Syllabus for M.S. of Sessions 2015-16 and 2016-2017

The admission to the Master of Science (M.S.) in Environmental Sciences will be in the accordance with the ordinance for the degree of Master of Science of this University. Courses leading to the degree of M.S. in Environmental Sciences will extend over one academic year and the examination in all courses for a total of 24 credits, as prescribed in this Syllabus, shall be held during or at the end of the academic year.

Students admitted into the M.S. program will be divided into two groups:
(i) General Group (Group A) and (ii) Thesis Group (Group B)

Selected students, according to departmental academic meeting, having aptitude for research may be allowed by the Department to offer thesis in M.S. course in a suitable field. The selection of the field of study will depend on the availability of the Research Supervisor/teachers in the Department. Rest students will be considered as general group (Group A).

Students of both groups (A & B) will have to take 20 credits of theoretical courses where 12 credits in three 4 credits courses and 8 credits in four 2 credits courses as recommended by the Departmental Committee and approved by the Chairman of the Department. In addition, general group students (Group A) have to take one more 2 credits course. The total marks for practical/field work/report of general group (A) students will be 4 credits in which 80 marks will be allotted for practical/field work/Project work/ Internee and 20 marks for viva/presentation. The total marks for research work (thesis) of thesis group (B) students will be 6 credits in which 100 marks (4 credits) will be allotted for research work (Thesis) and 50 marks (2 credits) for thesis presentation/viva. Students of both general and thesis groups will have a common viva voce examination of 2 credits at the end of their theoretical examination.

Outlines of the courses to be offered are stated below:

General group (Group A)

<table>
<thead>
<tr>
<th>Courses</th>
<th>Credits</th>
<th>Units</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theoretical courses</td>
<td>22</td>
<td>5.5</td>
<td>550</td>
</tr>
<tr>
<td>Practical/ Field/ project</td>
<td>4</td>
<td>1.0</td>
<td>100</td>
</tr>
<tr>
<td>Viva voce</td>
<td>2</td>
<td>0.5</td>
<td>50</td>
</tr>
<tr>
<td>Grand total:</td>
<td>24</td>
<td>6</td>
<td>700</td>
</tr>
</tbody>
</table>

Thesis group (Group B)

<table>
<thead>
<tr>
<th>Courses</th>
<th>Credits</th>
<th>Units</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theoretical courses</td>
<td>20</td>
<td>4.0</td>
<td>500</td>
</tr>
<tr>
<td>Thesis (Report + Presentation)</td>
<td>4+2=6</td>
<td>1+0.5=1.5</td>
<td>150</td>
</tr>
<tr>
<td>Viva voce</td>
<td>2</td>
<td>0.5</td>
<td>50</td>
</tr>
<tr>
<td>Grand total:</td>
<td>24</td>
<td>6</td>
<td>700</td>
</tr>
</tbody>
</table>

Section-I

Courses (both for Group A & B): (Any Three)

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Title of the Course</th>
<th>Credit</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Env. 5401</td>
<td>Advanced Techniques in Environmental Analysis</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>Env. 5402</td>
<td>Global Climate Changes and Environment</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>Env. 5403</td>
<td>Natural Resource Managements</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>Env. 5404</td>
<td>Industrial waste: Treatment and Management Plans</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>Env. 5405</td>
<td>Ecosystem Sustainability</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>Env. 5406</td>
<td>Disaster Management</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>Env. 5407</td>
<td>Public Health and Environment</td>
<td>4</td>
<td>100</td>
</tr>
</tbody>
</table>
Section-II
Courses:
(Five courses have to be taken by general group (Group A) students/
Four courses have to be taken by thesis group (Group B) students)

