, ROR, MOR, DCR etc., Settlement procedure and preparation of records of rights, historical background of settlement, land revenue systems and different register maintained for land revenue purposes, forest settlement procedures.

**Practical:**

1. Demonstration on drawing equipment and lettering practice.
2. Construction of different types of scale.
3. Conducting chain survey in the field.
4. Demonstration of traverse surveying in the field
5. Plane Table surveying in the field.
6. Demonstration of leveling in the field.
7. Contouring in hilly area.
8. Area calculation on map and land.
9. Copying, enlargement and reduction of maps used in surveying.

## References:

- Anderson, J. and Mikhail, E. 1997. Surveying: Theory and Practice. McGraw-Hill Science/Engineering/Math; 7 edition 1200 p.
- Bannister A. and Raymond, S. 1977. Surveying. Pitman Publishing Limited, London.
- Brinker, R. C. and Paul R. W. 1984. Elementary surveying. Seventh edition. Harper and Row Publishers, Inc. New York.
- Chandra, A. M. 2007. Higher Surveying. New Age International 424 p.
- Coover L. S. 1966. Drawing and Blueprint Reading. Third edition. McGraw Hill Book Company, NY.
- Kissan, P. 1971. Surveying Practice. Second edition. McGraw -Hill Book Company, New York.
- Kjellstrom, B. 1976. Be Expert with Map and Compass- The Orienting Handbook. Fourth edition. Charles Scribner's Sons.
- Miah, M.A.K. 2003. Bhumi Jarip O Bhumi Baybostaphona,
- Moffitt, F. H. and Harvy,B. 1982. Surveying. Seventh edition. Harper and Row Publishers, Inc, New York.
- Parkash, R. 1983. Forest surveying. International Book Distributors, Dehra Dun.
- Pugh, J.C. 1975. Surveying for Field Scientists. Methuen and Co. Ltd, London.
- Shahjahan, M.. and Aziz, M.A. 1984. A Textbook of Surveying. Hafiz Book Center, Dhaka. Dhaka-1.
- Whyte, W. and Paul, R. 1997. Basic Surveying. Taylor & Francis 335 p.

**Course No. : ENV 127**  
**Course title : Military Science**  
**Marks : Theory/Practical-25 (1cr.); Total = 25 (1cr.)**  
**Course Content:**

Introduction to military science, military rank, drill, raid, ambush, hiking, capsule training program, monthly training course, annual training exercise, annual camp, blood donation, tree plantation, collection and distribution of warm cloth in winter.

**Course No. : ENV 128**  
**Course title : FIELD TRIP AND VIVA- VOCE**  
**Marks : Field Trip and viva-voce -25 (1cr.); Total = 25 (2cr.)**

**Field Trip: 13**

Tour report	-	05
Tour Examination	-	08

**Viva- voce: 12**

A plantation plot of minimum 25 seedlings must be maintained by each student in the selected Plantation sites throughout the duration of his/her B.Sc. (Honours) course.

**The distribution of marks for the program for class attendance will be as follows:**

Attendance (%)	Marks
96 and above	5.0
91 - 95	4.5
86 - 90	4.0
81 - 85	3.5
76 - 80	3.0
71 - 75	2.5
66 - 70	2.0
60 - 65	1.5
Less than 60	00

## THIRD SEMESTER

**Course No. : ENV 211**

**Course title : ECOLOGY**

**Marks : Theory: 50 (2 cr.); Class Test/Tutorial: 25 (1 cr. : Written-20, Attendance-05); Practical: 25 (1 cr.); Total = 100 (4 cr.).**

### Theory :

1. **Introduction:** Basic concepts of ecology; sub-divisions of ecology; scope of ecology in environmental management.
2. **Ecosystem:** Concept, components and functional attributes of ecosystem; natural and man-made ecosystems (grassland vs pond and forest vs agricultural ecosystems); habitat and ecological niche; trophic level, food chain, food web; trophic structure and ecological pyramids.
3. **Environmental Factors:** Environmental factors and their role on the distribution and survival of organisms; effects of environmental factors on plant growth, regeneration and distribution; interrelations between environmental factors.
4. **Material cycling in environment:** Biogeochemical cycles, macro and micro nutrients; nutrient cycling, nutrient uptake, mycorrhiza and nutrient uptake in plants; nutrient input and nutrient return in ecosystems, soil organisms and their role in decomposition of organic matter; nutrient loss from ecosystems.
5. **Autecology:** Phenology, flowering, Pollination, fruiting, seed output, dispersal of fruits and seeds, seed viability, dormancy, reproductive capacity and plant percent, seedling and vegetative growth, adaptation on forest trees.
6. **Synecology:** Community composition, classification of communities, structure of vegetation, methods of studying plant community structure, gap phase dynamics.
7. **Succession and retrogression:** Concept and stages of succession, concept of climax, causes of retrogression and its relation in forest instability, succession in mangrove ecosystems, secondary forest succession. Coastal vulnerability and climate change
8. **Major ecosystems of Bangladesh:** Forest ecosystem, wetland ecosystem, village agroforestry ecosystem, riverine ecosystems, marine ecosystems, ecologically critical areas (ECAs) of Bangladesh.

### Practical:

1. Morphological study of different ecological adaptation of selected species.
2. Survey of different ecosystems: Village forest ecosystem, forest ecosystem and wetland ecosystem.
3. Studies on the succession/ retrogression processes in forest, rural and marginal homesteads.

### References:

- Anderson, I.M. 1981. Ecology for Environmental Biosphere: Ecosystems and Mass. Edward Arnold.
- Baubenmire, R. 1968. Plant Communities: A textbook of plant synecology. Harper & Row, Publishers. New York.
- Dash, M. C. and Das, S. P. 2009. Fundamentals of Ecology, Tata McGraw Hill, New Delhi.
- Etherington, J. R. 1975. Environment and Plant Ecology. John Wiley & Sons, London.
- Greig-Smith, P. 1983. Quantitative Plant Ecology. 3rd ed. Blackwell Scientific Publications. Oxford, London & Edinburgh.
- Grime, S. P. 1981. Plant strategies and vegetations processes. John Wiley & Sons, Chichester.
- Kamaluddin, M. 1984. Forest Ecology, Institute of Forestry, University of Chittagong, Chittagong, Bangladesh.
- Kershaw, K.A. 1969. Quantitative and dynamic ecology. Edward Arnold. Publishers Ltd., London.
- Kimmins, 2003. Forest Ecology, 3<sup>rd</sup> edition, University of British Columbia, Canada.
- Kormondy, E.J. 1976. Concepts of Ecology. 2nd ed. Prentice-Hall, Inc. Englewood cliffs. New Jersey.
- Lal, J. B. 1992. Forest Ecology. Natraj Publishers, Dehradun, India.
- Mackenzie, A., Ball, A.S. and Virdee, R. 2002. Instant Notes- Ecology. 2<sup>nd</sup> edition. Bios Scientific Publishers, UK
- Puri, G.S. 1960. Indian Forest Ecology. A comprehensive survey of vegetation and its environment in the Indian Subcontinent. Vol.I & II. Oxford Book & Stationery Co. New Delhi and Calcutta (India).
- Richards, P.W. 1976. The Tropical rain forest. An ecological study. Cambridge Univ. Press, Cambridge.
- Spurr, S. H. and Barnes, B.V. 1980. Forest Ecology 3rd ed. John Will & Sons., New York
- Whitmore, T. C. 1975. Tropical Rain Forests of the Far East. Clarendon Press. Oxford.

**Course No.** : ENV 212  
**Course title** : **COASTAL ZONE, FLOOD PLAIN AND DISASTER MANAGEMENT**  
**Marks** : Theory: 50 (2 cr.); Class Test/Tutorial: 25 (1 cr. : Written-20, Attendance-05); Practical: 25 (1 cr.); Total = 100 (4 cr.).

**Theory:**

**1. Coastal environment & Management:** Introduction, definition & importance; Classification of coastal system: estuaries, tidal wetlands, coral reefs, beaches and shoreline; erosion, accretion and coastal land stabilization; 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), Coastal resource evaluation of vital area, resource capability use allocation. Coastal plantation and coastal environment. Marine Protected Areas (MPAs) and Zonation

**2. Coast protection:** Multistructure embankment, groans, breakwater, jetty etc, their problems & remedies; establishment of coastal green belt. Development options in the coast, tourism and recreation (Coxs Bazar, Saint Martin Island & Kuakata), fisheries resources, Nature conservation. Infrastructure development guidelines for coast development & management; Policy analysis & case studies.

**3. Coastal hazard and disaster Management:** Definition of hazard and disaster, difference among hazard, disaster and risk. Types and causes of coastal hazard, Adjustment of hazards. Hazardous waste management in coastal areas of Bangladesh, Ship dismantling and coastal hazard, Warning and forecasting system for disaster management.

**4. Flood plain management:** Agro-ecological zones of Bangladesh, 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 flood plain) & non flooded land. Agriculture development on flood plains and its effect on environment. Human settlement & plantation management on flood plan areas.

**5. Climate change and Coastal Hazard:** Observed and expected coastal hazard due to climate change, Adaptation to climate change induced coastal disasters, Social and ecological resilience to climate change impacts in the coastal areas of Bangladesh

**6. ICZM (Intregated Coastal Zone Management):** The process and need for ICZM. Integration of Agriculture, forestry and fisheries into CZM. Conflict resolution in ICZM.

7. Integrated Coastal Management: Guiding principles for Integrated Coastal Zone Management, Tools used for ICM, ICZM in Bangladesh

Practical: Visit the coastal vulnerable areas and students have to write-up the problems, possible amelioration of the site, farther suggestions etc.

**Practical:**

1. Observe different land use pattern (e.g. shrimp cultivation, ship breaking industries, salt farming) in coastal area and sort out environmental problems due to disaster and climate change.
2. Survey in different vulnerable coastal areas and identify environmental degradation.
3. Familiar with voluntary works of disaster risk reduction in cyclone and other disaster periods. Students may visit Disaster Management Bureau, Bangladesh Red Crescent Society and other organizations working for disaster risk reduction.

**References:**

- PJS Boaden and R Seed, An introduction to Coastal Ecology - (1955)
- Cicin-Sain, B. and Knecht R. W.,1998. Integrated coastal and ocean management: concepts and practices
- Morris, M., Dyer, M. and Smith, P. 2007. Management of flood embankments: A good practice review. Environmental Agency and DEFRA, Department for Environment, Food and Rural Affairs, Flood Management Division, Ergon House, Horseferry Road, London SW1P 2AL
- Henocque, Y. and Denis, J. 2001. A Methodological Guide: Steps and Tools Towards Integrated Coastal Area Management. IOC Manuals and Guides No 42. UNESCO.

**Course No.** : ENV 213  
**Course title** : FUNDAMENTALS OF ECONOMICS  
**Marks** : Theory: 50 (2 cr.); Class Test/Tutorial: 25 (1 cr. : Written-20, Attendance-05); Total = 75 (3 cr.)

### Theory:

- 1. Introduction:** Definition of economics; basic themes of economics scarcity, choice, specialization, exchange; Different branches of economics.
- 2. Micro and Macro Economics:** Basic assumption in microeconomic, Micro and Macroeconomics; their importance and limitations.
- 3. Theory of Consumer Behavior:** Utility analysis; total utility vs marginal utility, law of diminishing marginal utility; indifference curve approach; assumptions of indifference curve approach; properties of indifference curve, consumer's equilibrium, separation of price effect into income and substitution effect, derivation of demand curve from price consumption curve.
- 4. Mechanics of Demand and Supply:** Demand, demand curve, demand schedule and demand function; causes of downward sloping demand curve, exceptions to the law of demand; Supply—the law of supply, factors affecting supply; equilibrium of supply and demand, changes in the equilibrium price; the concept of elasticity of demand and its importance; meaning, methods of measuring elasticity-price, cross and income; shifts in demand and supply.
- 5. Theory of production:** Production function; law of variable proportions; returns to scale, the least cost combination of inputs.
- 6. Product Pricing:** Nature of cost curves in the short and long runs, relation between marginal cost and average cost curves; the concept of revenue, relation between average revenue and marginal revenue; equilibrium of the firm under perfect competition and monopoly, profit maximization and lost minimization.
- 7. National Income and National Product:** The circular flow national income; gross national products.
- 8. Concept of Environmental Kuznet's Curve:** Economic growth, development and environment concepts of EKC, history and background of EKC, shapes of EKC, turning point, Bangladesh on EKC.

### References:

Lipsey, R. G. 1983. An Introduction to Positive Economics (6th ed.). Harper and Row.  
McGuigan, J.R. & Moyer, R.C. 1979. Managerial Economics, (2nd ed.). N.Y. West pub.  
Philpor, G. 1980, The National Economy; An Introduction to Macroeconomics, N.Y. Willey.  
Ruffin and Gregory. 1979. Principles of Macroeconomics.  
Samuelson, P.A. 1976. Economics (10th ed). McGraw-Hill.  
Shapiro, E. 1978, Macroeconomic Analysis, (4th ed.). N.Y. Harcourt.



**Course No. : ENV 214**  
**Course title : ATMOSPHERIC AND OCEANIC ENVIRONMENT**  
**Marks : Theory - 50 (2 cr.); Class Test/Tutorial: 25 (1 cr. : Written-20, Attendance-05); Total = 75 (3 cr.)**

### **Theory:**

- 1. Atmosphere:** Its structure, components, extent; thermal radiation and atmosphere; the effect of atmosphere on sunlight and radiation balance; Life forms in the atmosphere – their distribution and characteristics; Air and the circulation in the atmosphere; Effect of vegetation on atmospheric circulation and precipitation; Effect of atmospheric circulation and precipitation on vegetation;
- 2. Clouds:** Cloud formation, cloud classification; Precipitation formation, precipitation classification; Hails, fogs, thunderstorm.
- 3. Dynamic Meteorology:** Forces acting on a particle in the atmosphere; equation of motion of the atmosphere; geotropic wind.
- 4. Synoptic meteorology:** Basic principles; weather mapping and analysis; air mass front, depression, and anticyclones.
- 5. Satellite meteorology:** Orbits and satellite; Satellite picture analysis (Neph analysis)
- 6. Oceanic environment:** The relief of ocean and its distribution; continental shelf and continental drift; Ocean basins – its changes due to erosion, transportation and deposition; Oceanic currents – causes of origination, movement and its effect on the terrestrial environment and climatic changes; Marine water – its sources, salinity and causes of increase in the salinity, effect of increased salinity on the coastal vegetation particularly mangroves in Bangladesh;
- 7. Changes in the oceanic environment:** Solar radiation, atmospheric pressure phenomena; formation and consequences of cyclones, tidal surges, and their effects. Effect of human activities on oceanic environment; Sea level rise;
- 8. Marine ecology:** Ecological characteristics of marine environment; marine life forms and diversity of marine plants and animals;
- 9. Marine pollution:** Pollutants – their types and sources; Oil spills – causes and consequences; effect of oil spills on the mangrove vegetation in Bangladesh;
- 10. Remedial measures:** Remedial measures against the pollution of atmospheric and oceanic environment; role of forest cover (mainland and coastal) in the conservation of atmospheric and oceanic environment;
- 11. Global climate change:** Reconstructing past climates- climate throughout the ages. Natural climate cycles. Possible causes of climate change: Internal mechanism, external forcing and feedback, Earth radiation budget, Examples of variability driven by internal mechanisms (North Atlantic Oscillation, El Nino, Atlantic Multi-decadal Oscillation, Pacific Decadal Oscillation). Impacts of global warming on coastal and wetland ecosystem.
- 12. Weather forecast system in Bangladesh:** Weather forecast and its related organization in Bangladesh. Weather forecasting system and information dissemination. Weather forecasting technology available in Bangladesh.

### **References:**

- Beys, W.R. 1978. General Meteorology. McGraw Hill Book Co., New York.
- Cole, F.W. 1975. Introduction to Meteorology, John Wiley and Sons. Inc., London.
- Holton, J.R. 1972. Dynamic Meteorology. Academic press.
- Miller, A. 1967. Meteorology. Charles E. Merrill Publishing Co. Columbus, Ohio.
- Miller, A. and Thomson, J.C. 1975. Elements of Meteorology. Charles E. Merrill Publishing Co., Columbus. Ohio.
- Rogers, R. R. 1976. A Short Course in Cloud Physics, Pergamon press.
- Wickham, P. G. 1970. The Practice of Weather Forecasting Her Majesty's Stationery Office, London.

