DEPARTMENT OF ENVIRONMENTAL SCIENCES

UNIVERSITY OF KERALA

M.PHILPROGRAMME IN

ENVIRONMENTAL SCIENCES

Syllabus

Under Credit and Semester System w.e.f. 2016 Admissions

DEPARTMENT OF ENVIRONMENTAL SCIENCES
UNIVERSITY OF KERALA
M.PHIL PROGRAMME IN
ENVIRONMENTAL SCIENCES

Programme Objectives

- The program trains the students to solve fundamental problems in environmental science and engineering.
- The program helps to critically evaluate environmental and technological issues in the management and control of air, soil and water pollution and also help to acquire knowledge to conduct Environmental Impact Assessment studies and advanced technical skills in remote sensing and GIS.
- The course places emphasis not only on individual student development but also involves team-working and presentations to develop your interpersonal skills.
- This two semester programme will help to develop orientation in research field and after the completion of the programme students will equipped with capability in research aspects of various fields of environmental Sciences.

Semester No	Course code	Name of the Course	Number of Credits
I	ENS-711	Research Methodology	4
	ENS-712	Advances in Environmental Sciences	4
		Elective Courses	
	ENS-713 (i)	Environmental Pollution and Control Technology	4
	ENS-713 (ii)	Environmental Biology	4
	ENS-713 (iii)	Environmental Geology and Geochemistry	4
	ENS-713 (iv)	Environmental Microbiology	4
	ENS-713 (v)	Environmental Chemistry	4
	ENS-713 (vi)	Environmental Toxicology	4
	ENS-713 (vii)	Environmental Biotechnology	4
	ENS-713 (viii)	Environmental conservation and management	4
	ENS-713 (ix)	Environmental Waste management	4
II	ENS-721	Dissertation	20
		TOTAL CREDITS	32

Semester : I
Course code : ENS-711
Course Title : RESEARCH METHODOLOGY
Credits : 4

AIM: The course aims at providing an M.Phil student to design his dissertation programe, systematic data collection through various research tools and techniques, analysis of data and finally equip him to write a scientific report / monograph.

OBJECTIVES: Through the five modules in this course, a student gets the motivation to systematically collect, analyse and process the data using analytical, GIS and statistical tools, and finally equip the student to write a paper/monograph.

COURSE CONTENT

MODULE I: Environmental sampling - Sampling, preservation and storage of air, water and soil. Bio sampling, Bio-geochemical sampling. Environmental Analytical Methods - Methods of physical, chemical, biological and bacteriological analysis of air, water and soil - Air and water quality standards. Microscopy- Phase contrast, fluorescence, Electron microscope. Titrimetry- Principles and Methods- Buffers. Gravimetry- Mass spectrometry. Colorimetry- Spectrophotometry. Flame photometry- Atomic Absorption Spectrophotometry. Chromatography- Gaschromatography, Gas-liquidchromatography, High Pressure-LiquidChromatography. Emission Spectroscopy. Electrophoresis. X- ray diffraction, X- Ray fluorescence.

MODULE II: Environmental Impact Assessment-Methodology in Environmental Impact Assessment, Types of EIA, EIA of water resource projects, industries, mining and quarrying, highway construction, tourism developments. Environmental Audit - Objectives, frequency and criteria audit team, Environmental appraisal, accounting and environmental audit.Ecological Modelling -Ecological modelling: definition, its philosophy. Classification of Ecological Models based on various criteria. Systems Theory. Examples of EM as applied to various ecosystem processes: Hydrology, carbon cycle, nitrogen cycle, population dynamics, turbulent transport with examples. Development of a Process-based Ecological Model. Empirical vs Process-based approach. Stages of Modelling - Conceptualization,

Parameterization, Calibration, Validation, Experimentation, Scenario testing. Modelling uncertainties. Model optimization.

