The admission to M. Phil./Ph.D. programme in Environmental Sciences will be in accordance with the ordinance for the degree of M. Phil./Ph.D. of this University. The degree of M. Phil./Ph.D. consists of :(a) written examination on approved theoretical courses (b) submission of a thesis on an approved research topic and (c) an oral examination. A student admitted into the M. Phil./Ph.D. programme must undertake two theoretical courses, each of 100 marks. He/She must complete the course work within one year from the date of his/her admission. Department will offer a number of courses in the first year from which a student should take two courses after discussion with his/her supervisor. There will be a written examination on the approved courses at the end of the first year. The pass marks or grade point for the each course is 50% or GPA 3.25. If a student obtains less than 50% or GPA-3.25 in the written examination of any of the theoretical courses, he/she shall be declared to have failed the examination and his/her admission to the M. Phil/Ph.D. course shall be cancelled.

Further, the students are required to carry out research on approved topics and present a minimum of two seminars on the topics in his field of research approved by the supervisor. The period between the two seminars must be at least six months. Finally, the students have to appear for an oral examination provided his thesis is recommended for acceptance by the examiners. On the favorable recommendation of at least two examiners present at the oral examination, the students may be recommended for the award of the M. Phil/Ph.D.

Following courses will be offered for the degree of M.Phil./Ph.D. in Environmental Sciences

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<td>Env.710</td>
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Env.701 Climate Change: Impacts, Adaptation and Mitigation measures (4 Credits, 100 Marks)

1. Current knowledge about observed and future impacts of climate change on the natural and human environment: Freshwater resources and their management,
Ecosystems, their properties, goods and services, Food, fibre and forest products, Coastal systems and low-lying areas, Industry, settlement and society, Human health.

2. Future impacts of climate change in Africa, Asia, Australia and New Zealand, Europe, Latin America, North America, Polar Regions (Arctic and Antarctic) and Small islands.


4. Assessment of adaptation practices, options, constraints and capacity.

5. Inter-relationships between adaptation and mitigation.

6. Assessing key vulnerabilities and the risk from climate change.

7. Perspectives on climate change and sustainability.


9. Mitigation from a cross sectoral perspective.

10. Sustainable Development and mitigation.


12. Case studies.

**Recommended References:**


**Env. 702 Environmental hazards of trace and radioactive elements (4 Credits, 100 Marks)**


3. Environmental Radiation Monitoring and Detection: Radiation detectors, Different methods of detection, Gamma Spectroscopy system, Calibration, Efficiency and Minimum detection limit of gamma spectroscopy system, Environmental sample counting and analysis, Counting statistics, Dose measuring instruments, Survey meter, Pocket Dosimeters. TLD etc. Dose assessment from environmental radioactivity, radioactivity levels in the environment of Bangladesh.


5. Methods for Cleaning Contaminated Soils and Sediments:
6. Clean-up of Contaminated Soil and sediments: Thermal Treatment of Excavated Soils and sediments, In Situ Extractive Treatment of Contaminated Soil and sediments, Treatment Soil by Electroclamation, Treatment of soils and sediments by Biodegradation of the contaminants, Extensive Biological Treatment for control of Diffused- Sources Pollution

7. The Problems of Heavily Polluted Soils by Heavy metals: Introduction, Description of the Contaminated Locality, Methods, Results and Discussion (The extent of the Soil Contamination, Speciation of the Heavy Metals in the Soil, Contamination of Plants Growth on the Polluted Soils, The Application of Factor Analysis(FA) and Correspondence Analysis (CA) to the Analytical Data), Conclusions.

8. 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.

Suggested Books:

ENV. 703 Environmental Engineering and Risk Assessments (4 Credits, 100 Marks)
1. Soil mechanics and engineering: Basic behavior and site characterization, Introduction on geotechnical and geoenvironmental engineering, Basic soil mechanics: soil type, geologic formation and classification, basic elements, soil forming minerals and types of rocks, soil forming processes, soil fabric and structures, definitions, and relationships between basic soil properties, seepage through saturated soil, basic mechanics, compressibility and consolidation,