**Course No.** : ENV 215  
**Course title** : ENVIRONMENTAL BIOCHEMISTRY AND TOXICOLOGY  
**Marks** : Theory: 50 (2 cr.); Class Test/Tutorial: 25 (1 cr. : Written-20, Attendance-05); Practical: 25 (1 cr.); Total = 100 (4 cr.)

### **Theory:**

- 1. Environmental Biochemistry:** Definition, Biochemistry & the cell. Proteins, lipids, carbohydrates, enzymes, nucleic acids. Metabolic processes, Metabolism of Xenobiotic Compounds. Biochemical degradation of pollutants inside the cell, cellular interaction with pollutants, Pollutants interaction with biological system at different levels (e.g. Organisms, Organs, all Organelles).
- 2. Environmental Toxicology:** Introduction, principles & concepts, Classification & sources of toxic substances. Dose-response relationship; Relative toxicities, reversibility & sensitivity; Xenobiotic endogenous substances. Toxicological chemistry, Kinetic phase & Dynamic Phase, Principle & method of studying toxins in an ecosystem. Effect of toxic substances: emphasis on physiological effect (Teratogenesis, Mutagenesis, Carcinogenesis), Effect on the immune & reproductive system. Toxic elements and elemental forms. Toxicology of inorganic and organic compounds.
- 3. Pesticides & therapeutic agents:** Distribution, abuse, bioaccumulation, biomagnification biomonite, Toxicological case studies in developed and under developed countries.

### **Practical:**

1. Determination of protein, lipids and carbohydrates.
2. Find the sources of toxic substances and measure the level of toxicity.
3. Toxicological case studies from different toxic areas.
4. Determination of toxicity hazard of different types of wastes.

### **References:**

Stanley E. Manahan, Environmental Chemistry, 7th edn 2000.  
J. Rose Gordon & Beach, Environmental Toxicology,  
P.P. Sharma, Molecular Basis of Environmental Toxicity,

**Course No. : ENV 216**

**Course title : COMPUTER APPLICATION IN ENVIRONMENTAL SCIENCE**

**Marks : Theory: 50 (2 cr.); Tutorial: 25 (1cr.), Written -20, Attendance -05; Practical: 25 (1 cr.); Total = 100 (4 cr.)**

**Theory:**

- 1. Fundamentals of Computer:** Computers and their application in Forestry; Historical development of computer, computer system.
- 2. Hardware systems:** Number system and logic gates; CPU organization; miniframe, Mainframe and super computer; Hardware generations; Input, output, memory and other computer peripherals; form factor; Future directions in computer system – from Mainframe to wearable computing.
- 3. Software fundamentals:** Software, system software and application software; Operating system: types and functions; Cloud computing and web applications.
- 4. Computer Programming:** Introduction to flowcharts, algorithms, programs and program structure, basic ideas about programming language, generations of computer languages.
- 5. Application Packages for Environmental Sciences Major:** Productivity suits – Word processing, spreadsheets; presentations; database; statistical analysis using Excel, Minitab, SPSS; Bibliography management.
- 6. Networking and Communication:** Computer networking fundamentals – topology, hardware; protocols, LAN, MAN, WAN, Internet and intranet; World wide web; Web sites and web browsers, Search engines; Electronic communications – e-mail, forums, groups, messaging; Social web – wiki, social networks and blogs
- 7. Important web links for Environmental Sciences:** OARE, UNFCCC, UNEP, IUCN, Google earth, WMO, EPA, DoE.

**Practical:**

1. Exercise on MS Word, MS Excel, PowerPoint and MS Access.
2. Exercises with software's related to Forestry Minitab, SPSS.

**References:**

- Don Cassel and Jackson, M. 1980. Introduction to Computers and Information processing. Reston Publishing Company. Virginia.
- Khan, M.S. 1991. Fundamental Elements of Computers. UNDP/FAO Project BGD/ 85/011, IFCU, Chittagong.
- Khan, M.S. 1991. Applied Computer Science in Forestry. UNDP/ FAO Project BGD/85/011, IFCU, Chittagong.
- Mason, W.L. and Muetzelfield, R. 1984. Computers in Forestry. Heriot—Watt University, Edinburgh, UK.
- Tamu, A.B. 1990. Introduction to computers, IFESCU.

**Course No. : ENV 217**  
**Course Title : FIELD TRIP AND VIVA- VOCE**  
**Marks : Field Trip-25 (1cr.); Viva- voce-25 (1 cr.); Total = 50 (2cr.)**

**Field Trip: 25**

Environmental activities and reporting	-	05
Tour report	-	10
Tour examination	-	10

**Viva- voce: 25**

A plot of minimum 25 seedlings must be maintained by each student in the selected Plantation sites throughout the duration of his/her B.Sc. (Honours) course.

**The distribution of marks for the program for class attendance will be as follows:**

Attendance (%)	Marks
96 and above	5.0
91 - 95	4.5
86 - 90	4.0
81 - 85	3.5
76 - 80	3.0
71 - 75	2.5
66 - 70	2.0
60 - 65	1.5
Less than 60	00

## FOURTH SEMESTER

**Course No. : ENV 221**

**Course title : ECOSYSTEM MANAGEMENT**

**Marks : Theory: 50 (2 cr.); Class Test/Tutorial: 25 (1 cr. : Written-20, Attendance-05); Total = 75 (3 cr.)**

### **Theory:**

- 1. Ecosystem Management:** Concept; history; principles of application. Difference between ecosystem management and conventional forest management; Prospects and limitations of ecosystem approach in natural resources management of Bangladesh.
- 2. Ecosystem Health:** Genetic components of healthy ecosystems; Genetic diversity, genetic guidelines for forest management under ecosystem approach.
- 3. Ecosystem Restoration:** Approaches and methods of restoration of terrestrial and aquatic ecosystem and their biodiversity.
- 4. Conservation and management of Flora and Fauna:** The interaction between flora and fauna, vegetation and environment
- 5. Management of wetland ecosystem:** Principles of wetland conservation; wetland management in Bangladesh.
- 6. Landscape ecology:** Approach, habitat restoration, design and architecture.
- 7. Ecologically critical Areas:** Basis for declaration, area, protective measures; sustainable management.
- 8. The flux of energy and matter through ecosystems:** primary productivity and the relationship between primary and secondary productivity, the fundamental importance of energy transfer efficiencies, the relative roles of the live-consumer and decomposer, the process of decomposition, nutrient budgets in terrestrial and aquatic ecosystems, global biogeochemical cycles (the hydrological cycle, the phosphorus cycle, the nitrogen cycle, the sulphur cycle, the carbon cycle, human impacts on biogeochemical cycles.

### **References:**

- Hussain, K. Z. 1974. An Introduction to Wildlife of Bangladesh. Film and publication Govt. of Bangladesh.
- Khan, M..A. R. 1982. Wildlife of Bangladesh. University of Dhaka.
- Khan, M. M. H. 2008. Protected Areas of Bangladesh: A Guide to Wildlife. USAID.
- Mallya, A. 2006. Wildlife Tourism and Conservation. GNOSIS, Delhi, India.
- Ranga, M. M. 2005. Wildlife Management and Conservation. Agrobios, Jodhpur, India.
- Reddy, M. V. 2008. Wildlife Biodiversity Conservation. Daya Publishing House, Delhi, India.
- Sarker, S. U. 1992. Parks and Wildlife Management UNDP/FAO Project BGD/85/011, IFCU, Chittagong.
- Sarker, S. U. 1992. Wildlife Ecology and Biology. UNDP/FAO Project BGD/85/011, IFCU, Chittagong.
- Sarker, S. U. and Sarker, N.Y. 1988. Wildlife of Bangladesh (A Systemic List), Rickom Printer, Dhaka
- Thomas, J.A. and Huke, S. (1996), The Forest Service Approach to Healthy Ecosystems. Journal of Forestry; Vol. 94, No. 8.
- Golley F.B. 1983. Ecosystem of the world 14A – Tropical Rain Forest Ecosystem: Structure and Function, Elsevier Scientific Publication Company, Netherland.

**Course No.** : ENV 222  
**Course title** : STATISTICS  
**Marks** : Theory: 50 (2 cr.); Class Test/Tutorial: 25 (1 cr. : Written-20, Attendance-05); Practical: 25 (1 cr.); Total = 100 (4 cr.)

### Theory:

1. Definition, scope and importance of statistics in Environmental Science; Recent development of statistics use in Environmental Science.
2. Population and sample; data, attributes and variables; accuracy and precision; Frequency distribution and its graphical representation; categorical data, ordinal data; random variables, explanatory and response variables, dummy variables.
3. Measures of Central Tendency: Expected value, mean, median and mode.
4. Measures of Dispersion: Mean deviation, standard deviation, variance, standard error of mean, coefficient of variation, parameters and statistic; skewness and kurtosis.
5. Probability theory: Different approaches of probability, addition and multiplication rules; normal, binomial and Poisson distributions; Calculation of areas under normal curve; Sample space and predicting probabilities; probability density function; cumulative probability density function.
6. **Correlation and Regression:** Simple correlation coefficient and its properties; coefficient of determination, linear regression analysis, residual error, standard error, regression coefficient and estimation of future values; OLS assumptions, violation of assumptions, BLUE, consistency, asymptote, homoskedasticity, heteroskedasticity, collinearity, autocorrelation, choice of regression types based on data, regression for categorical data, regression for ordinal data, model specification.
7. **Sampling theory:** Simple random sampling, stratified sampling, systematic sampling, Sample size, sample vs. census; Sampling intensity.
8. **Sampling distributions and test of significance:** Formulation of null and alternative hypotheses, testing hypotheses, paired and unpaired t-tests, normal test (z-test), Chi-square test, F- test, confidence limit, choice of a test.
9. **Experimental designs:** Definition, principles, important steps of experiments, sample selection, Completely Randomised Block Design, Randomised Block Design, Latin Square Design, and Factorial Design, choice of a design, design for behavioural science.

### Practical:

1. Laboratory exercises in the calculation of means, variance, standard deviation, confidence intervals, *t*- test, Chi-square test.
2. Calculation of Correlation and regression coefficients. Determining variance covariance matrix
3. Simple and multiple regression analysis and interpretation of results
4. ANOVA, *F*-test.
5. Field layout of experimental Design and Analysis of variance.

### References:

- Campbell, R.C. Statistics for Biologists., Cambridge University Press; 3 edition  
Freese, F. . Elementary statistical methods for foresters. USDA Forest Service.  
Lapin, L.L. Statistics Meaning and Method. Harcourt Brace Jovanovich Inc. USA.  
Lewis, A. . Biostatistics DeMYSTiFied, McGraw-Hill Professional; 1<sup>st</sup> edition  
Mostafa, M.G. Methods of Statistics. Karim Press & Publications, Dhaka.  
Shokal, R.R. and Rohlf, F.J. Introduction to Biostatistics. W.H. Freeman and Company, New York. 4<sup>th</sup> Edition  
Snedecor, G.W. and Cochran, W.G. Statistical Methods. 7<sup>th</sup> Edn. Iowa State University Press, Ames, Iowa.  
Townend, J.. Practical Statistics for Environmental and Biological Scientists, Wiley; 1<sup>st</sup> edition  
Waipole, R.E. Introduction to Statistics. 3<sup>rd</sup> Edn. Millan Prb. Co. Inc. New York.  
Zar, J.H. Biostatistical Analysis, Books a la Carte Edition, 5th edition Pearson.  
Kutner, M.H., Nachtsheim, C.J. Neter, J. and Li, W. 2005. Applied linear statistical Models, 5<sup>th</sup> edition, Mc, Graw, Hill, NY.

**Course No. : ENV 223**  
**Course title : AERIAL PHOTOGRAMMETRY, REMOTE SENSING AND GIS**  
**Marks : Theory: 50 (2 cr.); Class Test/Tutorial: 25 (1 cr. : Written-20, Attendance-05); Practical: 25 (1 cr.); Total = 100 (4 cr.)**

**Theory:**

1. **Introduction:** Scope, importance, historical development of remote sensing, characteristics and behavior of electromagnetic waves.
2. **Aerial photography:** Cameras, films and filters in aerial photography; Planning, taking and handling of aerial photographs; Determination of scale of aerial photographs; supervised and unsupervised data; ground truthing.
3. **Photo mosaics.** Controlled and uncontrolled mosaics; Mapping from remote sensing data with emphasis on triangulation method.
4. **Photo Interpretation:** Principles, elements of image recognition; Topographical studies, drainage assessment and road planning from aerial photographs.
5. **Satellite imagery:** Types of imagery, Satellite technology, and imagery production; digital and manual image analysis; multi-concept of remote sensing and MSS data.
6. **Introduction to GIS:** Concepts and scopes components of GIS, Map data representation.
7. **Geographic database: concepts,** data input, verification and storage.
8. **Spatial data analysis:** Acquisition of data from different resources, analytical tools and analysis, Digital terrain model and satellite data processing, spatial data set management using GIS; GPS technique.

**Practical:**

1. Orientation of aerial photographs for stereo viewing. Scale measurement.
2. Visuals image interpretation –delineation of areas, measurement of height and canopy cover.
3. Practical works using GIS software's and GPS.
4. Field visits for mapping and computerized image analysis to Remote Sensing and Mapping Institutions SPARRSO, RIMS and Office of the Survey General of Bangladesh.

**References:**

- Akthar, S. and Karki, A.S. 1999. Application of GIS to Mountain Land-use planning. International Center for Integrated Mountain Development. Kathmandu, Nepal.
- Avery, T.F. and Berlin, G.L.. 1985. Interpretation of aerial photographs. 4th edn. Burgess publishing co. Minneapolis, Minnesota.
- Buhmann, S. 1996. Geographic Information System. Bruenig, E.F. and Bossel, H. (eds.). Natural Resource Systems Analysis.
- Burrough, P. A. and McDonnel, R. A. 1998. Principles of Geographic Information Systems. Oxford University Press.
- Chrisman, N. 1997. Exploring Geographic Information Systems. John Wiley & Sons.
- Clarke, K. C., Parks, B. O. and Crane, M. P. 2002. Geographic Information Systems and Environmental Modeling. Prentice-Hall of India.
- Colwell, R.N.; Esters, I.C. and Thorley, G.A. (eds.). 1983. Manual of Remote Sensing Vol. 2. Interpretation and Application. Amer. Soc. of Photogrammetry, Virginia.
- De Mers, M.N. 1999. Fundamentals of geographic information systems. Second edition. New York.
- EGIS. 2000. Geo-spatial tools for analysis of floodplain resources. UPL.
- IDRISI. 1997. IDRISI for WINDOWS ver 2. IDRISI resource center, Clark University, Worcester, MA, USA.
- Korte, P and George, B. The GIS Book. Onward press.
- Lillesand, T.M. and Kiefer, R.W. 1987. Remote sensing and Image Interpretation. Second edition. John Wiley and Sons. New York, USA.
- Lo, C. P. and Yeung A. K. W. 2002. Concepts and techniques of Geographic Information Systems. Prentice-Hall of India.
- Moffit. F.H. and Mihlail, G.W. 1980. Photogrammetry. 3rd edn. Harper and Row Publishers N. York.
- Paine, D.P. 1981. Aerial Photogrammetry and Image Interpretation for Resource Management. John Wiley & Sons. New York, USA.
- Sharma, M.K. 1986. Remote Sensing & Forest Surveys. International Book Distributors. Dehra Dun, India.
- Simonett, D.S. and Ulaby, F.T. (eds). 1983. Manual of Remote Sensing. Volume One. Second edition. American Society of Photogrammetry. USA.
- Walford, N. 1995. Geographical data analysis. John Wiley & Sons.