MODULE III: Geographic Information System - Introduction: Definition, Historic evolution, Components, Use. GISystem, GIScience and GIS Applications. Mapping system and Projection. Data Models. Databases - Relational Database Management, Spatial Database management. Spatial Analysis - Spatial concepts, Spatial Query, Overlay, Buffering, Spatial Interpolation, Density Analysis, Kriging, DEM, DTM, DSM. GIS Softwares - ArcGIS, Open source GIS

MODULE IV: Statistical Tools and Analysis - Statistics as a Tool in Scientific Research - Summarizing and Graphically Representing Data, Basic Numerical Summaries in Tables, Choosing the Appropriate Type of Graph, Shapes of Distributions and Outliers. Descriptive Statistics - Measures of Central Tendency and Variability. Test of Significance - Types of T Tests, ANOVA. Assessing the Relationship between Multiple Variables - Correlation and Regression. Hands-On Exercise - Using Excel and R Package

MODULE V: Research Objectives, Manuscript preparation and Thesis writing. Objectives of research, Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical; Defining and formulating the research problem. Literature review - Primary and secondary sources, Identifying gap areas from literature review - Development of working hypothesis. Thesis writing - Structure and components of scientific reports - Layout, structure and Language of typical reports - Illustrations and tables - Bibliography, referencing and footnotes, publication in scientific journals – impact factor. Making presentation - Use of visual aids - Importance of effective communication. Ethics in research - Intellectual property rights and patent law - Reproduction of published material - Plagiarism - Citation and acknowledgement - Reproducibility and accountability.

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Semester : I
Course code : ENS-712
Course Title : ADVANCES IN ENVIRONMENTAL SCIENCES
Credits : 4

AIM : The course aims at providing an M.Phil student to get the state-of-the art knowledge in the frontier areas of environmental sciences and to equip him to solve conflicts in environmental science, to minimize environmental degradation and for the conservation of the environment.

OBJECTIVES : The detailed study through five modules in the frontier areas of environmental sciences covering environmental and energy conservation, geological hazards, pollution-water-energy management, enable the student to familiarise with the advances in environmental sciences and help him to solve the conflicts in environmental sciences.

COURSE CONTENT

MODULE I: Environmental Conservation - Biosphere reserves of India - role in conservation, Ecology of Mangroves in India, Ecology of Reservoirs of India, Conservation of Wetlands, Causes and Management of Eutrophication, Biodiversity Conservation-Need and Conventions, Integrated Forest Management, Role of Ecotourism and Eco-clubs in environmental conservation.Energy Conservation - Role of Bio-energy in energy management, Land use Policy and Planning, Land and Soil conservation. Sand, granite and ore mining issues. Coral Reef Ecosystems - Threats and Conservation. Global warming -

causes and remedies. Interlinking of rivers - Pros and Cons. High dam vs low dam controversies.Environmental Laws and Legislations, Urban planning in India, Environmental Ethics, Cost-Benefit analysis of Environmental programmes, Concepts and Strategies of sustainable development, Environmental Education in India, Impact of GMOs and LMOs in natural ecosystems.

MODULE II: Climatology - Climate and Monsoons of India and Kerala. Pollution Climatology - Green house gases, global warming, climate change. Impact of climate change on agriculture, forestry, aquatic resources.

MODULE III: Impact of Geological Hazards on Environment - Floods, landslides, earthquakes, volcanoes, avalanche. Global impact of Elnino - Southern Oscillation. Applications of Remote Sensing and Geographical Information System in Environmental management. Disaster management.

MODULE IV: Environmental Pollution and Control - Effect of Environmental pollutants on Physiology of animals and plants. Sources of water pollution, effects and control. Air pollutants - Sources, effects and control. Soil pollution - sources, effects and control. Bio monitoring of water, air and soil pollution.

MODULE V: Water Resource Management. Management of polluted rivers – Ganga Action Plan. Techniques of Rain water harvesting.Solid Waste Management - Management of solid waste including hazardous wastes, Fermentation technology, Vermiculture. Methods of waste water treatment. Bioremediation - Its role in environmental cleanup. Ecofriendly technologies, Green chemistry.

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Semester : I

Course code : ENS -713 (i)

Course Title : ENVIRONMENTAL POLLUTION AND CONTROL TECHNOLOGY

Credits : 4

AIM: The course aims to give the students an insight on the major environmental pollution problems in detail and to acquire knowledge on the principles behind theprocesses& techniques related to the reduction of emissions to air, land and water and the effects of pollution.

OBJECTIVES: The course helps to understand the main causes of water pollution,different sources of water pollution and their characteristics and harmful effects. To equip the students with the methods of treatment of waste water, the need of establishing drinking and surface water quality standards etc.

