University of Moratuwa, Sri Lanka

M.Sc./PG. DIPLOMA IN

ENVIRONMENTAL ENGINEERING AND MANAGEMENT

AND

M.Sc./PG. DIPLOMA IN

ENVIRONMENTAL MANAGEMENT

ELIGIBILITY REQUIREMENTS, PERFORMANCE CRITERIA, CURRICULUM AND MODULE SYLLABI

Environmental Engineering Division
Department of Civil Engineering
University of Moratuwa

Master's Degree: Eligibility and Performance Criteria

(Formulated Under Clause 6.3 or By Law No. 49:2013)

1. Title of Degree: Master of Science

1.1 Title of Award:

(A) Master of Science in Environmental Engineering and Management

(B) Master of Science in Environmental Management

1.2 Programme Type: A

1.3 Programme Mode: Part-time

2. Extended Eligibility Requirements

Minimum eligibility requirements, constrained as per clause 2.1 of the By-Law No. 49:2013, and to be generally used in advertising the course.

The selection of students to the Master's Degree Programme will be made by the Department of Civil Engineering, in accordance with one of the following extended eligibility requirements, approved by the Senate.

For (A) - Master of Science in Environmental Engineering and Management

a) The Degree of Bachelor of the Science of Engineering of the University of Moratuwa, Sri Lanka or an equivalent degree in a relevant field as judged by the Faculty and approved by the Senate.

or

b) At least the Associate Membership of a recognized professional Engineering Institute in a relevant field and minimum of one year relevant experience after obtaining such membership, the acceptability of the Associate Membership status of the candidate, the recognition of the institute and relevancy of the field for this purpose shall be judged by the Faculty and approved by the Senate.

For (B) - Master of Science in Environmental Management

a) A degree in Science from a recognized university and minimum of 1 year of appropriate experience; the recognition of the degree to be judged by the Faculty and approved by the Senate.

or

c) The Degree of Bachelor of the Science of Engineering of the University of Moratuwa, Sri Lanka or an equivalent degree in a relevant field as judged by the Faculty and approved by the Senate.

or

d) At least the Associate Membership of a recognized professional Engineering Institute in a relevant field and minimum of one year relevant experience after obtaining such membership, the acceptability of the Associate Membership status of the candidate, the recognition of the institute and relevancy of the field for this purpose shall be judged by the Faculty and approved by the Senate.

or

e) At least the Graduate Membership of a recognized professional science institute deemed equivalent to a Bachelor of Science Degree in a relevant field and minimum of one year relevant experience after obtaining such membership, the acceptability of the Graduate Membership status of the candidate, the recognition of the institute and relevancy of the field for this purpose shall be judged by the Faculty and approved by the Senate.

3. Participation in the AcademicProgramme

3.1. A minimum of 80% attendance at lectures and during other contact hours will be required, as specified under clause 4.1.1(a) of the By- Law.

3.2. Submission of reports on laboratory work, projects, and assignments, and participation in seminars and field visits are required, as specified under clause 4.1.1(b) of the By-Law.

3.3. Undertaking research in a specific area is compulsory, as specified in clause 4.1.1(c) of the By-Law.

3.4. The Master's Degree programme is expected to be completed in the normal duration, but may go on till the permitted duration of study without the need of an extension as specified under section 5 of the By-Law.

3.5. It is the responsibility of the student to obtain an extension to the permitted duration, through the Head of Department. Such requests to extend the duration will be taken considering the progress of the student at the time of request.

3.6. Prior approval must be obtained in writing from the University, with the necessary documentation, for leave of absence (as defined by the Senate).Only such leave will

be considered for any official purpose, such as considering a subsequent attempt as a first attempt.

3.7. Only approved leave obtained on medical grounds will be normally be considered by the Senate in extending the maximum duration of study.

4. Evaluation and Grading

4.1. The performance of the each student in each module will be evaluated by continuous assessment (CA) and end-of-semester examination (WE), where applicable.

4.2. Credit Rating

Each course credit corresponds to 1 hour of lectures or 2 hours of assignment/discussion classes or 3 hours of field/laboratory classes.

4.3. Scheme of Examination and Award of Classes/ Subject Grades

The performance of the each student in each module will be evaluated at the end of the respective term. This includes continuous assessment (CA) and end-of-semester examination (WE), where applicable.

4.4. To pass a subject, student should obtain a grade of C+ or above.

4.5. The following grading system will be adopted.

Guideline percentage	Grade	Grade Point	Description
85% and above	A +	4.2	
75% - 84%	A	4.0	Excellent
70% - 74%	A -	3.7	
65% - 69%	B +	3.3	
60% - 64%	B	3.0	Good
55% - 59%	B -	2.7	
50% - 54%	C +	2.3	Pass
	I	0.0	Incomplete
	F	0.0	Fail

4.6. Grade C^+ or above is required to pass a module and earn credit for the subject. A minimum of 40% must be obtained separately for both Continuous Assessment (CA) and Written Examination (WE).

4.7. A student who has not obtained a grade of C+ in a subject but has obtained minimum marks for the course work component, receives the grade “Incomplete”, “I”.

4.8. A student receiving an F grade must repeat all the components.

4.9. "I" grade or "F" grade can be improved to C+ grade by repeating one or more components to satisfy the requirements for a pass in the subject. The maximum grade awarded for a course module after repeating one or more components will be a C+ and it will be used for calculating Grade Point Average. Normally only one re-examination will be allowed.

4.10. Calculation of Grade Point Average

The Grade Point Average (GPA) is calculated from the grade points received by the student (GRADE POINT) and the credits assigned for each of the course units (CREDITS) by the formula

$$GPA = \frac{\sum(GRADEPOINT \times CREDITS)}{\sum CREDITS}$$

4.11. Award of the Degree

A candidate is eligible to be awarded the M.Sc. Degree if the candidate has:

(a) obtained minimum of 44 credits and a minimum GPA of 2.3 from course modules

(b) successfully completed the Research Project (20 credits)

Note 1: No Classes will be awarded. However grades will be given in the transcript.

