Periyar University

Periyar Palkalai Nagar, Salem – 636 011

Department of Environmental Science

M.Sc. Environmental Science

Syllabus

(w.e.f. 2018-2019 onwards)

PERIYAR UNIVERSITY

M.Sc. ENVIRONMENTAL SCIENCE

CHOICE BASED CREDIT SYSTEM (CBCS)

REGULATIONS (w.e.f. 2018-2019 onwards)

1 INTRODUCTION

Growing populations and high standards of living put increasing pressure on our environment. Since the beginning of industrialization and urbanization, we have been facing with an increasing number of environmental challenges such as air, water and soil contamination, energy crisis, land degradation, deforestation, loss of biodiversity, global warming and climate change, etc., Considering the above issues, addressing environmental problems from a scientific perspective is utmost important for today's world. So, there is a need to develop the next generation as skilled professionals in a multidisciplinary Environmental Science programme to solve the environmental issues.

2. PROGRAMME OBJECTIVES

The general objective of Master of Environmental Science programme is to provide the students with the scientific principles, concepts, and methodologies required to understand the interrelationships of the organisms and ecosystem, and sustainable development.

The specific objectives of the programme are:

- To train and generate skilled graduates to identify and analyze environmental problems both natural and engineered.
- To generate skilled graduates to evaluate the environmental issues, and to find alternative solutions to resolve or prevent.
- To provide students with vertical knowledge in biodiversity, geographical information, biogeochemical processes, and energy systems.
- To provide students with complete knowledge and sills in environmental assessment, audit, management, and environmental remediation.
- Toproduce students with research capabilities in major areas of environmental science to provide innovative solutions to mitigate the environmental issues.

3. LEANING OUTCOMES

After successful completion of the two years programme, the students are expected to have the following:

- Deep knowledge in ecosystem, natural resources, biodiversity and its importance, environmental biogeochemical processes, and geographical information.

- Skills in remote sensing and Geographic Information Systems technology to monitor the environmental issues.
- Capability in applying microbes for potential environmental cleanup and energy production, and to generate value added products through waste recycling.
- Good knowledge and skills in environmental impact assessment, auditing pollution monitoring and management.
- Good understating in toxicological properties of environmental pollutants and their impact on environment.
- Expertise to become environmental consultants / managers at local, regional and national levels industrials/ institutions/organizations.
- Skills to become an entrepreneurs in the field waste management and recycling.
- Qualification to be employed as a researcher / scientist / faculty in colleges / universities / research organizations.

4. MODE OF DELIVERY

a) Direct contact classes involving students and faculty members.
b) Lectures, practicals, field visits, industrial visits and projects.

5. CONDITIONS FOR ADMISSION

A. ELIGIBILITY CONDITIONS FOR ADMISSION

Candidates who have passed the B.Sc. degree in Environmental Biology / Life Sciences / Botany / Zoology / Microbiology / Biotechnology / Biochemistry / Chemistry / Physics / Bioinformatics / Home Science/ Food Science & Nutrition/ B.Sc. (Agri. / Forestry)/ B.VSc./ B.F.Sc.) B.E/B.Tech. Environmental Engineering /BSMS/BAMS/BUMS or any other Degree in medical subjects of this University or an Examination of any other University accepted by the Syndicate as equivalent thereto shall be eligible for admission to M.Sc. Degree Course in Environmental Sciences.

Candidate shall be admitted to the examination only if he/she has taken the qualifying degree in Science/ Medical subjects as mentioned after having completed the prescribed courses consisting of twelve years of study and has passed the qualifying examination.

B. METHOD OF SELECTION

Candidates have to appear for an entrance examination in Environmental Science to be conducted by the Department/University and followed by an interview. The date, venue, and time of the entrance examination and interview will be notified to the applicants separately as soon as it is fixed.

6. ELIGIBILITY FOR THE AWARD OF DEGREE

A candidate shall be eligible for the award of the degree only if he/she has undergone the prescribed course of study in the University Department for a period of not less than two

academic years, passed the examination of all the four semesters prescribed earning 90 credits (plus 2 credits for Human Rights) and fulfilled such conditions as have been prescribed therefore.

7. DURATION OF THE COURSE

The duration of the course is two academic years consisting of four semesters.The duration of a semester is 90 working days.

8. EXAMINATIONS

There shall be four semester examinations: first semester examinations at the middle of the first academic year and the second semester examination at the end of the first academic year. Similarly, the third and fourth semester examinations shall be held at the middle and the end of the second academic year, respectively.

9. COURSE OF STUDY AND SCHEME OF EXAMINATIONS

S. No.	Course type	Course Title
		SEMESTER – I
1	Core - I	Ecology and Biodiversity Conservation
2	Core - II	Environmental Chemistry
3	Core - III	Environmental Microbiology
4	Core - IV (optional)	Environmental Geography / GIS and Remote Sensing
5	Elective - I	Elective Paper
6	Core Practical - I	Practical - I
7	Core	Seminar
		SEMESTER – II
8	Core – V	Environmental Pollution and Control Strategies
9	Core – VI	Environmental Biotechnology
10	Core – VII	Climate Change and Current Issues
11	Elective - II	Elective Course
12	Supportive - I	Supportive – I
13	Core Practical - II	Practical Paper - II
14	Core	Seminar
15	Online I	SWAYAM & MOOC Course I

SEMESTER - III		
16	Core -VIII	Waste Management
17	Core - IX	Environmental Biochemistry and Toxicology
17	Core - X	Research Methodology and Instrumentation
19	Core - XI	Environmental Impact Assessment /
	(optional)	Disaster Management
20	Supportive II	Supportive - II
21	Core Practical - III	Practical - III
22	Core	Seminar
	Online II	SWAYAM & MOOC Course II
SEMESTER - IV		
23	Core - XII	Environmental Law and Policies
24	Core - XIII	Environmental Engineering /
	(Optioanal)	Environmental Audit
25	Core	Industrial Visits / Study Tour
26	Core Project - I	Project Work
27	Core	Seminar

ELECTIVE COURSES

S.No.	Course Title
1	Energy Resources and Environmental Sustainability
2	Eco-Tourism and Wild Life Management
3	Environmental Nanotechnology
4	Environmental Health and Safety
5	Environmental Economics

SUPPORTIVE COURSES

S.No.	Course Title	Course Code
1	Ecology and Environment	18UPEVS1S01
2	Environmental Pollution	18UPEVS1S02
3	Environmental Health and Safety	18UPEVS1S03
4	Global Environmental Issues and Management	18UPEVS1S04

SCHEME OF EXAMINATIONS

The scheme of examinations for different semesters shall be as follows:

Theory Examination:

Theory examination Marks : 75 Duration: 3 hours

Internal Marks : 25

Total Marks : 100

Theory Examination Question Pattern:

Part A – 20 Marks (1 Mark x 20Objective type questions)
Part B – 15 Marks (5Marks x 3 Analytical thinking Questions – Internal Choice)
Part C – 40 Marks (10 Marks x 4 Descriptive type Questions – Internal Choice)

The following procedure will be followed for Internal Marks:

Theory Papers: Internal Marks 25

BestTwo tests out of three	10 Marks
Attendance	5 Marks
Seminar	5 Marks
Assignment	5 Marks

Practical: Internal Marks 40

Attendance	5 Marks
Practical Test	25 Marks
Periodical Performance / Observation	10 Marks

Practical **External Marks** **60**

Major Experiment	20 Marks
Minor Experiment	15 Marks
Spotters	15 Marks
Record	5 Marks
Viva-Voce	5 Marks

Industrial Visits / Study Tour

Sampling, Documentation and Report	40 Marks
Viva-Voce	10 Marks

Project

Internal Marks - Periodical Review	50 Marks
Viva-Voce	25 Marks
Project Dissertation	75 Marks

Break-up Details for Attendance

Below 60%	- No marks
60% to 75%	- 3 Marks
76% to 90%	- 4 Marks
91% to 100%	- 5 Marks

10. REQUIREMENTS FOR PROCEEDING TO SUBSEQUENT SEMESTERS:

(i) Candidates shall register their names for the First semester examination after the admission in the PG courses.

(ii) Candidates shall be permitted to proceed from the First Semester up to the Final Semester irrespective of their failure in any of the Semester Examination subject to the condition that the candidates should register for all the arrear subjects of earlier semesters along with current semester subjects.

(iii) Candidates shall be eligible to proceed to the subsequent semester, only if they earn sufficient attendance as prescribed therefore by the Syndicate from time to time.

Provided in case of candidate earning less than 50% of attendance in any one of the semester due to any extraordinary circumstance such as medical grounds, such candidates who shall produce Medical Certificate issued by the Authorized Medical Attendant (AMA), duly certified by the Head of the Institution, shall be permitted to proceed to the next semester and to complete the course of study. Such candidate shall have to repeat the missed semester by rejoining after completion of final semester of the course, after paying the fee for the break of study as prescribed by the University from time to time.

11. PASSING MINIMUM

a) There shall be no Passing Minimum for Internal.
b) For External Examination, Passing Minimum shall be of 50% (Fifty Percentage) of the maximum marks prescribed for the paper.
c) In the aggregate (External + Internal) the passing minimum shall be of 50% for each Paper/Practical/Project and Viva-voce.
d) Grading shall be based on overall marks obtained (internal + external).

12. CLASSIFICATION OF SUCCESSFUL CANDIDATES

Candidates who secured not less than 60% of aggregate marks (Internal + External) in the whole examination shall be declared to have passed the examination in the First Class. All other successful candidates shall be declared to have passed in Second Class. Candidates who obtain 75% and above of the marks in the aggregate (Internal + External) shall be deemed to have passed the examination in First Class with Distinction, provided they pass all the examinations (theory papers, practicals, industrial visits and study tour, project and viva-voce) prescribed for the course in the first appearance.

13. GRADING SYSTEM

The term grading system indicates a Seven (7) Point Scale of evaluation of the performances of students in terms of marks obtained in the Internal and External Examination, grade points and letter grade.

SEVEN POINT SCALE (As per UGC notification 1998)

GRADE	GRADE POINT	PERCENTAGE EQUIVALENT
`O' = Outstanding	5.50 – 6.00	75 – 100
`A' = Very Good	4.50 – 5.49	65 – 74
`B' = Good	3.50 – 4.49	55 – 64
`C' = Average	3.00 – 3.49	50 – 54
`D' = Below Average	1.50 – 2.99	35 – 49
`E' = Poor	0.50 – 1.49	25 – 34
`F' = Fail	0.00 – 0.49	0 - 24

10. RANKING

Candidates who pass all the examinations prescribed for the course in the first appearance itself alone are eligible for Ranking / Distinction. Provided in the case of candidates who pass all the examinations prescribed for the course with a break in the First Appearance due to the reasons as furnished in the Regulations under "Requirements for Proceeding to subsequent Semester" are only eligible for Classification.

11. PATTERN OF QUESTION PAPER

Part A – 20 Marks (1 Mark x 20 Objective type questions)
Part B – 15 Marks (5 Marks x 3 Analytical thinking Questions – Internal Choice)
Part C – 40 Marks (10 Marks x 4 Descriptive type Questions – Internal Choice)

12. EVALUATION PROCEDURE

Students failing in any paper in any semester must reappear for the examination in that paper and it is not necessary to repeat the course. A student who fails to attend the examination can reappear in the subsequent Terminal Examinations. A student who cannot appear for the examination due to lack of attendance, can appear for the examination only after earning the required minimum attendance.

Evaluation is based on 25% Continuous Internal Assessment (CIA) and 75% Semester Examination. A mark statement will be issued to every student at the end of every semester. The mark statement will contain the number of credits for each paper, the mark scored by the students in the individual paper and Cumulative Weighted Average Mark (CWAM). The CWAM will be computed as follows:

$$CWAM = \frac{\text{(Marks x Credits)}}{\Sigma\ \text{(Credits)}}$$

The Cumulative Weighted Average Marks (CWAM) will be calculated by taking into account the performance of the student in all the semesters including the paper(s), in which the candidate has to reappear (RA), if any. The absentees for the Semester Examination will be treated on par with reappearance.