COURSE CONTENT

MODULE I: Air pollutants- sources, effects and control. Composition of air, gaseous and particulate pollutants- effects on plants, animals, materials and man. Noise pollution and its impacts, noise standards; methods for the control of noise pollution.

MODULE II: Water pollution: Water pollutants and their sources, Types of water pollution, ground water and surface water, consequences of water pollution.

MODULE III: Soil pollution- Physical and chemical properties of soil. Wastes and pollutants in soil. human and animal excreta, fertilizers, pesticides, heavy metals, erosion, waste dumping. Remediation of contaminated soils, sanitation, control.

Module IV:Sampling, Physical, chemical bacteriological analysis of water. Water quality standards.

Module V: Water pollution indicators; waste water treatment methods; water contamination; standards for drinking, swimming etc. Control and prevention of water pollution.

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- https://link.springer.com/journal/11270
- http://www.science.uwaterloo.ca/~cchieh/cact/applychem/watertreatment.html

Semester : I

Course code : ENS-713 (ii)

Course Title :ENVIRONMENTAL BIOLOGY

Credits : 4

AIM: The course aims at exposing the students from non-biology background to the various aspects of ecosystem structure and functions. Also the course enables the students to understand the fundamental and applied aspects of environmental biology and ecosystem functioning.

OBJECTIVES: The course is designed to gain understanding of the structural and functional aspects of ecosystems. The course introduces the students to topics related to biomes and habitats, ecosystem dynamics, evolution of ecosystems, ecological interactions, population dynamics and limiting factors of the environment.

COURSE CONTENT

MODULE I: Biota and environment- physico-chemical factors influencing plants and animals of terrestrial and aquatic habitat. Producers, consumers and decomposers- energy flow, ecosystem.

MODULE II: Plant and animal behaviour, morphology, physiology and development in relation to their environment.

MODULE III: Limiting factors of environment. Concept of limiting factors, laws of limiting factors – laws of minimum and tolerance, combined concept of limiting factors, Earth's carrying capacity.

MODULE IV: Biomes and Habitats: Classification of biomes – Terrestrial biomes – tundra, taiga, grassland, desert, evergreen and deciduous forests, tropical rain forests and their characteristics – flora and fauna

MODULE V: Classification of aquatic habitats – fresh water - ponds, rivers, lakes, wetlands – their characteristics, flora and fauna. Marine habitats – pelagic, benthic, inter-tidal, estuarine, Mangroves – their characteristics, flora and fauna.

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Semester : I

Course code : ENS-713 (iii)

Course Title : ENVIRONMENTAL GEOLOGY AND GEOCHEMISTRY

Credits : 4

AIM: This course aims at providing students with improved understanding of the physical earth, geological processes, distribution of elements and water quality standards to solve conflicts in environmental science, to minimize environmental degradation, and to maximize the beneficial results of using our natural resources.

OBJECTIVES: The various modules in this course will provide students with a broad spectrum of environmental and geosciences subjects to facilitate greater awareness of the various geological processes occurring on earth and the methodology for understanding the environmental degradation of soil and water.

COURSE CONTENT

MODULE I: Distribution of elements in rocks and some geological associations. Weathering processes - physical, chemical and biological weathering of minerals and rocks

MODULE II: Formation of soils and soil profiles. Redistribution of elements by weathering in the surface environment. Metal pollution in soils and trace metals in soils.

MODULE III: Collection and geochemical analysis of surface and sub-surface sediment samples from terrestrial environment - Collection and geochemical analysis of water samples and bottom sediment samples from aquatic environments (i.e., river & lakes).

MODULEIV: Regional geochemical mapping and its application to environmental sciences. Sources, occurrence and movement of ground water - aquifer, aquitard and aquiclude. Contamination of surface water and ground water.

MODULEV: Water quality standards for drinking and domestic purposes. Factors influencing water quality - environmental influence, climate, geological effect, biological effect, microbiological effect, influence of man. Various remedial measures for improving the drinking water quality.

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Semester : I

Course code : ENS-713 (iv)

Course Title : ENVIRONMENTAL MICROBIOLOGY

Credits : 4

AIM: The course aims at imparting an understanding on the basic and applied aspects ofenvironmental microbiology and providing a comprehensive insight into the importance of microbes as key players in the various functions of the environment and also in degradation of wastes.