Note 2: If only the requirements of Section (a) are satisfied, a student may, on request, be considered for the award of a Postgraduate Diploma, as per clause 3.2.2 of By-law No. 3 of 49/2013.

4.12. Date of Award :

Date of award of the M.Sc. degree will be the first (01^{st}) day of the month following the successful completion of the following;

(a) Written examination(s)

(b) Laboratory work

(c) Assignments

(d) Examination of the Research Project, Dissertation and/or Project Report including a Viva-voce examination

PG Diploma: Eligibility and Performance Criteria

(Formulated Under Clause 6.3 or By Law No. 49:2013)

1. Title of Degree/Diploma: Postgraduate Diploma

1.1 Title of Award:

(A) Postgraduate Diploma in Environmental Engineering and Management

(B) Postgraduate Diploma in Environmental Management

1.2 Programme Type: A

1.3 Programme Mode: Part-time

2. Extended Eligibility Requirements

Minimum eligibility requirements, constrained as per clause 2.1 of the By-Law No. 49:2013, and to be generally used in advertising the course.

The selection of students to the Master's Degree Programme will be made by the Department of Civil Engineering, in accordance with one of the following extended eligibility requirements,approved by the Senate.

For (A) - Master of Science in Environmental Engineering and Management

a) The Degree of Bachelor of the Science of Engineering of the University of Moratuwa, Sri Lanka or an equivalent degree in a relevant field as judged by the Faculty and approved by the Senate.

or

b) At least the Associate Membership of a recognized professional Engineering Institute in a relevant field and minimum of one year relevant experience after obtaining such membership, the acceptability of the Associate Membership status of the candidate, the recognition of the institute and relevancy of the field for this purpose shall be judged by the Faculty and approved by the Senate.

For (B) - Master of Science in Environmental Management

a) A degree in Science from a recognized university and minimum of 1 year of appropriate experience; the recognition of the degree to be judged by the Faculty and approved by the Senate.

or

c) The Degree of Bachelor of the Science of Engineering of the University of Moratuwa, Sri Lanka or an equivalent degree in a relevant field as judged by the Faculty and approved by the Senate.

or

d) At least the Associate Membership of a recognized professional Engineering Institute in a relevant field and minimum of one year relevant experience after obtaining such membership, the acceptability of the Associate Membership status of the candidate, the recognition of the institute and relevancy of the field for this purpose shall be judged by the Faculty and approved by the Senate.

or

e) At least the Graduate Membership of a recognized professional science institute deemed equivalent to a Bachelor of Science Degree in a relevant field and minimum of one year relevant experience after obtaining such membership, the acceptability of the Graduate Membership status of the candidate, the recognition of the institute and relevancy of the field for this purpose shall be judged by the Faculty and approved by the Senate.

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3.7. Only approved leave obtained on medical grounds will be normally be considered by the Senate in extending the maximum duration of study.

4. Evaluation and Grading

4.1. The performance of the each student in each module will be evaluated by continuous assessment (CA) and end-of-semester examination (WE), where applicable.

4.2. Credit Rating

Each course credit corresponds to 1 hour of lectures or 2 hours of assignment/discussion classes or 3 hours of field/laboratory classes.

4.3. Scheme of Examination and Award of Classes/ Subject Grades

The performance of the each student in each module will be evaluated at the end of the respective term. This includes continuous assessment (CA) and end-of-semester examination (WE), where applicable.

4.4. To pass a subject, student should obtain a grade of C+ or above.

4.5. The following grading system will be adopted.

Guideline percentage	**Grade**	**Grade Point**	**Description**
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55% - 59%	B -	2.7	
50% - 54%	C +	2.3	Pass
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4.6. Grade C^+ or above is required to pass a module and earn credit for the subject. A minimum of 40% must be obtained separately for both Continuous Assessment (CA) and Written Examination (WE).

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4.11. Award of the Diploma

A candidate is eligible to be awarded the Postgraduate Diploma if the candidate has obtained minimum of 44 credits and a minimum GPA of 2.3 from course modules.

Note: No Classes will be awarded. However grades will be given in the transcript.

4.12. Date of Award :

Date of award of the Postgraduate Diploma will be the first (01^{st}) day of the month following the successful completion of the following;

(a) Written examination(s)

(b) Laboratory work

(c) Assignments

Curriculum and Scheme of Evaluation

(a) **Postgraduate Diploma**[at least 44 credits from the following list]

Compulsory Modules for both Streams (A & B)

Code	Subject	Credits*	Evaluation (%)	
			Continuous Assessment	Final Exam
CE5527	Environmental and Social Impact Assessment	2	40 ± 20	60 ± 20
CE5560	Surface water pollution and control	4	40 ± 20	60 ± 20
CE5561	Groundwater pollution and control	2	40 ± 20	60 ± 20
CE5562	Noise & Air pollution and control	2	40 ± 20	60 ± 20
CE5563	Solid and Hazardous Waste Management	2	40 ± 20	60 ± 20
CE5564	Environmental Chemistry	4	40 ± 20	60 ± 20
CE5565	Statistical and Research Methods	2	40 ± 20	60 ± 20
CE5566	Environmental Law and Policy	2	100	
CE5567	Microbiology and Biotechnology for Environmental applications	2	40 ± 20	60 ± 20
CE5568	Water Safety and Principles of Water and Wastewater Treatment	4	40 ± 20	60 ± 20
CE5569	Seminars on Global Environmental Issues	2	100	
CE5591	Comprehensive Design Project	4	100	-