M.Sc. DEGREE PROGRAMME IN ENVIRONMENTAL SCIENCE

Course	Course Code	Title of the Course	Hours/ Week	Credits	Internal Marks	External Marks	Total
SEMESTER I							
Core I	18UPEVS1C01	Ecology and Biodiversity Conservation	4	4	25	75	100
Core II	18UPEVS1C02	Environmental Chemistry	5	4	25	75	100
Core III	18UPEVS1C03	Environmental Microbiology	4	4	25	75	100
Core IV (optional)	18UPEVS1C04 18UPEVS1C05	Environmental Geography / GIS and Remote Sensing	5	4	25	75	100
ElectiveI	18UPEVS1E01 / 18UPEVS1E02 /	1. Energy Resources and Environmental Sustainability / 2. Eco-Tourism and Wild Life Management	4	3	25	75	100
Practical I	18UPEVS1P01	Practical – I (18UPEVS1C01 - 18UPEVS1C05)	6	4	40	60	100
Core		Seminar	2				
		Subtotal	**30**	**23**	**165**	**435**	**600**
SEMESTER II							
Core V	18UPEVS2C06	Environmental Pollution and Control Strategies	5	4	25	75	100
Core VI	18UPEVS2C07	Environmental Biotechnology	5	5	25	75	100
Core VII	18UPEVS2C08	Climate Change and Current Issues	5	4	25	75	100
Elective II	18UPEVS2E03 18UPEVS2E04 18UPEVS2E05	1. Environmental Nanotechnology 2. Environmental Health and Safety 3. Environmental Economics	4	3	25	75	100
Supportive I	18UPEVS2S01 18UPEVS2S02 (optional)	1. Ecology and Environment / 2. Environmental Health and Safety	3	3	25	75	100
Practical II	18UPEVS2P02	Practical – II (18UPEVS2C06 -18UPEVS2C08)	6	4	40	60	100
Online 1	18UPEVS2OL1	SWAYAM-MOOC Course 1	-	4	25	75	100
Core		Seminar	2				
		Sub total	**30**	**26**	**190**	**510**	**700**

Course	Course Code	Title of the Course	Hours/ Week	Credits	Internal Marks	External Marks	Total
SEMESTER III							
Core VIII	18UPEVS3C09	Waste Management	4	4	25	75	100
Core IX	18UPEVS3C10	Environmental Biochemistry and Toxicology	5	4	25	75	100
Core X	18UPEVS3C11	Research Methodology and Instrumentation	5	4	25	75	100
Core XI (optional)	18UPEVS3C12 18UPEVS3C13 (optional)	Environmental Impact Assessment / Disaster Management	4	4	25	75	100
Suppor -tive II	18UPEVS3S03 18UPEVS3S04 (optional)	Supportive-II Environmental Pollution / Global Environmental Issues and Management	4	3	25	75	100
Practical III	18UPEVS3P03	Practical-III (18UPEVS3C09 - 18UPEVS3C13)	6	4	40	60	100
		SWAYAM-MOOC Course 2		4	25	75	100
Core		Seminar	2				
		Sub total	**30**	**27**	**190**	**510**	**700**
SEMESTER IV							
Core XII	18UPEVS4C14	Environmental Law and Policies	4	4	25	75	100
Core XIII	18UPEVS4C15 18UPEVS4C16 (optional)	Environmental Engineering / Environmental Audit	4	4	25	75	100
Core	18UPEVS4CIV	Industrial Visits / Study Tour		2	-	50	50
Core	18UPEVS4CPR	Project work	20	6	50	100	150
		Seminar	2				
		Sub total	**30**	**16**	**100**	**300**	**400**
		Grant Total	**120**	**92**	**645**	**1755**	**2500**

SEMESTER I

CORE I: 18UPEVS1C01

ECOLOGY, BIODIVERSITY AND CONSERVATION

Course Objectives:

The purpose of this course is to gain an understanding of the value of biodiversity and drivers of its loss; current efforts to conserve biodiversity on global, national and local scales; practical issues with local conservation and organizations, policies and programmes for sustainable management of bioresources.

UNIT I – Ecology and Biodiversity

Ecology: Types of ecosystem – Terrestrial and Aquatic ecosystems - Ecological pyramids - Food Chain - Food Web - Energy flow - Types of Biodiversity: Species, Genetic and Ecosystem diversity – Alpha, beta, and gamma diversity – Biodiversity and ecosystem function – Megadiversity zones and Biodiversity Hot Spots in India – Ecologically Sensitive Areas (ESA) in India - Values of Biodiversity – Biodiversity Prospecting - Examples of biopiracy and bioprospecting

UNIT II - Threats to Biodiversity

Endangered and endemic species of flora and fauna in India - Biodiversity threats under Anthropocene era: Habitat loss, fragmentation and degradation – Pollution - Overexploitation - Human-Animal conflict with special reference to elephants – IUCN Threat Categories – Red Data Book – Climate change on species extinction - Causes and Impacts of Invasive species to biodiversity – Global Taxonomy Initiative to combat invasive alien species

UNIT III - Conservation Strategies

In-situ conservation: Afforestation, Social Forestry, Agro-forestry, Zoos, Biosphere Reserves, National Parks, Sanctuaries, Protected Area Network, Sacred Groves and Sthalavrikshas – Ex-situ conservation: Botanical gardens, Cryopreservation, Gene Bank, Seed Bank, Pollen Bank, Sperm Bank, cDNA Bank - Conservation Genomics: Environmental DNA (eDNA) for wildlife biology and biodiversity monitoring, Next Generation Sequencing (NGS) Techniques, DNA barcodes, Transcriptome and Epigenome tools, CRISPR based gene drives

UNIT IV - Sustainable Management of Bioresources

Ecological intensification for agricultural sustainability - An elementary account on WTO, GAAT and TRIPS to agricultural biodiversity - National Biodiversity Authority (NBA) – Functions of State Biodiversity Board (SBB) and Biodiversity Management Committee's (BMC) – People's Biodiversity Register (PBR) – Biodiversity informatics Portals - International Organizations and biodiversity conservation: Objectives and Targets 2011-2020 of Global Strategy for Plant Conservation (GSPC), WWF-India for priority and threatened species conservation, UNESCO - Man and Biosphere Programme (MAB), UNDP - Biodiversity Finance Initiative (BIOFIN) and UNEP – Global Environment Facility (GEF) for biodiversity conservation

UNIT V - Policies, Programmes and Acts for Conservation

Salient features of Biological Diversity Act 2002 - Status and protection of species in National and International levels – Policies implemented by MoEF & CC for biodiversity conservation - Role of CITES, IUCN and Convention on Biological Diversity (CBD) in biodiversity conservation – Nagoya Protocol on Access and Benefit-Sharing – Cartagena Protocol on Biosafety - The Aichi Biodiversity Targets – Monitoring the Illegal Killing of Elephants (MIKE) programme – Strategic programme 2016-2020 for The International Consortium on Combating Wildlife Crime (ICCWC) – SAWEN and TRAFFIC Networks to combat illegal wildlife trade – Ramsar Strategic Plan 2016-2024 for wetland conservation

Learning Outcomes:

After completing this course, the students will be able to:

- Discuss the relationship between biodiversity and ecosystem.
- Describe the direct and indirect values of biodiversity resources.
- Assess the factors responsible for the loss of biodiversity.
- Outline the main reasons for decline and threats to biodiversity worldwide.
- Evaluate the pros and cons of species introductions and reintroductions.
- Make critical judgments on the conflict between conservation and development.
- Argue the case for local action to address the global loss of biodiversity and
- Know and apply the rules and recommendations related to environmental protection.

Text Books

1. Eugene P. Odum and Gary W. Barrett. (2004) Fundamentals of Ecology (5^{th} Edition) Brooks/Cole Publishers.
2. Krishnamurthy KV (2003) An Advanced Textbook on Biodiversity – Principles and Practice, Oxford and IBH Publishing, New Delhi.

References

1. Alonso A. Aguirre and Raman Sukumar (2017) Tropical Conservation. Perspectives on Local and Global Priorities, Oxford University Press, USA.
2. Chaudhuri AB and Sarkar DD (2003) Megadiversity Conservation, Flora, Fauna and Medicinal Plants of India's Hot Spots. Daya Publishing House, New Delhi.
3. Dadhich LK and Sharma AP (2002) Biodiversity –Strategies for Conservation, APH Publishing Corporation, New Delhi.
4. John Kress W, Carlos García-Robledo, Maria Uriarte and David L. Erickson (2015) DNA barcodes for ecology, evolution, and conservation. Trends in Ecology and Evolution. 30:25-35.
5. John-James Wilson, Kong-Wah Sing, Ping-Shin Lee and Alison K. S. Wee (2016) Application of DNA barcodes in wildlife conservation in Tropical East Asia. Conservation Biology. 30:982-989.
6. Kristine Bohmann, Alice Evans, M. Thomas P. Gilbert, Gary R. Carvalho, Simon Creer, Michael Knapp, Douglas W. Yu and Mark de Bruyn (2014) Environmental DNA for wildlife biology and biodiversity monitoring. Trends in Ecology and Evolution. 29:358-367.
7. Muthuchelian K (2013) Glimpses of Animal Biodiversity, Astral International (P) Ltd., New Delhi.

8. Muthuchelian K (2013) Uyir Virimam (Tamil), Pranisha Pathippagam, Madurai.
9. Muthuchelian K (2016) Bioinformatics, Barcoding and Benefit Sharing in Biodiversity Educationist Press, New Delhi.
10. Richard Frankham, Jonathan D Ballou and David A. Briscoe (2010) Introduction to Conservation Genetics, Second edition, Cambridge University Press, UK.
11. William V. Holt, Janine L. Brown and Pierre Comizzoli (2014) Reproductive Sciences in Animal Conservation. Progress and Prospects, Springer, New York.

Web References

1. www.iucn.org
2. www.cites.org
3. www.cbd.int
4. www.wri.org
5. http://www.traffic.org
6. http://www.sawen.org
7.https://cites.org/sites/default/files/eng/prog/iccwc/ICCWC_Strategic_Programme_2016-2020_final.pdf
8. http://www.ramsar.org/sites/default/files/hb2_5ed_strategic_plan_2016_24_e.pdf
9. https://www.thegef.org/topics/biodiversity
10. https://www.cbd.int/gspc/strategy.shtml

CORE II: 18UPEVS1C02

ENVIRONMENTAL CHEMISTRY

Course Objectives:

The purpose of this course is to develop an understanding of environment, chemicals and their effects on the environment, to provide students with an understanding of the fundamental chemical processes and pollutants effects on environment.

UNIT I - Fundamentals of Environmental Chemistry

Definition - Concept and Scope - Preparation of Standard Solutions – Molarity, Molality, Normality, Percent and PPM (mg/l) Solutions - Stoichiometry - Gibb's energy - Chemical Potential - Chemical Equilibria - *Acid-base Reactions*: pH and pOH and Buffer Solutions - Solubility and Solubility Product - Solubility of Gases in Water - The Carbonate System - Unsaturated and Saturated Hydrocarbons - Radionuclides.

UNIT II - Atmospheric Chemistry

Classification of Elements – Particles, Ions and Radicals - Formation of Inorganic and Organic Particulate Matter - Thermochemical and Photochemical Reactions in the Atmosphere - Oxygen and Ozone Chemistry - Chemistry of Air Pollutants (Oxides of Carbon, Nitrogen, Sulphur).

UNIT III - Water Chemistry

Formation of Water - Water Resources – Sources and Types - Hydrological Cycle - Unique Properties of Water - Role of Water in the Environment - Physical, Chemical and Biological Parameters of Water – Phenomenon of Eutrophication - Concept of DO, BOD, COD - Distribution of Chemical Species in Water - Organic Matter and Humic Matter in Water.

UNIT IV - Soil Chemistry

Nature of soil – Formation and Types - *Mechanical, Physical and Chemical Properties of Soil*: Soil Structure, Texture, Temperature, Bulk Density, Permeability, Moisture, Air, pH, Cation Exchange Capacity, Macro and Micronutrients, Humus and Organic Matter, C/N Ratio.

UNIT V - Pollutant Chemistry

Chemistry of various Organic and Inorganic Compounds - Chemistry of Hydrocarbon Decay - Effects on Macro and Microorganisms – Surfactants - Cationic, anionic and non-ionic detergents, modified detergents - *Pesticides*: Classification, Degradation, Analysis - Pollution due to Pesticides – DDT and Endosulphan - *Heavy metals*- Toxic effects of Ar, Cd, Pb & Hg.

Learning Outcomes:

After completing this course, the students will be able to:

- Have knowledge of theories and problems of Environmnetal chemistry
- Describe important chemical reactions in the atmosphere, water and in soil
- Demonstrate knowledge of chemical principles of various fundamental environmental phenomena

- Understand the cyclic processes of chemical species and processes in land, water, and air.
- Apply basic chemical concepts in understanding the behavior of pollutants
- To analyze chemical processes involved in air, water and soil environmental problems.
- Know the different types of toxic and hazardous substances.
- Understand the toxic responses and analyze toxicological information.

Text Books:

1. De, A.K. (2007) Environmental Chemistry, Seventh Edition, New Age International Publishers.
2. Sharma, B.K and H.Kaur, (1994) Environmental Chemistry, Goel Publishing House Ltd., Meerut, UP

References

1. Balram Pani, (2007) Text Book of Environmental Chemistry, I.K. International Publishing House PVT. Ltd.
2. Manahan, S.E. (2010), Environmental Chemistry, Ninth Edition, CRC Press
3. Dara, S.S and D.D.Mishra (2009) A Text Book of Environmental Chemistry and Pollution Control, 10th edition, S.Chand & Company.

Web references:

1. http://www.*nptel.ac.in/courses/122106030/Pdfs/3_1.pdf*
2. http://www.*crystal.med.upenn.edu/sharp-lab-pdfs/sharp_EncLifeSci.pdf*
3. http://www.fao.org/docrep/field/003/AC172E/AC172E04.htm
4. http://www.essentialchemicalindustry.org/materials-and-applications/surfactants.html
5. http://agriinfo.in/?page=topic&superid=5&topicid=174
6. http://www.*citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.800.8713&rep=rep1...pdf*

CORE III: 18UPEVS1C03

ENVIRONMENTAL MICROBIOLOGY

Course Objectives:

The purpose of this course is to impart knowledge about soil fertility, biogeochemical cycles, plant growth promoting rhizobacteria, microbial interactions in soil and other soil activities. To enhance the skill on microbial analysis of environment.