**Course No. : ENV 224**

**Course title : BIODIVERSITY CONSERVATION**

**Marks : Theory: 50 (2cr.); Class Test/Tutorial: 25 (1 cr. : Written-20, Attendance-05); Practical: 25 (1 cr.); Total = 100 (4 cr.)**

### **Theory:**

1. **Concept and overview of the status of Biodiversity:** Current state of biological diversity-global and regional context, terrestrial and aquatic biodiversity, the value of biodiversity, human dependence on biological diversity, genetic variation within plant populations, species and ecosystem diversity, biodiversity and evolution of species
2. **Measuring and Monitoring Biological Diversity:** The richness of species within communities, key elements of the global biodiversity strategy, essential elements of the convention on biological diversity, methods for measurement and monitoring of species diversity; Village biodiversity register and participatory biodiversity assessment.
3. **Threats to Biodiversity:** Biodiversity and extinctions, extinctions as a natural process; Anthropogenic losses of species richness, unsustainable exploitation, species made extinct or endangered over harvesting, introduced species, habitat destruction; Deforestation and the loss of biodiversity in tropical forests and in Bangladesh; increasing diversity by restoring damaged ecosystems.
4. **Biodiversity conservation principles, strategies and methods:** Rationalization of the conservation of species, conservation activities, challenges to the conservation of biodiversity, conservation of biological diversity in Botanical gardens, policies to protect diversity, International development and the protection of biological diversity, ex-situ and in-situ conservation, participatory approach in the biodiversity conservation; Ecosystem approach to conservation, biodiversity friendly practices and technologies, developing and implementing national biodiversity strategies and action plans (NBSAP) in Bangladesh and South-east Asian countries, World Heritage site and the Sundarbans. Forest genetic resources conservation and utilization in Bangladesh.
5. **Homestead biodiversity:** Topographical features of homesteads and the importance of homestead forests. Special features of homestead flora; livestock and fisheries diversity and conservation approaches.
6. **Efforts Towards Biodiversity Conservation:** International, national, NGO, community and individual efforts; CBD principles and IUCN guidelines; Institutes and organizations related to biodiversity conservation- IUCN, MAB, ITTO, IPGR, CIFOR, BNBG and WWF.

### **Practical:**

1. Assessment of biodiversity in different ecosystems.
2. Monitoring of Biodiversity hotspots.

### **References:**

- Agarwal, S.K. Tiwari, S. and Dubey, P.S. 1996. Biodiversity and Environment. A. P. H. Publ. India.
- Boyle, T. J.B. and Boontawee, B. (eds.). 1994. Measuring and monitoring biodiversity in tropical and temperate forest. Proceedings of IUFRO Symposium, Thailand.
- Hasan, M. A. 2000. Biodiversity and Conservation. Hasan Book House. Dhaka.
- Negi, S. S. 1993. Biodiversity and its conservation in India. Indies Publishing Company, New Delhi,
- Poore, D. and Sayer, J. 1991. The Management of Tropical Moist Forest Lands: Ecological Guidelines. IUCN, Switzerland
- Schulze, E. D. and Mooney, H. A. (eds.). 1993. Biodiversity and ecosystem function. Springer-Verlag, Gambtt&Co, Berlin.
- Terborgh, J. 1992. Diversity and the tropical rain forest. W. H. Freeman & Co. Ltd. USA.
- Tewari, D. N. 1994. Biodiversity and Forest Genetic Resources. International Book Distributors, India



**Course No. : ENV 225**

**Course title : ENVIRONMENTAL POLLUTION**

**Marks : Theory: 50 (2 cr.); Class Test/Tutorial: 25 (1 cr. : Written-20, Attendance-05); Practical: 25 (1 cr.); Total = 100 (4 cr.)**

### **Theory:**

1. **Introduction:** General concepts of environmental pollution; types of pollution, global, regional and local levels of environmental pollution.
2. **Transport and behaviour of pollutants in the environment:** Source of pollutants, transport media, transport of pollutant in air, transport of pollutants in water, behaviour of pollutants in the soil.
3. **The pollutants:** Inorganic pollutants: Ozone, oxides of carbon, nitrogen and sulphur, heavy metals, other metals, radio nuclides, particles; Organic pollutants: smoke, methane and other hydrocarbons, organic solvents, pesticides, PCBs and dioxins, odours.
4. **Air pollution:** Types and sources of air pollutants and their effects on human, plants and ecosystem; greenhouse effect; forest damage symptoms; forest decline hypotheses; decline mechanisms; Air pollution sampling and control techniques, meteorological aspects of air pollution and air quality management systems.
5. **Water pollution:** Types and sources of water pollutants and their effect on human life, plants and other organisms; Causes of pollution of water in lakes, rivers, streams and their effects on ecosystem. Marine pollution and its effects on human, mangrove vegetation, fish and fisheries and other marine life system. Microbiological contamination of water. Mineral load of ground water and its relation to water use. Arsenic contamination in water and soil and its effects on human and other organisms. Water quality standards for different uses. Biological and physical methods of water and wastewater treatments.
6. **Soil pollution:** Sources of soil pollutants and their effects on soil quality and soil organism's; Soil as a recipient of waste.
7. **Noise pollution:** Concept of sound and noise; Nature of sound and noise, sources and causes of noise pollution and their control measures, noise abatement, injurious effect of noise on human health and other organisms; specially wildlife sanctuary and parks/ zoos.
8. **Thermal pollution:** Sources, effects and control of thermal pollution; Thermal pollution over different locations of land, air and water bodies, Possible long term effects of thermal pollution.
9. **Radioactive pollution:** Sources and types of radioactive pollutants; Effects and control of radioactive pollutants.

### **Practical:**

Demonstration of the use of air and water sampling/monitoring equipment; study of damage symptoms in different components of environment.

Analysis of water quality Parameter, analysis of air quality parameter.

### **References**

- Alloway, B.J. and D.C. Ayres. 1993. Chemical Principles of Environmental Pollution, Blackie Academic and Professional, London.
- Arora, M. 1998. Biological Control of Environmental Pollution. Vol, 1, 2 & 3. Anmol Publications Pvt. Ltd.
- De, A K . 2007. Environmental Chemistry. New Age International (P) Ltd.
- Kovacs, M. 1985. Pollution Control and Conservation. John Wiley & Sons.
- Mohan, I. 1989. Environmental Pollution and Management. Asish Publishing House, New Delhi-110026.
- Rajavadipa, N. and Markandey, D.K. 1998. Advances in Environmental Science and Technology. Vol. 1. DPH Publishing House, New Delhi, India.
- Shukla, S.K. and P.R. Srivastava. 1992. Pollution Control: Objectives and the Regulatory Framework. Common Wealth Publishers, New Delhi.
- Trivedi, P.R. 1999. Encyclopedia of World Environment Pollution. A.P.H. Publishing Corporation, New Delhi.

**Course No : ENV 226**

**Course title : PROTECTED AREA MANAGEMENT AND ECOTOURISM**

**Marks : Theory: 50 (2 cr.); Class Test/Tutorial: 25 (1 cr. : Written-20, Attendance-05); Total = 75 (3 cr.)**

**Theory:**

1. **Introduction:** The role of protected areas in biodiversity conservation; changing social expectations for protected area management; threats to biodiversity and their implications for protected area management; Gaining support for protected areas and strategies to gain support for protected areas, History of ecotourism and its definitions; Nature based tourism, Characteristics of ecotourism; Benefits of ecotourism.
2. **Protected areas and society:** Brief historical overview of protected areas in Bangladesh; stakeholders and the local community; the issues - protected areas and society; impact of people on protected areas; Impact of protected areas on people; benefits from protected areas; Indigenous peoples and local community rights and protected areas; Managing the interface and meeting the challenge; linking development and conservation through protected areas, protected area categories; Management structures and systems, protected area governance and models of management, adaptive management and challenges.
3. **Linking protected areas with the surrounding landscape:** Bioregional planning and protected areas; system planning; bioregional planning, putting systems and bioregional planning into practice; ecosystem management; lessons from experiences with ecosystem management and implications for protected area management practice; Principles of ecosystem management proposed for the Convention on Biodiversity.
4. **Tourism in protected areas:** Wildlife tourism in protected areas; Ecotourism: towards recreation and conservation, problems and prospects of sustainable tourism growth; alternate sustainable tourism, adventure tourism and wilderness, coastal ecotourism and mass tourism and their ecological effect; Coastal tourism and ecological aspects, tourism issues related to socio-culture, hospitality and authenticity, economic and environmental accessibility, strategies of different types of tourism issues, economic significance of tourism, tourism as an element in sustainable development, environmental codes of conduct for tourism.
5. **Tourism planning and management in protected areas:** Historical perspective, scope, nature and evolution of tourism; the dimensions of tourism and their relation with environment; implications of climate change for tourism; organizations of tourism; principles of tourism planning, goals and methods; purpose and approaches of tourism planning; Essentials of tourism planning, elements of tourism, regional planning concepts, planning process, implementation and monitoring of tourist plan, cost-benefit analysis; Elements, trends and scope of tourism management; Tourism issues and management strategies, tourism impact assessment, environment tourism management and policy, modes of travel and services, travel pattern and management, demand and motivation and their marketing and management.
6. **Tourism Impact Assessment:** Models and variability in tourism, national, regional and international structure of tourism; Economic, ecological and socio-cultural impact of tourism development; Measuring and assessment of ecotourism impact.
7. **Tourism marketing, research, policy and regulation:** Prospects of tourism marketing; Methods, planning and management of tourism marketing, tourism services, guides and information systems and identification and evaluation of tourist resources, publicity and promotion in tourism, tourism policy consideration and structure planning, formulation of tourism policy, towards sustainable tourism policy.
8. **Co-management in resource management:** Ecotourism for natural resource conservation and community development; Community based ecotourism; Participatory Eco-park management

## References:

- Ali, S. and Ripley, S. D. 1983. Handbook of the Birds of India and Pakistan Compact Edition. Oxford Univ. Press. New Delhi.
- Anon. 1973. Bangladesh Wildlife (Preservation) order, 1973. (President's Order no. 23 of 1973) - Published in the Bangladesh Gazette, Extraordinary, part. 111A dated the 28<sup>th</sup> March, 1973.
- Anon. 198. Report of the Wildlife Task Force the Forest Department Bangladesh, Ban Bhavan, Dhaka.
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- Daniel, J. C. 1983. The Book of Indian Reptiles Bombay Natural History Society, Bombay.
- Feeroz, M.M., Hasan, M.K., Khan, M. M. 2011. Biodiversity of Protected Areas of Bangladesh. Vol. I: Rema-Kalenga Wildlife Sanctuary. Bio Track. Arannayak Foundation, Dhaka, Bangladesh.
- Feeroz, M.M (ed.). 2013. Biodiversity of Protected Areas of Bangladesh. Vol. III: Teknaf Wildlife Sanctuary. Bio Track. Arannayak Foundation, Dhaka, Bangladesh.
- Gill P. S. (ed.). 1999. Dynamics of Tourism. Vol. I-IV. Anmol Publications PVT LTD, New Delhi, India.
- Hussain, K. Z. 1974. An Introduction to Wildlife of Bangladesh. Film and publication Govt. of Bangladesh.
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- Kumar, R. B. 1995. Coastal Tourism and Environment. APH Publishing Corporation, New Delhi, India.
- Malhotra, R. K. 1998. Socio-Environmental and Legal Issues in Tourism. Encyclopaedia of Hotel Management and Tourism Series. Anmol Publications PVT LTD, New Delhi, India.
- Malhotra, R. K. 1998. Growth and Development of Tourism. Encyclopaedia of Hotel Management and Tourism Series. Anmol Publications PVT LTD, New Delhi, India.
- Malhotra, R. K. 1998. Tourism Marketing. Encyclopaedia of Hotel Management and Tourism Series. Anmol Publications PVT LTD, New Delhi, India.
- Olivier, R. C. D. Wildlife Consultant, Field Document No. 10 on Wildlife Conservation and Management in Bangladesh, BFRI.
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- Sethi, P. (ed.). 1999. Handbook of Sustainable Tourism. Anmol Publications PVT LTD, New Delhi, India.
- Sethi, P. (ed.). 1999. Handbook of Modern Tourism. Anmol Publications PVT LTD, New Delhi, India.
- Sinha, P.C. (ed). 1997. International Encyclopaedia of Tourism Management. Vol. 1-12. Anmol Publications PVT LTD, New Delhi, India.
- Trippense, R.E. 1953. Wildlife Management Vol. I & II McGraw Hill Book Co.
- Van Tyne, J. and Berger, A. J. 1976. Fundamental Ornithology , N.Y.
- Wallace, G. J. and Mahan H. D., 1975. An Introduction to Ornithology. 3<sup>rd</sup> ed. MacMillan Publishing Co. Inc. N. Y
- Whitaker, R. 1982. Export Prospects from commercial Crocodile farms in Bangladesh. ITC/DIP63, 1982 Project No. GTO/03/07.
- Wiley, J. C. 1962. The life of Birds. Philadelphia and London. Sawnders. Chapter 5.

**Course No. : ENV 227**  
**Course title : FIELD TRIP AND VIVA- VOCE**  
**Marks : Field Trip-25 (1cr.); Viva- voce-25 (1 cr.); Total = 50 (2cr.)**

**Field Trip: 25**

Environmental activities and reporting	-	05
Tour report	-	10
Tour examination	-	10

**Viva- voce: 25**

A plot of minimum 25 seedlings must be maintained by each student in the selected Plantation sites throughout the duration of his/her B.Sc. (Honours) course.

**The distribution of marks for the program for class attendance will be as follows:**

Attendance (%)	Marks
96 and above	5.0
91 - 95	4.5
86 - 90	4.0
81 - 85	3.5
76 - 80	3.0
71 - 75	2.5
66 - 70	2.0
60 - 65	1.5
Less than 60	00

## FIFTH SEMESTER

**Course No. : ENV 311**

**Course title : ENERGY MANAGEMENT**

**Marks : Theory: 50 (2 cr.); Class Test/Tutorial: 25 (1 cr. : Written-20, Attendance-05); Practical: 25 (1 cr.); Total = 100 (4 cr.)**

### Theory:

1. **Energy:** Definition and classification of energy; The Sun: an ideal energy source; Energy and industrial revolution; Energy and sustainability; Human energy sources and consumption; Energy conservation processes.
2. **Fossil Fuels:** Origin of fossil fuels; Carbon cycle; Oil, natural gas, coal; Fossil fuel and global warming and its consequences; Decarbonization.
3. **Renewable Energy:** Concepts of renewable energy; Bioenergy-conventional and development outlook; Sources, types and technology, global outlook, potential of bioenergy in Bangladesh, challenges related to bioenergy; Solar energy-status quo, development outlook; Hydroelectricity, Wind power, Ocean energy, Geothermal energy.
4. **Nuclear Energy:** Isotopes and radioactivity; Naturally occurring radioisotopes; Radioactivity-Biological effect; Fission and Fusion; Hazards of nuclear power; Nuclear waste disposal; Nuclear energy and environment.
5. **Energy utilization:** Energy, industrialization and its impacts on environment; National, regional and international energy politics; Energy crisis; Conflict resolution regarding energy in Bangladesh; Energy planning; Energy use pattern in Bangladesh; Management of energy in Bangladesh; Energy planning in rural Bangladesh; Development of energy efficiency in Bangladesh-Traditional cooking, Automobiles; Energy and societies; Future energy supply outlook.
6. **Projection of energy demand and supply:** Models to analyze and forecast energy demand (econometric models & land use models); Integration of supply and demand of energy; Renewable; energy efficiency programs; demand side management.
7. **Energy balance:** Fundamentals of energy balance. Energy balances on closed systems. Energy balances on open systems at steady state. Energy Balance on a single and multi-component process. Energy balance on non-reactive processes and reactive processes.
8. **Pinch technology for efficient energy management at industrial scales:** Heat Exchanger Networks (HEN) design to meet the energy targets and efficient energy management. Heat Exchanger Networks (HEN)-capital and total cost targets. Heat exchanger networks (HEN)-network design.

### Practical:

1. Bio-energy planning for a community
2. Measurement of biomass carbon/energy to be supplied from a energy plantation
3. Biogas plant

### References:

Klass, D.S. 2004. Biomass and renewable energy, Encyclopedia of energy, Elsevier, Inc, 193-212 pp  
Richard M. Felder and Ronald W. Rousseau. Elementary principles of chemical processes, Third Edition.  
Robin Smith. Chemical Process: Design and Integration. 2005 edition. John Wiley & Sons, Ltd. ISBN: 978-0-471-48681-7.

- Sabonnadiere, Jeas-Claude,(ed). 2007. Renewable energy technologies, Johan Wiley & Sons, Inc. 501pp
- Shukla, S.K. and Srivastava, P.R. (eds.), Environmental Energy: Impact Analysis, 1992
- Stanlay E. Manattan, Environmental Chemistry, 2005 CRC Press, London.
- Swisher, J.N. Jannuzzi, G.D.M. and Redlinger, R.Y. 1997. Tools and Methods for Integrated Resource Planning: Improving Energy Efficiency and Protecting the Environment, UNEP.
- Tomar, S.S., Energy Agriculture and Environment, 1995 Mittal Publications, New Delhi.