2. Engineering properties of geologic materials : Engineering properties of soils typical correlation, particle shape, void ratio, density index, Atterberg Limits, expansion index, sensitivity, hydraulic conductivity, elastic properties, swelling and shrinkage, strengths of geologic materials, shear strength, factors affecting soil shear strength, strength of intact rock and rock masses, stability analysis,
3. Site planning and preparations, ground improvement, earth structure and foundation
4. Slope, retaining structures, and excavation:
   a. Slope and embankment stability, stability analysis, soil slopes and rock slopes, treatments to provide stability.
   b. Surface retaining structures: retention of soil slopes, open excavation, support systems, water front retaining structures.
   d. earthquake resistance design, investigation and important structures in high hazards areas.
   e. coastal defense: groins, head land control, inlet, entrance, bypassing, shoreline harbors, walls and revetments, beach nourishment, dredging, different problem of coast.
5. Risk Assessment: Definition of risk, hazard and disaster, factors of risk, types of risk, point of risk analysis, risk management goals, strategies, principles of risk
management framework, risk management methods, principles of decision making, and public perception of risk.

6. Geoenvironmental problems identification and risk management, framework for risk-based site management, defining goals, regulatory and societal issues, site assessment for risk-based site management.

Suggested Books:
2. Robert F. Legget , Geology and Engineering, Second edition,
4. Applied Geology for Engineers, by: Military Engineering volume XV.
5. P. Leonard Capper, W. Fisher Cassie, and JD. Geddes, Problems in engineering soils,
6. Roy E. Hunt, geotechnical engineering investigation manual,.
8. R. Silvester, Coastal Engineering ,2.

ENV. 704 Landscape Evolution and Land Use Planning (4 Credits, 100 Marks)

1. The aims and methods of landforms study: About landforms, scope of landform study, classification of landforms, explanation, basic difficulties in geomorphology
2. weathering, transport and erosion: Factor controlling the type and role of weathering,Geological structure and landforms, the cycle of erosion, slope development, drainage development
3. Landscape evolution by fluvial processes, climate morphogenesis, Deformation and river response: type of deformation, types of alluvial rivers, evidence of deformation
4. Ground water and surface water resources management: Criteria for planning of ground water remediation schemes, efforts to improvement of ground water management, ground water protection and water supply, Potential hazards for ground water and environment.
5. Urbanization: Definition, growth of cities, measure of economic growth and industrialization, technology of production.
6. Planning Requirement: Purposes of planning, stages, formulation of study, evaluation of alternatives and their effects, adoption of a plan, Legislative, controls, political influences, future challenges
7. Land use planning: Sustainable development for planning, environmental appraisal of development plans, difficulties in pursuing land planning audit, state of environment monitoring, policy impact assessment, the interdependence of decisions, checklists for land use planning.
10. Digital Elevation Model (DEM): Definition and its application, data capture and generation of DEM, hydrological application of DEM.
11. Natural Resource Assessment: Land use survey, crop estimates, human settlement, study of soils, forest management, drought surveillance, monitoring of water resources, coastal zone studies, mangrove preservation, fisheries development, mineral exploration and disaster appraisal.
Env. 705. Global Biogeochemistry and Climate Change (4 Credits, 100 Marks)
1. Scope and goal of biogeochemistry and climate changes, link between biogeochemistry and climate changes, and impact of climate change on global biogeochemistry.
2. Climate changes and biogeochemical cycles: Carbon cycle, sulfur cycle, phosphorus cycle and nitrogen cycles
3. Biogeochemical tools for climate change study: Biogeochemical signatures in natural archives, application of isotope for studying biogeochemical and climatic process in natural environment, application of biomarker as a biogeochemical tool for studying material cycling, transportation of terrestrial biogenic materials to the ocean and paleovegetation and climate reconstructions, Molecular evolution of recent environments: Examples of source indicator of recent environments, diagensis at the molecular level, paleotemperature measurements.
4. Impact of climate changes on the biogeochemistry of world Major River: Carbon Transport by the Himalayan Rivers with especial focus on the G-B-M rivers, Carbon and Mineral Transport in Major North American, Russian Arctic, and Siberian Rivers: The St Lawrence, the Mackenzie, the Yukon, the Arctic Alaskan Rivers, and the Yenisei, Fate of Riverine Particulate Organic Matter, Dissolved Organic Carbon in Rivers.
5. Impact of Climate change on the biogeochemistry of ocean: primary production in coastal area and deep sea, fate of terrestrial organic matter and biogenic materials in coastal area and deep sea, role of ocean biogeochemistry for controlling global climate changes.
6. Impact of climate changes on the biogeochemistry of wetland: Focus on the Haor and Bhaor of Bangladesh, agriculture production of wetland, Wetland as natural resources, wetland managements.
7. Impact of climate changes on the biogeochemistry of Mangrove forest: a case study of Sunderbans