UNIT I - Introduction to Microbiology

History and scope of microbiology - Ultrastructure of Prokaryotic and Eukaryotic cell – Physical and Chemical methods of Sterilization techniques used in microbiology - Preparation of media for isolation and culture of microorganisms – General structure, Microbial growth and multiplication of bacteria, virus and fungi .

UNIT II - Geomicrobiology

Soil micoflora – Factors influencing the soil microflora – Role of microorganisms in soil fertility. Microbial interactions – Mutualism, Commensalism, Competition, Amensalism, Parasitism and Predation. Interaction between microbes and plants: Rhizosphere, phyllosphere and mycorrhizae.

UNIT III - Biogeochemical Cycles

Carbon cycle - Role of microbes in Carbon cycle - Nitrogen cycle - Mechanism of biological nitrogen fixation - Ammonification, Nitrification, Denitrification - Phosphorous cycle and Sulphur cycle - Phosphate solubilization.

UNIT IV - Air and Water-Borne Diseases

Microbial air pollutants - Bioaerosols, Aero allergens – Airborne diseases, Symptoms and preventive measures - Water pollution: Sources and nature of pollutants in water – waterborne diseases, Symptoms and preventive measures (Cholera and Typhoid). Microbial assessment of water quality - MPN technique and Biological Oxygen Demand.

UNIT V - Environmental Applications of Microbes

Introduction to the use of microbes in environmental applications - Biodegradation - Biotransformation - Bioremediation - Phytoremidiation- Microbially Enhanced Oil Recovery – Bioethanol and Biogas Production - Wastewater treatment - Domestic sewage, Industrial wastewater – sago, textile, tannery.

Learning Outcomes:

After completing this course, students will be able to:

- Understand and describe the microbial growth, their diversity and role in biogeochemical processes, and microbial issues in environment.
- Understand the role of microbes in soil fertility, biogeochemical cycles, plant growth promotion
- Know about the impact of microbial air pollutants.
- Understand the microbial diseases related to environment

- Understand the molecular microbial biotechnology and its applications
- Know and develop microbial products for biotechnological applications
- Apply the microbial processes to clean environmental cleanup.
- To enhance the skill on microbial analysis of environment.

Text Books

1. Dubey and Maheshwari, 1999, A text book of Microbiology, 1/e, Chand publications, New Delhi.
2. Mohapatra P K (2008)Text Book of Environmental Microbiology, I K International Publishing House Limited.

References

1. Subba Rao NS (2004) Soil Microbiology. 4th Edition, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Subba Rao NS (1995) Biofertilizers in Agriculture and Forestry. 3rd Edition, Oxford and IBH Pub. Co. Pvt. Ltd., New Delhi.
3. Singh DP & SK Dwivedi (2005). Environmental Microbiology and Biotechnology. 1st Edition, New Age International (P) Ltd., Publishers, New Delhi.
4. Brock TD, Madigan MT, Martinko JM and Parker J (1994) Biology of Microorganisms, VII Ed., Prentice-Hall, New Jersy, USA.
5. Ronald M. Atlas and Richard Bartha, 1997, Microbial Ecology, 4/e, Benjamin Cummings Publishing company, USA.

Web References

1. www.wastewatertreatment.co.in/index.php
2. www.microbialfuelcell.org
3. www.pollutionissues.com/A-Bo/Bioremediation.html
4. www.bioreactors.net
5. http://www.cpeo.org/techtree/ttdescript/biorec.htm
6. http://www.personal.psu.edu/jel5/biofilms/
7. www.rdp.cme.msu.edu

CORE IV: 18UPEVS1C04

ENVIRONMENTAL GEOGRAPHY

Course Objectives:

The purpose of this course is to provide knowledge and understanding of Earth's natural processes and geological hazards.

UNIT I - Environmental Geography

Environmental Geography – Concept and Scope, Geomorphology-Nature and Scope. Earth: Interior Structure and Isostasy. Earth Movements: Plate Tectonics, Types of Folds and Faults, Earthquakes and Volcanoes.

UNIT II -The earth systems / Geomorphology

Geomorphic Processes: Weathering, Mass Wasting, Cycle of Erosion (Davis and Penck). Evolution of Landforms (Erosional and Depositional): Fluvial, Karst, Aeolian, Glacial, and Coastal. Conservation of matter in various geospheres – lithosphere, hydrosphere, atmosphere and biosphere. Energy budget of the earth. Earth's thermal environment and seasons.

UNIT III - Earth's Processes and Geological Hazards

Earths processes; concept of residence, time and rates of natural cycles. Catastrophic geological hazards. Study of floods, landslides, earthquakes, volcanism and avalanche. Prediction and perception of the hazards and adjustments to hazardous activities.

UNIT IV -Environmental Geochemistry

Concept of major, trace and REE. Classification of trace elements, Mobility of trace elements, Geochemical cycles. Biogeochemica! factors in environmental health. Human use, trace elements and health. Possible effects of imbalance of some trace elements. Diseases induced by human use of land.

UNIT V- Geography of India

Physical: Physiographic Divisions, soil and vegetation, climate (characteristics and classification). Population: Distribution and growth, Structure.Physiographic, Socio – cultural and Economic Regionalisation of India

Learning Outcomes:

After completing this course the students will be able to:

- Aware of the basic phenomenon's of earth sciences.
- Know the process of eart movements.
- Acquaint adequate knowledge on geo morphology and processes.
- Understand the impact of geological hazards.
- Know the various elements and trace metals of earth.
- Understand the process of geochemical cycles.
- Know the physiographic divisions of India.
- Understand various types of Indian geographic regionalization.

Text books:

1. Chandna R. C., (2002): Environmental Geography, Kalyani Publications, Ludhiana, Punjab
2. Kale V. S. and Gupta A., (2001): Introduction to Geomorphology, Orient Longman, Hyderabad.

References:

1. Dorothy Merritts, Andrew De Wet, Kirsten Menking (1991). Environmental Geology - Earth System Science Approach. Freeman Publishers.
2. Saxena, H.M (2005). *Environmental Geography*, Milton Book Company.
3. Bloom A. L., (2003): Geomorphology: A Systematic Analysis of Late Cenozoic Landforms, Prentice-Hall of India, New Delhi.
4. Bridges E. M., (1990): World Geomorphology, Cambridge University Press, Cambridge.
5. Christopherson, Robert W., (2011), Geosystems: An Introduction to Physical Geography, 8th Edition., Macmillan Publishing Company

Web References

1. http://nrsc.gov.in/ Tutorial_Geowebservices_HCK.pdf
2. https://joe.org/joe/2005june/a6.php
3. http://www.istl.org/11-spring/internet.html
4. http://www.eoearth.org/

CORE IV: 18UPEVS1C05

REMOTE SENSING AND GIS

Course Objectives:

The purpose of this course is to introduce the principles, processes and application of Remote sensing and GIS, and to impart practical knowledge on the use of remote sensing and GIS techniques for Environmental management.

UNIT I - Remote Sensing

Definition and Overview of Remote Sensing History and Evolution of Remote Sensing and Remote Sensing Systems Electromagnetic Radiation, EMR Spectrum- Interactions- Remote Sensing Systems - Active and Passive Systems, Imaging and Non Imaging Systems, Concept of Resolutions in RS - Spatial, Spectral, Radiometric and Temporal. Overview of Remote sensing Satellites.

UNIT II - Image Interpretation and Analysis

Principles of visual Interpretation of aerial photos and satellite imagery Recognition Elements and Interpretation keys for Visual Interpretation Techniques Interpretation of Multi-spectral Imagery,Thermal Imagery and Microwave Imagery (SAR) Image Enhancement Techniques- Linear Non- linear Contrast Enhancement Filtering - Principles of Image Classification Feature Selection & Separability Analysis Supervised Classification - Unsupervised Classification, knowledge based classification Classification Accuracy

UNIT III - GIS concepts

Introduction to Geographical Information Systems and GIS software, Fundamentals of GIS: Data structures - vector and raster data. Data input – storage - editing - Hardware and Software requirement - Data attributes and spatial topology, Projection / Image registration, Digitization and data attributes -map data representation.

Unit IV – GPS Concepts

Introduction to GPS, Error Sources and Positioning, GPS Satellite Systems, Types of GPS, Elements of GPS types of GPS machines and its applications for surveying and mapping Global Navigation Satellite System

Unit V - Application of Remote sensing and GIS

Applications of remote sensing for land use/land cover, landscape mapping, vegetation analysis, climate change studies, flood, drought assessment desertification and water shed management. Application of GIS for environmental studies- decision support system, GPS-applications for surveying and mapping, interface of GPS data with GIS.

Learning Outcomes:

After completing this course the students will be able to:

- Acquaint adequate knowledge on the use of remote sensing.
- Know the basic concepts of GIS and its mechanisms.
- Know to interpret satellite Images.
- Understand Image Classification Techniques.

- Understand image enhancement and interpretation methods.
- Know the various types of GPS systems.
- Use GPS for various environmental applications.
- Able to apply the tools of remote sensing and GIS for environmental disaster. management and conservation.

Text Books

1. Burrough, P. P. & McDonnel, R. A. (1998). Principles of GIS.Oxford University Press.
2. George Joseph, (2003).Fundamentals of Remote Sensing, Universities press (India) Pvt Ltd., Hyderabad.

References

1. Chang, K. T. (2006). Introduction to Geographic Information Systems. The McGraw-Hill
2. Michael N. Demers (2008) Fundamentals of Geographical Information Systems. John Wiley & Sons, Inc. Natraj Publishers, Dehradun, India.
3. Jenson, J.R. (1996)..Introductory Digital Image Processing: Prentice Hall Series.

Web References

1. http://nrsc.gov.in/ Tutorial_Geowebservices_HCK.pdf
2. http://web.mit.edu/urbanupgrading/upgrading/resources/bibliography/TOC/Satellite-Remote-Sense.html
3. http://www.ustudy.in/civil/gis
4. https://joe.org/joe/2005june/a6.php
5. http://www.istl.org/11-spring/internet.html

SEMESTER II

CORE V: 18UPEVS2C06

ENVIRONMENTAL POLLUTION AND CONTROL STRATEGIES

Course Objectives:

The purpose of this course is to gain awareness of environmental pollution and an overview of causes and consequences to natural, economic and social systems, to understand the fundamental principles governing the interactions between transport of pollutants in the environment.

UNIT I - Air Pollution & Control

Definition - Natural and Anthropogenic Sources - Types of Air Pollutants: Primary and Secondary - Classification of Air Pollutants - Effects of Air Pollution on Environment - Transport and Diffusion of Pollutants (Gaussian Plume Model) - Monitoring of Air Pollution - Sampling and Analysis Techniques of SOx, NOx, hydrocarbons and particulate matter - Ambient air Quality Standards of CPCB - Air Pollution Control Methods: Particulate matter (Settling Chamber, Cyclones, Fabric Filter, Electrostatic Precipitator and Wet Scrubbers) - Gaseous Pollutants (NO_x, SO_2, CO, CO_2 and Hydrocarbons).

UNIT II - Water Pollution & Control

Definition – Sources, types and effects – Water Sampling Techniques - Water Quality Parameters and Standards - Drinking and Wastewater Treatment Methods: Primary Treatment (Screening, Grit Removal, Neutralization, Coagulation, Skimming, Sedimentation) - Secondary Treatment (Aerobic – Aeration, Activated Sludge Process, Trickling Filters, Biological Contact Filters, Rotating Filters, Oxidation Ponds; Anaerobic – Anaerobic Digestion, Septic Tanks, Lagoons) - Tertiary Treatments (Ozonation, Chlorination, Activated Carbon filtration, UV, Reverse Osmosis) - Water Management Strategies: Rain Water Harvesting, Recharging of Ground Water, Reuse of Domestic and Industrial Wastewaters.

UNIT III - Soil Pollution & Control

Definition - Sources (Industrial, Domestic, Agricultural) - Effects of Soil Pollution on environment - Soil Sampling Devices, Methods and Analysis - Soil Remediation Techniques: In situ and Ex situ - Physical (Soil Covering, Excavation, Electrokinetic Remediation, Air Sparging, Encapsulation) - Chemical (Soil Washing, Solidification, Vitrification) - Biological (Bioremediation and Phytoremediation).

UNIT IV - Noise Pollution & Control

Definition – Sources - Properties of Sound Waves, Sound Pressure Levels, Decibel, Intensity and Duration - Effects of Noise Pollution on Humans and Animals - Noise Permissible Standards of CPCB (Industrial and Domestic Zones) - Noise Control Measures (Greenbelt and Protective Instruments).

UNIT V - Radiation and Thermal Pollution & Control

Definition - Sources - Radioactive Elements, Radioactive Decay, Units of Radioactivity and Radiation Dose – Monitoring – GM and Scintillation Counter - Effects of Radiation on Environment - *Thermal Pollution*: Definition – Sources - Chemical and Biological Effects - Thermal Pollution from Power Plants and their Control.