Elective Modules for both (A) & (B) –Minimum of 8 Credits to be selected**

CE5525	Environmental Economics	2	100	-
CE5570	Meteorology & Climate Change	2	40 ± 20	60 ± 20
CE5571	Contaminated Land Management	2	40 ± 20	60 ± 20
CE5572	Design of Water Treatment systems	4	40 ± 20	60 ± 20
CE5573	Design of Wastewater Treatment systems	4	40 ± 20	60 ± 20
CE5574	Environmental Quality Management and Environmental Auditing	2	100	
CE5575	Geographical Information Systems (GIS) for Environmental Applications	2	100	
CE 5576	Integrated Water Resources Management	2	40 ± 20	60 ± 20
CE 5577	Sustainable Building and Infrastructure Design	2	40 ± 20	60 ± 20

Compulsory Only for Environmental Engineering &Management (A) –Minimum of 4 Credits to be selected**

CE5543	Design of Water Retaining Structures	4	40 ± 20	60 ± 20
CE5544	Advances in Water & Wastewater Treatment	4	40 ± 20	60 ± 20
CE5545	Water Supply & Sewerage Design	4	40 ± 20	60 ± 20

Compulsory Only for Environmental Management (B) - Minimum of 4 Credits to be selected**

CE5552	Applied Ecology	4	40 ± 20	60 ± 20
CE5554	Natural Resources Management	4	40 ± 20	60 ± 20
CE5555	Forestry and Wildlife Conservation	4	40 ± 20	60 ± 20

***** 1 credit corresponds to 14 hours of lectures or 28 hours of assignments.

** Elective modules will be offered subject to availability of resources.

(b) **Master of Science** [at least 44 credits from the list (a) as stated above **and** the following module]

CE6501	M.Sc. Dissertation	20	100	-

Document 3: Module Syllabi

Compulsory Modules

CE5527 - Environmental and Social Impact Assessment(2 Credits)

1. Overview of EIA process in relation to National Environmental Act, the same in relation to Safeguard policies of Donor agencies such as World Bank, ADB
2. EIA process
    - Environmental scoping & TOR setting
    - Methods used in EIA preparation and impact weightage
3. Identification, Quantification and Mitigation of Environmental Impacts
    - Physical
    - Biological
    - Social
4. Social Impact Assessment
5. Preparation of Environmental Management Plan
6. Public participation in Environmental Decision making
7. Presentation of Case study

Learning Outcomes

On the satisfactory completion of this module, students will be able to;

1. participate in discussions on and express opinions about global environmental issues, Global trends and Sri Lanka's commitment to sustainable development, International treaties and Conventions on Environment,
2. explain the purpose and role of Environmental Impact Assessment in the decision making process,
3. serve as a member of a team of consultants who undertake an Environmental Impact Assessment Study,
4. prepare the Terms of Reference and to evaluate an EIA report submitted by a client as an officer in a Project Approving Agency,
5. quantify the impacts and recommend measures to avoid or minimise social and environmental concerns in engineering projects.

CE5560 - Surface Water Pollution and Control(4 Credits)

1. Types of pollution, Indicators of pollution, Sources of pollution
2. Limnological processes (physical, ecological, chemical)
3. Lakes & reservoirs pollution and control; Case studies
4. River hydrodynamics and contaminant transport processes
5. River and coastal water pollution and control; Case studies
6. Near-shore processes including Tidal Impacts
7. Marine water pollution (Near-shore and Offshore); Case studies
8. Field visit / Introduction of the case study (Field-based project)
9. Modeling of contaminant transport in Rivers
10. Dispersion modeling of contaminants from sea outfalls
11. Field work & Lab work
12. Presentation of the case study

Learning Outcomes

On the satisfactory completion of this module, student will be able to,

1. demonstrate the understandingof common pathways of surface water pollution;
2. analyse a given scenario based on key environmental concepts and to propose solutions to environmental-related problems such as surface water pollution;
3. describe the role that microbes and minerals play in key geological processes related to pollutants;
4. assess the magnitude of environmental consequences related to human activities and propose mitigatory actions for remediation of surface water pollution.

CE5561 - Groundwater Pollution and Control(2 Credits)

1. Introduction to Hydrogeology & Groundwater

   Groundwater table, Ground water flow (Infiltration, Percolation, Occurrence of Ground Water),Recharge, Piezometric line, Phreatic line, Groundwater yield, Confined &Unconfined aquifers, Aquifer characteristics (Permeability, Transmitivity, Resistivity, Hydraulic Conductivity, Porosity, Storage coefficient)

2. Groundwater Quality

   Types of pollution, Sources of pollution, Indicators of pollution, Mineral-groundwater interaction, interpretation of water quality data(piper diagrams & stiff diagrams)

3. Movement of aquifer water (during extraction & exploitation), pumping & recovery test, contaminant transport
4. Modeling of contaminant transport
5. Remediation of Groundwater pollution
6. Case studies and Exercise

Learning Outcomes

On the satisfactory completion of this module, student will be able to,

1. demonstrate the understandingof common pathways of Groundwater pollution;
2. analyse a given scenario based on key environmental concepts and to propose solutions to environmental-related problems such as groundwater pollution;
3. describe the role that microbes and minerals play in key geological processes related to pollutants;
4. assess the magnitude of environmental consequences related to human activities and propose mitigatory actions for remediation of groundwater pollution.