**Course No. : ENV 312**

**Course title : ENVIRONMENTAL ENGINEERING**

**Marks : Theory: 50 (2 cr.); Class Test/Tutorial: 25 (1 cr. : Written-20, Attendance-05); Practical: 25 (1 cr.); Total = 100 (4 cr.)**

### **Theory:**

- 1. Introduction to water supply:** Introduction to water supply system; essential elements of water supply system.
- 2. Sources of water:** Ground and surface water; collection and distribution of water; water pipes, fittings and fixings; pumps and pumping machinery; fire hydrants.
- 3. Water treatment:** Review of water quality and water quality standards for the purpose of treatment; water treatment methods-aeration, sedimentation, filtration, disinfections; Geometric and structural design of water treatment units.
- 4. Water supply systems:** Water supply systems in rural and urban. areas; industrial water supply systems.
- 5. Introduction to sewerage:** Essential elements of sewerage system. Classification, characteristics, components, and decomposition of sewage; sewer pipes and sewer systems.
- 6. Sewage treatment and disposal:** Physical, chemical and biological treatment of sewage; sewage disposal techniques; sludge treatment and disposal; treatment of industrial waste; review on solid waste disposal.
- 7. Environmental Sanitation:** Different treatment plants; ETP, ATP, STP, WTP, CETP, etc. Application of engineering principles to the control of communicable diseases; industrial hygiene and air contamination; plumbing; camp sanitation.
- 8. Planning and Design:** Geometric and structural design of the components of water supply and sewerage systems; a review on construction materials commonly used for constructing water treatment and sewage treatment plants.
- 9. Effluent Treatment Plant (ETP):** Design, installation and assessment procedure as per guidelines of Department of Environment (DoE), Bangladesh.

Engineering aspects of air quality improvement,

### **Practical:**

Students have to work on assignments related to water supply system, water treatment, sewerage, assessment of ETP/ ATP/ STP/ WTP efficiency at different industries and projects etc.

### **References:**

- Aziz, M. A. 1976. Sewerage Engineering. Hafiz Book Center 167-Govt. New Market, Dhaka.
- Aziz, M.A. 1976. Water Supply Engineering. Hafiz Book Center 167-Govt. New Market, Dhaka.
- Hossain, M. M. *et al.* 1981. Study on water quality and design of water treatment plant for Chittagong Engineering College Campus, B. Sc. Engineering thesis, Chittagong Engineering College, Chittagong.
- Kulkarni, G. J. 1977. A textbook of Water Supply and Sanitary Engineering, 9<sup>th</sup> ed., Wiley & Sons, N. Y.
- Singh, G. 1984. Water Supply and Sanitary Engineering, 3rd ed. Standard Publishers Distributors, Delhi,
- Steal, F. W. and McGhee, T. J. 1979. Water Supply and Sewerage, 5<sup>th</sup> ed., McGraw Hill Kogakusha, Ltd, New Delhi.

**Course No : ENV313**

**Course title : MICROBIOLOGY AND ENVIRONMENT**

**Marks : Theory: 50 (2 cr.); Class Test/Tutorial: 25 (1 cr. : Written-20, Attendance-05); Practical: 25 (1 cr.); Total = 100 (4 cr.)**

### **Theory**

1. **Fundamentals of microbiology:** Definition; Classifications; Application; Prokaryotic eukaryotic cell; Microbial metabolism; Microbial growth and genetics.
2. **Bacteria, viruses, algae, fungi and protozoa:** Morphology and growth; Metabolism; Classifications; Significance in plants and animals including human life; Diseases of human, caused by microbes and dissemination of diseases
3. **Bio-fertilizer:** Concept, nature and types; Microbial fixation of nitrogen; Cyano-bacteria; free living and symbiotic nitrogen fixation; *Rhizobium*, mycorrhiza.
4. **Host-microbe interaction:** Principles of disease and epidemiology; microbial mechanisms of pathogenicity; specific and nonspecific defenses of the host; practical application of immunology; disorder associated with the immune system; antimicrobial drugs.
5. **Methods for controlling microorganisms:** Microbiology and the environment; sterilization, disinfection, decontamination; terrestrial and aquatic microbiology; microbiology of foods and water, microbiology of waste disposal; commercial applications of microbiology.
6. **The Law:** Role of enforcement officers, and the powers to control the sale of unfit, sub-standard or injurious food; Consequences of non-compliance with food safety law; importance of training, training records and refresher training; legal requirements in relation to food handler training; importance of accurate record-keeping to a food business; concept of 'due diligence'; legal requirement to handle food safely

### **Practical:**

1. Microscopic study of microorganisms
2. Culture of microbes
3. Isolation, preservation and identification of microbes.

### **References:**

- Edward Alcanco, 1984. Fundamentals of Microbiology, Addison-Wesley publishing Company, London.
- Kumar, H. D. and Kumar, S. 1999. Modern Concepts of Microbiology. Vicas publishing house Pvt Ltd.
- Madigen. Mantriko Pancer, 1997. Biology Microgesing, Prenter Hall International Inc. USA.
- MERCK-Microbiology Manual (12<sup>th</sup> Edition), G.A. Traley 48/1, Purana Paltan (3<sup>th</sup> Floor), Dhaka-1000.
- Nester, E.W., B.J. Mcearthy, C.E. Roberts and N.N. Parsell, 1973-Microbiology Fort Rinehant and Winsten, Inc. New York.
- Pelegen (Jr). Chang & Raieg 1997 Microbiology Tata McGraw Hall Edition, New York 902
- Staing, Ingraham, Wheli & Poester, 1986. General Microbiology, The Macmillan Press Ltd. London.
- Wisterich & Lechtman 1980-Microbiology Glencoe Publishing Co Inc. London
- Paul Edmords, 1978. Microbiology: an environmental perspectives.
- Sharma, P.D. 1996. Microbiology and Pathology.
- Alexander. Soil Microbiology.
- Alexopoulos, C.S. and Mims, C.W. 1979. Introductory Mycology. Wiley Hastern Limited, New Delhi.
- Bakshi, B.F. 1976. Forest pathology: Principles and practice in forestry, Govt. of India.



**Course No.** : ENV 314  
**Course title** : ENVIRONMENTAL CHEMISTRY  
**Marks** : Theory: 50 (2 cr.); Class Test/Tutorial: 25 (1 cr. : Written-20, Attendance-05); Practical: 25 (1 cr.); Total = 100 (4 cr.)

### Theory:

1. **Basic concept of Environmental Chemistry:** Chemical process: Cycles in water, air, soil and their importance to everyday life and to industry / forestry/ agriculture etc. Importance of environmental chemistry in resource management especially in forest, soil and atmosphere, Some basic concepts: Redox potential, Complexation & speciation, Trace elements, pollutants and contaminants.
2. **Atmospheric chemistry:** General concepts and composition of the atmosphere. Chemical process in the atmosphere. Pollutants in the atmosphere - particulate, gaseous and others. Global warming, O<sub>3</sub> layer depletion and related issues. Acid precipitation, sources of acidifying chemical substances, their reactions, atmospheric transport and deposition, dry deposition, effect of acid rain and dry deposition. Photochemical smog.
3. **Soil chemistry:** The general characteristics of soil solution, anion and cation exchange. Soil nutrients and soil pollutants and contaminants. Soil acidification- process, effects and mitigation.
4. **Water Chemistry:** Water environment, water quality standards. Parameters to measure the chemical nature of H<sub>2</sub>O and waste water. COD, BOD, DO, P<sup>H</sup>, salinity, TOC etc. Common chemical pollutants of water – Sources, effects and treatments. Arsenic in ground water in Bangladesh –Sources, effects, and remedial measure, aquatic biochemical processes.
5. **Toxic and hazardous wastes:** Classification, categorization and listing of solid and hazardous wastes. On site storage and transportation of solid and hazardous wastes in accordance with international law (WHO, UNEP), Disposal techniques of toxic, solid and hazardous wastes: – reuse, in-situ treatment, incineration and chemical fixation.
6. **Chemical toxicology:** Toxic chemicals in the environment, biochemical effects of arsenic, cadmium, lead, mercury, carbon mono oxide.
7. **Material Balance:** Fundamentals of material balances. Chemical process classification. The general material balance equation. Material balances on different industrial chemical processes, single and multiple-unit processes. Material balance for recycle and bypass. Chemical reaction stoichiometry and its application for materials balances in industrial chemical processes. Material balances on industrial reactive processes. Material balances for product separation, recycle, and purging. Material balances for combustion reactions. Material balances for single phase systems, material balances ideal and non-deal gases.

### Practical

Determination of different parameters related to the chemical changes in different segments of the environment including air, water, soil etc.

### References:

Andrew, R. W. and Jackson, J. M. 1996. Environmental Science, the Natural Environment and Pollution Hazards. Bishen Singh Mahendra Singh, Dehra Dun, India.

- Canter L. W. 1986. Acid Rain and Dry Deposition. Lewis publishers, INC.
- Cresser, M.; Killham, K. and Edwards, T. 1993. Soil Chemistry and It's Application. University of Cambridge.
- De, A K . 2007. Environmental Chemistry. New Age International (P) Ltd.
- Harte, J.; Holdren, C.; Schneider, R. and Shirley. 1993. Toxics A to Z: A Guide to Everyday Human Impact.
- Rajavadipa, N. and Markandey, D.K. 1998. Advances in Environmental Science and Technology. Vol. 1. DPH Publishing House, New Delhi, India.
- Richard M. Felder and Ronald W. Rousseau. Elementary principles of chemical processes, Third Edition.

**Course No.** : ENV 315  
**Course Title** : **Environmental Communication and Journalism**  
**Marks** : Theory – 50 (2 cr.); Class Test/Tutorial-25 (1cr.) Total = 75 (3 cr.)

## Theory

### **Part-1 Communication:**

1. **Introduction:** Definitions; Principles of Communication; Theories; Types of Communication
2. **Disseminating Information:** Different Media; Extension; Participatory Communication
3. **Communication Models:** Diffusion-Adoption Model; Mass communication models
4. **Development Communication:** Support; Technological interventions in communication

### **Part-2 Journalism:**

1. **Introduction:** Definitions; Scope; Role and Use of Journalism in Environmental Development; Ways to make news; Categories of news
2. **Media:** Mass media; Hypermedia; Planned behavior model; Process model.
3. **Writing of News:** General Styles of writings; Print; Electronic; Broadcast; News operation; Headline writing; Writing for magazines; Popular news; and Feature Writing
4. **Reporting:** Depth reporting; Crime reporting; Feature reporting, Proof reading
5. **Technology and Research:** Photo-journalism; Investigation; Techniques and Sources
6. **Development and Public Journalism:** Civil and participatory journalism; Special correspondent; Editorial; Idea about News paper publications and Electronic media establishment.
7. **Ethics in Journalism:** Morale of a Journalist: Social Responsibility; Yellow Journalism; Public Relation.

## Recommended bibliography

- Anon. Environment and Development; Vol. 1; 2; 3; 4. The University Press Ltd. Dhaka.
- Anthony J. E. 1993. 3-Public Journalism Row mans & little field 02 & political knowledge. Proceedings of a national Symposium held in Dhaka-people development and environment complex inter linkages in Bangladesh. IUCN; Staitor land.
- ESCAM/AFEJ/DABAF. 1996. Reporting on the environment: A handbook for Journalism. ESCAP.
- evsjv†'k cwi†ek I AvBbwe' mwgwZ (†ejv) cwi†ek I AbymÜvbx mvsevw'KZv-1993| Hypermedia; Civil and Participatory Journalism
- Jan Service *et al.* 1996. Participatory Communication for Social Change Sage.
- Kamnath M.V. 1998. Professional Journalism. Hakkani Publications. Dhaka. 275p
- Philip; G. (ed.). Bangladesh Environment-Facing the 21<sup>st</sup> Century. SEHD.
- Probhakar, N and Basu N. 2007. Journalism and Mass Communication. Commonwealth publications. 271p
- Rahman; M. G. 2000. 'Communication Issues in Bangladesh'. Har-Annand.

**Course No. : ENV 316**  
**Course title : ENVIRONMENTAL HEALTH AND OCCUPATIONAL SAFETY**  
**Marks : Theory: 50 (2cr.); Class Test/Tutorial: 25 (1 cr. : Written-20, Attendance-05);Total = 75 (3 cr.)**

**Theory:**

**1. Introduction to Environmental Health:**

Human impact on the environment, environment-human interaction, environmental impact on humans. Concept of environmental health, sanitation and public health. Concept of medicine in relation to social, community and curative medicine. Changing concept of health including dimensions, determinants and indicators of health. Concept of well being and human development index.

**2. Epidemiology:**

Concept of epidemiology, different epidemiological approach, tools for epidemiological measurement, epidemiologic methods, investigation of an epidemic.

**3. Management of public health diseases:**

Concept and natural history of disease. Different communicable diseases, and their transmission and control principle. Management of Viral hepatitis- Hepatitis A and Hepatitis B disease, Diarrhoeal diseases, Enteric fevers, Mumps, Chicken pox, Aids, Dengue, Malaria, Rheumatic fever etc.

**4. Health Education**

Definition, aims, methods, barriers, contents, principle of health education. Definition and aims of health communication and its function. Media and methods in health communication. Health education in Bangladesh and communication of needs for using safe water, proper nutrition and personal hygiene in Bangladesh context.

**5. Medical Entomology**

Arthropods borne diseases and an overview of arthropods of medical importance causing diseases. Role of vectors for causing diseases and principles of vector control.

**6. Environmental health, sanitation and housing**

Water borne disease. Water purification in small scale and large scale. Water quality standard for potable use. Air and ventilation including indoor air quality for various activities. Lighting, noise and radiation. System of sewage disposal. Design and construction of septic and imhoff tanks. Basic principles of healthful housing. Major health effects caused or exacerbated by poor housing conditions. Engineering strategies to protect residents from health hazards in the home

**7. Occupational health and Industrial hygiene**

Occupational health and occupational diseases and principles of prevention of occupational diseases. Definition and concept of industrial hygiene and industrial hygiene practices. Occupational health programmes in Bangladesh. Health, and hygiene provisions and special provisions relating to health, and hygiene of Bangladesh Labor Act, 2006.

**8. Occupational Safety**

History of safety in the workplace. Safety procedures in the workplace. Industrial environments safety issues. Occupational safety and health. Biological, chemical, and physical hazards to workplace safety and health, and protective measures for avoiding occupational health hazards. OSHA standards and origin of OSHA standards. Workman's compensation issues. Occupational safety and Workman's compensation provisions and special provisions relating to occupational safety and Workman's compensation of Bangladesh Labor Act, 2006.

**9. Primary Health Care**

Concept and definition primary health care (PHC). Principles and Components of PHC. Concept of health care services, health care delivery system, health status, health problems of Bangladesh; major problems and deficiencies of the present health care system. National Health Programme. International Health organizations working for primary health care. School health diseases and control.

**10. Environmental risk assessment:** Key concepts in modern environmental risk assessment. Perception, Planning and Scoping, Problem Formulation, and Hazard Identification-components of environmental risk assessment. Exposure assessment, Dose-response assessment, Risk characterization. Ecological risk assessment. Challenges and new direction of environmental risk assessment.

**References:**

Antonio Marcomini, Glenn W. Suter, and Andrea Critto (Edt.). Decision Support Systems for Risk-Based Management of Contaminated Sites. 2009. Springer publication.

Bangladesh Labor Act, 2006.

Geoff Taylor, Kellie Easter, Roy Hegney, Enhancing Occupational Safety and Health, Elsevier Butterworth-Heinemann, UK.

Stewart Jill, Taylor & Francis, Environmental health and housing, London, UK.

Environmental Health, D. W Moeller, Harvard University Press, Cambridge, UK.

Essentials of Environmental Health, Robert H. Friis, Jones & Bartlett Publishers, London, UK.

Essentials of Public Health Communication, Claudia F. Parvanta, David Nelson, Claudia Parvanta, Sarah Parvanta, Richard Harner, Jones & Bartlett Publishers, USA.

Essentials of Public Health, Bernard J. Turnock, Jones & Bartlett Publishers, USA.

Fundamentals of Industrial Hygiene, Barbara A. Plog, Patricia J. Quinlan, National Safety Council Press.

Fundamentals of Occupational Safety and Health, Mark A. Friend, James P. Kohn, Government Institutes- The Rowman & Littlefield Publishing Group.

Global Change and Health, Kelley Lee, Tata McGraw-Hill Education, India.

Occupational and Environmental Health : Recognizing and Preventing Disease and Injury, Barry S. Levy, David H. Wegman, Sherry L. Baron, Rosemary K. Sokas, Oxford University Press, USA.

Park's Textbook of Preventive and Social Medicine, K. Park, Banarsidas bhanot publishers, Jabalpur, India.

Short Textbook of Preventive and Social Medicine, GN Prabhakara, Jaypee Brothers Publishers.