Learning Outcomes:

After completing this course, the students will be able to:

- Learn about the air, water and soil pollutants, sources and its effects.
- Have clear understanding on the air, water, noise and radiation standards and its techniques.
- Apply relevant techniques, skills and modern engineering tools to solve the environmental problems.
- Get exposed good practice of technologies and options used to remediate reduce/eliminate pollution of the environment
- Able to analyze, synthesize, and evaluate evidence to problem creating pollutants
- Understand problems in order to select control measures and techniques concerning atmospheric, water or terrestrial challenges.
- Understand the ill effects of noise and radioactive pollution
- Create awareness to public on Environmental pollution and its control

Text Books

1. Vallero, D (2014) Fundamental of Air Pollution, 5th edition, Academic Press.
2. Murali Krishna, K.V.S.G. (2015) Air Pollution and Control, University Science Press.
3. Goel, P.K. (2006) Water Pollution Causes, Effects and Control, New Age International Publishers.

References

1. Nesaratnam, S.T (2014), Water Pollution Control, John Wiley Publishers.
2. Olga Sanchez (Ed.) (2015) Bioremediation of Wastewater Factors and Treatment, CRC Press.
3. Meuser, Helmut (2013), Soil Remediation and Rehabilitation treatment of contaminated and disturbed land, Springer.
4. Jeffrey Peirce, J., F. Ruth, P. Weiner, and A.Vesilind (2015) Environmental Pollution and Control, Fourth Edition, Elsevier.
5. Rao, S. (2006), Environmental Pollution Control Engineering, 2nd edition, New Age International (P) Ltd.
6. Spellman, F.R. (2013) Handbook of Water and Wastewater Treatment Plant Operations, Third Edition, CRC Press
7. Khopkar, S.M. (2013) Environmental Pollution Monitoring and Control, 2nd edition, New Age International Publishers.

Web References

1. http://download.nos.org/333courseE/10.pdf
2. http://www.ilocis.org/documents/chpt55e.htm
3. http://mjcetenvsci.blogspot.in/2013/11/thermal-pollution-causes-effects-and.html
4. http://calhoun.nps.edu/bitstream/handle/10945/13283/thermalpollution00mann.pdf?sequence=1
5. http://www.nios.ac.in/media/documents/313courseE/L36.pdf
6. http://www.environmentalpollution.in/radiation-pollution/radiation-pollution-types-sources-effects-control-of-radiation-pollution/313
7. http://defence.gov.au/jlc/Documents/DSCC/ADF%20Health%20Manual%20Vol%2020,%20part8,%20chp2.pdf

CORE VI: 18UPEVS2C07

ENVIRONMENTAL BIOTECHNOLOGY

Course Objectives:

The purpose of this course is to acquaint students with knowledge in environmental biotechnology for gene cloning, to apply the microorganisms for remediation of environmental pollutants, to develop skills in manipulating the microbial process for waste conversion and resource recovery, and to produce microbial bioproducts for environmental applications.

UNIT I - DNA Structure and DNA modifying enzymes

Introduction to Biotechnology - Organization of bacterial genome - Structure of DNA - Restrictionenzymes: Nomenclature - Classification - restriction and Methylation - Type II restriction endonuclease - Use of restriction endonucleases - Restriction mapping and its applications - DNA modifying enzymes - nucleases - polymerases - DNA ligases.

Unit II - Gene Cloning and PCR Techniques

Gene Cloning - Over view, Cloning vectors – Plasmids, phages and cosmids, phagemids, Ti plasmids and viral vectors M13 - Cloning strategies, cloning and selection of individual genes – PCR - Working principle, types and applications. Environmental genome.

Unit III - Environmental Applications Microbes

Use of microbes in environmental decontamination - Biodegradation - Biosorption - Biotransformation - Bioaugmentation, Biostimulation - Phytoremediation, Mycoremediation - Phycoremediation - Bioleaching and Biomining - MEOR - Bioremediation pollutants - arsenic, chromium, fluoride, PAHs, POPs and VOCs - Bioindicators and biosensors for detection of pollution.

Unit IV - Biotechnology for waste management and Resource recovery

Biotechnology for waste management and resource recovery - sewage treatment - activated sludge process - Anaerobic treatment - sludge stabilization - aerobic composting, anaerobic digestion, biogas production, algal cultivation: nutrient removal. Solid waste treatment - biocomposting - vermicomposting - Air pollution control - bioscrubber, biofilters.

Unit V - Microbial Bioproducts

Microbial bioproducts for environmental cleanup - Microbial biomass - Biosorbents - Biosurfactants - Microbial enzymes: lignocellulases, lipases, dioxygenases - Bioflocculants - Bioplastics - Biofertilizers - Biopesticides - Microbial fuels: Bioethanol, Biobutanol, and Biohydrogen.

Learning Outcomes:

After completing this course, students will be able to:

- Acquie knowledge on basic principles and technologies of DNA and its manipulation, gene cloning and PCR techniques.
- Understand the basic principles and techniques of remediation of environmental pollutants.
- Explain the role of microbes in degradation of environmental pollutants.
- Get skills in manipulating the microbes for biodegradation of pollutants.

- Describe biotechnological solutions to address the waste bioconversion.
- Describe the microbial process to produce value added products.
- Analyze reports in key areas of environmental biotechnology.
- Apply the biotechnological process to recover resources from different wastes.

Text Books

1. P.K. Mohapatra (2008) Text Book of Environmental Biotechnology. IK International Publishers Ltd
2. Thakur, I.K. (2013) Environmental Biotechnology: Basic Concepts and Applications. 2nd edition.

References

1. Alexander N. Glazer Hiroshi Nikaido (1995) Microbial Biotechnology, WH Freeman and Company, NY, USA.
2. Bernaral R. Glick and Jack J. Pastemak (1994) Molecular Biotechnogy: Principles and Applications of Recombinant DNA, ASM Press. Washington, DC USA.
3. Brown TA (1995) Gene cloning – A introduction – Chapman & Hall, London.
4. Glazer and Nikaido (1995) Microbial Biotechnology. WH Freeman & Co., New York.
5. Kreuzer and Massey (2001) rDNA & Biotechnology. A guide for Teachers, 2nd Edition, ASM Press, Washington DC, USA.
6. Old RW and Primrose SB (1994) Principles of Gene Manipulation. Blackwell Scientific Publications, Oxford, UK.
7. Primrose SB (1994) Molecular Biotechnology, 2nd edition, Blackwell Scientific Publications, UK.
8. Singh DP & SK Dwivedi (2005). Environmental Microbiology and Biotechnology. 1st Edition, New Age International (P) Ltd., Publishers, New Delhi.
9. Fulekar, M.H. (2010) Environmental Biotechnology, CRC Press.
10. Cheremisinoff, N.P. (1997) Biotechnology for Waste and Wastewater Treatment. Sciencedirect.

Web References

1. www.microbialfuelcell.org
2. www.pollutionissues.com/A-Bo/Bioremediation.html
3. www.bioreactors.net
4. http://enhs.umn.edu/current/5103/gm/harmful.html
5. www.wastewatertreatment.co.in/index.php
6. http://archive.industry.gov.au/Biotechnologyonline.gov.au/enviro/environment.html
7. https://preventioncdnndg.org/eco-quartier/biomethanization-2/
8. https://www.nrel.gov/workingwithus/learning.html
9. https://www.epa.gov/recycle/composting-home
10. https://www.epa.gov/remedytech/green-remediation-best-management-practices-bioremediation

CORE VII: 18UPEVS1C07

CLIMATE CHANGE AND CURRENT ISSUES

Course Objectives:

The purpose of this course is to focus on improving understanding of the climate system and climate science and the impacts of climate change, mitigation and/or adaptation to climate change and related issues.

UNIT I - Meteorological Elements for Climate Change

Structure of atmosphere: Vertical structure of atmosphere - Atmospheric stability: Adiabatic process – Air Temperature, Humidity, Condensation: Dew and Frost, Fog, and clouds – Clouds: Classification of clouds - Precipitation processes: Collison and Co-alescence process and Ice-crystal or Bergeron process – Cloud seeding – Precipitation types (Rain, snow, Sleet and freezing rain, snow grains and snow pellets, hail) - Air Pressure and Winds: Atmospheric pressure – Forces that influence the wind (Pressure gradient force, Coriolos force, centripetal force, friction)

UNIT II - Atmospheric Circulation, Air masses and Fronts

Atmospheric circulation: Hadley circulation – Intertropical Convergence Zone (ITCZ) – Jet streams - Global wind patterns: Trade winds, Westerlies and Polar Easterlies – Thermal circulations: Sea and land breezes, Mountain and valley breezes, Katabatic winds, Chinook (Foehn) winds, Santa Ana winds, Desert winds - Air masses: Source regions – Classification and characteristics of air masses – Types of air masses – Fronts: Type of fronts: Stationary fronts, cold fronts, warm fronts, occluded fronts

UNIT III - Air Quality and Consequences of Climate Change

Global Air Quality and CO_2 concentration scenario - Role of air pollutants in climate change – Sources of greenhouse gases: Coal burning, Transportation sectors (vehicle, railways, shipping and aviation) - Ozone depleting substances – Facts and figures of current global warming scenarios in the world – Extreme events of climate change: - El Niño, La Niña and El Niño Southern Oscillation (ENSO) – Recent extreme events in the world – Global consequences of El Niño – Impacts of climate change: Changes in the SW and NE monsoon patterns in India – Glaciers, Ice caps, Ice sheets and Sea levels - Water scarcity - Food security – Species extinction – Human health – Civil Wars and Migration

UNIT IV - Climate Classification, Measurement of Climate Change and Weather forecasting

Classification of climate: Koppen's and Thornthwaite' scheme - The measurement of climate change: Tree rings, ice cores, ocean sediments, pollen records, Boreholes and other proxy measurements Weather forecasting tools: AWIPS computer work station, Doppler radar data, metogram, satellites and weather forecasting – Types of forecasts: Nowcast, short-range forecasts, medium and long-range forecasts

UNIT V - Global/National Action Plans to Combat Climate Change Issues

Key steps taken by UNFCCC to combat climate change: Kyoto Protocol – Bali Action Plan 2007 – Copenhagen Accord 2009 - Cancun Agreements 2010 to establish Green Climate Funds – Paris Climate Agreement 2015, Intended Nationally Determined Contribution (INDC) to cut greenhouse gas emissions at CoP 21 – Montreal Protocol for ODS, Kigali Amendment 2016 to phase out hydroflurocarbons (HFC) – Green climate funds – Clean Development Mechanism (CDM) – Climate Change Information Network (CC:iNet) – National Action Plan on Climate Change (Eight missions) – Recent initiatives related to climate change adaptation and mitigation in India

Learning Outcomes:

After completing this course, students will be able to:

- Understand the climate and climate change processes at local to global scales.
- Empower the students to think critically about climate science.
- Sources and impacts of climate change due to anthropogenic activities especially energy utilization.
- Understand the existing novel technologies used for measurement of climate change and weather forecasting.
- Understanding of the recent initiatives and policy framework by UNFCCC and MoEF &CC.
- Evaluate the successes and failures of past national and international efforts to address climate change.
- Know how decisions about carbon emissions and other human activities might impact future climate.
- Evaluate prospects for future management of climate change.

Text Books

1. Donald Ahrens C and Robert Henson (2016) Meteorology Today: An Introduction to Weather, Climate, and the Environment. Eleventh Edition, Brooks/Cole, Cengage Learning, USA.
2. Galvin JFP (2016) An Introduction to the Meteorology and Climate of the Tropics. John Wiley & Sons Ltd., UK.

Reference Books

1. Alberto Troccoli, Laurent Dubus and Sue Ellen Haupt (2014) Weather Matters for Energy. Springer, New York.
2. Cowie J (2007) Climate Change: Biological and Human Aspects, Cambridge University Press, UK. 32
3. Dogra N and Srivastava S (2012) Climate Change and Disease Dynamics in India, TERI, New Delhi.
4. Filho WL (2012) Climate Change and the Sustainable Use of Water Resources, Springer-Verlag, Berlin, Heidelberg.
5. John Turner and Gareth J Marshall (2011) Climate Change in the Polar Regions. Cambridge University Press, UK.

6. Kala CP and Silori CS (2013) Biodiversity Communities and Climate Change, TERI, New Delhi.
7. Newman J, Anand M, Henry H, Hunt S and Gedalof Z (2011) Climate Change Biology, CAB International, Cambridge, MA, USA.
8. Ramesh Chandrappa, Sushil Gupta and Umesh Chandra Kulshrestha (2011) Coping with Climate Change. Principles and Asian Context. Springer-Verlag, Berlin.

Web References

1. http://www.un-redd.org/
2. http://unfccc.int/
3. https://www.ipcc.ch
4. https://www.co2.earth/
5. http://www.climatecentral.org/
6. http://climate.nasa.gov/
7. http://www.who.int/mediacentre/news/
8. http://aqicn.org/map/

SEMESTER III

CORE VIII: 18UPEVS3C09

WASTE MANAGEMENT

Course Objectives:

The purpose of this course is to understand the problems of municipal waste, biomedical waste, hazardous waste, e-waste, industrial waste etc.,

---

UNIT I - Municipal Solid Waste Management

Wastes – Introduction, Definition, Sources and Classification; Municipal Solid Wastes – Source, Types, Per Capita Generation, Global Scenario Wastes; Collection and Transportation Methods, Waste Processing and Material Recovery (TMRF), Effects of Municipal Solid Wastes on Environment. Disposal Methods (Landfill, Composting, Burning, Incineration, Pyrolysis, Anaerobic Digestion).