Recommended References:
1. Biogeochemistry of Major World Rivers by E. T. Degens, S. Kempe and J. E. Richey

Env. 706. Global Environmental Issues and Policies (4 Credits, 100 Marks)
1. Characterization of global environmental issues and overview of global sustainability around the world.
2. Key environmental issues for global sustainability: Population and demographic transition, Food production, urbanization, Oil production, electricity generation, greenhouse gas production, climate change, sea level rise and the renewable transition, Deforestation and biodiversity, desertification, water use, and waste production, war and terrorism.
3. Global sustainability for Ecological health; grass-roots development, gender equity and appropriate technology; Global sustainability for Green politics and economics; civil society, ethics and spirituality.
4. Basic principles for institutional, legal, and regulatory framework for environmental policies, strategies, regulations and governance.
5. State of the environment and policy retrospective of 1972–2008: Our common future, Earth Summit, Kyoto protocol, and Johannesburg Earth Summit; Innovation and
networking for environmental policy for sustainable environmental management since Rio (Earth Summit): Guidelines for environmental policies of World Bank, UNEP, WHO, OECD, and other international and UN organizations.

6. Market-based environmental policies and actions for achieving the Millennium Development goals and related outcomes; Analysis of environmental policies between developed and developing countries.

7. Case study of environmental policies and natural resource management in South-East Asia.

Recommended References:

Env.707. Green Technologies for Clean Environment (4 Credits, 100 Marks)

1. Green technology: Global perspectives, selectivity of green technology, solvent free microwave assisted technique, microwave activation, non-purely thermal techniques, hyphenated techniques, use of hyphenated tools, species derivatization, opportunity and challenges.

2. Non-traditional green alternatives: Oxidative technology mechanism, mechanism of oxidation of pollutants, cavitation, application of cavitation to wastewater treatment, the use of fenton chemicals, sonophotocatalytic oxidation, hybrid and photo-fenton process.

3. Cleaner technology: the transition to cleaner technology, factors promoting cleaner technology, regulatory frameworks, need for state intervention, impacts of regulation on innovation and competitiveness, policy instruments, cleaner technology versus competitiveness, cost minimization, public information, cleaner technology promotion, radical changes in process technology.

4. Preventing Industrial Waste and Pollution through Cleaner Production: Cleaner industrial production without use of toxic chemicals, Cleaner agricultural production, Cleaner renewable energy sources, Clean coal technology, Change in production processes for cleaner production, Material substitution for cleaner production, Equipment modification for cleaner production.

5. Environmental accounting: Audit types, audit criteria and audit tools, steps for performing audit, environmental audit confidentiality, cost-effective approach to environmental auditing.

6. Corporate environmental performances: Regulation, sectoral and regional differences, economic factors, relative value and resource efficiency, interaction of economic and regulatory factors, decision making in the firm.

Suggested Books:
Env. 708. Hydrology and Water Resource Management (4 Credits, 100 Marks)

2. Precipitation and Water losses: Types and forms, causes and measurements of precipitation and its analysis; types of water losses, Infiltration, methods determining Infiltration, Factors affecting evaporation, methods determining evaporation and evapotranspiration.
4. Hydrograph: Definition, Hydrograph separation, Unit Hydrograph, Preposition and application of unit hydrograph, Catchment modelling.
8. Water pollution and Scarcity in Bangladesh: Causes, State, Impact and responses, Options and actions for pollution management.