OBJECTIVES: The course is designed to provide a comprehensive introduction to both fundamental andapplied aspects of environmental microbiology. The course will provide information on microbial evolution and classification, microbial ecology and diversity, metagenomics, microbial interactions, microbial degradation of pesticides and recalcitrant compounds, food and industrial microbiology, medical environmental microbiology, biomining and microbial genetic engineering.

COURSE CONTENT

MODULE I: Microbes in the environment – major groups of microorganisms – evolution and classification

MODULE II: Microbiology of water, soil and sediments - isolation and purification of bacteria, fungi- bacterial growth curve- characterization of aerobic and anaerobic microbes

MODULE III: Role of microbes in waste degradation - microbial conversion of solid waste composting - different methods of composting- microbial processes during composting- biogas- microbiology of methane production.

MODULE IV: Metagenomics – gene amplification and sequencing; molecular phylogeny; microbial database. GEMS - merits, demerits, bio-safety and regulations.

MODULE V: Role of microbiology in industrial processes- fermentation - single cell protein- bioleaching- energy production by microorganisms

REFERENCES

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Semester : I

Course code : ENS-713 (v)

Course Title : ENVIRONMENTAL CHEMISTRY

Credits : 4

AIM: The course aims to give deep information on the chemistry of air, water and soil. Also to give details on the environmental fate of toxic organic chemicals, pollution due to pesticides, heavy metals, and the options for natural and green insecticides.

OBJECTIVE: To achieve a detailed knowledge on the sources of chemicals and their effects on the environment. Also to gain an understanding of chemical processes in the different segments of the environment.

COURSE CONTENT

MODULE I: Environmental segments, natural cycles of the environment, Persistent Organic Pollutants (POPs) of Environmental concern: Dioxins, Furans, Polychlorinated Biphenyls (PCBs), Polynuclear Aromatic Hydrocarbons (PAHs): their sources, structure and health impacts. Principles and concept of Green chemistry.

MODULEII : Water chemistry, physico-chemical characteristics of water, chemical analysis of water and waste water, water pollutants, water quality standards.

MODULEIII : Soil chemistry, waste and pollutants in soil, soil sampling and analysis.

MODULE IV: Atmosphere and atmospheric chemistry, Greenhouse gases, air pollutants, sampling and analysis of air pollutants like SO_2, NO_x, H_2S and metals, ambient air quality standards.

MODULE V: Toxic Organic Chemicals and Pesticides- Classification, degradation, Pollution due to pesticides, Organochlorine pesticides - structure and chemistry, DDT, bioaccumulation and biomagnification. Organophosphates and carbamate insecticides: structure and chemistry. Natural and Green insecticides: Sources, target insects, Integrated Pest Management. Heavy metals in the environment: Speciation and toxicity of heavy metals, Bioaccumulation of heavy metals.

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Semester : I

Course code : ENS -713 (vi)

Course Title : ENVIRONMENTAL TOXICOLOGY

Credits : 4

AIM: The course aims to equip students with the skills to critically evaluate and understand chemical hazards, as well as making informed decisions in terms of potential health risks for both humans and wildlife.

OBJECTIVE: The course gives an overview of the distribution of pollutants in theenvironment, their entry, movement, storage and transformation within the environment. It aspires to assess the impact of chemicals not only on individuals but also on populations and whole ecosystems.

COURSE CONTENT

MODULE I: Environmental toxicants – Principles of toxicology – types of toxicants - synergism, potentiation and antagonism.

MODULE II: Dose-response relationships, LD_{50}, Animal toxicity tests, bioassays – acute and chronic toxicity – detoxification mechanisms.

MODULE III: Biological and chemical factors that influence toxicity, bioaccumulation, bio-magnifications, bio-stratification, bio-monitoring.

MODULE IV: Routes of entry of toxicants – inhalation – skin – oral; ADME studies; biochemical effects of toxicants.

MODULE V: Global dispersion of toxic substances, xenobiotic and endogenous substances-toxic elements and organic compounds- chemical pollutants within the human environment hazards to human health- metals and toxicity. Degradable and non-degradable toxic substances- biochemical effects of heavy metals and pesticides- carcinogens and mutagens and teratogens. Lipid peroxidation, Free radicals. Enzymatic and Non-Enzymatic Antioxidants.