UNIT II - Hazardous & Radioactive Waste Management

Hazardous waste - Introduction, Characteristics, Classification of Hazardous Waste (Industrial, Hospital and Domestic) – Labeling and Handling of Hazardous Solid Wastes (Segregation, Recovery of Hazardous Waste Substances) - Hazardous Waste Disposal Techniques. *Radioactive Wastes*: Sources, Types, Effects, Control and Disposal Methods.

UNIT III - Biomedical, Plastic & e-waste Management

Biomedical Wastes: Sources, Types of Biomedical Wastes, Impacts of Biomedical Wastes on Environment - Control Measures of Biomedical Wastes. *Plastic Wastes*: Sources, Types, Facts & Figures of Plastic Waste Scenarios in National & International, Effects of Plastic Wastes on Environment, Control Measures of Plastic Wastes. *E-wastes*: Sources, Types of e-wastes – Impacts of e-wastes on Environment - Control measures of e-wastes.

UNIT IV - Energy Recovery from Wastes

Vermicomposting, mushroom cultivation, fly ash bricks, biogas, and electricity; Bioelectro chemical systems – Microbial electrolysis cell – Microbial fuel cell - Production of methane, ethanol, electricity.

UNIT V- Industrial Waste Management

Paper and Pulp, Tanneries, Textiles, Thermal Power Plants, Mining and Ore Processing, Refineries, Iron Casting, Cement and Asbestos. Waste Sludge Dewatering and its Disposal.

Learning Outcomes:

After completing this course, the students will be able to:

- Do sampling and characterization of solid waste; analysis of hazardous waste constituents and its quality control issues.
- Become aware of Environment and health impacts solid waste mismanagement.
- Understand engineering, financial and technical options for waste management,
- Understand wealth from waste techniques
- Understand industrial specific wastes and their efficient management.

- Understand health and environmental issues related to solid waste management; Select the appropriate method for solid waste collection, transportation, redistribution and disposal
- Describe methods of disposal of hazardous solid waste.
- Understand the energy recovery and industrial specific treatment techniques.

Text Books

1. Kinnaman, T.C and Takeuchi, K. (2014). Handbook on Waste Management, Edward Elgar Publishing, UK.
2. Ramesha Chandrappa and Jeff Brown, (2012). Solid Waste Management: Principles and Practice, Springer Science and Business Media Publishers.

References

1. Basarkar Shishir, (2009) Hospital Waste Management: A Guide for Self-Assessment and Review, JAYPEEDIGITAL
2. Hieronymi, C.K, R. Kahhat, and Williams, E. (2012) E-waste Management: From waste to resource. Routledge Taylor Francis Group Publishers.
3. Bhide and Sundaresan (2000) Solid Waste Management in Developing Countries – Indian National Scientific Documentation Center, New Delhi.
4. Hester, R.E and Harrison, R.M. (2009) Electronic Waste Management, Design Analysis & Application, RSC Publishing, UK.
5. James Saling (2001) Radioactive Waste Management, CRC Press, FL, USA.
6. John Pitchel (2005) Waste Management Practices, Municipal, Hazardous, and Industrial. Taylor & Francis Group, LLC.
7. Lagrega, M.D, Buckingham, P.L and Evans, J.V. (2001) Hazardous Waste Management, McGraw Hill Int. Ed. New York.
8. Lie, D.H.F and Liptak B.G (2000) Hazardous Wastes and Solid Wastes, Lewis publishers, New York.

Web References

1. http://www.cpeo.org/techtree/ttdescript/pyrols.htm
2. www.satavic.org/vermicomposting.htm
3. http://web.mit.edu/urbanupgrading/urbanenvironment/sectors/solid-waste-landfills.html
4. www.cement.org/waste/wt_apps_radioactive.asp
5. www.ipma.co.in/recycle.asp
6. linkinghub.elsevier.com/retrieve/pii/S026974910600042X
7. www.algae.info

CORE IX: 18UPEVS3C10

ENVIRONMENTAL BIOCHEMISTRY AND TOXICOLOGY

Course Objectives:

The purpose of this course is to focus on understanding the role of pollutants, xenobiotics in the natural environment and to understand the basics of environmental toxicology, cell biology and biochemistry and to characterize the adverse effects of chemical substances on the ecosystem and humans.

UNIT I - Basic Cell Biology

Prokaryotic and Eukaryotic cell structure and intracellular organelles – Cell wall, membranes, nucleolus, endosomes, peroxisomes, mitochondria, endoplasmic reticulum, plant vacuoles, plastids, microbodies and chloroplast. Cell growth and division-Meiosis and Mitosis, genotypes and phenotypes

UNIT II - Cellular Processes

Cellular permeability, diffusion, osmosis, absorption of water, transpiration, photosynthesis, Respiration, translocation of solutes, Photoperiodism and vernalisation, plant movements, Dormancy, senescence. Animal Phylogeny.

UNIT III - Basics of Toxicology

Introduction to toxicology, scope and types - Classification of toxic agents. Routes of exposure, duration and frequency of exposure, Dose response relationship - LC_{50} LD_{50}, Margin of safety levels. Environmental Risk – Definition, Risk Characterization - Hazard Identification, Exposure Assessment Methods, Risk Assessment – National and International guidelines. Environmental Risk – Mitigation measures.

UNIT IV - Toxicity Testing and Bioassay

Toxicity testing –laboratory animals, toxicity testing in animals, toxicological field studies,Concepts of Bioassay, Types and characteristics - Field based microbial bioassay, Test models and classification - Immunotoxicity, histotoxicity and cell toxicity.

UNIT V - Xenobiotics

Xenobiotics - Bioaccumulation and Biomagnifications - mechanisms of toxicity. - Drug Development and safety, Drugs and chemicals induced hepatotoxicity, food toxicity,genotoxicity, Molecular neurotoxicity.

Learning Outcomes:

After completing this course, the students will be able to:

- Acquire broad knowledge of the field of environmental toxicology and biochemistry.
- Undertsnad the basic principles, target organ toxicity and the toxicity of a select group of chemical compounds.

- Synthesize and apply concepts from multiple sub-disciplines in environmental cell biology, biochemistry and toxicology.
- Use technical and analytical skills to quantify the level xenobiotics in environmental compartments.
- Understand the effects of xenobiotics in on human health.
- Understand relationships between chemical/drug exposure and their effects on physiological systems.
- Acquire skill is toxiciolgical bioassays.
- Design strategies for study of dose-response relationships.

Text Books

1. Alberts B, Bray D, Hopkin K *et al.* (2009) Essential Cell Biology, 3rd edition,
2. Alberts B, Johmson A, Lewis J, Raff M, Roberts K and Walter P (2002) Molecular Biology of the Cell, Garland Science, New York.

References

1. Buchanan BB, Gruissem W and Jones RL (2002) Biochemistry and Molecular Biology of Plants, ASPB, USA.
2. Cooper GM and Hausman RE (2013) The Cell: A Molecular Approach, 6th edition, Sinauer Associates, Sunderland, MA, USA.
3. David L. Nelson, Michael M. Cox (2004) Lehninger Principles of Biochemistry (1970) by Albert L. Lehninger Published April 23rd 2004 by W. H. Freeman (first published).
4. Gerald Karp (2002) Cell and Molecular Biology: Concepts and Experiments, 7th edition.
5. Klaassen, Curtis D; Casarett, Louis J; Doull, John, (2013). Casarett and Doull's toxicology : the basic science of poisons (8th Edition)Mc Graw Hill Publishers.
6. Ted A. Loomis, A. Wallace Hayes. Loomis's Essentials of Toxicology (1996) . 4th Edition, Academic Press Publishers
7. Sharma PD, Rastogi and Lamporary (1994) Environmental Biology and Toxicology, Rajpal and Sons Publishing, New Delhi.
8. Ted A Simon. Environmental Risk Assessment: A Toxicological Approach (2014). CRC Press publications.

Web References

1. www.cellsalive.com
2. www.cytochemistry.net/cell-biology/lysosome.htm
3. www.cellsignal.com
4. www.cellsignallingbiology.org
5. ilocis.org/documents/chpt33e.htm
6. www.uji.es/bin/ocit/grups/00503001.pdf
7. www.cis.rit.edu/htbooks/nmr/
8. www.toxnet.nlm.nih.gov/
9. www.biologydiscussion.com/**notes**/**notes**-on-**environmental**-**toxicology**/4906

CORE X: 18UPEVS3C11

RESEARCH METHODOLOGY AND INSTRUMENTATION

Course Objectives:

The purpose of this course is to acquaint students about various types of research methods, instruments and their working principles, data process, report generation and to train the students to handle various research instruments.

UNIT I - Research Methods

Basics of Fundamental and Applied Research, Types, scope, hypothesis. Concept of research articles, research papers, reviews, scientific popular articles; Components of a Research Article (title, author-line, address, abstract, summary, hypothesis, keywords, introduction, methodology, observations, discussion, conclusion, citing relevant work of others); Reference protocols ; Copyright Act (in brief), Plagiarism, Cheating / academic frauds; process of reviewing; Concept of Impact factor; H-Index, i-10 index and SCI Impact factor for journals.

UNIT II - Basic Analytical Equipments

Principle, Working mechanism and environmental applications of pH Meter, Conductivity meter, Nephlometer. Basic principles and applications of light and electron microscopes. Types, function and applications of centrifuges. Principle, types and environmental application of elctrophoretic techniques and radio immune assay techniques.

UNIT III - Spectroscopy

Various ranges of electromagnetic radiation - Interaction of electromagnetic radiation with matter, Spectrophotometry - Principles and working mechanism, types and applications of colorimeter, UV - Visible spectrophotometer, fluorimeter, flame photometer, AAS, AES, ICP-MS, IR, NMR spectrophotometer and XRD spectrometer.

UNIT IV - Chromatography & Mass Spectrometry

Principle and concept of chromatography- stationary phase, mobile phase, partition and adsorption, coefficients. Working principle, instrumentation and environmental applications of Thin layer and Ion exchange chromatography, HPLC, HPTLC, LC-MS, and GC-MS.

UNIT V - Statistical Analyses

Statistical Analysis: Sampling Methods and Data Collection – Questionnaire Survey, Experiments and Field works. Measures of central tendency: Mean, Median and Mode-Merits and demerits. Measures of dispersion: Range, Standard Deviation, Variance, Skewness and Kurtosis; Distribution- Normal, *t* test and *chisquare* test, Difference among means - ANOVA. Correlation and Regression - Linear and Multiple. Introduction to statistical Softwares (SPSS, R, MATLAB).

Learning Outcomes:

After completing this course students will be able to:

- Know the types of research and scientific databases, report writing and plagiarism.
- Chose the research that they want to carryout.
- Identify and design their research problems.
- Understand the principles of research methods and instruments.
- Identify instruments required for their research experiments.
- Acquire skills to handle the scientific instruments.
- Collect primary and secondary data and do the analysis and interpretation.
- Write the research report and thesis.

Text Books:

1. Rt Kumar, (2010.) Research Methodology: A Step-by-Step Guide for Beginners, SAGE Pub.
2. Gurumani, N. (2006).Research Methodology for Biological Science. MJP Publishers.

References:

1. Christian GD (2001), Analytical Chemistry, 5th edition, John Wiley and Sons Inc., India
2. Khopkar SM (1993) Environmental Pollution analysis, Wiley Eastern Ltd.
3. Manahan SE (2007) Environmental Chemistry, 7th edition, Lewis Publications, Florida, USA.
4. Banerjee PK (2004) *Introduction to Biostatistics*. S. Chand and Co., New Delhi.
5. Manly, Bryan FJ (2001) Statistics for Environmental Science and Management, Chapman and Hall / CRC Press, Boca Raton, FL, USA.
6. Skoog DA, Holler FJ and Nieman TA (1980) Principles of Instrumental Analysis –5th edition, Thomson Asia Pvt., Singapore.
7. Vogel AI (1998) Quantitative Analysis, 6th edition, Prentice Hall Inc., Willard HH, Merrit LL and Dean JA (1976) Instrumental Methods of Analysis, 5th edition, Van Nostrand Reinhold.
8. Rastogi VB (2007) *Fundamentals of Biostatistics*. Ane Books India, New Delhi.
9. Wilson, K, Walker, J (2010) Principles and Techniques of Biochemistry and Molecular Biology, 7th edition, Cambridge University Press.

Web References

1. https://www.bio.umass.edu/biology/forms/content/499e-research-methodology
2. www.computerhope.com/os.htm
3. http://www.fao.org/docrep/005/ac665e/ac665e05.htm#TopOfPage
4. http://www.rss.hku.hk/plagiarism/page2s.htm
5. https://esajournals.onlinelibrary.wiley.com/doi/full/10.1002/bes2.1258
6. www.fao.org/docrep/W7295E/w7295e08.htm
7. https://chemistrynotesblog.wordpress.com/seperation-techniques/introduction-to-separation-techniques-2/
8. https://www.epa.gov/sites/production/files/2015-05/documents/402-b-04-001b-14-final.pdf
9. https://en.wikibooks.org/wiki/Proteomics/Protein_Identification_-_Mass_Spectrometry/Types_Mass_Spectrometry

CORE XI: 18UPEVS3C12

ENVIRONMENTAL IMPACT ASSESSMENT

Course Objectives:

The purpose of this course is to introduce the methodology of environmental impact assessment (EIA) as a vital tool for sound environmental management and decision-making and to provide an overview of the concepts, methods, issues and various forms and stages of the EIA process.