CE5562 – Noise & Air pollution and control (2 Credits)

Air Pollution & Control

1. Sources of pollution, Types of air pollutants, Health effects, Ambient & emission standards, Global Impacts, Indoor air pollution
2. Measurement of air pollutants, Direct methods and indirect (passive) techniques
3. Atmospheric dispersion of pollutants from stationary stacks, multiple stacks, line sources, principles of stability classes
4. Modeling of pollutants from stationary stacks, predictions of air quality from models under different meteorological conditions
5. Control technologies of Air pollution, Odour control

Noise pollution & Control

1. Basics of Environmental Noise, Health impacts, Noise descriptors, sound propagation, properties of sound
2. Acoustics principles in relation to frequency spectrum applications in Music, Addition and Subtraction of Noise Levels, Legislation on Noise, Measurement of Noise, Octave Band analysis
3. Industrial noise control, Highway noise control, Railway noise control, Aircraft noise control, Vibration control
4. Principles of Building Acoustics, Propagation of noise levels within building spaces, Different types of Noise rating, Noise descriptors in building acoustics
5. Principles of refraction, reflection, absorption and transmission of Noise through building elements, Echoing and reverberation, resonance, Noise Die-off, Building elements for noise control, use of sandwich panels, Design of Auditoriums [for speech], Opera halls (for Music), Lecture halls, Libraries, etc.

Learning Outcomes

On the satisfactory completion of this module, student will be able to,

1. demonstrate the understandingof common pathways of Air and Noise pollution;
2. analyse a given scenario based on key environmental concepts and to propose solutions to environmental-related problems such as air pollution;
3. assess the magnitude of environmental consequences related to human activities and propose mitigatory actions to control air and noise pollution;
4. demonstrate the understandingof principle and advanced techniques used in environmental analysis.

CE5563 - Solid and Hazardous Waste Management(2 Credits)

1. Municipal Solid Waste Management
   Generation, Collection, Storage, Transport, Final Disposal, Sources, Waste minimization, 3-R principle
2. Composting
   Sorting, Home composting, Large scale composting, Windrow, Leachate management, quality of compost, value addition
3. Design of a typical Compost Yard
4. Landfills
   Open dumps, Engineered Landfills, Sanitary Landfills, Different types of Landfilling, operations of Landfills, closure of Landfills
5. Design of a typical Sanitary Landfill
6. Thermal & Biochemical processes for waste management

   Biogas plants

   Waste to-Energy

   - Different combustion processes
   - Air quality controls
   - Flu gas management
   - Fly ash&Bottom ash management
   - Electricity generation
7. Hazardous Waste Management
   Types, Regulations, Characteristics of hazardous waste,Generation, Storage, Transport, Handlings, Treatment &Final Disposal

Learning Outcomes

On the satisfactory completion of this module, student will be able to,

1. understand theorigins and characteristics of different types of wastes;
2. recognize the magnitude of waste generation and the strategies of waste minimization and prevention;
3. demonstrate the skill and knowledge to propose suitable single or integrated waste management/treatment options
4. realize the potential for resource material and energy recovery from waste
5. appreciate the need and rationale of guidelines and regulations in environmentally responsible waste management.

CE5564 - Environmental Chemistry (4 Credits)

1. Water Chemistry

   Basic concepts of general chemistry, physical and chemical quality of water, sampling & testing, Thermodynamics and Kinetics of Acids & Base reactions, Carbonate chemistry, Air water exchange, Precipitation, Dissolution, Complexation, Oxidation & Reduction, Sorption, Coagulation, Ion exchange, Corrosion

2. Environmental Geochemistry

   Introduction to geochemistry, Chemical Thermodynamics and kinetics, Acids and Bases, The carbonate system and pH in natural waters, Metal complexation in aqueous solutions, Precipitation and dissolution of minerals, Oxidation and Reduction, Reactions at the Mineral-water interface

3. Case studies and Exercise

4. Modern analytical techniques
   - Atomic Absorption Spectroscopy, Flame photometry, Inductively Coupled Plasma Atomic Emission Spectroscopy, Scanning Electron Microscopy
   - Chromatography

     Gas-Solid chromatography, Gas-Liquid chromatography, High Performance Liquid Chromatography, Ion-Exchange chromatography
   - Radio- Analytical methods

     Neutron activation analysis, Isotope dilution analysis, use of Radio Isotopes
   - Spectroscopic Techniques
   - NMR techniques
   - X-Ray spectroscopy

5. Visit to Analytical Laboratories

Learning Outcomes

On the satisfactory completion of this module, student will be able to,

1. demonstrate the understandingof principle and advanced techniques used in environmental analysis;
2. describe the role that microbes and minerals play in key geological processes related to pollutants;
3. explain the physical and chemical processes relevant to a range of keyenvironmental chemistry issues (e.g. colloid formation and stability; transport of pollutants)
4. predict the fate of a range of species from a knowledge of the various processes in which they react, complex or participate.

CE5565 - Statistical & Research Methods(2 Credits)

1. Sampling and Data collection
2. Presentation of data
   Central tendency (Arithmetic mean, Mean, Median, etc.), Measure of dispersion (Range, Standard Deviation, Variance, Quartile deviation, Coefficient of variability, Skewness, Qurtosis, Outliers)
3. Statistical methods
   Hypothesis testing,Significance and Correlation, Linear models & regression, multiple regression
4. Distribution
   Normal, t-and Chi-Square tests
5. Difference among means
   F test: One way ANOVA
   F test: Two way ANOVA

   Introduction to computer based applications
6. Analysis & Interpretation of data
7. Exercise using computer software for analysis & interpretation of data
8. Introduction to concepts of scientific research and research process
   Laboratory – based, field – based, and computer based research, The framework for hypothesis generation, planning &design of research
9. Research proposal writing
10. Preparation of Research &Technical papers/reports

Learning Outcomes

On the satisfactory completion of this module, student will be able to,

1. demonstrate the understanding of research, available methods, suitability of data collection and sampling, and selection of appropriate analysis method
2. demonstrate the ability to appropriately use available statistical analysis techniques for data analysis
3. demonstrate the skill and knowledge to study, evaluate and identify a research problem, select an appropriate method of execution, establish a method for evaluation and prepare an action plan for research project completion
4. demonstrate the skill to write a systematic research proposal in a report format and carryout an effective presentation of outputs