Ted Simon. Environmental Risk Assessment: A Toxicological Approach. CRC Press, Taylor & Francis Group. 2014.

Textbook of Community Medicine and Public Health, K.M. Rashid, Md. Khabiruddin and Sayeed Hyder (Edt.).

Selim Reza, The Essentials of Community Medicine (4th edition), Essence Publications, Dhaka.

**Course No. : ENV 317**  
**Course Title : FIELD TRIP AND VIVA- VOCE**  
**Marks : Field Trip-25 (1cr.); Viva- voce-25 (1 cr.); Total = 50 (2cr.)**

**Field Trip: 25**

Environmental activities and reporting	-	05
Tour report	-	10
Tour examination	-	10

**Viva- voce: 25**

Minimum 25 seedlings must be maintained by each student in the selected Plantation sites throughout the duration of his B.Sc. (Honours) course.

**The distribution of marks for the program for class attendance will be as follows:**

Attendance (%)	Marks
96 and above	5.0
91 - 95	4.5
86 - 90	4.0
81 - 85	3.5
76 - 80	3.0
71 - 75	2.5
66 - 70	2.0
60 - 65	1.5
Less than 60	00

## SIXTH SEMESTER

**Course No** : ENV321

**Course title** : SOIL POLLUTION

**Marks** : Theory: 50 (2 cr.); Class Test/Tutorial: 25 (1 cr. : Written-20, Attendance-05); Practical: 25 (1 cr.); Total = 100 (4 cr.)

### Theory:

- 1. Introduction:** Soil in the natural and man made environment; soil as a sink of contaminants; concepts of soil pollution, quality and soil health; resistance and resilience in soil quality; soils and global ecosystem services; sustaining the human population; intensified agriculture and its effect on soil quality; impacts of vastly increased ratio of population to land; sustainable agriculture in developing countries; organic farming system; sustainable development for resource-poor farmers; improving soil quality in Asia.
- 2. Physical Causes of Soil Pollution:** Effects of global warming on soils, greenhouse effect on soils, effects of irrigation, ploughing and cultivation on soil environment;
- 3. Soil chemical pollution:** Six general kinds of pollutions- pesticides, inorganic, organic wastes, salts, radionuclides and acid rain in soil and their major uses, sources, chemistry and effects on soil pollution.
- 4. Soil acidification:** Processes, causes, effects and remedial measures of acidification in soil; acid rain and its greater impact on forests than on commercial agriculture; importance of parent materials in soil acidification; effect of forest management on soil acidification.
- 5. Soil pollution and the biosphere:** Effect of soil pollution and soil contaminants on human health, effects of soil contaminants on plants and other resources,
- 6. Management of problem soils:** Neutralization of acidified soil; amelioration of unproductive soil, degraded hill soil, beach land, waterlogged and swampy soil, saline soil, cosh soil and polluted soil; special problems of waste disposal sites and their remedial measures; impacts of soil improvement of problem soils on the environment.

### Practical:

1. Physical and Chemical analysis of polluted soils.
2. Demonstration of physical and biological conditions in polluted sites
3. Preparation and submission of reports.

### References:

- Alam, M. S. 2002 . Effect of Acid rain and Enhanced Nitrogen Deposition on Soil Water Chemistry and Growth of Scots and Seedlings. Ph D Thesis. University of Aberdeen, UK.
- Brady, N.C. 1996. The Nature and Properties of Soils. Prentice Hall (India) Ltd. (14<sup>th</sup> edition) New Delhi.
- Kennedy, I.R. 1994. Acid soil and acid rain, Research studies press ltd.
- Kovacs, M. 1985. Pollution Control and Conservation. John Wiley & Sons.
- Riedl, O. and D. Zachar. 1984. Forest Amelioration. Elsevier, Oxford.
- Sethi, M.S. and Sethi, I.K. 1991 Understanding our Environment.
- Wild, A. 1996. Soils and the Environment – an Introduction. Cambridge University Press.

**Course No : ENV 322**

**Course title : POLLUTION BIOLOGY**

**Marks : Theory: 50 (2 cr.); Class Test/Tutorial: 25 (1 cr. : Written-20, Attendance-05); Practical : 25 (1 cr.); Total = 100 (4 cr.)**

### **Theory:**

- 1. Introduction:** Basic concepts: Physical and biological environment; living organisms and Pollution of air, water and soil.
- 2. Biology:** Flora and fauna including microorganisms in soil, water and air, concept of prokaryotic and eukaryotic organisms. Classifications, characteristics and importance of flora and fauna including microorganisms in the environmental pollution phenomena. Diversity of microbial habitat; Microbiological aspects of air, water and soil pollution.
- 3. Sampling and analysis:** Sampling and analysis of biological parameters in soil, air and water; Methods involved in sampling and analysis of the biological parameters; Microbial analysis of water, soil and air.
- 4. Pollutants and living organisms:** Physiological and biochemical responses of plants, animals and other organisms to different pollutants; Defense mechanisms; Human infection diseases; Microbial diseases of man; Microbial toxin in environment.
- 5. Biological indicators:** Definition, concept and applications; Biological indicator and environment; Evolution and pollution effect on biological component; Practical uses of tolerance and resistance

### **Practical:**

Analysis of polluted air, soil and water and identification of microbes in polluted food, water, soil and air

### **References:**

- Andrew, R W. and Jackson, J. M. 1996. Environmental Science – the Natural Environment and Human Impact. Longman group Ltd, UK.
- Gupta, P. K. 2000. Methods in environmental analysis of soil, water and Air. Agrobios (INDIA)
- Paul Edmords, 1978. Microbiology: an environmental perspectives.
- Sharma, P.D. 1996. Microbiology and Pathology.



**Course No.** : ENV 323  
**Course title** : RESEARCH METHODOLOGY  
**Marks** : Theory: 50 (2 cr.); Class Test/Tutorial: 25 (1 cr. : Written-20, Attendance-05); Practical: 25 (1 cr.); Total = 100 (4 cr.)

### Theory:

- 1. Introduction:** Introduction to research; objectives and types of research, research design and planning.
- 2. Research ethics:** Concepts of research ethics; Its importance; Codes and policies of research Ethics; ethical and legal misconducts; Common ethical misconducts; authorship dispute and its resolution; Promoting ethics in research and its benefits; Some important violation of research ethics in the history (1932-2012).
- 3. Research steps:** Problem identification; Literature searching- necessity and procedure (both off- and online searching); Research gap and justification for research; objectives and hypothesis formulation; methodology – experimental designs, sampling methods, collection, manipulation, validation, and analysis of data, procedure with particular reference to various fields of Environmental Science; use of secondary data- when why and how to use secondary data, preparation of questionnaire and schedules; data, and results; interpretation and presentation of data/results.
- 4. Proposal writing:** concepts and necessities; ways to keeping an eye on funding/scholarship opportunities; steps involved in proposal writing (motivation, reading, preplanning writing the proposal, submitting, awaiting the decision, and resubmission); necessity to maintain quality in a research proposal, points not to be forgotten while writing a good proposal.
- 5. Writing report:** Types of reports, their contents and formats; write up style, clients/beneficiaries of research reports; procedures and rules followed in writing various parts viz. introduction-the single most important part of a research report-why, materials and methods, results, discussion, conclusion, recommendations and references in a report; Special precautions in publishing of research results.
- 6. Application of software in statistical analysis in research:** Need for software application in the present context; Advantages of software use in data analysis; Statistical knowledge and software use; facts and reasons behind executing a program; risk of improper/incorrect use of software; practical demonstration of data analysis through Excel, R, and SAS (examples/assignments on reading, manipulating, analyzing datasets.); exporting software outputs to expected locations or word files; interpretations of the output- what do those number in the results mean?
- 7. Research problems:** Recent developments in Environmental Science research, problems common in Environmental Science research, probable solutions to outcome of the problems.
- 8. Bibliography management:** Concept and importance of bibliography management; manual versus electronic management of biography; uses of reference writing software; software and researchers- an obvious interface; some commonly used bibliography management software, how to use EndNote/Zotero- creating library, adding-deleting references, import and export of references, editing reference in the text, and creating list of references; risk in using bibliography software and possible solutions.

### Practical:

1. Writing a dissertation research proposal.
2. Analysis of small datasets through software packages (SAS, R, Excel)
3. Writing references (both manually and electronically) from given bibliographic situations, and
4. Writing a sample research paper.

**References:**

- Cochran, W.G. 1963. Sampling Techniques, 2<sup>nd</sup> edition John Wiley & Sons Inc. New York. 413p.
- Kothari, 2001. Research Methodology
- Myres, W.L. and Shelton, R.L. 1980. Survey Methods for Ecosystem Management. John Wiley and Sons, London.
- Panneerselvam, R. 2004. Research Methodology. PHI Learning Private Limited, New Delhi, India
- S.M. Sirajul Haque and Mohammad Moafuzur Rahman, 2013, Research Methodology in Forestry and Environmental Science, IFESCU and USDA

**Course No.** : ENV 324  
**Course title** : WATER QUALITY MANAGEMENT  
**Marks** : Theory: 50 (2 cr.); Class Test/Tutorial: 25 (1cr.), Written -20, Attendance -05; Practical - 25 (1 cr.); Total = 100 (4 cr.)

### Theory:

1. **Introduction:** Emergence of water quality issue; important characteristics of water; availability of water as resources; practical environmental implications in water uses
2. **Evaluation of water quality:** Environmental water quality standards to be followed by different sectors, regulated quality water use, Systems for measuring water quality; measurement of the effects of constituents in water; qualitative and quantitative characteristics of water.
3. **Causes of water quality problems:** Sources and quality of water pollution type, drivers of potential pollutants and polluting agents causing water quality deterioration; evaluation of stream pollution
4. **Municipal and industrial water supply:** Role of water in municipalities and industries; water quality related to sources; municipal and industrial water quality needs; typical water treatment and distribution process; wastewater characteristics; consideration of wastewater in water quality management; waste licensing and discharge permits; illegal and accidental release and its impact on marine resources.
5. **Major water quality issues in Bangladesh:** Evaluating risk of water quality vs. human health, Arsenic contamination and management; Water contamination by flood and its management; Industrial effluents in water quality deterioration; Agrochemicals from water quality perspective.
6. **Indigenous techniques in water quality management in Bangladesh:** Rain water harvesting, Boiling and settling in pitchers, Application of CaO and alum.
7. **Economics of water quality management:** Water as an economic good- ethical justification, Why investing in water quality management projects (to be supplemented with worldwide data on investing in water quality management), Cost of quality water (what if quality water is not available), Supply of potable water across the world, Water scarcity (availability) and economic competitiveness (regional, interregional, and global), Sustainable use of ground and surface water, law and policies related to water quality.

### Practical:

Determination of Physical, Chemical and Biological properties of water (BOD, COD, DO, pH, conductivity, turbidity, DS, TDS, SS, Heavy metals, Hardness etc.)

### References:

- Chorley, R. J. (ed.). 1977. Introduction to Physical Hydrology. Methuen & Co. Ltd. Harper & Row Publishes, Inc., U.S.A.
- Lamb, J.C. 1985. Water Quality and its Control. John Wiley & Sons, N.Y..
- Rahman, A. A. *et al.* (eds.). 2000. Environmental Aspects of Surface Water Systems of Bangladesh. The University press limited. 114 Motijheel C/A. Dhaka.
- Robin Smith. Chemical Process: Design and Integration. 2005 edition. John Wiley & Sons, Ltd. ISBN: 978-0-471-48681-7.

Steel, E.W. and Mc Ghee, T.J. 1985. Water Supply and Sewerage McGraw Hill Book Company, New Delhi.

Trivedi, P.R. and Raj, G. 1997. Water Pollution. Akashideep Publishing House, New Delhi-110002,

**Course No. : ENV 325**  
**Course title : HYDROLOGY AND WATER RESOURCES**  
**Marks : Theory: 50 (2cr.); Class Test/Tutorial: 25 (1 cr. : Written-20, Attendance-05); Total = 75 (3 cr.)**

**Theory:**

1. **Introduction:** Hydrology and environmental sciences; hydrologic cycle; Importance of Hydrology and water resources in National Economy.
2. **Precipitation, Evaporation and Transpiration:** Different forms and types of precipitation; measure of precipitation; rainfall intensity and duration; water-budget and energy-budget determination of evaporation; evapotranspiration.
3. **Subsurface water:** Soil-water relationship and movement of soil moisture; aquifers; sources and discharge of ground water; Hydraulics of wells.
4. **Surface water and stream flow:** Sources of surface water; open channel design; surface run off process; introduction to stream flow hydrographs.
5. **River navigation and flood control:** Requirements of navigable waterway; navigation dams; flood control and water resource policy.
6. **Water resources and power generation:** Water source and strength for generating hydroelectric power, thermal versus waterpower
7. **Regional conflicts on Water resources:** Farakka barrage, Cross/Trans-boundary rivers, Inter river linking projects, Tipi daun /barrage.
8. **Planning for water resources development:** Objectives, data requirements, project formulation and environmental considerations in planning water resource development projects.

**Practical:**

1. Open channel flow measurement in different calculation methods.
2. Precipitation measurement by rain gauge and familiar with charts and graphs used in precipitation calculation.
3. Familiar with different instruments used in hydrological analysis, such as, current meter

**References:**

- Ali, M. M. *et al.* (eds.). 1998. Bangladesh Flood Views from Home and abroad. The University Press Ltd. Dhaka.
- Chorley, R.J. (ed.). 1977. Introduction to Physical Hydrology. Methuen and Co. Ltd., Harper & Row Publishes, Inc.
- Chow, V.T. 1959. Open Channel Hydraulics. McGraw Hill Kogakusha, Ltd. New Delhi.
- Hewlett, J.D. 1982. Principles of Forest Hydrology, The University of Georgia Press, Athens..
- Lal, R. *et al.* (eds.). 1990. Tropical Agricultural Hydrology. International Book Distributions, 9/3 Rajpur Rd., Dehra Dun-248001.
- Linsley, R.K. *et al.* 1972. Water-Resources Engineering. McGraw Hill, Inc. New Delhi.
- Linsley, R.K. *et al.* 1982. Hydrology for Engineers. 3<sup>rd</sup> ed. McGraw Hill International Book Co., New Delhi.
- Rahman, A. A. *et al.* (eds.). 2000. Environmental Aspect of Surface Water Systems of Bangladesh. The University Press Ltd. Red Crescent Building, 114 Motijheel C/A, Dhaka,
- Schwab, G. O. *et al.*, 1966. Soil and Water Conservation Engineering, 2nd ed., John Wiley and Sons, Inc. N. Y., London, Sydney.
- Walton, W. C. 1970. Ground Water Resource Evaluation. McGraw Hill Kogakusha, Ltd. New Delhi.

**Course No. : ENV 326**  
**Course title : AIR QUALITY MANAGEMENT**  
**Marks : Theory: 50 (2cr.); Class Test/Tutorial: 25 (1 cr. : Written-20, Attendance-05); Total = 75 (3 cr.)**

**Theory:**

**1. Introduction to air quality**

Concept of air quality, air pollution. Units for expressing air pollutant concentration and conversion between gravimetric and volumetric units of air pollutants. Typical concentrations of air contaminants in ambient air and polluted air. Ambient air quality standards of Bangladesh and other countries. Sources of different air pollutants. Primary and secondary air pollutants. Meteorological parameters affecting transport of pollutants. Some major air pollution accidental releases. Air quality management- Bangladesh perspective and other countries.

**2. Clean air regulations**

A brief history of the air pollution problem. A historical overview of the development of clean air regulations in Bangladesh. Different international protocols regarding air pollution. Relevant provisions of clean air regulations in the Bangladesh Environment Conservation Act (1995), the Environment Court Act (2000), the Environment Conservation Rules (1997), the Brick Burning (Control) Act and Rules (1989), the Brick Burning (Control) (Amendment) Act (1992), the Brick Burning (Control) (Amendment) Act (2001). Air quality management philosophies and strategies. Political, moral and legal aspects relating to air pollution control. Development of Air pollution indices.

**3. Ambient air quality and emissions monitoring**

Ambient air quality sampling program and its objectives. Sampling requirements for gases and particles pollutant sampling. Gas sampling methods and different instruments of gas sampling and gas concentration measurement. Different methods and instruments of particle sampling and particle measurement. Emission measurement from stationary and mobile sources. Ambient Air Quality Monitoring Systems- Fixed vs. Mobile Sampling, Continuous vs. Integrated Sampling.