UNIT I – Introduction to EIA

Definition – Principles of EIA – Short-term and Long-term objectives - Evolution of EIA worldwide and in India – Types of EIA - Projects subject to EIA (Category 1, 2 and 3) – Steps in EIA process – Objectives of the Standard Terms of Reference (TOR) - Stages and time frame for obtaining Environmental Clearance from MoEF & CC according to EIA notification 2006 – Merits and Demerits of EIA

UNIT II – EIA Methodologies

Assessment of impacts: Air, water, soil, noise, biological, social, cultural, economical, and environmental factors – EIA Methodologies: Adhoc Method – Checklist Approach – Matrix Methods – Network Methods – Overlay Method

UNIT III - Public Participation, Preparation and Review of EIA Report

Objectives of People's Participation - Advantages and Disadvantages of People's Participation - People's Participation Techniques: Public Hearing - Preparation and Review of EIA Report: EIA Reports Content - Basis and Criteria for Evaluation of EIA Reports and EIA

UNIT IV - EIA case studies for major development projects

Major Highways Projects - Airport - River valley Projects – Mining and quarrying - Thermal and Hydroelectric Power Projects - Cement Industries

UNIT V – Environmental Management System

Environmental Management System**:** Core elements of EMS - Benefits of EMS - Certification body assessments of EMS - Documentation for EMS – ISO 14001 standard – PDCA (Plan-Do-Check-Act) in ISO 14001 Certification – Corporate Social Responsibility (CSR) Plan in India

Learning Outcomes:

After completing this course, students will be able to:

- Explain the major principles and components of EIA processes.
- List and comply with the environmental clearance procedures in India.
- Discuss the implications of current jurisdictional and institutional arrangements in relation to EIA.
- Understand about the methods used for EIA studies.
- Communicate both orally and in written form the key aspects of EIA.
- Understand how to liaise with and the importance of stakeholders in the EIA process.
- Access different case studies/examples of EIA in practice and
- Summarize the EIA report with suitable environmental management plan.

Text Books

1. Canter LW (1996) Environmental Impact Assessment. McGraw Hill, New York.
2. EIA Manual (2001) Ministry of Environment, Forest and Climate Change, New Delhi.

References

1. Anjaneyulu Y and Valli Manickam (2007) Environmental Impact Assessment Methodologies, 2nd Edition, B.S. Publications (ISBN: 978-81-7800-144-9).
2. Bregman JI (1999) Environmental Impact Statements. Lewis Publishers, London.
3. Eccleston CH (2000) Environmental Impact Assessment - A Comprehensive Guide to Project and Strategic Planning, John Wiley and Sons, NY.
4. Peter Wathern (2015) Environmental Impact Assessment: Theory and Practice, Taylor & Francis, London
5. Singleton R, Castle, P and Sort, D (1999) Environmental Assessment, Thomas Telford Publishing, London.
6. Whitelaw K and Butterworth (1997) ISO 14001: Environmental System Handbook.

Web References

1. http://environmentclearance.nic.in/
2. www.fao.org/docrep/V8350E/v8350e06.htm
3. http://www.moef.nic.in/division/eia-manual
4. http://www.moef.nic.in/circulars
5. https://www.adb.org/documents/adb-environmental-assessment-guidelines

CORE XI: 18UPEVS3C13

DISASTER MANAGEMENT

Course Objectives:

The purpose of this course is to mainly focus on understanding the different types of hazards and their impacts and the techniques for preparing effective disaster management plan including recovery and rehabilitation.

UNIT I – Types of Disasters

Geological Disasters - Hydro-Meteorological Disasters - Biological Disasters - Technological Disasters - Intentional, Civil, and Political Hazards - Global Outlook on Disaster Science

UNIT II – Geological Hazards

Earthquake: Origin of Earthquake, its magnitude and intensity - Earthquake prone zones in India - Effects of earthquake - Earthquake prediction & control. Volcanoes: Types of volcanic eruptions - Active volcanic belts in the world - Nature and magnitude of volcanic hazards - Prediction of volcanic eruptions - Mitigation of volcanic hazards. Mass movement hazards: Landslides and Snow avalanche hazards

UNIT III – Hydrological and Meteorological Hazards

Hydrological Hazards - Floods: Flooded geographical land types – Flash flood - Flood management strategies - Regions of flood prone zones in India – Flood forecasting and warning. Droughts: Types of droughts – Drought assessment parameters: Drought indices (meteorological indices, hydrological indices and agriculture index) - Preventive measures and preparedness plan for drought mitigation. Meteorological hazards - Cyclones: Tropical cyclones & Local storms – Heat waves and cold waves

UNIT IV – Disaster Management Cycle and Framework

Disaster Management Cycle – Pre-Disaster: Risk Mapping - Zonation and Microzonation - Prevention and Mitigation of Disasters - Early Warning System – Preparedness - Capacity Development – Awareness. During Disaster: Evacuation – Disaster Communication – Search and Rescue – Emergency Operation Centre – Incident Response System – Relief and Rehabilitation. Post-disaster: Damage and Needs Assessment - Restoration of Critical Infrastructure – Early Recovery – Reconstruction and Redevelopment

UNIT V – Disaster Management in India

Disaster Management Act 2005 - National Guidelines and Plans on Disaster Management - Role of Government (local, state and national), Non-Government and Inter-Governmental Agencies: National Disaster Management Authority (NDMA) - NIDM (National Institute of Disaster Management) - State Disaster Management Authorities - National Disaster Response Force

Learning Outcomes:

After completing this course, students will be able to:

- Develop an understanding of the different types of hazards.
- Understand the different disaster prone zones.

- Develop a basic under understanding of prevention, mitigation, preparedness, response and recovery.
- Understand the technological advancements for early warning system.
- Develop the disaster assistance tools and disaster preparedness.
- Understand the disaster relief and recovery measures.
- Acquire knowledge for capacity building and institutional framework for disaster management, and
- Develop a basic understanding for the role of public and private partnerships.

Text Books

1. Donald Hyndman and David (2005) Hyndman Natural Hazards & Disasters, Cengage Learning
2. Palanivel K, Saravanavel K and Gunasekaran S (2015) Disaster Management, Allied Publishers Pvt Ltd., New Delhi.

References

1. BimalKanti Paul (2011) Environmental Hazards and Disasters - Contexts, Perspectives and Management, John Wiley & Sons, UK.
2. Bryant Edwards (2005) Natural Hazards, Cambridge University Press, UK.
3. Carter Nick W (1991) Disaster Management: A Disaster Manager's Handbook, ADB Manila
4. Collins Larry R and Schneid Thomas D (2000) Disaster Management and Preparedness, Taylor and Francis.
5. Coppola DP (2011) Introduction to International Disaster Management, 2nd Edition, Elsevier Science (B/H), London.
6. Indrajit Pal and Rajib Shaw (2018) Disaster Risk Governance in India and Cross Cutting Issues, Springer Nature, Singapore.
7. Jack Pinkowski (2008) Disaster Management Handbook, CRC Press -Taylor & Francis Group.
8. Jha and Kumar M (2010) Natural and Anthropogenic Disasters; Vulnerability, Preparedness and Mitigation, Springer.
9. Joseph F. Gustin (2010) Disaster & Recovery Planning: A Guide for Facility Managers, 5th Edition, Taylor &Francis.
10. Pradeep Sahni, Alka Dhameja and Uma Medury (2001) Disaster Mitigation: Experiences and Reflections, PHI Learning.
11. Sharma RK and Sharma G (2005) Natural Disaster, APH Publishing Corporation, New Delhi.

Web References

1. www.nidmindia.nic.in
2. http://www.cambridge.org
3. Web based course material on Disaster Management of the University of Wisconsin Disaster Management Center (http://epdweb.engr.wise.sedu/dmc)
4. http://www.worldbank.org/html/fpd/dmf/risk_managemnt.htm

SEMESTER IV

CORE XII: 18UPEVS4C14

ENVIRONMENTAL LAW AND POLICIES

Course Objectives:

The purpose of this course is to introduce the students to the vast field of Laws and Policies both at the national and international level relating to environment.

UNIT I - Environmental Protection

Constitutional Perspective: Fundamental right to wholesome environment. Directive principles of state policy. Duties and responsibilities of Indian citizens for environmental protection. Environmental Regulatory Framework in India. Role of International Environmental Agencies - UNEP, GEF, UNFCC and IPCC

UNIT II - Environmental Laws in India

Indian Wildlife (Protection) Act, 1972 amended 1991; Forest Conservation Act 1980; Indian Forests Act (Revised) 1982; Water (Prevention and Control of Pollution) Act, 1974 as amended up to 1988 and Rules 1975; Air (Prevention and Control of Pollution) Act 1981 as amended by Amendment Act, 1987 and Rule 1982; Environment (Protection) Act, 1986 and Rules 1986; Motor Vehicle Act, 1988; National Environment Appellate Authority Act, 1997; Public Liability InsuranceAct,1991; Biodiversity Act 2002; National Green Tribunal Act 2010

UNIT III - Guidelines and Rules for Environmental Protection in India

Bio-Medical Waste (Management & Handling) Rules,1998; Recycled Plastics Manufacture and Usage Rules, 1999; Noise Pollution (Regulation and Control) Rules, 2000; Municipal Solid Waste (Management and Handling Rules) 2000; The Hazardous Wastes (Management, Handling and Transboundary Movement) Rules,2008; Wetland Rules 2009; Coastal Regulation Zones (CRZ) Rules 2011; E-waste Management and Handling Rules 2011; Plastics Manufacture, Sale and Usage Rules, 2011

UNIT IV - International Environmental Treaties and Conventions

Stockholm Conference on Human Environment,1972; Ramsar Convention on Wetlands, 197; Montreal Protocol, 1987; Basel Convention (1989,1992); Earth Summit at Rio de Zaneiro,1992; Kyoto Protocol, 1997; Earth Summit at Johannesburg, 2002; Summit on Millennium Development Goals 2000, Copenhagen Summit 2009. Paris Agreement, 2016.

UNIT V - Major Initiatives/Policies from MoEF

Central and State Pollution Control Boards: Powers and functions of pollution control boards - Penalties and procedure - National Policies for Environmental Protection in India: National River Conservation Plan (NRCP), National Ganga River Basin Authority (NGRBA), Ganga Action Plan Phase I and II, Green India Mission – Environmental Clearances: National Environmental Assessment and Monitoring Authority (NEAMA)

Learning Outcomes:

After completing this course students will be able to:

- Understand environmental legislation and policies of national and international regime.

- Have an insight into major acts and rules applicable for pollution control and natural resource conservation,
- To develop the skills needed for interpreting laws, policies and judicial decisions about the environment
- Know regulations applicable to industries and other organizations with significant environmental aspects.
- Apply the legislation concepts for solving the local environmental problems.
- Get knowledge of the legal system operating in India and
- Be in a position to prepare compliance reports for getting environmental clearance.
- Prepare the environmental management system for an organization.

Text Books

1. Environmental Law in India (2000) P. Leelakrishnan Butterworths IndiaPublishers
2. Textbook on Environmental Law (2010) N. Maheshwara Swamy, Asia Law House Publishers

References

1. Gurudeep Singh (2005) Environmental Law in India, Mc Millan, New Delhi.
2. Shyam Diwan and Armin Rosencrany (2001) Environmental Law and Policy in India, Oxford University Press, New Delhi.
3. Singh G (1995) Environmental Law: International & National Perspectives.
4. Tamil Nadu Pollution Control Board (1999) Pollution Control Legislation Vol. I and II, Chennai.

Web References

1. cpcb.nic.in/
2. www.tnpcb.gov.in/
3. www.thesummitbali.com/
4. envfor.nic.in/legis/legis.html
5. edugreen.teri.res.in/explore/laws.htm
6. envfor.nic.in/legis/crz/crznew.html
7. rti.gov.in/
9. www.ngosindia.com/resources/pil.php

CORE XIII: 18UPEVS4C15

ENVIRONMENTAL ENGINEERING

Course Objectives:

The purpose of this course is to teach the students about the background of engineering principles, designs and methods to solve the environmental problems like wastewater treatment, sludge stabilization and biogas production, and to monitor environmental pollutants.

UNIT I - An Overview of Wastewater Treatment and Disposal

Environmental sanitation, wastewater - wastewater quantity and quality-characteristics - treatment required - preliminary, primary, secondary, and tertiary treatments - sedimentation - effluent disposal - chlorination - sludge stabilization - biosolids. Sewer system - design of sewers, estimation of sewage flow, sewage collection, and odor control.

UNIT II - Design of Pre and Primary Wastewater Treatment Plant

Principle and design of screening, equalization tank, grit chambers, rectangular and circular coagulation and flocculation tank, sedimentation tank. Chemically Enhanced Primary Treatment (CEPT) - Design for a Small Community level.

UNIT III - Design of Facilities for Aerobic Treatment of Wastewater

Principles and design of aerobic biological treatment of sewage - Activated sludge process, Oxidation Ditch, Aerobic lagoons, Trickling filters, Sequencing batch reactors, Fluidized-bed bioreactors - Nutrient removal and pathogen reduction.