CE5566- Environmental Law and Policy(2 Credits)

1. International Environmental Protocols
    - Evolution and development of International Environmental laws with reference to Stockholm conference, Nairobi Declaration, Rio conference, Rio+5 and Rio+10 etc.
    - Global Environmental issues and International laws to control Global warming,Ozone depletion, Acid rains, hazardous waste, CITES etc.
    - Role of UN authorities in protection of Global Environment, Multinational authorities and agreements, future of International laws
    - International treaties, declarations and global conventions related to the Environment: Agenda 21, Kyoto protocol, MARPOL convention, Stockholm convention, Rotterdam convention, Basel convention
2. Environmental Laws in SL
    - National Environmental Act and related regulations, Marine Pollution Prevention Act, Coastal Zone Management Act, Public Nuisance Ordinance, North Western Environmental Statute, Wildlife Act, Flora & Fauna Act, Forest Ordinance, Water Resources Act, Irrigation Ordinance, Mahaweli Act, Antiquity Act, Urban Development Act, etc.
3. National Environmental policies
    - Solid Waste Management policy, Hazardous Waste Management policy etc.
4. Exercise on development project and need for compliance with Environmental legislation

Learning Outcomes

On the satisfactory completion of this module, student will be able to,

1. Identifydifferent sectors of environmental regulations and explain the philosophical and historical foundations of environmental law;
2. demonstrate a comprehensive knowledge of the key principles of environmental law;
3. demonstrate awareness of the main ethical perspectives of environmental law and policy;
4. identify and evaluate the current content and direction of environmental law;
5. demonstrate an ability to use relevant information to explain and discuss how environmental law has developed and is applied in practice.

CE5567 – Microbiology and Biotechnology for Environmental Applications (2 Credits)

1. Fundamental aspects of Environmental Microbiology

   Types of microorganisms and their identification, Environmental significance

2. Microbial metabolism, Growth and Biokinetics
3. Microbial Genetics

   DNA technology, Concepts of PCR, Cloning, Gene Probes, Applications in Environmental Engineering

4. Bioremediation for Soil Environment

   Soil microorganisms and their interactions with soil, Role of microorganisms in soil remediation, applications of bioremediation

5. Introduction to Biotechnology

   Applications of Biotechnology in Environmental Engineering such as Phytoremediation, Sequestering Carbon Dioxide, Biomarkers, High rate growth applications, Application of effective microorganisms, Gene modifications, Adaptation of pest resistant crops, Research and Development in Biotechnology

6. Application in Wastewater Engineering
7. Case Studies

Learning Outcomes

On the satisfactory completion of this module, student will be able to,

1. demonstrate the understandingof fundamentals of environmental microbiology and biotechnology;
2. explain various techniques used in environmental microbiology and their applications;
3. analyze various environmental problems, formulate strategies to cleaning up contaminated environmentand apply the microbial and biotechnological techniques to improve environmental quality;
4. appraise and assess the advances in biological applications for environmental contamination remediation

CE5568 –Water Safety and Principles of Water and Wastewater Treatment (4 Credits)

Water Safety

1. Preparation and implementation of Water Safety Plans according to WHO guidelines, with case studies

Water Treatment

1. Water quality sampling, Testing for water treatment, compliance with Guidelines / standards
2. Introduction to water treatment processes
3. Aeration, Air stripping and Advanced oxidation
4. Coagulation, Flocculation, Mixing
5. Sedimentation and Filtration
6. Disinfection
7. Chemical treatment processes such as Adsorption, Ion exchange, Softening
8. Membrane technologies
9. Water Treatment Sludge management

Wastewater Treatment

1. Characterization of wastewater for wastewater treatment and reuse
2. Introduction to basic principles of wastewater treatment
3. Principles of Biological wastewater treatment processes including microbial kinetics
4. Overview of Wastewater treatment systems
5. Sludge management
6. Case Studies on different treatment processes

Learning Outcomes

On the satisfactory completion of this module, student will be able to;

1. demonstrate the ability in preparation and implementation of Water Safety Plans
2. select suitable unit operations for treatment of the source water to achieve the requiredquality to meet drinking water standards and provide a conceptual design for a watertreatment plant,
3. explain the processes taking place in biological and physicochemical wastewater treatmentsystems

CE5569 – Seminar on Global Environmental Issues (2 Credits)

Method of delivery and the Content to be decided based on current trends.

Learning Outcomes

On the satisfactory completion of this module, student will be able to;

1. assimilate and critically review advanced literature (e.g. research papers, web-based resources and publications) in the relevant areas in an environmental context to expand the basic knowledge;
2. apply the basic knowledge to analyse current and future environmental issues;
3. understand the complex environmental issues for good environmental governance.

CE5591 – Comprehensive Design Project(4 Credits)

1. Basic introduction
    - Formulation of Problem Statement in relation to Environmental Impacts
    - Preparation of concept note and comprehensive project proposal
2. Site Visits and collection of Preliminary and Secondary data, Collection of Literature
3. Presentation of Method Statement
4. Carrying out necessary data collection, analysis and reporting
5. Presentation of the project

Learning Outcomes

On the satisfactory completion of this module, student will be able to;

1. propose design alternatives for a given project brief and analyse feasibility of these alternatives, considering environmental, social and economic aspects,
2. apply standard methods to carry out Environmental Impact Assessments,
3. perform preliminary and detailed structural analysis, geotechnical investigations and respective designs required to complete the project,
4. demonstrate the necessary skills to undertake design projects, work in a team and complete the design phase and deliver the outcome to the satisfaction of all stakeholders involved.