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Title of the Course</th>
<th>Credit</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Env. 5201</td>
<td>Agroindustrial Pollutants and Management</td>
<td>2</td>
<td>50</td>
</tr>
<tr>
<td>Env. 5202</td>
<td>Environmental Safety</td>
<td>2</td>
<td>50</td>
</tr>
<tr>
<td>Env. 5203</td>
<td>Environmental Issues: Bangladesh Perspectives</td>
<td>2</td>
<td>50</td>
</tr>
<tr>
<td>Env. 5204</td>
<td>Biomonitoring of Pollution</td>
<td>2</td>
<td>50</td>
</tr>
<tr>
<td>Env. 5205</td>
<td>Environmental Radiation</td>
<td>2</td>
<td>50</td>
</tr>
<tr>
<td>Env. 5206</td>
<td>Environmental Management Systems</td>
<td>2</td>
<td>50</td>
</tr>
<tr>
<td>Env. 5207</td>
<td>Groundwater Exploration and Management</td>
<td>2</td>
<td>50</td>
</tr>
<tr>
<td>Env. 5208</td>
<td>Applied Environmental Biotechnology</td>
<td>2</td>
<td>50</td>
</tr>
<tr>
<td>Env. 5209</td>
<td>Aquatic Ecology</td>
<td>2</td>
<td>50</td>
</tr>
<tr>
<td>Env. 5210</td>
<td>Water Resources Management</td>
<td>2</td>
<td>50</td>
</tr>
</tbody>
</table>

Section-III
Thesis/Field work/Project/Practical/ Internee (Group A & B):

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Title of the Course</th>
<th>Credit</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Env. 5001</td>
<td>Practical/Field work/Report/ Internee (for only general group student)</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>Env. 5011</td>
<td>Thesis (for only thesis group student) (Thesis Report + Presentation)</td>
<td>4+2</td>
<td>150</td>
</tr>
</tbody>
</table>

DETAIL COURSE CONTENTS FOR ONE YEAR M.S. DEGREE IN ENVIRONMENTAL SCIENCES

Section I

Env. 5401 Advanced Techniques in Environmental Analysis
(4 Credits, 100 Marks)


3. ICP Techniques: Production of plasma and its analytical uses, ICP-OES and ICP-MS. Basic instrumentation in ICP-MS, sample introduction, mass separation techniques and detection, Applications of ICP-MS to problems of environmental analysis.

4. High Performance Liquid Chromatography (HPLC). Principles of operation, retention time and its relation to quantitative analysis, instrumentation and segmented modules, Qualitative and quantitative analysis, Application to environmental chemical analysis with special reference to analysis of pesticide residues, PCBs and PAHs in environmental samples.

5. Gas chromatography (GC). Principles of GC separation, Instrumentation: packed columns and capillary columns, Injection systems for High Resolution GC, GC-C-MS, Qualitative and quantitative analysis, Specific applications


8. Methods for determination of Environmental Radioactivity. Occurrence and monitoring of radioactivity in the environment, counting instruments for α, β and γ emitting radionuclides, Methods for determination of gross alpha and gross beta radioactivity, Gamma spectroscopic method and its applications, total radioactive strontium and Sr-90 measurement in water and wastewater samples.


10. Relevant laboratory visit to show necessary instruments.

Recommended References:

Env. 5402 Global Climate Changes and Environment (4 Credits, 100 Marks)

1. The climate System: Climate and the climate system, Natural forcing of the climate system, Natural variability of climate, Extreme events, human influence on the climate system, modelling and projection of anthropogenic climate change, observing anthropogenic climate change.

2. Observed climate variability and change: Land-surface, sea surface temperature, sea air temperature, Temperature of the upper air, changes in the cryosphere. Temperature of the past 1000 years, volcanic and solar effects, changes in precipitation and related variable (Land, Palaeo-drought, Ocean), water vapor, evaporation, clouds the atmospheric / oceanic circulation change, extreme weather and climate events.

3. The carbon cycle and Atmospheric carbon dioxide: Terrestrial and ocean biogeochemical carbon cycle, Palaeo CO2 and Natural changes in the carbon cycle, anthropogenic source of CO2, CO2 concentration measurement methods, Carbon cycle model evaluation, Projection of CO2 concentration and their implications.


5. Aerosols, their direct and indirect effects: Aerosol properties, sources and production mechanisms of atmospheric aerosols, indirect forcing associated with aerosols, global models and calculation of direct and indirect climate forcing, aerosol effects in future scenarios.


7. Model evaluation: Mean state and variability in climate models, model Hierarchy, coupled climate models-some methodologies, coupled climate models-means, 20th century climate and climate variability, coupled model Phenomena, extreme events, coupled models-dependence on resolution, sources of uncertainty and levels of confidence in coupled models.

