DEPARTMENT OF ENVIRONMENTAL SCIENCES
UNIVERSITY OF KERALA

M.PHIL PROGRAMME 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.

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<th>Semester No</th>
<th>Course code</th>
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<td>Advances in Environmental Sciences</td>
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<td><strong>TOTAL CREDITS</strong></td>
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AIM: The course aims at providing an M.Phil student to design his dissertation programme, 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


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


**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.

**REFERENCES**

ADDITIONAL REFERENCES
• https://www.lucideon.com/testing/analytical-techniques-chemical-analysis
• https://www.journals elsevier.com/ecological-modelling
• www.scimagojr.com/journalrank.php?category=2302
• https://www.esri.com/
• www.qgis.org
• www.ibm.com/analytics/us/en/technology/spss
• https://www.r-project.org

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 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 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.


**REFERENCES**

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

REFERENCES


ADDITIONAL REFERENCES

- http://www.water-pollution.org.uk/types.html
- https://www.journals.elsevier.com/environmental-pollution/
- https://www.journals.elsevier.com/atmospheric-pollution-research/
- https://link.springer.com/journal/11270
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 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.

REFERENCES
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 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).

MODULE IV: 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.


REFERENCES

ADDITIONAL REFERENCES
• https://www.geolsoc.org.uk/ks3/gsl/education/resources/rockcycle/page3461.html
• https://www.researchgate.net/publication/259532941_Principles_of_Lake_Sedimentology
• https://www.epa.gov/standards-water-body-health/
• https://www.who.int/water_sanitation_health/water-quality/guidelines/en
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 of environmental 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 and applied 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

ADDITIONAL REFERENCES
- https://www.cdc.gov/microbenet/index.htmlaem.asm.org
- https://www.sciencedaily.com/
- http://aem.asm.org/
- http://www.nature.com/nrmicro/focus/metagenomics
- https://www.nature.com/subjects/industrial-microbiology
- https://courses.lumenlearning.com/boundless-microbiology/
- https://link.springer.com/journal/10295
- http://sitn.hms.harvard.edu/flash/2015/how-to-make-a-gmo/

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

MODULE III: 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 SO₂, NOₓ, H₂S and metals, ambient air quality standards.


REFERENCES


ADDITIONAL REFERENCES

- http://www.newworldencyclopedia.org/entry/Atmospheric_chemistry
- https://link.springer.com/journal/10874
- http://www.ecy.wa.gov/puget_sound/toxicchemicals/effects.html
- http://wwf.panda.org/about_our_earth/teacher_resources/webfieldtrips/toxics/
- https://www.epa.gov/environmental-topics

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 the environment, 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\textsubscript{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.


REFERENCES

- Hayes, W.A. 2001. Principles and Methods of Toxicology, CRC, USA.

ADDITIONAL REFERENCES
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

MODULE II: Biotechnology and pollution abatement: aerobic and anaerobic treatment processes- bioreactors, biofilms, biofilters- immobilized enzymes- bioactivators- biodecolorization and deodourisation.


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

REFERENCES
• Bitton, G. 2005. Wastewater Microbiology. A. John Wiley and Sons, Inc. Publication

ADDITIONAL REFERENCES
• http://www.ifsc.usp.br/~ilanacamargo/FFI0740/2.pdf
• 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 energy management. 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 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

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

REFERENCES

- Bide, A.D. and R.R. Sundaresan. 2001. Solid Waste Management: Collection, processing and disposal. INSDOC, New Delhi

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.