CE5525- Environmental Economics (2 Credits)

1. The Economy and the Environment: Two Parts of a whole – inter-linkages between the economy and the environment
2. Introduction to basic micro and macro-economic theory

   The demand function, The indifference curve, adding surpluses, the market system
3. Conventional project evaluation

   Investment appraisal (cost benefit analysis), incorporation of environmental costs and benefits into decision-making
4. Economics and Environment

   Linking economics and the Environment, economic significance of an improved environment, pollution as an externality
5. Environmental Valuation

   Techniques for valuation of environmental impacts, environmental valuation case studies

Learning Outcomes

On the satisfactory completion of this module, student will be able to;

1. understand the history of the environmental economics and core economic concepts/principles;
2. demonstrate knowledge of the main linkages/interactions between the environment and the economy and environmental regulations and competitiveness;
3. apply tools developed in the Environmental economics to appreciate and analyse issues related to the environmental degradation
4. apply environmental valuation methods to valuation of environmental impacts.

CE5570 –Meteorology and Climate Change (2 Credits)

1. Introduction to Meteorology

   Basics of Meteorology, Impacts on air quality, forces, stability classes, vertical motion of clouds, precipitation and extreme events, global warming and carbon air pollution

2. Atmospheric processes

   Radiative heat transfer, Sensible and laidenheatfluxes,Global energy budget, Longitudinal & seasonal variability, Energy fluxes, Atmospheric motion

3. Atmospheric moisture and precipitation

   Atmospheric water storage, Condensation &Droplet formation, Cloud development, Rainfall formation and the role of ice, Precipitation mechanisms

4. Impacts of Climate change

   Interpretation of wind patterns, Storm events, Extreme weather patterns, Prediction of weather conditions, Global weather patterns & changes, Global & Regional climate models, Diurnal changes and micro climatic conditions

5. Sri Lanka's commitment to control of climate change

6. Case studies

   Case studies on normal weather conditions, prediction and extreme weather patterns

Learning Outcomes

On the satisfactory completion of this module, student will be able to;

1. acquire knowledge on basics of meteorology and atmospheric processes;
2. possess knowledge on climate change trends, driving forces and impacts;
3. demonstrate knowledge on vulnerability and adaptation to climate variability and change.

CE5571 – Contaminated Land Management (2 Credits)

1. Principles of pollutant transport in soil, Soil properties and their influence on solubility and toxicity of pollutants
2. Methods of site investigation, Soil sampling, Interpretation of results, Leachability of contaminants
3. Methods of Risk assessment and Evaluation of contaminated sites
4. Remediation techniques

    Soil washing, Phytoremediation, Stabilization, Pump &Treat, Reactive Barriers, etc.

Learning Outcomes

On the satisfactory completion of this module, student will be able to;

1. possess knowledge oncontamination of soil, major contaminant classes, their origins and acceptable concentrationlevels, principles of pollutant transport and itssignificance;
2. plan a site investigation that aims to obtain samples to assess soil quality;
3. carry out a risk assessment to determine whether a land is contaminated;
4. demonstrate an understanding of current decontamination and cleanuptechniques, interpret a site investigation andidentify appropriate remediation techniques based on the interpretations.

CE5572 –Design of Water TreatmentSystems (4 Credits)

1. Conceptual design of treatment trains to achieve objective water quality
2. Design of Aeration, Air stripping and Advanced Oxidation unit processes and their Operation and Maintenance
3. Design of Coagulation, Flocculation and Mixing chambers/tanks and their Operation and Maintenance
4. Design of Sedimentation and Filtration units and their Operation and Maintenance
5. Design of Adsorption, Ion exchange and Softening processes and theirOperation and Maintenance
6. Design of Disinfection units and their Operation and Maintenance
7. Design Guidelines for membrane technologies and theirOperation and Maintenance
8. Design Guidelines for Sludge Management and their Operation and Maintenance
9. An assignment on Design of a water treatment system
10. An overview of costing of unit operations

Learning Outcomes

On the satisfactory completion of this module, student will be able to;

1. apply the basic scientific principles underlying environmental systems used in watertreatment unit operations and processes, including reactor hydraulics, mass balance/transfer and water chemistry in conceptual and detailed designs,
2. analyse a given scenario and evaluate the situation, select unit operations and describe underlying mechanisms of basic design principles of common water treatment processes,
3. apply these principles to select conventional and advanced treatment options andproduce creative, cost-effective conceptual designs of water treatment engineering systems,
4. perform detailed calculations for each unit operation/process and device solutions and stipulate technical specifications and cost calculations.

CE5573 –Design of Wastewater Treatment Systems (4 Credits)

1. Introduction to design of Wastewater treatment systems
2. Design of Preliminary treatment units and their Operation and Maintenance

   Oil &Grease traps, Screening, Grit removal, Dissolved Air Floatation, Equalization, and Neutralization tanks, Pumping pits
3. Design of Primary treatment units and their Operation and Maintenance

   Pumping, Clarifiers
4. Design of Secondary treatment units (Suspended Growth) and their Operation and Maintenance
   - Activated Sludge Treatment processes (Aerobic & Anaerobic)
   - Oxidation Ditch (Aerobic)
   - Sequencing Batch Reactor (Aerobic)
   - Clarifiers
5. Design guidelines for Secondary treatment units (Attached growth)
6. Design guidelines for tertiary treatment units
7. An assignment on Design of a Wastewater Treatment Plant
8. An overview of costing of unit processes

Learning Outcomes

On the satisfactory completion of this module, student will be able to;

1. apply the basic scientific principles underlying environmental systems used inwastewater treatment unit operations and processes, including mass balances, reactor hydraulics, mass transfer, water chemistry and wastewater microbiology in conceptual and detailed designs,
2. analyse a given scenario and evaluate the situation, select unit operations and describe underlying mechanisms of basic design principles of common wastewater treatment processes
3. apply these principles to select conventional and advanced treatment options and produce creative, cost-effective conceptual designs of wastewater treatment engineering systems
4. perform detailed calculations for each unit operation/process and device solutions and stipulate technical specifications and cost calculations.