8. Projections of future climate change: Climate and climate change, global mean response, patterns of future climate change, range of temperature response, factors that contribute of the response, changes in variability, charges of extreme events.

9. Changes in Sea level: Factors contributing to sea level change, Past sea level changes, future sea level changes, reducing the uncertainties in future estimates of sea level change.

11. Climate Change and Bangladesh: Scenarios, Impacts and adaptation measures.
12. Climate Change and health: Health and environmental effects, Climate sensitive diseases, Climate induced natural hazards and health, Uncertainties.

**Recommended References:**


**Env. 5403 Natural Resource Managements**

1. Definition, scope and goal of natural resource managements and its relation to environmental sciences
2. Natural resources conservation and management: past present and future, quality of human life on earth, a brief history of resources conservation, environment and sustainability movements, classification of natural resources, approaches to natural resources management, basic reason of the depletion of natural resources and their conservation
3. Water resources: Importance and properties of water, sources and worldwide supply and national consumption, water supply problems, building dams and water diversion projects, groundwater use, water conservation
4. Managing water resources: the water cycle, flooding- problems and solution and adaptation, water shortage-issue and solutions, irrigation-issues and solution, groundwater pollution in Bangladesh-a detrimental threat to the safe drinking water supply.
5. Food resources: Food supply, population growth and world food problems, human nutrition, world agriculture system, fish and fish farming, increasing crop yield, climate changes and food security.
6. Forests and wildlife resources: History of plant and animal extinction, saving endangered species-integrated species management, legal solution
7. Mineral resources: Abundances and formation of mineral resources, location, mining and processing of mineral resources, population, technology and resources, Key resources in Bangladesh; hard rock and coal mining
8. Energy resources: Types of energy resources, brief history of energy resources, fossil fuel, energy concepts: energy quality, energy efficiency, and net useful energy, non-renewable energy resources-valuating energy resources, conventional and unconventional oil, conventional and unconventional natural gas, coal, renewable energy resources; direct solar energy for producing heat and electricity, indirect solar energy from falling water and ocean waves, indirect solar energy from thermal gradients in ocean and solar ponds, indirect energy from wind, indirect solar energy from biomass.

**Recommended References:**

3. A New Century for Natural Resources Management by Robert Costanza, Steward Pickett, James Kennedy, and Jack Ward Thoma
5. Natural Resources Management Practices: A Primer by Peter F. Ffolliott

**Env. 5404 Industrial Wastes: Treatment and Management Plans**

1. Treatment Plant Design and Maintenance: The planning process, Treatment costs, Plant setting, Construction staging and Process design, Mechanization, Instrumentation and Automation, Plant layout, Building design, Example of design information, Other significant design features, Maintenance of treatment plant, Health and safety issues of treatment plant.


6. Disinfection Processes: Regulatory requirements for wastewater disinfection, Disinfection theory, Methods and mechanism of disinfectants, Disinfection with Chlorine, Ozone, Ultraviolet radiation, Disinfection systems, Environmental impact of Disinfection systems, Comparison of alternative disinfection technologies, Advantages and disadvantages.


8. The 3R’s Golden rule (Reduction, Reuse & Recycling) of Industrial Waste Management: Concepts of Sustainable Industrialization, Reducing the waste or zero waste discharge and environmental costs of industrial production by 3R’s approach, Reducing solid waste by dematerialisation technology, waste reduction by water conservation in industrial production, Industrial complexing to reuse waste of one industry as raw material by another, Recycling of industrial waste to recover useful by-products, Global waste trade and exchange for non hazardous industrial waste recycling, environmental significance of recycling, Economic benefits of recycling.

9. Preventing Industrial Wastes and Pollution through Cleaner Production: The concept of cleaner production, Strategies to prevent and reduce the generation of toxic waste at source, Changing production process in industries to reduce toxicity and achieve cleaner production, Equipment modification for cleaner production, Material change and substitution to reduce hazardous waste and achieve cleaner production in industries, Clean and safe alternative to conventional plastic, Cleaner agriculture and food production by reducing dependence on agro chemicals, Cleaner energy production.