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Semester : I

Course code : ENS-713 (vii)

Course Title : ENVIRONMENTAL BIOTECHNOLOGY

Credits : 4

AIM: The course on environmental biotechnology helps to educate the students about the recent concepts of biotechnology and can acquire knowledge for using the biological systems for remediation of contaminated environments and for eco-friendly processes.

OBJECTIVE: Environmental Biotechnology course introduces the student the applications of biotechnology in environmental monitoring, waste management and pollution abatement, biodiversity conservation and bioenergy production.

COURSE CONTENT

MODULE I. Environmental biotechnology – definition, principles – scope – role of biotechnology in environmental protection and biodiversity conservation

MODULEII: Biotechnology and pollution abatement: aerobic and anaerobic treatment processes- bioreactors, biofilms, biofilters- immobilized enzymes- bioactivators- bio-decolorization and deodourisation.

MODULE III: Solid wastes- Bioconversion of industrial sludge, garbage, sanitary landfills – biocomposting - vermicomposting.

MODULE IV: Bioremediation- Principles, types; biodegradation of organic pollutants and xenobiotics - Biostimulation- Bioaugmentation; heavy metals - biosorption, role of bacteria, fungi, algae. genetically engineered microorganisms

MODULE V: Molecular methods of pathogen distruction- PCR- 16s rDNA sequencing, recombinant DNA technology. Biochips- Biosensors- microarray. Bioenergy – biofuels and biodiesel - bioenergy from wastes; ecofriendly products – biopolymers

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- http://www.sciencedirect.com/science/journal/01681656?sdc=1
- https://www.journals.elsevier.com/journal-of-biotechnology
- https://en.wikipedia.org/wiki/Environmental_biotechnology

Semester : I

Course code : ENS-713 (viii)

Course Title : ENVIRONMENTAL CONSERVATION AND MANAGEMENT

Credits : 4

AIM: This course aims to equip students with the necessary knowledge and skills in the areas of natural resources, and energy management. In particular, the course caters to the rising demand from the public and private sectors for environmental managers in the field of energy, environment and sustainability. Based on such knowledge gain in this course, the students can develop innovative and creative solutions to various energy and environmental problems.

OBJECTIVE: This course provides a broad overview of natural resources and energymanagement. The interdisciplinary nature of this course allows students to learn about conservation, protection and management of variety of natural resources. Principles and

practices for sustainably managing natural resources i.e. soil, water, forests, biodiversity are taught. Different sources of energy production systems and their environmental impacts; broad comprehension of alternative fuels, bioenergy and their production methodologies are also included in the course syllabus so that the students can appreciate the importance of energy efficiency and energy conservation strategy for sustainable environment.

COURSE CONTENT

MODULE I: Natural Resources – Classification and types of natural resources. Land resources – land use and land cover, land use change – drivers of land use change.

MODULE II: Soil and mineral resources- major soil types and mineral deposits in India. Environmental effects of mining, Reclamation techniques. Water resources types – surface water, ground water, water availability and uses. Management and conservation of water resources. Laws and regulations.

MODULE III: Forest resources - Major forest types in India with special reference to Kerala. Social forestry, Agroforestry. Exploitation by man. Control measures, conservation techniques.

MODULE IV: Biodiversity - levels, importance of biodiversity , hotspots of biodiversity – gene pool – threats to biodiversity – endangered and endemic species – biodiversity conservation – in situ and ex situ conservation methods

MODULE V: Energy resources: renewable and non-renewable resources, distribution and availability, past, present, and future technologies for capturing and integrating these resources into our energy infrastructure, energy-use scenarios in rural and urban setups, energy conservation.

REFERENCES

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- Boyle,G., Bob Everett and J.Ramage. 2003. Energy System and Sustainability, Oxford University Press, New York.
- Daniel,D. Chiras and Reganold,John,P. 2009. Natural Resource Conservation: Management for a Sustainable Future, Addison Wesley, Boston.
- Dwidei,A.P. 2003. A text bookofSilviculture. International Book Distributors, Dehradun.
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- Ghosh,S.K. and Singh,R. 2003. Social Forestry and Forest Management, Global Vision Publication, New Delhi.
- Jha,L.K. 1995. Advances in Agroforestry, APH Publication Corporation, New Delhi.