**4. Concentrations and deposition of Air pollutants**

Patterns of occurrence of gaseous pollutants- Ozone, Nitrogen dioxide, Sulphur dioxide, Carbon monoxide, Volatile organic compounds. Deposition of gases and particles- dry deposition, wet deposition, and cloud-water deposition and factors affecting them. Total deposition and deposition budgets. Development of pollutants measurement networks and air quality information systems.

**5. Particulate management**

Airborne particles and particle terminology. Relative sizes of particles and gas molecules. Aerosol mechanics- drag force, sedimentation, Brownian diffusion, coagulation, the influence of shape and density, relaxation time. Particle sources- wind erosion, sea salt, other natural sources, anthropogenic sources. Collection mechanisms of particulates- basic mechanisms: impaction, interception, diffusion and other mechanisms: electrostatic attraction, gravity, centrifugal force, thermophoresis and diffusiophoresis.

**6. NO<sub>x</sub> management**

NO<sub>x</sub> from Combustion- thermal NO<sub>x</sub>, prompt NO<sub>x</sub> and fuel NO<sub>x</sub>. Control techniques- combustion control techniques (e.g. - low-excess air firing, flue gas recirculation, reduce air preheat, water/steam injection, reburn, low-NO<sub>x</sub> burners and ultra low-NO<sub>x</sub> burners etc.) and flue gas treatment techniques (e.g. - selective non-catalytic reduction, selective catalytic reduction, catalytic absorption).

**7. SO<sub>x</sub> management**

H<sub>2</sub>S control and SO<sub>2</sub> removal- calcium-based reactions and calcium-based reaction products, sodium-based reactions and sodium-based reaction products. SO<sub>2</sub> removal processes- wet limestone, wet soda ash or caustic soda, lime spray drying, circulating lime reactor, sodium bicarbonate injection and other SO<sub>2</sub> removal processes

- 8. Environmental Design for Atmospheric Emissions control:** Control of solid particulate emissions to atmosphere. Control of VOC emissions to atmosphere. Control of sulfur emissions. Control of oxides of nitrogen emissions. Control of combustion emissions.
- 9. Indoor air quality**  
Building ventilation. Combustion- solid-fuel combustion, gas combustion, tobacco combustion. Indoor organics sources. Bio-aerosols and their categories. Sick building syndrome. Odour and ventilation. Clean rooms. Indoor plants and their influence on indoor air quality.
- 10. Modern technology for controlling air pollution in BD:** Brick field and air pollution in BGD; old versus modern method of brick kiln, FCK (Fixed Chimney Kiln), zigzag method, hybrid holfman kiln (Auto bricks). CDM and carbon trade. Installation of ATP (Air treatment plant) in different industries and projects. CAMS (Continuous Air Monitoring System).

**References:**

- Karl B. Schnelle, Jr. and Charles A. Brown, Air pollution control technology handbook, CRC Press.  
Air Pollution, Jeremy Colls, Spon Press, London, UK.  
Air Pollution, Rao, TMH, India.  
Air Quality Assessment and Management: A Practical Guide, Owen Harrop, Taylor & Francis.  
Air quality management, James W. S. Longhurst, Derek M. Elsom, and H. Power, WIT Press.  
Air quality management, R. Ronald E. Hester and Roy M. Harrison, Royal Society of Chemistry.  
Integrated Air Quality Management: Asian Case Studies, Nguyen Thi Kim Oanh, CRC Press.  
Principles of Air Quality Management, Roger D. Griffin, Taylor & Francis.  
Regional and local aspects of air quality management, Derek M. Elsom, WIT Press.  
Technical Challenges of Multipollutant Air Quality Management, George M. Hidy, Springer.  
The Brick Burning (Control) (Amendment) Act (1992), Bangladesh.  
The Brick Burning (Control) (Amendment) Act (2001), Bangladesh.  
The Brick Burning (Control) Act and Rules (1989), Bangladesh.  
The Environment Conservation Act (1995), Bangladesh.  
The Environment Conservation Rules (1997), Bangladesh.  
The Environment Court Act (2000), Bangladesh.  
Robin Smith. Chemical Process: Design and Integration. 2005 edition. John Wiley & Sons, Ltd. ISBN: 978-0-471-48681-7.

**Course No. : ENV 327**  
**Course Title : FIELD TRIP AND VIVA- VOCE**  
**Marks : Field Trip-25 (1cr.); Viva- voce-25 (1 cr.); Total = 50 (2cr.)**

**Field Trip: 25**

Environmental activities and reporting	-	05
Tour report	-	10
Tour examination	-	10

**Viva- voce: 25**

A plot of minimum 25 seedlings must be maintained by each student in the selected Plantation sites throughout the duration of his/her B.Sc. (Honours) course.

**The distribution of marks for the program for class attendance will be as follows:**

Attendance (%)	Marks
96 and above	5.0
91 - 95	4.5
86 - 90	4.0
81 - 85	3.5
76 - 80	3.0
71 - 75	2.5
66 - 70	2.0
60 - 65	1.5
Less than 60	00

## SEVENTH SEMESTER

**Course No. : ENV 411**

**Course title : ENVIRONMENTAL MANAGEMENT**

**Marks : Theory: 50 (2 cr.); Class Test/Tutorial: 25 (1cr.), Written -20, Attendance -05; Total = 75 (3 cr.)**

### **Theory:**

1. Environment and its Component: Introduction, basic concepts, principles and objectives of biophysical environmental conservation and management. National/ regional strategies of environmental conservation and management. Major environmental issues in developing vs. developed countries.
2. Biological components of terrestrial ecosystem: Review of the methods and techniques for conducting biological surveys and measurements in environment related ecosystems: rationale for biological surveys and management, scientific information as basis for rational natural and environmental resource conservation and management.
3. Environment and sustainable development: Impact of development on environment, Environmental resources, effects of resource utilization, through brick fields, shrimp culture, harvesting of natural frogs, forest harvesting on environment in Bangladesh
4. Basic concepts, principles and criteria for industrial environmental management involving manufacturing, processing and chemically based industries. Methods of treatment, control, surveillance, and management of industrial pollutions, biomonitoring of industrial environment using plants.

### **References:**

- Alam, M. S. 2002. Effect of Acid rain and Enhanced Nitrogen Deposition on Soil Water chemistry and Growth of Scots and Seedlings. Ph D Thesis. University of Aberdeen, UK.
- Andrew, R W. and Jackson, J. M. 1996. Environmental science- the Natural Environment and Human Impact. Longman Group Ltd. UK.
- Anon. 1990. Bangladesh paribesh o paribesh Adhidaptar, (Bangla version)
- Anon. 1992. Training manual on environmental management in Bangladesh. Department of Environment, Dhaka.
- Chhatwal G. R.1998. Encyclopaedia of Environmental management, Anmol Pulication Pvt Ltd Delhi.
- Kumar, A. 1999. Environmental problems, protection and control. Anmol Pulication Pvt Ltd Delhi.
- Pandey, G. N. 1997. Environmental Management. Vikas publishing house Pvt. Ltd. Delhi.
- Srivastaba, M. M. 1995. Environment some focal issue. (ed) Bishen Singh and Mahendra Pal Singh, Dehra dun.



**Course No : ENV 412**

**Course Title : ENVIRONMENTAL IMPACT ASSESSMENT**

**Marks : Theory: 50 (2 cr.); Class Test/Tutorial: 25 (1 cr. : Written-20, Attendance-05); Practical - 25 (1 cr.); Total = 100 (4 cr.).**

**Theory:**

- 1. Concepts of EIA:** Definition, history, basic principles and importance of EIA; Examples from developed and developing countries (EIA in Europe, EIA in Asia).
- 2. Methodology in EIA:** Initial Environmental Examination (IEE) and Scoping; Baseline studies in EIA, Impact identification and prediction, impact assessment methods, mitigation measures, documentation and environmental management projects.
- 3. Environmental Statements (ES):** EIA document preparation, project decision network, ecology, air and water in the ES; people and landscape in the ES.
- 4. EIA and Sustainable Resource Management:** Social Impact Assessment, Cost and benefits of Environmental Management.
- 5. Strategic Environmental Assessment (SEA):** SEA for transnational corporations, environmental sustainability and global issues.
- 6. Environmental auditing:** Auditing, External Audit, Internal Audit, Key policy issues.

**Practical:**

Exercise of applying EIA methods for a given Resource Management project, data collection, analysis, interpretation and submission of EIA report.

**References:**

- Baldwin, J.H. 1985. Environmental Planning and Management. International Book Distributors, Dehra Dun, India. 336p.
- Diwan, P. and Diwan, P (eds.).1998. Environmental Management, Law and Administration (Reading and Cases). Vanity Books International, New Delhi.485p.
- DoE, 1997. EIA Guidelines for Industries, Department of Environment, Bangladesh
- Environmental Impact Assessment, R.R. Barthwa, 2002, New Age Int'l Ltd. Publishers, New Delhi, India.
- Hosetti, B.B. and Kumar, A. (eds.).1998. Environmental Impact Assessment and Management. Daya Publishing House, New Delhi, India. 382p.
- Shukla, S.K. and Srivastava, P.R. (eds.).1992. Environmental Energy Impact Analysis. Commonwealth Publishers, New Delhi., India.415p.

**Course No.** : ENV 413  
**Course title** : ENVIRONMENTAL ETHICS  
**Marks** : Theory: 50 (2 cr.); Class Test/Tutorial: 25 (1cr.), Written -20, Attendance -05; Total = 75 (3 cr.)

### Theory:

1. **Introduction:** Environmental Ethics; Who, When, Where and How of Environmental Ethics; Empirical and the Ethical - Risk, Harm, and Prediction; Development vs. Preservation – ethical dimension of sustainability; Wilderness versus the Built Environment - Geoengineering; Historical root of ecological crises; The Early Development of Environmental Ethics; The Challenges of Environmental Ethics.
2. **Philosophical aspects of environmental ethics: Moral philosophy** - Fundamental Moral Concepts- human relationship with earth; Methods of moral philosophy upon current environmental issues; Distinctions of moral philosophy- *facts* and *values, rights* and *duties*, and *utility* and *autonomy*; Reductionism, Contextualism, Monoism, Pluralism, Holism, Hedonism and Egoism; Game theory; Environmental racism.
3. **Traditional Ethical Theories and Contemporary Environment Ethics:** Individual vs. Collective Responsibility toward the Environment, Responsibility to Future Generations, Tragedy of the Commons; Environmental Justice and Virtue Ethics Gaia-Centrism ("The Land Ethic"), Biophilia (evolved needs for nature); Anthropocentrism; Biocentrism; Sentientism (animal welfare and animal rights views), Eco-Centrism; Environmental holism.
4. **Environmental Ethics and Politics:** Deep Ecology; Feminism and the Environment; Disenchantment and the New Animism; Social Ecology and Bioregionalism; Ethical duality of nations and its implication to their behavior.
5. **Environmental Ethical Issues:** Technological ethics; Food ethics; Land ethics; Resource ethics; Bioethics; Medical ethics; Business ethics; Pathology of ethical crises related to these issues; Solution to environmental ethical crises.
6. **Environmental ethical standards – origin and implications:** Sources of ethical standards – Religion, Culture and Norms; Incorporation of ethical standards in conventions, protocols, treaties, policies, laws and in planning; Translating environmental ethics into competitive advantage.
7. **Environmental ethics and Bangladesh:** Environmental ethical standards in Bangladesh; Major environmental ethics issues and their pathology; Resolution of environmental ethical issues in Bangladesh – factors, guidelines and challenges.

### References:

- Brennan, Andrew, ed. The Ethics of the Environment. Brookfield, VT: Dartmouth Publishing Company, 1995.
- Christians, Media Ethics: Cases and Moral Reasoning, Pearson, India, 2006
- Clare Palmer, 1998. Environmental Ethics: A Reference Handbook (Contemporary Ethical Issues) ABC-CLIO (ISBN-10: 0874368405 and ISBN-13: 978-0874368406)
- David DeCosse, Discussion Panel: Ethics-Based Decision-Making in Societal Water Management, 6 Santa Clara J. Int'l Law 33, 2008 (accessible in internet as PDF document)
- DesJardins, Joseph R. Environmental Ethics: An Introduction to Environmental Philosophy, 3rd edition. Belmont, CA: Wadsworth/Thomson Learning, 2001.
- Donald VanDeVeer and Christine Pierce. 1997. Environmental Ethics and Policy Book: Philosophy, Ecology, Economics (2nd edition), Wadsworth Pub Co; ISBN-10: 0534525245 and ISBN-13: 978-0534525248, 672 pp
- Gleick, Peter, The Human Right to Water, 1 Water Pol'y 487, 1999 (accessible in internet as PDF document)
- Guinn, Handbook of Bioethics and Religion, OUP, India, 2006

- Kaufman, Frederik A. *Foundations of Environmental Philosophy*. New York: McGraw-Hill, 2003.
- Kristin Shrader-Frechette. 2005. *Environmental Justice: Creating Equality, Reclaiming Democracy* (Environmental Ethics and Science Policy Series), Oxford University Press, USA, ISBN-10: 0195183576 ISBN-13: 978-0195183573, 288 pp
- Light, Andrew, and Holmes Rolston III, eds. *Environmental Ethics: An Anthology*. Malden, MA: Blackwell Publishing, 2003.
- Newton, Lisa H., and Catherine K. Dillingham. *Watersheds: Classic Cases in Environmental Ethics*. Belmont, CA: Wadsworth Publishing Company, 1994.
- Osborne, An Introduction to Game Theory, OUP, India, 2011
- Palmer, Clare. *Environmental Ethics: Contemporary Ethical Issues*. Santa Barbara: ABC-CLIO, Inc., 1997.
- Tongjin Yang, *Towards an Egalitarian Environmental Ethics*, UNESCO, 2006 (accessible in internet as PDF document)
- Wenz, Peter S. *Environmental Ethics Today*. New York: Oxford University Press, 2001.
- Weston, Anthony, ed. *An Invitation to Environmental Philosophy*. New York: Oxford University Press, 1999.
- Ziganshina, Dinara, *Rethinking the Concept of the Human Right to Water*, 6 Santa Clara J. Int'l Law 113, 2008 (accessible in internet as PDF document)
- Zimmerman, Michael E., et al. *Environmental Philosophy: From Animal Rights to Radical Ecology*. Upper Saddle River, NJ: Pearson Prentice Hall, 2005.

Course No. : ENV 414

Course title : **SOLID WASTE MANAGEMENT**

Marks : Theory: 50 (2 cr.); Class Test/Tutorial: 25 (1 cr. : Written-20, Attendance-05); Practical: 25 (1 cr.); Total = 100 (4 cr.)

Theory:

**1. Integrated solid waste management**

Solid waste in history. Economics and solid waste. Legislation and regulations. The need for integrated solid waste management.

**2. Municipal solid waste characteristics and quantities**

Definitions, Municipal solid waste generation and characteristics. Composition by identifiable items. Moisture content, particle size, measuring particle size, chemical composition, heat value, bulk and material density, mechanical properties, biodegradability.

**3. Collection**

Waste collection-municipal, commercial, hospital and industrial wastes collection. Transfer stations. Collection of recyclable materials. Litter and street cleanliness. Design of wastes collection systems.

**4. Landfills**

Planning, siting, and permitting of landfills. Landfill design and Geotechnical aspects. Landfill operational processes. Leachate and Landfill gas collection. Storage water management. Landfill equipment. Post-closure care and use of old landfills.

**5. Processing of municipal solid waste**

Storing and processing of MSW. Conveying compacting and shredding of MSW. Use of shredders in solid waste processing. Types of shredders used for solid waste processing and health and safety issues. Hammer wear and maintenance. Pulping, roll crushing and granulating.

**6. Materials separation**

Binary separators and polyandry separators. Effectiveness of separation picking (hand sorting). Screens-trommel screens, reciprocating and disc screens. Float/sink separators. Magnets and electromechanical separators. Other devices for materials separation. Performance of materials recovery facilities.

**7. Combustion and energy recovery**

Ultimate analysis, compositional analysis and proximate analysis. Materials and thermal balances. Thermal balance on a waste-to-energy combustor. Different types of combustion hardware. Waste-to-energy combustors- modular starved air combustors, etc. Undesirable effects of combustion-waste heat, ash and air pollutants.

**8. Biochemical processes**

Fundamentals of composting. Composting of municipal solid waste. Methane generation and anaerobic digestion and use of anaerobic digesters. Methane extraction from landfills. Other biochemical processes- glucose production by acid and enzymatic hydrolysis.

**9. Current issues in solid waste management**

3R concept reuse, recycling, recovery, Life cycle analysis and management. Public or private ownership. Financing solid waste facilities. Calculating annual cost, present worth and sinking funds, capital plus operating and maintenance costs. Hazardous wastes management.