10. Case analysis and presentation.

11. Effluent Treatment Plant/ Recycling Plant visit.

Recommended References:

Env. 5405 Ecosystem Sustainability (4 Credits, 100 Marks)

1. Introduction: Nature of inland water bodies and macrophytes of inland water bodies of Bangladesh; Vegetation of Bangladesh, their economic importance and environmental roles.
2. Forest Ecosystems of Bangladesh: Role of forest dwellers for ecosystem sustainability; Hill forest and Sal forest of Bangladesh as potential resources, The Sundarbans biodiversity conservation, Wildlife of Bangladesh as a resource and their protection.
3. Wetlands of Bangladesh: History and heritage of wetlands, Importance of wetlands for Bangladesh, Resources of wetlands, Haor basins of Bangladesh as resource base - Haor systems of international importance; Socioeconomic values of wetlands - Over fishing and the vanishing of fish species, impact of flood control and irrigation project on fish species; Marine and estuarine ecosystem of Bangladesh; Coral reef - St. Martin island and its significance; Impact of development activities on wetlands, Management and regulations of wetlands - National and global importance of coastal and wetland biodiversity, Coastal wetlands biodiversity management, Mangrove of the Chokoria Sundarbans; Aquaculture and mangrove forestry, Flood plain ecosystem of Bangladesh, International collaboration for management of wetlands.

4. Coastal Afforestation and Environment: Plantation in coastal areas of Bangladesh; Windbreaks and Shelterbelts: Wind and vegetation, functions of windbreaks and shelterbelts, types of windbreaks and shelterbelts for coastal regions.

5. Participatory Forestry: Agro-forestry and Social Forestry.

6. Restoration Ecology: Theory, forest restoration, Urban greening and green spaces, Importance of urban forestry and aquatic urban habitat for urban landscape developments and environment.

7. Wastelands: Wasteland as a dormant resource base for sustainable development; Development of wastelands - Technology for development of wastelands - coastal sands, dry and rocky areas, wet lands, denuded and eroded hill slopes, land slips and mined areas.

8. Impact of artificial trans-boundary barrages on different ecosystems of Bangladesh.


Recommended References:
5. Neaz Ahmad Siddiqi. 2001. Mangrove Forestry in Bangladesh. Institute of Forestry and Environmental Sciences, University of Chittagong.

Env. 5406 Disaster Management  
(4 Credits, 100 Marks)

Disaster Concepts, Regulatory and Institution Framework in Bangladesh: Terms and concepts used in disaster management, Disaster risk situation in Bangladesh and global scenarios, Comprehensive disaster management (CDM) approach, Cross cutting themes such as, Gender, Ethnic minorities, Globalization, global insecurities & its linkages to disasters and food Security, Bangladesh Disaster management models and approaches, Regulatory framework of Bangladesh DM system, Institutional Framework of Bangladesh DM system, Standing Orders on Disasters and roles of DMC(s).

1. Disaster Risk Management and Sustainable Development: Methodologies for undertaking disaster risk management and provide tools for understanding and assessing: Hazards and its classification, Community risk assessment, vulnerability and institution profiling, Vulnerability factors, Coping capacities and mechanisms, Community empowerment, Evolution of disaster risk management, Relation between disaster and sustainable development, Climate change impact and livelihood adaptation to climate change.


4. Disaster Response: Key steps for emergency response, Warning information/message dissemination, warning signals in Bangladesh, Evacuation and evacuation equipments, Search and rescue of vulnerable communities, Transitional shelter and shelter management, Public critical services restoration, Damage, loss and needs assessment, Other sectoral support during emergencies e.g. food, health, Nutrition, water & sanitation, and education, Working with the media and information management, Resource management, The emergency coordination centre and role of incident manager.


6. Disaster Management Plan and Implementation Aspect: Preparation of disaster management plan, Relief management, coordination and distribution through DMC, Accountability in disaster management projects, Monitoring of risk reduction interventions and evaluation, Development and implementation of sectoral / personal action plans.


**Recommended References:**

4. Training Manual on Disaster Management in Bangladesh, 2009, Department of Environmental Sciences, Jahangirnagar University.

More reading material will be supplied at classroom.