- Kesler,P. 2002. Mineral Resources: Economics and Environment, CBS Publishers and Distributors, New Delhi.
- Rajora Rajesh. 1998. Integrated Watershed Management : A field Manual for Equitable, Productive and Sustainable Development, Rawat Publications, Jaipur.
- Sudhakara Reddy, B.P.Balachandra. 2006. Energy, Environment and Development, Narosa Publishing House Pvt. Ltd., New Delhi.
- Thapar,S.D. 1975. India's Forest Resources, Macmillan India, New Delhi.

ADDITIONAL REFERENCES

- http://healingearth.ijep.net/natural-resources/
- https://www.nal.usda.gov/soil-resource-management
- http://www.sanjuanwatershed.org/resources/soil-resources/
- http://mppscgyan.com/forest-resources/
- http://fsi.nic.in/
- http://envfor.nic.in/
- https://academic.oup.com/forestry
- https://www.iucn.org
- https://link.springer.com/journal/10531
- https://www.nature.com/subjects/water-resources
- http://www.em-ea.org/gbook11.asp
- https://www.iea.org/topics/renewables/subtopics/bioenergy/

Semester : I

Course code : ENS-713 (ix)

Course Title : ENVIRONMENTAL WASTE MANAGEMENT

Credits : 4

AIM: The course aims to impart knowledge on the management of solid and liquid wastes from municipal and industrial sources and to teach the principles and applications of remedial measures viz., recycling, reuse and recovery from the wastes.

OBJECTIVE: The students will be exposed to different types of waste management their characteristics and management. In addition the course will provide an overview of of waste water, solid wastes and hazardous wastes and waste management policies.

COURSE CONTENT

MODULE I: Waste – types; definitions; Waste water : nature and types; sources and characteristics, treatment methods – physical, chemical, biological and advanced treatment methods; waste water treatment plants – composition of municipal and industrial waste waters, treatment and disposal

MODULE II: Soild Wastes – sources of origin- Types- qualitative and quantitative analysis- Muncipal solid wastes- MSW management- collection, transportation and disposal- methods and procedures.

MODULE III: Management of agricultural, commercial and industrial wastes – composting and vermicomposting, sanitary and secured land-fills, incineration, biogas production, recycling, 3R's principles of Waste water treatment - rules and regulations.

MODULE IV: Hazardous wastes- Definition, sources and disposal. Management of medical wastes, nuclear wastes, e-wastes.

MODULE V: Waste management policies, polluter pays principle, wealth from waste, single cell protein, waste to energy – ethanol, biogas, hydrogen.

REFERENCES

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- Agarwal,S.K. 2005. Wealth from waste, APH Publishing corporation, New Delhi
- Bhatia,S.C. 2007. Solid and Hazardous Waste Management. Atlantic Publishers and Distributors, New Delhi
- Bide,A.D. and R.R.Sundaresan. 2001. Solid Waste Management: Collection, processing and disposal. INSDOC, New Delhi
- Khan,M.K. 2004. Hospital waste Management: Principles and guidelines, Kanishka Publishers, New Delhi
- Liu,D.H.F. and R.G.Liptak. 2000. Hazardous waste and solid waste. Lewis
- Metcalf and Eddy. 1991. Waste Water Engineering – Treatment, Disposal and Reuse. McGraw Hill International Edition, New York.

ADDITIONAL REFERENCES

- https://www.wm.com/us
- https://www.journals.elsevier.com/waste-management
- https://www.epa.gov/hw/hazardous-waste-recycling

Semester : II

Course code : ENS-721

Course Title : DISSERTATION

Credits : 20

AIM: The course aim to impart skill in research skill in various aspects of Environmental Sciences. After the completion of the course the students will equipped with knowledge of research methods, thesis writing and presentation of research work.

OBJECTIVES: The duration of the course is six months**.** During the course students can select any relevant research topic which is related to Environmental Sciences. They have the

facility to do the research work under the guidance of a Teacher. The dissertation should be submitted and presented before the examiners at the end of the course.

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