CE5574 –Environmental Quality Management and Environmental Auditing

(2 Credits)

1. Environmental Management Systems (EMS) and Environmental Auditing
2. Life Cycle Assessment (LCA) and Life Cycle Design (LCD)
3. Cleaner Production (CP)
4. Environmental Cost accounting
5. Environmental Performance Evaluation (EPE) and Corporate Environmental Reporting (CER)
6. Green Supply Chain Management (SCM)

Learning Outcomes

On the satisfactory completion of this module, student will be able to;

1. assess the role and rationale behind quality and available environmental management systems within organisations;
2. evalaute the key requirements ofenvironmental management systems and be able to practice a range of skills for the preparation of procedures and the completion of internal quality audits;
3. Evaluate the relationship between the establishment and maintenance of environmental management systemsand quality management and improvement in organisations;
4. Synthesise the current operational and strategic issues in relation to quality, environmental and sustainable management systems; including proposed revisions and recent developments.

CE5575 –Geographical Information Systems (GIS) For Environmental Applications (2 Credits)

1. Introduction to GIS Principles
2. Introduction to GIS software and Arc GIS
3. Analysis of spatial attributes
4. Building Environmental attributes in temporal and spatial domains, an application to a case study
5. New developments of GIS and computer hardware required, handling of Mega-database
6. Presentations of GIS related data
7. An assignment on GIS based analysis

Learning Outcomes

On the satisfactory completion of this module, student will be able to,

1. demonstrate the understanding of the theoretical and practical considerations required for conducting a GIS/RS based resource planning and management analysis for decision support
2. prepare, manipulate, display and analyze spatial data for resource planning and management
3. demonstrate the skill to use a Handheld GPS for field data collection
4. demonstrate the skill and knowledge to study, evaluate, and analyze a planning and management problem, to propose alternative solutions using GIS/RS/GPS techniques
5. synthesize and present a high quality GIS based project output in a report format

CE5576 –Integrated Water Resources Management (IWRM) (2 Credits)

1. Introduction to IWRM
2. Principles of IWRM
3. Water Resources Allocation and their impacts, conflicts among water users
4. Process of IWRM
5. Policy, Legal and Institutional Framework
6. Case studies of IWRM

Learning Outcomes

On the satisfactory completion of this module, student will be able to;

1. demonstrate the understanding the concepts of IWRM, principles and importance of water management considering a catchment based approach; recognise the multi user environments and sectoral concerns applicable to water management
2. demonstrate the appreciation of tools and processes for, and practice of water resources management including the importance of economic and financial instruments in water management, concepts of social equity, sustainability and institutional roles in river basin organizations
3. evaluate the role, strengths and limitations of policy approaches used in integrated water resources management
4. demonstrate the understanding of complexities in socio-political and economic contexts affecting water management decision making
5. demonstrate the skill and knowledge to study, critically evaluate a field problem and identify alternatives for water resources management within sectors

CE5577 – Sustainable Building and Infrastructure Design (2 Credits)

1. Carbon, Water and EcologicalFootprint
2. Sustainablematerials
3. Sustainable buildings
4. Sustainable transport
5. Sustainablewaste management
6. Smart Citiesand SustainableUrban planning
7. Case studies / Exercise

Learning Outcomes

On the satisfactory completion of this module, student will be able to;

1. acquire a good command of the quality indicators in construction and the concept of benchmarking;
2. apply principles and practice of sustainability concepts in a given infrastructure development project and to recognize engineering designs as a multi-disciplinary practice;
3. acquire the knowledge about the current trends and the innovations regarding both sustainable materials and construction procedures that ensures the sustainability of the project execution process;
4. apply the concept of sustainability to the design of any civil work, building or urban development at the project level and the construction management level.

CE5543 –Design of Water Retaining Structures(4 Credits)

1. Basis of design

   Structural action, Exposure Classification, Structural layout, Influence of Construction methods, Materials and concrete mixes, Introduction to Code of Practice BS 8007

2. Control of cracking in Reinforced concrete

   Crack width due to flexure and direct tensile forces, cracking in immature concrete

3. Design of Groundwater tanks

   Shapes and size, Load evaluation and analysis of structure, Design of structural elements

4. Design examples

   Rectangular tanks, Cylindrical tanks, Underground Reservoirs

5. Design of Water Towers

   Decision on size, height and shape, Analysis of cylindrical, conical and Intze type tanks

6. Construction of Water Tanks

   Construction techniques, Joints in tanks, Testing &Rectification of water tanks

7. Design Assignment

Learning Outcomes

On the satisfactory completion of this module, student will be able to;

1. idealise and model a reinforced concrete rectangular water tank and analyse the structure for design bending moments and shear forces,
2. design of structural elements of a water retaining structure for serviceability limit state of crack control and ultimate limit state in accordance with BS 8007 and BS 8110,
3. specify suitable materials and appropriate construction methods for construction of water retaining structures to achieve the expected performance and durability during the lifespan of the structure,

CE5544 –Advances in Water and Wastewater Treatment (4 Credits)