**Env. 5407 Public Health and Environment**

**1. Introduction:** Concept of health, history of public health in Bangladesh, concept of health and health care, screening of disease, International classification disease, health and socioeconomic profile of Bangladesh, Environmental Change and Health: Changing environment and changing disease patterns; Examples of environmental diseases.


3. Insect and Rodent control: Types of insects of public health significance, Environmental and health problems created by insects, Control of insects, Rodent problems and their effect on human, Standards, practices and techniques for rodent control.

4. Environment and Health: water pollution and health, health related chemical constituents: As, Cd, Pb, Hg, Cr, Fl, CN, other organic pollutants, Air pollution: Sources of air pollution, meteorological factors, air pollutants; CO, SO2, Pb, Cd, HC, H2S, O3, PAH, and particulate matter, Indoor air pollution.


9. Special Health Problems in Bangladesh: Recent out breaks of viral diseases e.g. HIV, Dengue, Avian flu and Swine flu, Influenza A etc; Malaria, Tuberculosis, Diarrhoeal diseases, Drug dependency, Mental Health and Psychiatric disorder.
Recommended References:

2. Environmental Geochemistry and Health. J.D. Appleton. The geological society of London, UK.

Section II

Env. 5201 Agroindustrial Pollutants and Management (2 Credits, 50 Marks)

1. Introduction: Historical perspectives of agrochemical uses, Basic principle of agriculture crop production, types of agrochemicals, Effect of agrochemicals on soil, Fresh water and plant kingdom, Agrochemical residues, misuse of agrochemicals. Agrochemicals properties, the role of pesticides in agriculture.
2. Physicochemical aspects of pesticides formulation and application: Target surfaces for pesticide application, plant leaf cuticle, the insect integument, pesticide formulation and state of application.
4. Persistent Organic Pollutants (POPs): Introduction, POPs effects on human health and the environment, properties of POPs, POPs as a concern for developing countries, POPs sources and convention Provisions, POPs and sustainable human development.
5. Toxicity and remediation of POPs: Methods development for the degradation of POPs, sample collection and treatment from food and environment, Implementing the Stockholm Convention and role of UNDP-GEF.

Recommended References:

Env. 5202 Environmental Safety (2 Credits, 50 Marks)

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

Recommended References:
Env. 5203 Environmental Issues: Bangladesh perspectives  

(2 Credits, 50 Marks)

1. Bangladesh: Country profile, State of the Environmental Resources (Natural Physical and Biotic), Quality of life (population growth, poverty and malnutrition), Major Environmental Concerns (Agricultural resource base, biomass, chemical fertilizers and pesticides, pollution, deforestation, wetland and fisheries, mangrove ecosystems, salinity, health and sanitation, urbanization, health and sanitation, water pollution).

2. Land degradation: Pressures, State, Impact and responses, Options and measures need to combat land degradation.

3. Water pollution and Scarcity: Causes, State, Impact and responses, Options and actions for pollution management.


7. Case study: Dhaka city
   b. Key Environmental Issues:
      i. Air: Status of Air Quality in Dhaka.
      iii. Land: State of Land Resources, Soil Pollution.
      viii. Slums and Squatters: Lack of Water Supply and Sanitation Facility, Land Use Violation, Poor Housing Settlement, Biomass Fuel Burning, Unsocial or anti-social activity.
      ix. Natural Disaster: Water legging in Dhaka city.

Recommended References:

Env. 5204 Biomonitoring of Pollution  (2 Credits, 50 Marks)

1. Pollution and Biomonitoring: An Overview, Chemical versus Biological Pollution Monitoring.
4. Seaweeds for Monitoring Eutrophication and Heavy Metal Pollution: Introduction, seaweeds as bioindicators for eutrophication, biomonitoring at the community level, biomonitoring at the species level, seaweeds as bioindicators for heavy metals.
6. Protozoa: Bioindicators of Environmental Monitoring and Pollution Control - The biological Peculiarities of Protozoa, Protozoa and environment, protozoa as bioindicators, use of protozoa in water purification plants, protozoa and soil pollution monitoring.
7. Zooplankton for Monitoring Heavy Metal Pollution: Heavy metal accumulation in marine ecosystems, heavy metal accumulation in freshwater ecosystems, zooplankton bioassay.