UNIT IV - Anaerobic Treatment of Wastewater and Sludge Treatment

Design of facilities for anaerobic treatment of wastewater and sludge -Anaerobic digesters and septic tanks, Anaerobic filters, Upflow anaerobic sludge blanket reactor - Sludge thickening and digestion -Biogas production - Sludge dewatering process, Biosolids - drying and disposal.

UNIT V - Design of Air Pollution Control Equipments

Principle and design of minimum stack height - Settling chamber - Cyclone collector - Fabric filter and Electrostatic Precipitators (ESP) - Bioscrubbers.

Learning Outcomes:

After completing this course students will be able to:

- Understand the complex environmental issues.
- Know the various engineering strategies to apply to solve environmental issues.
- Understand the basic principles and methods of environmental engineering.
- Identify the suitable treatment methods for wastewater treatment.
- Identify an appropriate method for sludge stabilization.

- Understand the process of biogas production from sewage sludge.
- Use their acquired knowledge to design the reactors for sewage treatment.
- Monitor the environmental pollutants and control the treatment process.

Text Books

1. P. Venugopala Rao (2002). Textbook of Environmental Engineering PHI Learning Pvt. Ltd.
2. N. N. Basak (2017).Environmental Engineering Tata Mc.Graw Hill Publishing Company.

References

1. Air Pollution Control Technology Manual (1998) Overseas Environmental Cooperation Center, Japan.
2. Anne Maczulak (2010) Environmental Engineering: Designing a Sustainable Future, Infobase Publishing, NY, USA.
3. Louis Theodore (2008) Air Pollution Control Equipment Calculations, John Wiley & Sons, NJ, USA.
4. Mihelcic JR, Fry LM, Myre EA, Phillips L and Barkdoll BD (2009) Field Guide to Environmental Engineering for Development Workers - Water, Sanitation, and Indoor Air, American Society of Civil Engineers, USA.
5. Pawlowski A, Dudzinska MR and Pawlowski L (2013) Environmental Engineering, CRC Press, Boca Raton, FL, USA.

Web References

1. http://www.suez-environnement.com/design-construction-water-plants/
2. https://www.dsd.gov.hk/EN/Sewerage/Sewerage_Strategy/index.html
3. http://www.eolss.net/sample-chapters/c09/e4-11-05.pdf
4. http://onsite.tennessee.edu/Aerobic%20Treatment%20&%20ATUs.pdf
5. http://www.thomasnet.com/products/air-pollution-control-equipment-780809-1.html
6. https://www.env.go.jp/earth/coop/coop/document/01-apctme/contents.html
7. https://engineeringonline.ucr.edu/blog/what-are-advanced-water-treatment-processes/
8. http://gcus.jp/wp/wp-content/uploads/2014/06/ebd9e233be72625b03c96047573177f9.pdf
9. https://www.diva-portal.org/smash/get/diva2:808135/FULLTEXT02.pdf
10. https://www.host.nl/en/biogas-plants/sludge-treatment/

CORE XIII: 18UPEVS4C16

ENVIRONMENTAL AUDIT

Course Objectives:

The aim of this course is to provide students with a broad understanding about environmental auditing and its methodology, planning, implementation, and documentation.

UNIT I - Introduction to Environmental audit

Audit concept - terms and definitions. Environmental auditing – Principles, Scope, origin and nature, history, objectives,and types of audit - external audit, internal audit. Assessment method, environmental issues, identification of problems. Auditor's Code of Ethics.

Unit II - Frame work of Environmental audit

Scope of audit - the auditors - audit tools - steps in environmental auditing - Protocols and Checklists, procedures of pre-audit activities, on-site activities, post-audit activities.

Unit III - Planning and the course of the audit

Scope of the audit plan, responsibilities, resources and procedures within the audit records from the audit program, monitoring and reviewing the audit program. Start, setting objectives, scope and audit criteria, determining the feasibility of the audit, the audit team selection, establishing initial contact with the audited organization, document review, preparation of the on-site audit - program, allocation of team work, preparation of working documents.

Unit IV - Implementation of on-site audit

Initial meeting, communication during the audit, the role and responsibilities of guides and observers, collect and verify information - Environmental impact assessment - Environmental surveys - Environmental SWOT analysis - strength, weakness, opportunities and threats – Environmental quality management - summary of findings from the audit, preparation of audit findings, the final meeting.

Unit V - Certification

Audit reviews - preparation, approval and distribution of messages, Resolution of disagreements, corrective and preventive actions, Quantitative Assessment, Qualitative Assessment, Certification, accreditation, Environmental Statement.

Learning Outcomes:

After completing this course, students will be able to:

- Understand the process of auditing and environmental auditing.
- Know the applications of environmental auditing.
- Get knowledge of methodologies for environmental auditing
- Independently practice auditing procedure.
- Plan, execute and document the environmental audit.
- Commit the ethical commitment.
- Implementof environmental auditing.
- Get qualification for environmental auditing.

Text Books

1. Shrivastava, A. K. (20003) Environment Auditing. APH Publisher.
2. Environmental Auditing (1993)., CPCB Publication.

References

1. Simon Watson Pain (2018) Safety, Health and Environmental Auditing: A Practical Guide, Second Edition. CRC Press.
2. John T. Willig (1995) Auditing for Environmental Quality Leadership: Beyond Compliance to Environmental Excellence, 1st Edition.
3. Christopher Sheldon Mark Yoxon (2006) Environmental Management Systems: A Step-by-Step Guide to Implementation and Maintenance. Earthscan Publishers, UK.
4. Stephen Tinsley, Ilona Pillai (2006) Environmental Management Systems: Understanding Organizational Drivers and Barriers.

Web References

1. http://www.snh.org.uk/publications/on-line/advisorynotes/45/45.htm
2. http://www.nptel.ac.in/
3. https://www.epd.gov.hk/epd/english/how_help/tools_ea/tools_ea.html
4. https://www.soas.ac.uk/cedep-demos/000_P508_EAEMS_K3736-Demo/unit1/page_14.htm
5. http://www.bcorporation.net/sites/default/files/documents/bestpractices/em_environmental_audit.pdf
6. https://www.rmagreen.com/rma-blog/what-is-an-environmental-audit
7. https://industry.gov.au/resource/Programs/LPSD/Evaluating-performance-monitoring-and-auditing/Auditing/Pages/Environmental-audits.aspx
8. https://www.britsafe.org/audit-and-consultancy/audit/iso-14001-environmental-audit/
9. https://sisu.ut.ee/env-intro/book/module-3-introduction-auditing-waste

ELECTIVE COURSES

ELECTIVE I:18UPEVS1E01

ENERGY RESOURCES AND ENVIRONMENTAL SUSTAINABILITY

Course Objectives:

The purpose of this course is to understand the various forms of conventional energy resources, to learn the present energy scenario and the need for energy conservation, to explain the concept of various forms of renewable energy, outline division aspects and utilization of renewable energy sources for both domestics and industrial application and to analyse the environmental aspects of renewable energy resources.

UNIT I - Energy sources

Introduction to nexus between Energy, Environment and Sustainable Development; Energy transformation from source to services; Energy sources, sun as the source of energy; biological processes; photosynthesis; food chains, classification of energy sources, quality and concentration of energy sources; fossil fuel reserves - estimates, duration; theory of renewability, renewable resources; overview of global/ India's energy scenario.

UNIT II - Thermodynamics and Non-renewable Energy Sources

First and second laws of thermodynamics – Energy conversion – Global Energy crisis - Non-renewable energy sources: Fossil fuels – Composition and Classification of coal, crude oil and natural gas – Consumption and demands of coal, crude oil and natural gas – Environmental impacts of fossil fuel consumption

UNIT III - Renewable Energy Sources

Solar energy, geothermal, tidal, wind energy - Principals of generation of hydro-electric power - Ocean thermal energy conversion - Energy use pattern in different parts of the world - Management of renewable energy - Present scenario of renewable energy sources in India

UNIT IV - Green innovation & Sustainability

Criteria for choosing appropriate green energy technologies, life cycle cost; the emerging trends – process/product innovation-, technological/ environmental leap-frogging; Eco/green technologies for addressing the problems of Water, Energy, Health, Agriculture and Biodiversity- WEHAB (eco-restoration/ phyto-remediation, ecological sanitation, renewable energy technologies, industrial ecology, agro ecology and other appropriate green technologies); design for sustainability (D4S).

UNIT V - Green Energy and Sustainable Development

The inseparable linkages of life supporting systems, biodiversity and ecosystem services and their implications for sustainable development; global warming; greenhouse gas emissions, impacts, mitigation and adaptation; future energy Systems- clean/green energy technologies; International agreements/conventions on energy and sustainability - United Nations Framework Convention on Climate Change (UNFCC); sustainable development.

Learning Outcomes:

After completing this course, the students will be able to:

- Describe the environmental aspects of non-conventional energy resources. In Comparison with various conventional energy systems, their prospects and limitations.
- Know the need of renewable energy resources, historical and latest developments.
- Describe the use of solar energy and the various components used in the energy production with respect to applications like - heating, cooling, desalination, power generation, drying, cooking etc.
- Appreciate the need of Wind Energy and the various components used in energy generation and know the classifications.
- Understand the concept of Biomass energy resources and their classification, types of biogas Plants- applications
- Compare Solar, Wind and bio energy systems, their prospects, Advantages and limitations.
- Acquire the knowledge of fuel cells, wave power, tidal power and geothermal principles and applications.

Text Books:

1. Boyle GF (2004) Renewable Energy - Power for a Sustainable Future, Second edition, Oxford University Press, UK.
2. Glyll Henry and Gary W. Heinke (1996) Environmental Science and Engineering Pearson Education, New Delhi.

References:

1. John Andrews and Nick Jelly (2007) Energy Science: Principle, Technologies, and Impacts - Oxford University Press, UK.
2. Kurian Joseph and Nagendra R (2004) Essential of Environmental Studies, Pearson Education, New Delhi.
3. Sharma BK and Kaur SH (1992) Environmental Chemistry. Goel Publishing House, Meerut.
4. Taylor and Miller (2008) Environmental Science -10th Edition, Thomson Asia Pvt. Ltd. Publications, Singapore.
5. Viswanathan B (2006) An Introduction to Energy Sources- Indian Institute of Technology.

ELECTIVE II:18UPEVS1E02

ECO-TOURISM AND WILD LIFE MANAGEMENT

Course Objectives:

The purpose of this course is to know about the concept of ecotourism, development of ecotourism places, the impacts and management issues of ecotourism.

UNIT I - Introduction to Eco-Tourism

Principles of Ecotourism – Types of Ecotourism – Concepts of Ecotourism – Origin of Ecotourism – Objectives of Ecotourism – Benefits of Ecotourism – Trends affecting Ecotourism. Concepts of Tourism - Classification – Religious Tourism – Cultural Tourism – Heritage Tourism – Monumental Tourism – Adventure Tourism – Mass Tourism – Sustainable Tourism – Consumptive and NonConsumptive Tourism.

UNIT II - Interesting Eco-tourism

Places of interests of Ecotourism – Ecocircuit of the Western Ghats – Infrastructural facilities for Ecotourism – Maintenance of Ecological Centers – Important Biosphere Reserves. Target group of Ecotourism – Ecotourism and Conservation – Study of different Ecosystem – Rain forest Ecotourism – Mountain Ecotourism – Polar, Islands and Coasts Ecotourism – Wilderness – Marine Ecosystem.

UNIT III -Impact of Eco-tourism

Impact of Ecotourism – Economic Impacts (Fiscal Impacts, Concept and Methods) – Types and Degree of Impacts from Ecotourism activities – Socio-cultural Impacts – Ecotourism related organization – Ecotourism Research - Disasters and Ecotourism.

UNIT IV - Wildlife Conservation

Wildlife conservation - Protected Areas Network in India - Goals of management, Strategies for planning. Factors influencing wildlife management such as habitats, population, behavior, foodhabits, health, etc. - Tools for data collection and analysis.

UNIT V - Wildlife Management

Human land-use and wildlife management units - Important projects for the conservation of wildlife in India - Role of local communities in wildlife management – Man-wildlife conflicts - Poaching of wildlife - Wild life conservation laws - The Wildlife (Protection) Act, 1972 (2002 amendment)

Learning Outcomes:

After completing this course, the students will be able to:

- Know the principles and concept of ecotourism.
- Understand the types and benefits of ecotourism.
- Know interesting places of ecotourism.
- Evaluate the impacts of ecoutourism on the environment.

- Understand the need for wildlife conservation.
- Relate wildlife resources with Ecotourism.
- Acquire the knowledge on management of Ecotourism.

Text Books

1. Dasman RF (1968) Environmental Conservation: John Wiley and Sons, New York.
2. Mukherjee N (2008) Ecotourism and sustainable Development. Cybetech Publications, New Delhi.

References:

1.. Prabhas Chandra (2003) Global Ecotourism, Kaniskha Publishers, New Delhi.
2. Sinha, P.C (2003) Encyclopedia of Ecotourism, Volume I, II and III, Anmol Publications Pvt. Ltd., New Delhi.
3. Weaver DB (2001) The Encyclopedia of Ecotourism, CABI Publishing, UK.