**Practical:** Visit solid Waste dumping sites.

- Separate and segregate the SW components and analysis into different fractions.

**References:**

- George Tchobanoglous and Frank Kreith, Handbook of Solid Waste Management, McGraw-Hill.
- Christian Ludwig, Stefanie Hellweg, Samuel Stucki, Municipal solid waste management: strategies and technologies for sustainable solutions, Springer.
- P. Jayarama Reddy, Municipal Solid Waste Management: Processing, Energy Recovery, Global Examples, CRC Press.
- B. B. Hosetti, Prospects and Perspectives of Solid Waste Management, New Age International, India.
- Solid Waste Engineering, William A. Worrell and P. Aarne Vesilind, Cengage Learning, USA.
- Solid Waste Management, Surendra Kumar, Northern Book Centre.
- Solid Waste Management: Critical Issues for Developing Countries, Elizabeth M. Thomas-Hop, Canoe Press.
- Solid Waste Technology and Management, Thomas Christensen, John Wiley & Sons.
- Sustainable Solid Waste Management: Issues, Policies and Structures, Urvashi Dhamija, Academic Foundation.

**Course No.** : ENV 415  
**Course title** : WASTEWATER ENGINEERING  
**Marks** : Theory: 50 (2 cr.); Class Test/Tutorial: 25 (1 cr. : Written-20, Attendance-05); Practical: 25 (1 cr.); Total = 100 (4 cr.)

**Contents:**

- 1. Overview of Wastewater Treatment:** Important Terminology related to wastewater (WW) management, Importance of WW management with respect to health and environmental concern, WW characteristics, WW treatment methods, current status, new directions and concerns, WW reclamation and reuse, Biosolids and residuals management.
- 2. Constituents of wastewater:** WW constituents, Physical characteristics, Inorganic nonmetallic and metallic constituents, Organic constituents, Biological characteristics.
- 3. Operation of Physical and Chemical Unit processes:** Components of WW flows, WW sources and flowrates: Domestic and industrial, Reactors used for the treatment of WW, Physical Processes: Screening, coarse solid reduction, Flow equalization, Mixing and Flocculation, Grit separation theory, Grit removal, Primary sedimentation, Aeration systems, Removal of volatile organic compounds by aeration, Chemical Processes: Role of Chemical processes, Fundamentals of chemical coagulation, chemical precipitation for removal of heavy metals and dissolved inorganic substances, Chemical oxidation, Chemical neutralization and storage.
- 4. Fundamentals of biological WW treatment (BWWT):** Overview of BWWT, composition and classification of microorganisms, Microbial metabolism, aerobic biological oxidation, biological nitrification and denitrification, Biological phosphorus removal, Anaerobic fermentation and oxidation, Biological removal of heavy metals.
- 5. Suspended growth biological treatment processes:** WW characterization, Processes for BOD removal and Nitrification, Processes for biological nitrogen removal, Processes for biological phosphorus removal, biological treatment with membrane separation.
- 6. Attached growth and combined biological treatment processes:** Introduction, Trickling filter, combined aerobic treatment processes, activated sludge with fixed film packing, submerged attached growth processes.
- 7. Anaerobic Treatment of Sludge:** Uses for methanogenic treatment, advantages and disadvantages of anaerobic treatment over aerobic treatment, general consideration for anaerobic treatment processes, Process chemistry and microbiology, Design and types of anaerobic digesters.
- 8. Treatment, Reuse and disposal of solids and bio-solids:** Characteristics of solids, solid processing flow diagram, primary operations, Thickening, stabilization, anaerobic digestion, aerobic digestion, composting, dewatering, drying, incineration, biosolids conveyance and storage.
- 9. Water Reuse:** WW reclamation reuse applications, need for water reuse, public health and environmental issues in water reuse, risk assessment, water reclamation technologies, storage of

reclaimed water, industrial water use, groundwater recharge with reclaimed water, Planning for WW reclamation and reuse.

10. **Pinch technology for efficient water consumption at industrial scales:** Water use and the limiting water profile. Targeting maximum water reuse for single contaminants. Design for maximum water reuse for single contaminants. Targeting and design for maximum water reuse based on optimization. Targeting minimum wastewater treatment flow rate for single contaminants. Design for minimum wastewater treatment flow rate for single contaminants. Regeneration of wastewater.

### **Practical:**

Students have to visit different Industrial WWT plants/ETPs, collect inlet and outlet samples from those industries, characterize the samples, and analyze TOC, COD, BOD<sub>5</sub>, DO, alkalinity, pH and other important parameters in the laboratory. Finally, they have to submit a report individually comparing the efficiency of ETPs of visited industries with standards prescribed by DoE.

### **References:**

1. Rittmann, B. E and McCarty, P. L. (2001). *Environmental Biotechnology: Principles and applications*. McGraw Hill companies, Inc., New York, NY 10020, 754pp.
2. Metcalf and Eddy. (2004). *Wastewater engineering, treatment and reuse*. Mc Graw Hill co. Inc., 1221, Newyork, NY 10020,1819pp.
3. Mino, T., Van Loosdrecht, M. C. M., Heijnen, J. J. 1998. Microbiology and biochemistry of enhanced biological phosphate removal process. *Water Res.*, 32:3193– 207.
4. Satoh H., Iwamoto Y., Mino T., Matsuo T. 1998. Activated sludge as a possible source of biodegradable plastic. *Wat. Sci.Tech.*, 37: 579-582.
5. APHA. 2005. Standard methods for the examination of water and wastewater, 21st ed. American Public Health Association, American Water Works Association, and Water Environment Federation ,Washington, DC.
6. Comeau, Y., Hal, K. J., Huncok, R. E. W., Oldham, W. R. 1986. Biochemical model for enhanced biological phosphorus removal. *Water Res*, 20:1511 –21.
7. Robin Smith. Chemical Process: Design and Integration. 2005 edition. John Wiley & Sons, Ltd. ISBN: 978-0-471-48681-7.

**Course No : ENV 416**

**Course title : ENVIRONMENTAL ECONOMICS**

**Marks : Theory: 50 (2 cr.); Class Test/Tutorial: 25 (1 cr. : Written-20, Attendance-05); Practical: 25 (1 cr.); Total = 100 (4 cr.)**

**Theory:**

**1. Introduction:** Basic concepts of and in Environmental Economics (EE), Grounds for the evolution of EE, Environmental Policy and EE, Natural Resource Economics and EE, Current state of and advances in EE, Contributions of EE. The economic process and the natural assimilative capacity, the environment as an economic and social asset, fundamental balance of the environment and the economy, environmental Kuznets curve hypothesis.

**2. Assumptions:** Microeconomic assumptions: both implicit and explicit, Validity of microeconomic assumptions like property rights, price, demand, supply, market, price/WTP/WTA and so forth in EE

**3. Social choices:** Pollution - when and how much, Social choice mechanism (individual and social welfares, Social welfare functions, Pareto preferences, Potential Pareto improvement, Compensation principle, Arrow's Impossibility Theorem). The equi-marginal principle and its application to emissions reduction, the optimal level of pollution, Effect of preferences and technology changes on optimal level pollution.

**4. Efficiency and markets:** Efficiency using Pareto optimality, Concepts of Edgeworth Box and Contract Curve, Efficiency in exchange (assuming indifference curve is both straight and convex), Markets and exchange (Trade, Initial endowment, final allocation, and price ratios), Efficiency in bads, Efficiency in production, Principles of welfare economics, Efficiency in supply and demand, Pollution cost and its impacts on production functions and welfare.

**5. Market failure:** Open access to environmental resources and tragedy of commons, Externality (Concept of externality, Levels of externality, Abatement and externality, incorporating externality in production function, Internalization of externality, pecuniary externality, externality and public goods/bads), Public goods and bads (excludability, rivalry, categories of goods and bads based on excludability and rivalry, Supply and demand of environmental goods and bads, Efficient provision of environmental goods and bads (Deducing individual and market demand and supply curves for private and environmental goods), Pricing environmental goods and bads (Market provision of environmental goods- utility maximizing function containing prices for private and public goods, non-cooperative and cooperative provisions for pricing environmental goods, Efficient uniform environmental/public good pricing, budget and optimal producer pricing, personalized price)

**6. The economics of environmental regulation:** Regulatory framework of pollution control- liability law, coasian approach, emission standards, effluent charge, transferable emission permits, and abatement subsidies.

**7. Evaluation of environmental programs:** Environmental project (What it is, good or bad, how big), Environmental regulatory design (concept, effective or not, how stringent), Benefit cost analyses- BCA (concept, shortcomings, modification, market discount rate, social discount rate/factor, integrational social discounting rate), Cost effectiveness analysis (CES), Measuring incidence (welfare analysis) of environmental fees, taxes, and incentives.

**8. Environmental demand theory:** Concepts of demand for environmental goods/bads, Environmental goods Vs conventional goods, WTP (Prices and MWTP Total WTP Vs MWTP), WTA, Value types of environmental goods (use value and nonuse value), Measuring demand for environmental goods (Revealed preferences and Stated Preferences), Ordinary demand (Marshallian) Vs Compensated demand (Hicksian), Expenditure function, Welfare effects of a price change and environmental improvement, Consumer/restricted demand for environmental goods.

**9. Contingent Valuation (CV):** Stated preferences (concept and controversy), Designing a CV (The NOAA Blue-Ribbon Panel, Carson's six main components of a successful CV), Experimental markets, Referenda, Dichotomous-choice (referendum-style) CV estimation, Procedure for estimating a RUM with a linear utility function, Procedure to calculate the Turnbull Distribution-Free Estimator



**Class Test-1 Cr. Hr.**

Two test each weighing 10 marks and class performance 5

**Practical-1 Cr. Hr.**

**Lab-1 (WTP):** Estimate a probit model of WTP that is linear in utility and assumes constant marginal utility of income. Also calculate marginal effect associated with independent variables, mean WTP, confidence for WTP using Turnbull Lower-Bound method

**Lab-2 (TCM):** Estimate a regression equation for number of trips to a tourism spot. Explain your model estimates (betas). Incorporate in your model an entrance fee and estimate the change in number of trips to that palace.

**Lab-3 (HPM):** Estimate a logit model from categorical data and explain the model estimates (betas)

**References:**

Arrow et al. 2001. Report of the NOAA Panel on Contingent Valuation, Pp.67

Daly, H.E. and Farley, J. 2004. Ecological Economics: Principles and Applications, Island Press, Washington, Pp.484

Hanley et al. 1999. Environmental Economics in Theory and Practice, McMillan India, 1<sup>st</sup> Ed, Pp.463

Kolstad, C.D. 2011. Environmental Economics, Oxford University Press, NY, 2<sup>nd</sup> Ed, Pp.480

Varian, H.R. 2005. Intermediate Microeconomics, W.W. Norton and Co., NY, 7<sup>th</sup> Ed, Pp.774

**Course No. : ENV 417**  
**Course Title : FIELD TRIP AND VIVA-VOCE**  
**Marks : Field Trip-25 (1cr.); Viva- voce-25 (1 cr.); Total = 50 (2cr.)**

**Field Trip: 25**

Environmental activities and reporting	-	05
Tour report	-	10
Tour examination	-	10

**Viva- voce: 25**

Minimum 25 seedlings must be maintained by each student in the selected Plantation sites throughout the duration of his/her B.Sc. (Honours) course.

**The distribution of marks for the program for class attendance will be as follows:**

Attendance (%)	Marks
96 and above	5.0
91 - 95	4.5
86 - 90	4.0
81 - 85	3.5
76 - 80	3.0
71 - 75	2.5
66 - 70	2.0
60 - 65	1.5
Less than 60	00

## EIGHTH SEMESTER

**Course No. : ENV 421**

**Course title : INDUSTRIAL ECOLOGY**

**Marks : Theory: 50 (2 cr.); Class Test/Tutorial: 25 (1 cr. : Written-20, Attendance-05);Total = 75 (3 cr.)**

### **Theory:**

#### **1. Fundamentals of Industrial Ecology**

Defining Industrial Ecology and its different perspectives. Industrial Ecology as a Field of Ecology. Goals of Industrial Ecology. Key Concepts of Industrial Ecology- Systems Analysis, Material & Energy Flows and Transformations, Multidisciplinary Approach, Analogies to Natural Systems, Open- vs. Closed-Loop Systems, the role of companies, dematerialization and eco-efficiency, Industrial symbiosis. The boundaries of industrial ecology.

#### **2. Sustainability and its dimensions**

Population and their resources consumption patterns in relation to Earth's carrying capacity; Definitions and Drivers for Sustainability; Indicators of Sustainability – *Equity* in social and Demographic sustainability; *Genuine Progress Indicator (GPI)* in Economic sustainability, *Ecological and Carbon footprint* in ecological sustainability; PAT Equation and its drivers; Technological advancement in changing consumption patterns, resources conservation, recycle and reuse to ensure sustainability.

#### **3. History of Industrial Ecology**

Metabolism in biology, agronomy and ecology; Metabolism in Social Theory; Metabolism in Cultural and Ecological Anthropology; Metabolism in the industrial development; Industrial metabolism: use and misuse of metaphors; Industrial ecosystems; Different development perspectives of Industrial ecology as a scientific discipline- The Belgium ecosystem, The Japanese view and American view; A brief history of cleaner production;

#### **4. Material and Energy consumption in context of industrial ecology**

Energy resources- classification (renewable and non-renewable), production data, consumption data; Materials resources- classification (renewable and non-renewable); Global material resources: overview and consumption patterns; Resource Scarcity of minerals, metals, water and energy; Consequences of living in an industrial world.

#### **5. Material Flow Analysis (MFA) and Substance Flow Analysis (SFA)**

Definition and concept of MFA and SFA; Types and uses of MFA; General framework, procedure and elements of MFA and SFA; System definition-space and function, time, materials, the economy–environment distinction, the economy–environment Integration; Economy-wide MFA; MFA-based indicators for sustainability - Input Indicators, Output Indicators, Consumption Indicators, Balance Indicators and Efficiency Indicators; Quantification of the flows and stocks- accounting, static modeling, dynamic modeling.

#### **6. Life Cycle Assessment (LCA)**

Definition and applications of LCA; Historical development; LCA and ISO14000 standards; Technical framework for LCA; Ways of defining system boundaries; Components and methodology of LCA; Impact categories for life cycle impact assessment; The choice of the model parameters and uncertainty in LCA; Software tools and databases for conducting LCA; Specific uses of LCA; LCA of products and processes for manufacturing and service sectors.

#### **7. Emerging concepts of Industrial Ecology**

Sustainable resource and materials management in developed and developing countries; Industrial symbiosis; Industrial metabolism and cannibalism; Industrial symbiosis - the legacy of Kalundborg; Industrial scavenging; Waste mining.

#### **8. Industrial Ecology: Bangladesh perspective**

Applicability of IE in Bangladesh, Cases of IE investigations in Bangladesh, State of IE and future directives.

## References:

- Robert U. Ayres and Leslie W. Ayres (edt.), *A Handbook of Industrial Ecology*, Edward Elgar Publishing Limited, UK.
- Daily, Gretchen C. and Paul Ehrlich. *Population, Sustainability, and Earth's Carrying Capacity*, BioScience, 1992: pp. 761-764.
- Ecology of Industrial Pollution, Lesley C. Batty and Kevin B. Hallberg (Edt.), Cambridge University Press, UK.
- Ehrenfeld, John and Nicholas Gertler. *Industrial Ecology in Practice: The Evolution of Interdependence at Kalundborg*. *Journal of Industrial Ecology* (1997) 1(1): 67-79.
- Environmental Life Cycle Assessment of Goods and Services: An Input-Output Approach, Chris T. Hendrickson, Lester B. Lave and H. Scott Matthews, Routledge.
- Environmental Life-Cycle Assessment, Marry Ann Curran, McGraw-Hill.
- Handbook of Input-Output Economics in Industrial Ecology, Sangwon Suh (Edt.), Springer.
- Henrickson, C.; et. al. *Economic Input-Output Models for Environmental Life-Cycle Assessment*. *Environmental Sci. & Tech.*, (1998) 32: 184A-191A.
- Hunt, Robert G., Jere D. Sellers, and William E. Franklin. *Resource and Environmental Profile Analysis: A Life Cycle Environmental Assessment for Products and Procedures*. *Environmental Impact Assessment Review*, Spring (1992): pp. 245-269.
- Industrial Ecology and Global Change, R. Socolow, C. Andrews, F. Berkhout, and V. Thomas (Edt.), Cambridge University Press, UK.
- Industrial Ecology, T. E. Graedel, and Braden R. Allenby, Prentice Hall.
- ISO 14040 International Standard, Environmental management – Life cycle assessment – Principles and framework, 1997, 06-15.
- Jelinski, L.W., T.E. Graedel, R.A. Laudise, D.W. McCall, and C. Kumar N. Patel. *Industrial Ecology: Concepts and Approaches*. *Proceedings, National Academy of Sciences, USA* 89 (1992): pp. 793-797.
- Life Cycle Assessment in the Built Environment, Robert H Crawford, Taylor & Francis.
- Life Cycle Assessment: Inventory Guidelines and Principles (EPA 600/R-92/245). Cincinnati, OH: U.S.EPA, Office of Research and Development, Risk Reduction Engineering Laboratory, February 1993.
- Life Cycle Design Guidance Manual: Environmental Requirements and the Product System. (EPA/600/R-96). Keoleian, G. and Menerey, D. Cincinnati, OH: U.S. EPA, Office of Research and Development, Risk Reduction Engineering Laboratory, January 1993.
- Materials Count: The Case For Material Flows Analysis, Committee on Material Flows Accounting of Natural Resources, Products, and Residuals, Committee on Earth Resources, National Research Council, National Academies Press, 2004
- Wackernagel, M. and W. Rees, Chapter 3 in *Our Ecological Footprint*, New Society Publishers: Gabriola Island, B.C. Canada (1996) pp. 61-124.