**Recommended References:**

Env. 5205 Radiation & Environmental Safety  (2 Credits, 50 Marks)

1. Radioactivity and Interaction of Radiation with Matter: Radioactivity, laws of radioactivity, important decay chains, Transformation mechanism, Decay equation, Interactions with matter.
2. Radiation Effects: Acute effects, Delayed effects, Risk estimates (BEIR III), Relative biological effectiveness (RBE) and Weighting factor (WF), Dose equivalent, Basic radiation dose limits and Standards.
3. Environmental Radiation Monitoring and Detection: Radiation detectors, Different methods of detection, Gamma Spectroscopy system, Environmental sample counting and analysis, Dose measuring instruments, Survey meter, Pocket Dosimeters. TLD etc.
6. Migration Behavior of Radionuclide into the Environment: Basic principle, Sources of Environmental radioactivity, Atmospheric dispersion, migration in soil and ground water, Site characterization- Soil to plant transfer factor, distribution coefficient and Retardation factor, Conceptual model, Radiological consequence analysis.

**Recommended References:**
1. Herman Cember, Introduction to Health Physics, McGRAW-HILL, INC.
5. Generic Models and Parameters for Assessing the Environmental Transfer of Radionuclides from Routine Release, LAEA TRS No. 57 (1982)

Env. 5206 Environmental Management Systems  (2 Credits, 50 Marks)


3. General requirements of EMS, Applicability of environmental policy, Environmental aspects; legal and other requirements; objectives, targets and program(s).

4. Implementation and operation: Resources, roles, responsibility and authority; competence, training and awareness; communication; documentation; control of documents; operational control; emergency preparedness and response.

5. Checking: Monitoring and measurement; evaluation of compliance; nonconformity, corrective action and preventive action; control of records; internal audit.

6. Relationships among ISO 9000 (QMS), ISO 14000 (EMS) and OSHAS 18000 (Occupational health, safety and environment).

**Recommended References:**

2. Environmental Laws in Bangladesh” Published by Environment & Development Alliance, June 1999.

**Env. 5207 Groundwater Exploration and Management**

(2 Credits, 50 Marks)

1. Groundwater exploration methods: principal and applications
2. Static Water level, pumping water level, drawdown, residual drawdown, well yield, specific capacity, cone of depression, radius of influence, Darcy’s law, transmissivity, storage coefficient
3. Equilibrium well equation, nonequilibrium well equation, hydrogeologic condition that affect time drawdown graph, distance drawdown graph and boundary effect, combined use of semilog graph, effect of partial penetration, water well recovery data, theis non equilibrium equation.
4. Well drilling Methods: Different types of well drilling methods, well drilling fluids, function of drilling fluids, properties of water based drilling fluids, drilling fluids additives, typical drilling problems, air drilling.
5. Water well design: casing distance, casing materials, well depth, well screen length, well screen slot openings, pressure release screens, well screen diameter, open area, selection of materials, design of domestic well, design for sanitary protection, special well-design.
6. Development of water-wells: well development, factors that affect development and well development methods.
8. Water quality protection for wells and nearby ground water resource, choosing a well site, predicting the pollution potential at a drilling site, well design, disinfecting procedure, sealing well head, horizontal suction lines, sealing abandoned wells, major causes of deteriorating, well performance
10. Ground Water Monitoring Techniques: Sources of Ground water contamination, effect of aquifer characteristics on the spread of ground water contamination, monitoring contaminant movement, locating monitoring wells, personal safety at monitoring site, design of monitoring wells, sampling monitoring wells, task of ground water protection, aquifer restoration.

**Recommended References:**


**Env. 5208 Applied Environmental Biotechnology**

(2 Credit, 50 marks)

1. An introduction to Environmental Biotechnology: Introduction; The main areas of application of environmental Biotechnology.
2. Fermentation technology: Introduction; Substrate for biotechnology; Media design for fermentation; The development of inocula for fermentation; Design of a bioreactor/fermenter; Solid substrate fermentation; The recovery and purification of fermentation products.


4. Biotechnological methods for pollution detection: General bioassay in pollution monitoring; Cell biology in environmental monitoring; Molecular biology in environmental monitoring; Biosensors in environmental analysis.