Recommended References:

Env. 709 Advanced Environmental Sciences (4 Credits, 100 Marks)

2. Biogeochemical Cycles of some important elements: Nitrogen, Carbon and Sulfur. Their Implications for global changes.
3. Important Global and Regional Environmental Issues: (a) Global warming: Ozone layer and its Function. Depletion of Ozone layer and alternative of CFC, Green house gasses (GHG) and effects of GHG and remediation of GHGs. (b) Acid rain: Causes of acid rain, effects on environment and control of acid rain.
4. Industrial and Agricultural Pollution: Some major Industrial Pollutants, Control and Management of Hazardous waste, Agricultural pollutants such as Fertilizer, Pesticides.
5. Biodiversity: Biological Evolution, Basic concept of Biological Diversity, Interaction between species, Environmental factors that influence diversity, Importance of preserving Biodiversity
6. Ecosystem and Ecological Communities and their importance
7. Ecological Succession
8. Air Pollution and advanced techniques for remediation:
9. Water Pollution and indigenous mitigation method:
10. Waste Management and reuse

Recommended References:
2. Environmental Science, 1990, Karen Arms, Saunders college
3. Environmental Science: working with the Earth (8th edition), 2001, G. Tyler Miller, Wadsworth

Env. 710 Food Microbiology and Environment (4 Credits, 100 Marks)

1. Historical background of Food Microbiology; history of microorganisms in food; foods as a substrate for microorganisms; Contamination of Foods.
2. Role and significance of microorganisms: primary sources of microorganisms found in foods; synopsis of common food borne bacteria, molds and yeasts. Intrinsic and extrinsic parameters of foods that affects microbial growth.
3. Indicators and food borne pathogens: Indicators organisms for food and water; coliforms, faecal coliforms; enterococci; total counts as indicators of food sanitation quality.
4. Food spoilage: spoilage of vegetables and fruits; spoilage of different kinds of meats; spoilage of eggs; spoilage of milk and milk products and spoilage of canned food.
5. Food poisoning: Staphylococcal gastroenteritis; food poisoning caused by Clostridium botulinum, Bacillus cereus, mycotoxins, aflatoxin and ochratoxins.
6. Fermented foods and other products: Bread, dairy products, cheese, curd, buttermilk; single cell protein, amino acids, citric acid, butyric acid and ethanol.
7. Measurement of growth of microorganisms and cultivation of microorganisms: Types, uses and applications of culture media; designing of culture media for isolation of specific microbes; enrichment technique; Different methods for measurement of microbial growth.
8. Control of microorganisms: Control of microorganisms by physical agents, e.g. temperature, desiccation, osmotic pressure, UV, gamma ray, filtration etc.; Control of microorganisms by chemical agents, e.g. phenol, phenolic compounds and halogens, their mode of actions; Control by dyes and detergent; Control by antibiotics.

References:
2) Modern Food Microbiology. James M. Jay. Van Nostrand Rainhold, NY, USA.
Env. 711 Methods of tracking environmental changes (4 Credits, 100 Marks)

1. Scope and goal of tracking environmental changes and its relation to climate changes and human civilization, Paleoenvironmental changes, paleovegetational changes and its relation to global climate.
2. Physical and lithostratigraphy techniques
3. Mineralogical and geochemical indicator techniques
4. Stable isotope and biomarker techniques
5. Exploration of the biogeochemical techniques in the Ganges flood plain and coastal area of Bangladesh.

Recommended References:
Tracking environmental changes using lake sediments; Physical and geochemical methods by J.W. M. Last and J P Smol.
Biogeochemistry of Major World Rivers by E. T. Degens, S. Kempe and J. E. Richey

Env. 712 Remote sensing and GIS in Natural Resource Management (4 Credits, 100 Marks)

1. Introduction to different branches of Geographic Information Sciences (Global Positioning System (GPS), Remote Sensing (RS) and Geographical Information Systems (GIS)): Definition, history, functions and uses.
5. Spatial data analysis and modelling.

Recommended References:

Env. 713. Wastewater Treatment and Reuse (4 Credits, 100 Marks)

1. Wastewater: An overview health and Environmental concerns in wastewater management, wastewater characteristics wastewater reclamation and reuse.
5. Aggregate Organic constituents: BOD, Total and soluble chemical Oxygen Demand (COD and SCOD), Total and Dissolved organic carbon (TOC and TOC), Oil and grease, Surfactants.
7. Biological Treatment: Over view of Biological wastewater treatment, Objectives of Biological Treatment, Role of Microorganisms in wastewater Treatment, Types of Biological processes for wastewater Treatment.

**Recommended References:**

2. Industrial Water Pollution Control, Second Edition, By W. Wesley Eckenfelder, Jr