**Course No. : ENV 422**

**Course title : WATERSHED MANAGEMENT**

**Marks : Theory : 50 (2 cr.); Class Test/Tutorial: 25 (1 cr. : Written-20, Attendance-05); Practical : 25 (1 cr.); Total = 100 (4 cr.)**

### **Theory:**

**1. Introduction:** Concepts of watershed, its management, objectives, importance and classification in Bangladesh; Important surface and under ground features of watershed; Classification of soil mantle and nomenclature of various components of under ground water; Hydrological characteristics of rocks and sediments, ground water depth in Bangladesh.

**2. Hydrology:** Hydrology and hydrological cycle, factors influencing infiltration; Measuring infiltration rates; Infiltration rates under varied micro-environmental situations, water balance in Bangladesh; Influences of forests on infiltration, rainfall, interception and soil water storage.

**3. Erosion and sedimentation:** Geologic and accelerated erosion; agents, types and causes of erosion; forms of water erosion; Estimating rate of erosion, universal soil loss equation, erosivity and erodibility; Conditions, phases, causes and control measures of wind erosion, sediments and sedimentation process; Causes of flood in Bangladesh.

**4. Shifting cultivation:** Shifting cultivation worldwide and in CHTs, land administration system, extent, intensity and causes of shifting cultivation in CHTs.

**5. Soil conservation:** Aim and principles of soil conservation; mechanical, vegetative, agronomic and management based measures of soil conservation in upland watershed; low cost and expensive soil conservation structures; contour and contouring; effects of different forest management activities on watershed health; SALT in soil conservation; indigenous technology knowledge for watershed management in Bangladesh and mouza forest.

**6. Planning for watershed development:** Need for planning, procedure of watershed planning, data requirements for an integrated plan, economic analysis and watershed work plan for watershed development.

### **Practical:**

1. Field demonstration on concepts and important features of a watershed.
2. Laying out of contours on hill slope and measurement of hill slopes.
3. Surveying and identifying various forms of soil erosion including gullies.
4. Demonstration of techniques and procedures to reduce various soil erosions related problems.
5. Measurements of discharge and sediment loads in streams.
6. Determination of watershed characteristics, such as length of stream, stream density, and drainage density of watershed using maps of river systems in Bangladesh.
7. Determination of infiltration rates in the field under different land uses and topographical positions, and drawing graphs with collected data.
8. Preparation of report based on collected information from laboratory and field.

### **References:**

- S. M. Sirajul Haque, Hill cutting in and around Chittagong city, IFESCU and USDA, 2011, 90 pp.
- S. M. Sirajul Haque, Infiltration in upland watershed of Bangladesh, IFESCU and USDA, 2012, 75 pp.
- Raeder-Roitzsch, J. E. Lectures on Watershed Management and Forest Hydrology. 1968, Pakistan Forest College, Peshawar.
- Principles of Forest Hydrology, Hewlett, J. D. 1982

Soil and water in upland watershed of Bangladesh, S. M. Sirajul Haque, IFESCU and USDA, 2013, 350 pp.

Soil Conservation. Hundson, N. 1971, B. T. Batsford Limited.

Soil erosion in upland watershed of Bangladesh, S. M. Sirajul Haque, IFESCU and USDA, 2012, 131 pp.

Watershed Management Extension and Environmental Conservation in Bangladesh, S. M. Sirajul Haque and Maung Hla Myant, IFESCU and USDA, 2011, 188 pp.

Watershed Management in Bangladesh, S. M. Sirajul Haque, IFESCU and USDA, 2013, ---- pp.

**Course No : ENV 423**

**Course title : ENVIRONMENTAL POLICY, LAW AND ADMINISTRATION**

**Marks : Theory: 50 (2 cr.); Class Test/Tutorial: 25 (1 cr. : Written-20, Attendance-05); Total = 75 (3 cr.).**

**Theory:**

1. Principles and process as of formulating policies connected with environmental matters.
2. Environmental pollution control ordinance 1977.
3. Environmental court act 2000 (Amended 2010).
4. Bangladesh Environment Conservation Rules, 1997.
5. Environmental Action Plan, 1992.
6. Bangladesh Environment Conservation Act, 1995 (Amended 2010).
7. Treaties having bearing on Environment of which Bangladesh is a Party .
8. Smoke Nuisances Act, 1905.
9. Administration, Organization and Management of DoE (Department of Environment), Bangladesh
10. Brick burning (control) Act, 1905
11. Building Construction Rules and Acts
12. Tobacco Products Act 1988
13. Destructive Insects and Pest Act, 1914.
14. Environment Court and Law
15. Agricultural Pesticides Ordinance, 1971.
16. Relationship with Forest Policies and Acts.
17. Environmental Ethics.
18. Various policies and systems of administration of the environment as practiced by other countries of the world.
19. Different sources of environmental pollution and their probable control measure in line with existing environmental policies, acts and rules.
20. Building construction act, 1952
21. The Sound pollution (control) rules, 2006
22. Ship breaking and hazardous waste management rules, 2011
23. Medical waste management rules, 2008
24. Bangladesh biosafety rules, 2012

**References:**

- Anon.1990. Environmental problems in Bangladesh, An NGO perspective for policies and action, Asaduzzaman, M.1989. Socio-economic issues in Environment management in Bangladesh. ADAB-Environment Advisory Group.
- Baldwin, J.H. 1988. Environmental Planning and Management, International Book Distributors, 9/3 Rajpur Road (1<sup>st</sup> floor), Dehra Dun 248001 (India).
- Dietz et. al 1988. Environmental Policy in a market Economy, Selected papers from the congress “Environmental Policy in a market Economy”, Wageningen, Netherlands, 8-11 Sept. 1987.
- E. Hoque, BEMP-1995-A Compilation of Environmental laws administered by the Department of Environment. E-16 Agargaon, Sher-e-Banglanagor, Dhaka.
- Farooque and Hasan 1996. Laws Regulating Environment in Bangladesh, BELA, The Ford Foundation, Dhaka.
- GOB.1994. The Environmental Policy, Implementation and Action Plan, Ministry of Environment and Forest, Peoples Republic of Bangladesh.
- Rahman, A. A.2003, Environment and Development in Bangladesh (in two Vol.).
- Tripathi, 2003 Advances in Environmental Sciences.
- Turner, K., 2003 Sustainable Environmental Management.

**Course No. : ENV 424**  
**Course title : LAND USE, URBAN AND TRANSPORT PLANNING**  
**Marks : Theory: 50 (2 cr.); Class Test/Tutorial: 25 (1 cr. : Written-20, Attendance-05); Total = 75 (3 cr.)**

### **Theory:**

- 1. Land and Land use:** Land and its characteristics; Land tenure- ownership rights; Importance of land use study; Land use models and examples; Combined and multiple land uses, irreversible and reversible land uses; Drivers/factors, effects and history of land use change; Agrarian transformation; Land reforms and some experiences; Land use conflicts
- 2. Land and land use policy in Bangladesh:** Land use policies, Principles and national policies covering land and land use in Bangladesh
- 3. Land use planning and Landscape management:** Nature, scope, usefulness; Planning goals and focus of land use planning; Levels of planning, Planning process and steps in land use planning; Characteristics, objectives and procedures of landscape management.
- 4. Urban planning:** Factors to be considered, principles and models; Effect of urban system planning on environment, aesthetics and better living
- 5. Introduction to transport system:** Review of basic road engineering terms; Road classification and types, Rural and urban roads; Road design elements and standards, road drainage; Relationship among transport system, land use and environment
- 6. Basic road engineering and transport system planning:** Planning, location, design, construction and maintenance of suitable transportation systems to serve various aspects of resource management, recreation and environment; Road and street network design; Transport system planning in forested environment; Data gathering and project appraise techniques for transport system planning
- 7. Traffic flow and environment:** Traffic flow computation techniques; Impact of heavy load on the road and on its vicinity; Smoke emission of old vehicles; Noise pollution in roads and highway.

### **References:**

- Brammer, H. 2002. Land Use and Land Use Planning in Bangladesh. The University Press Limited, Dhaka.
- Davidson, D.A. 1982. Soil and Land Use Planning. Longman, London.
- Davies, K.P. 1976. Land Use. McGraw-Hill Inc. USA.
- FAO. 1993. Guidelines for Land-use Planning. Food and Agriculture Organization of the United Nations, Rome
- Mandal, R.B. 1990. Land Utilization: Theory and Practice. Concept Publishing, New Delhi.
- OECD, 1976. Land use policies and agriculture. Organization for Economic Co-operation and Development, Paris.
- Bindra, S. P. 1981; A course on Highway Engineering. Dhanpat Raj and Sons. 1682 Nai Sarak, Delhi-110006.
- Castaneda, F. 1989. Forest Transportation Engineering, UNDP/FAO/BGD/85/011, Institute of Forestry, Chittagong University, Chittagong.
- FAO. 1977. Planning Forest Roads and Harvesting Systems, FAO Forestry Paper 2, FAO, Rome.
- Hossain, M. M. 2001, Forest Roads: Edited Readings Packege. UNBC Copy & Publishing Service, British Columbia.
- Kramer, B. W. 1993. A road design process for low volume recreation and resource development roads. Oregon State University Book Store, Inc., Oregon.
- Oglesby, C. H. and Hicks, R. G. 1982. Highway Engineering 4<sup>th</sup> ed., John Willey & Sons, N. Y.
- Rowan, A. A. 1976. Forest Road Planning. Forestry. Commission Booklet 43. 49 High Holborn, London.
- Sanares, R. A. 1986. Project Study: Road Construction. University of Nueva Caceres, Naga City, Philippines.
- Andrew I. Cavin (Ed.). 2003. Urban planning, Hw Wilson Company, ISBN 0824210220, 9780824210229, 197 pp.
- Yin, J. 2012. Urban Planning For Dummies, John Wiley & Sons, ISBN 1118101685, 9781118101681, 384 pp.



**Course No.** : ENV 425  
**Course title** : HUMAN DIMENSIONS IN ENVIRONMENTAL MANAGEMENT  
**Marks** : Theory: 50 (2 cr.); Class Test/Tutorial: 25 (1 cr.); Total = 75 (3 cr.)

### Theory

1. **Introduction:** Definition, rationale and philosophy of human dimensions in environmental management
2. **Human-environment interaction:** Human causes and consequences environmental hazards and disasters; Delivery system and institutional development of environment management
3. **Environment education:** People's awareness creation, motivation and participation
4. **Human Impact on the Natural Environment:** Land utilization – a focus on agriculture and forestry, past patterns of land use, Urban and Industrial development, Agriculture, Forestry.
5. **Environmental development program:** Planning, designing, monitoring, and evaluation of environment management program; Participatory program development; Sustainability; Community organizing, community resources mobilization; self-help environment friendly enterprises.
6. **Gender issues in environmental development:** Women's role and participation in environment management; Strategies to incorporate women in environmental development;

### References

- Hester, R.E. (ed.). 1986. Understanding Our Environment. The Royal Society of Chemistry Burlington House, London. 333p.
- Kautman, P.B. and La Croix, J.D. (eds.). 1979. Plants, People and Environment. MacMillan Publishing Co., Inc. New York, USA. 542p.
- Lal, J.B. 1987. Environmental Conservation. International Book Distributors, Dehra Dun, India. 111p.
- Rahman, A.A.; Haider, R.; Huq, S. and Jansen, E.G. (eds.). 1994. Environment and Development in Bangladesh. Vol.1 & 2. The University Press Ltd. Dhaka. 345p.
- Singh, P.I. and Tiwari, S.C. (eds.). 1980. Man and his Environment. Concept Publishing Company, New Delhi. 276p.
- Sinha, R.N.P. (ed.). 1990. Environment and Human Response. Concept Publishing Company, New Delhi, India. 340p.

**Course No.** : ENV 426  
**Course title** : PROJECT PAPER  
**Marks** : Project Paper: 50 (2 cr.); Seminar/ Practical-25 (1 cr.) Total = 75 (3 cr.)

Review of relevant literature or scientific publications on a selected issue in Environment and /or conduct of simple research/ study on a Environment problem. The text of the review paper topic should not more than 100 pages (spacing 1.5, font size 12) including references. Topic of the review paper should be presented by the students in the seminar. Review paper could be evaluated on the basis of the following criteria:

1. **Logic and organization:** Problem well defined, rationale clearly stated; Methods 40% clearly described; Data collection, analysis and guided an appropriate conceptual framework; Conclusions/Recommendations based on observation and/or analysis.
2. **Relevance:** Topic is directly related to current Environment issues; 15% Materials/ Information presented is appropriate.
3. **Simplicity and clarity:** Ideas are expressed clearly and simple; Correct grammar 15% used and rules of composition observed.
4. **Originality and creativity:** Diverse information/ideas are well integrated or 30% synthesized into a new form/ structure; Interesting and relevant insights are drawn form study results.

**Course No.** : ENV 427  
**Course title** : ENVIRONMENTAL MANAGEMENT PLAN  
**Marks** : (Field Assessment 10; Management Plan (Field work Report) 50; Viva-voce 15; Total =75)

**Course Contents:**

1. Before field work, theoretical background will be given on:
  - i. Definition and object of Environment Management plan (EMP).
  - ii. Management Plan components.
  - iii. Working circles.
  - iv. Forest Regulation: Long rotation and short rotation.
  - v. Difference between FMP and working skills
  - vi. Need for EMP;
  - vii. Relevance of FMP with local national and regional plans.
  - viii. Socioeconomic survey.
  - ix. Procedure for preparation of EMP.
  - x. Forest Inventory Planning and procedure.
2. Collection of actual field data from forests/homesteads/ roadside plantations covering materials sufficient for preparation of at least four working circles.
3. Collection of Secondary information from concerned authority.
4. Socio economic survey and local market survey.
5. Compilation of collected data.
6. Each student will write FMP according to Balmforth/Cananizado latest format based on collected data.
7. Students will submit FMP in bound form for evaluation.
8. Field assessment will be done by guide teacher(s) directly in the field, based on each student's overall performance; prepared management plan will be evaluated by two examiners—one guide teacher and one external; viva-voce examination will be evaluated by the examination committee including at least one guide teacher.

**References:**

Balmforth. Manual of Forest Management Plan.  
Davis, P.K. 1966. Forest Management, 2<sup>nd</sup> Edition McGraw Hill Book Company, New York.  
Ganss. Manual of Forest Management Plan.  
Osmaston, F.C. 1994. The Management of Forests

**Course No. : ENV 428**  
**Course title : FIELD TRIP AND VIVA-VOCE**  
**Marks : Field Trip-25 (1cr.); Viva- voce-25 (1 cr.); Total = 50 (2cr.)**

**Field Trip: 25**

Environmental activities and reporting	-	05
Tour report	-	10
Tour examination	-	10

**Viva- voce: 25**

Minimum 25 seedlings must be maintained by each student in the selected Plantation sites throughout the duration of his/her B.Sc. (Honours) course.

**The distribution of marks for the program for class attendance will be as follows:**

Attendance (%)	Marks
96 and above	5.0
91 - 95	4.5
86 - 90	4.0
81 - 85	3.5
76 - 80	3.0
71 - 75	2.5
66 - 70	2.0
60 - 65	1.5
Less than 60	00