1. Advanced Nanomaterials for water treatment and wastewater remediation
    - Nanoscience and nanotechnology; Nanomaterials: Synthesis and Characterization; Magnetic Nanoparticles;Graphene based nanocomposits; Kinetic modeling; Desorption, Regeneration and Reuse of Nanoadsorbents
2. Membrane Bioreactor processes: Principles and Applications
    - Principles of membrane filtration; Membrane fouling; MBR design; Membrane Contactors for Gas Transfer, Membrane Process for Water Reclamation
3. Wastewater Treatment: Occurrence, Fate and removal of Polycyclic Aromatic Hydrocarbons (PAHs)
    - Introduction; PAHs in Natural Waters: Natural and Anthropogenic Sources, and Environmental Behavior; PAHs in Wastewater, Sewage Sludge, Soils, and Sediments
4. Harmful Algal Blooms (HAB) in Drinking water: Removal of Cyanobacterial cells and Toxins
    - Occurrence and Ecology of HABs; Toxin Properties, Toxicity, and Health Effects; Regulation of HABs and Toxins in Drinking Water; Conventional and Advanced Treatment Processes for Removal of HAB Cells and Toxins
5. Case studies on Advanced Nanomaterials for water treatment and wastewater remediation, Membrane Bioreactor processes, Wastewater Treatment and PAHs, HABs in Drinking water

Learning Outcomes

On the satisfactory completion of this module, student will be able to;

1. demonstrate knowledge on application of nano-materials for water treatment and wastewater remediation;
2. describe the principles of membrane processes for water purification and wastewater treatment including general and specific membrane problems;
3. understand the occurrence, fate and removal of Polycyclic Aromatic Hydrocarbons (PAHs) in natural waters and wastewaters;
4. demonstrate knowledgeon occurrence and ecology of harmful algal blooms in drinking water and application of conventional and advanced treatment processes for removal of harmful algal blooms.

CE5545 –Water Supply and SewerageDesign (4 Credits)

Water Supply

1. Planning of Water Supply schemes

   Demand forecasting, Source selection, Levels of service

2. Design of Water Supply Schemes

   Head works and Distribution systems,Optimization, Pipe materials, Appurtenances,Surge protection, Model based design of water supply systems, Tariff Structure for water supply

3. Case studies

Sewerage

4. Sewer hydraulics

   Application of formulae, Hydraulics of flow in partially full pipes, Self-cleansing velocity, Water hammer effect

5. Wastewater collection

   Estimation of wastewater and stormwater flows, Sanitary, Storm and combined sewer design, Pipe materials, Appurtenances, Tariff structure for wastewater collection and treatment

6. Case studies

Learning Outcomes

On the satisfactory completion of this module, student will be able to;

1. demonstrate the ability to plan a water supply scheme for a given community based on sound engineering principles and determine the operating levels and sizes of all components,
2. assess the requirement for and provide detailed designs for wastewater collection systems for urban communities

CE5552 –Applied Ecology (4 Credits)

1. Agro-ecosystem management: applying ecological concepts and principles to the design, development and management of sustainable agricultural systems
2. Biodiversity conservation and Conservation biology/ecology
3. Terrestrial, aquatic, coastal and marine ecosystems conservation and management, Habitat management
4. Invasive species management
5. Protected areas management
6. Restoration ecology

Learning Outcomes

On the satisfactory completion of this module, student will be able to;

1. demonstrate the understanding on ecological theory and its application for best management of agro-ecosystems, fisheries and conservation;
2. appreciate the complexity of species-habitat interaction and their importance when formulating suitable management techniques;

CE5554* –Natural Resources Management (4 Credits)

1. Dynamic Efficiency and Sustainable Development
2. Depletable Resource Allocation: The Role of Longer Time Horizons, Substitutes, and Extraction Cost
3. Energy: The Transition from Depletable to Renewable Resources
4. Recyclable Resources: Minerals, Paper, Plastics, Glass, and E-Waste
5. Water as a Renewable and Depletable Resource
6. Land Use as a Locationally Fixed, Multipurpose Resource
7. Forests and Agriculture as Storable, Renewable Resources
8. Commercially Valuable Fisheries and other Common-Pool Resources
9. Air Pollution: Stationary-Source: Local and Regional; Mobile-Source
10. Climate Change
11. Toxic Substances and Environmental Justice
12. Economics of Pollution Control: An Overview
13. Ecosystem Goods and Services
14. The Economic Approach: Property Rights, Externalities, and Environmental Problems; Evaluating Trade-Offs: Benefit-Cost Analysis and Other Decision-Making Metrics; Valuing the Environment: Methods

Learning Outcomes

On the satisfactory completion of this module, student will be able to;

1. understand the issues related to supply and demand of natural resources over the long term, approaches to resource management, application of alternative management instruments and sustainable resource management initiatives;
2. understand the concepts of urbanization/development, water resources use and management, land use and management, ecology, potential impacts of climate change and other associated sub topics in relation to natural resource use and management;
3. apply concepts and theories from resource economics to the formulation of strategies to facilitate efficient use of resources;
4. acquire knowledge and understanding of the contribution of economic analysis to problems in natural resource economics and apply different methods to value environmental resources and conduct a Cost -Benefit Analysis.

CE5555 –Forestry & Wildlife Management and Conservation (4 Credits)

1. Introduction to forestry including fundamentals of terrestrial ecology
2. Principles of Sustainable Forest Management; Forest Principle
3. Extent of forest and wildlife resources
4. Biological diversity
5. Wildlife management and conservation
6. Forest health and vitality
7. Productive functions and forest resources
8. Protective functions of forest resources
9. Socio-economic functions; Legal, policy and institutional framework

Learning Outcomes

On the satisfactory completion of this module, student will be able to;

1. understand the fundamental concepts of forest ecology and sustainable forest management;
2. acquire knowledge on extent of forest and wildlife resources, interaction between people, society and forests and the development of policies for forest/wildlife management and conservation;
3. appreciate the importance of sustainable forest management for multi-purpose objectives such as timber production, biodiversity conservation and environmental protection.

Further Information and Details:

Professor Jagath Manatunge / Dr. (Ms) Buddhika Gunawardana
Course Coordinators
Environmental Engineering Division
Department of Civil Engineering, University of Moratuwa.

Tel:0112650301ext :2533/2537
E-mail: manatunge@uom.lk or buddhikag@uom.lk
Mobile: 071-804 5546 or 077-961-1200