5. Biotechnological methods in pollution abatement: Biotechnology in the reduction of CO₂ emission; Algal photosynthesis in waste treatment; Eutrophication in biological phosphorus removal; Metal pollution and its bioabatement; cell immobilization as a tool in waste treatment.

6. Biotransformation and Biodegradation: Aerobic and anaerobic biodegradation; Bioaugmentation; Bioremediation; Biodegradation of hydrocarbons, herbicides, pesticides and halogenated solvents; Biodegradation and transformation of nitroaromatic compounds; Biotransformation of polychloronated biphenyls (PCB): Testing for Biodegradability.

7. Biohydrometallurgy and Biomining: Bioleaching, Biosorption; Bioabsorbent microbial groups; Macrophytes.

**Recommended References:**


**Env. 5209 Aquatic Ecology** (2 Credits, 50 Marks)

1. Introduction: Approaches to the study of aquatic ecology, Botanical approach, Zoological approach, Ecosystem approach, Biotic approach, Habitat approach, Productivity approach, Population approach, Statistical approach.
5. Marine Ecosystem: Classification of Marine Habitat, Classification of Biota of Marine Ecosystem, Deep sea adaptation.
8. Role of primary producer and consumer in freshwater and marine environment.

**Recommended References:**

3. Limnology- Pauls and wells,
Env. 5210 Water Resources Management  
(2 Credits, 50 Marks)


11. Case studies.

Recommended References:


More reading material will be supplied at classroom.

Section-III

Env. 5001 Practical/Field work/Project work/ Internship (for only general group student; Group A)  
(4 Credits, 100 Marks)

Integrated practical and field work will be assigned for general group students. Apart from practical and field work, department can assign project work / internee to individual or group of students.

Student will submit a report (according to instruction) after 60 days of the last theoretical examination /final viva voce and will present their work.

Env. 5011 Thesis (for only thesis group student; Group B)  
(6 Credits, 150 Marks)

Thesis area and title will be made by the student after consultation with respective supervisor. Students have to give a proposal presentation after approval of thesis by the departmental committee. Student will submit a thesis (according to instruction) after 90 days of the last theoretical examination/final viva voce and will present their work.

Instructions for Thesis/ Report preparation (Both for Env. 5001 and Env. 5011)

Thesis/ Report should be in 80 gms offset A4 sized paper having 2.5cm margin in all sides, standard font of 12 sizes and maintain although 1.5 line spacing.

Table of Content should have at least following subsections:
1. **Abstract** - within 500 words
2. **Introduction** - including objectives, thesis outline and literature review
3. **Materials and Methods / Experiments**
4. **Results / Results & Discussion**
5. **Discussion**
6. **Conclusion**
7. **References** - should be in any standard format. Here, an example is cited from Environmental International Journal:

   “The journal generally follows the referencing style of the Council of Biological Editors. In the text, refer to the author(s) and the year. Examples for one author, two authors and more than two authors are: Gambrell (1994); Dockery and Pope (1994); Gunter et al. (1996). If there is more than one listing of the same author and year, use a, b, c, etc.

   Prepare a list in alphabetical order containing all literature cited. In this list of references, include initials and surnames of the authors, title of the paper, name of the journal using the World List of Scientific Periodicals abbreviations, volume number and page number(s). Note that et al. is not acceptable in the reference list unless the publication has more than six authors. The following examples should be used as a guide:

   **Article**: Vazquez, G.F.; Enisco, G.; Morales J.W. Metal ions in water and sediments of the Pom-Atasta lagoon, Mexico. Environ Int. 25:599-604; 1999


8. **Appendix** - (if necessary)

   **Thesis/Report** should not exceed 150 pages including everything.

   Figures and Tables should be in proper position (incorporated within text).

   Five copies of hard binding thesis/ Report along with soft copy in a CD should be submitted to the chair of examination committee.

   Evaluation copies (Three copies) should contain only student’s roll and registration numbers (student’s, supervisor’s name and acknowledgement should not be printed anywhere in the thesis).

**Viva Voce (for both Group A & Group B) (2 Credits, 50 Marks)**

All students will face a year end viva voce in front of examination committee including external member. Viva voce will take place at the end of theoretical examinations.