Web References

1. www.incredibleindia.org/newsite/cms_page.asp?pageid=994
2. www.nativescience.org/html/eco-tourism.html
3. www.wcsindia.org/
4. envfor.nic.in/divisions/9-10.pdf
5. http://www.ceeraindia.org/documents/lib_tabofcon_160300.htm

ELECTIVE III:18UPEVS2E03

ENVIRONMENTAL NANOTECHNOLOGY

Course Objectives:

The purpose of this course is to provide background, principles, development of nanomaterials and their applications pertaining to remediation of environmental contaminants, water purification, and to understand the impact of nanomaterials on environment.

UNIT I - Introduction to Nanotechnology

Introduction to Nanoscience and Nanotechnology - Nanoscale Properties -Electrical, Optical, Chemical - Engineered Nanomaterials - Carbon based nanomaterials -Fullerins, Carbon Nanotubes; Metal based Nanomaterials - Metal and Metal oxide Nanoparticles; Dendrimers – Nanocomposites - Nonporous materials.

UNIT II - Synthesis of Nanomaterials

Introduction to synthesis of nanomaterials - Bottom-up approach - Top-down approach - Physical methods - ball milling, melt mixing, physical vapour deposition, sputter deposition, evaporation; Chemical methods - chemical reduction, sol-gel method, photochemical synthesis, electrochemical synthesis, emulsion synthesis, sonochemical methods, microwave assisted synthesis; Biological methods - Green synthesis of nanoparticles using Bacteria - Fungi - Actinomycetes- Plants and plant metabolites.

UNIT III - Characterization of Nanomaterials

Nanomaterials characterization using Spectrometer - UV-Vis, FT-IR, Fluorescence Spectrophotometer,Raman Spectroscopy; Electron Microscopy - TEM, SEM, Cryo-SEM, Scanning Probe Microscopy (AFM, STM), Confocal Microscopy, Diffraction Techniques (XRD, Synchrotron).

UNIT IV: Environmental Applications of Nanomaterials

Nanomaterials for environmental remediation – Nanoscale zero-valent iron (NZVI), Titanium dioxide nanoparticles - Bimetallic nanoparticles - Silver nanoparticles - Metal oxide nanoparticles - Nanoadsorbents - Nanocatalysts - Nanoflocculant. Degradation and transformation of environmental pollutants - Halogenated Organic Solvents, Persistent Organic Pollutants, PPCPs, dyes, explosives, toxic heavy metals - arsenic and chromium. Nanoremediation - Ground Water Remediation - Permeable Reactive Barrier - Air purification - Soil remediation.

UNITV - Nanotoxicology and Environmental Impacts

Routes of nanomaterials into the water environment, Hazardous effects of nanomaterials on Human and Animal Health. Impacts of nanomaterials on environmental microbial community - bioaccumulation - cytotoxic - genotoxic - effects of engineered nanoparticles.

Learning Outcomes:

After completing this course students will be able to:

- Understand the background about on nanotechnology.
- Understand the different types of nanomaterials.
- Acquire skills to synthesis the nanomaterials by different methods.
- Characterize the properties of the nanomaterials.
- Apply nanomaterials for degradation of pollutants.
- Acquire skills in nanoremediation
- Find out the impact of nanomaterials on environment.
- Develop ecofriendly nanomaterials.

Text Books

1. A Textbook of Nanoscience and Nanotechnology (2012)T. Pradeep. Tata McGraw-Hill Education (India).ISBN: 9781259007323.
2. Textbook of Nanoscience and Nanotechnology (2013). Murty, B.S., Shankar, P., Raj, B., Rath, B.B., Murday, J.

References

1. Pradeep, T. (2008) Nano: The Essentials - Understanding Nano Science and Nanotechnology,Tata Mc.Graw Hill Professional.
2. Rao, C.N.R., Muller, A., Cheetham, A.K. (2004) The Chemistry of nanomaterials: Synthesis, Properties and Applications.
3. Niemeyer, C.M., Mirkin, C.A. (2004)Nanobiotechnology:Concepts, Applications and Perspectives, Wiley VCH.
4. Mirkin, C.A. Niemeyer, C.M. (2007) Nanobiotechnology - II more concepts and applications, Wiley VCH.
5. Zhang, T.C., Hu, Z., Surampalli, R., Tyagi, R.D. Lai, K.C.K, Lao, I.Mc. (2009) Nanotechnologies for Water Environment Applications. American Society of Civil Engineers (ASCE) Publications.
6. Mark Wiesner, Jean-Yves Bottero (2007) Environmental Nanotechnology: Applications and Impacts of Nanomaterials, McGraw, Hill Professional.
7. Simeonova P.P, Opopol N, and Luster M.I. (2006) Nanotechnology - Toxicological Issues and Environmental Safety, Springer.
8. Poole, C.P.Jr.,Owens, F.J. (2003) Introduction to Nano Technology Wiley India Pvt Ltd.

Web References

1. https://foresight.org/nano/
2. https://www.nano.gov/you/environmental-health-safety
3. http://www.trynano.org/nanomaterials/nanoparticles
4. http://nano.materials.drexel.edu/research/synthesis-of-nanomaterials/carbon-onions/
5. http://shodhganga.inflibnet.ac.in/bitstream/10603/23334/10/10_chapter%203.pdf
6. https://aip.scitation.org/doi/full/10.1063/1.4942825
7. https://ec.europa.eu/health/scientific_committees/opinions_layman/nanomaterials/en/l-3/6.htm
8. https://www.kemi.se/global/pm/2015/pm-1-15-impact-assessment-of-further-regulation-of-nanomaterials-at-a-european-level.pdf

ELECTIVE IV:18UPEVS2E04

ENVIRONMENTAL HEALTH AND SAFETY

Course Objectives:

The purpose of this course is to understand the role of environmental health, protection, safety at work, occupational health and safety, compliance and best practices.

UNIT I - Environmental Health

Concept and scope; Global and regional perspectives; Basic requirements for healthy environment; Environmental quality, human exposure and health impact – impact of environmental factors on human health

UNIT II - Industrial Pollution and Chemical Safety

Extent of industrial pollution, Public exposure from industrial sources, Hazards by industry, Major chemical contaminants at workplace, Industrial environmental accidents

UNIT III - Environmental Diseases

Asbestosis, Silicosis, Sycosis, Asthma, Fluorosis and Allergies; Epidemiological issues - Malaria and Kala -azar

UNIT IV - Occupational Safety and Health

Occupational hygiene/ safety and disease; Principles and methods of occupational health, Health problem due to industrial dust, heat, chemicals, noise, toxic gases and metals, Health hazard in agriculture - Pesticides and environment, Pesticides and human health.

UNIT V - Environmental Health Hazard and Risk Assessment

Hazard and risk, Biological, chemical, physical and psychological health hazard; Health risk assessment and management

UNIT VI

Safety and health Management System model, Participation and Representation, Training, Awareness and competence; Document Control : Safety and Health Management System records: Operational Control – Workplace Precautions, Safety And Health training and Competence. Training for Safety, Health, Rules and regulation of safety department

Text Books:

1. Shaw, J. Chadwick (1998) Principles of Environmental Toxicology,Taylor& Francis Ltd

2. AnnaleeYassi, TordKjellstr"om, Theo de Kok, Tee Guidotti (2001). Basic Environmental Health, Oxford University Press

References:

1. Monroe T. Morgan (2003) Environmental Health, Third Edition, Thomson/Wadsworth Publishers.

2. . Koren, H. (2002). Handbook of Environmental Health and Safety - Principle and Practices, Fourth Edition, Lewis Publishers, CRC Press.

3. Risk assessment- A Practical Guide, 1993, Institution of Occupational Safety and Health, United Kingdom

Web References:

1. www.ehs.ucsb.edu/
2. www.ifc.org/ehsguidelines
3. slintec.lk/wp-content/uploads/2011/08/HealthSafetyManual.pdf

ELECTIVE V: 18UPEVS2E05

ENVIRONMENTAL ECONOMICS

Course Objectives:

The purpose of this course is to introduce different aspects of the sub-discipline of environmental economics to the students and enable them to understand the economics of the relationship between economic activities and environmental impacts

---

UNIT I - Environmental Economics

Meaning and Central Themes of Environmental Economics, Ecology- Environment and Economy Perspectives, Environment and Economy Linkages, Different Perspectives on Development - Limits to Growth, Thermodynamics School and Simon Julian's Thesis of "Ultimate Resource", Current State of Environment, Sustainable Development: Basic Issues, Concepts, Definitions Approaches, Rules and Indicators

UNIT II – Micro and Macro economics

Externality, Public goods, Asymmetric Information, Environmental problem as an Externality, Environmental Conservation as a Public Good , Correcting Market Failures, Impact of environmental damage on macroeconomic variables, Concepts on Green National Income Sustainable Development - Weak notion - Strong Notion, Practising Sustainable Development.

UNIT III - Cost-Benefit Analysis and Environment

Damage and Benefit Estimation: Background and Introduction, Some objections to CB Analysis Benefit "Routes" – A Brief Review , Demand shifts: Complementarity, Cost Shifts: Averting, Replacing or Curing Expenditure, Travel Cost and Its Relation to Environmental Quality, Hedonic Pricing, Direct Methods of Benefit Estimation

UNIT IV - Economics of Natural Resources

Natural Resources and the Economy, Natural Resource Scarcity-a Historical Perspective Economics of Natural Resource Exploitation, Economic Analysis of Non-Renewable and Renewable Natural Resources; Optimal Extraction of Non-renewable Resources, Common Property Management Open access and community management, Coordination problem - Folks Theorem - Privatisation of the Natural Resources

UNIT V- Environmental valuation, monitoring and enforcement

Theory of Environmental Valuation- Introduction to Methods of Valuation. Theory of Regulation and instruments of Regulation, Elements of a Monitoring and Enforcement System Economics of Monitoring and Enforcement, Major Laws and policies for enforcement.

Learning Outcomes:

After completing this course the students will be able to:

- Aware of the concepts of environmental economics.
- Know the macro and micro issues and their impact.
- Acquaint adequate knowledge on sustainable development concept.
- Understand the impact of economic growth on environment.
- Know the concept of natural resource economics.
- Understand the process of cost benefit analysis.
- Know the valuation, monitoring and enforcement methods.
- Understand various laws and policies for environmental economics.

Text books

1. Nick Hanley, Jason F. Shogren and Ben White, Environmental EconomicsIn Theory and Practice, MacMillan Press Ltd.. Hampshire
2. Russell, Clifford. S., Economics of Natural Resources and Environment, Oxford University Press, New York.

References

1. Baumol, William J. and Wallace E. Oates, (1988) the Theory of Environmental Policy, 2nd Edition, Cambridge University Press, (Ch.3,4,5)
2. Dasgupta, Kristrom and Maler (1997), Poverty, institutions and Environmental Resource Base, in J. Berhman & T. N. Srinivasan (Eds.), Handbook of Development Economics, Vol. IIIA.
3. Hanley, Shogren and White (1997), Environmental Economics in Theory and Practice, Macmillan India Ltd.(and Oup Edition).
4. Hussen, Ahmed. M,(2000), Principles of Environmental Economics: Economics,Ecology and Public Policy, Routledge, New York. Kadekodi,Gopal K.(2004) Ed."Environment Economics in Practice. Oxford University Press, New York.
5. Kolstad, D. Charles. (2004). Environmental Economics. Oxford University Press,• New Delhi

Web References

1. www.evri.ca
2. www.rff.org
3. www.undp.org
4. www.worldwatch.org
5. www.ecologicaleconomics.org

SUPPORTIVE COURSES

SUPPORTIVE I: 18UPEVS2S01

ECOLOGY AND ENVIRONMENT

Course Objectives:

The purpose of this course is to introduce and provide basic knowledge on the concept and principles of Environmental science, ecology and ecosystems, and to give adequate knowledge on natural resources, biodiversity and their conservation.

UNIT I - Introduction

Environmental Science - Definition, Scope and Importance - *Components of the environment*: Atmosphere, Hydrosphere, Lithosphere and Biosphere – Structure and composition - History and scope of Ecology - Terminologies in ecology.

UNIT II - Ecosystem

Types of ecosystems – Terrestrial and aquatic ecosystems, Structure and functional aspects of ecosystem - Food Chain, Food Web, Energy flows, Ecological pyramids - Productivity of an ecosystem - Biogeochemical cycling - Ecological succession.

UNIT III - Population Ecology

Population ecology - Levels of Organization, population characteristics - density, natality, mortality, survivorship curves, age distribution, growth curves and models - Population interactions - Co-evolution, Neutralism, symbiosis, commensalism, mutualism, antagonism, antibiosis, parasitism, predation; competition- inter and intra specific.

UNIT IV - Natural Resources

Classification and significance of natural resources – Soil, forest, water, wildlife and minerals - Concepts and approaches of natural resource conservation - Natural resources of India - Legal provisions to conserve natural resources in India

UNIT V - Biodiversity

Introduction to Biodiversity - Species, Genetic, Community and Ecosystem diversity - *Biodiversity Conservation*: Principles and Strategies – In-situ and Ex-situ Conservation - Megadiversity zones and Hot Spots - *Use of Biodiversity:* Food, medicine, raw material, aesthetic and cultural value.

Learning Outcomes:

After completing this course, students will be able to:

- Understand the basic concepts and functions of environment, ecology and ecosystem
- Adequate knowledge on the status of available natural resources and biodiversity and its conservation principles.
- Understand the significance and need for environmental protection and sustainability.

Text Books

1. Sharma P. D (2015). Ecology and Environment (12th Edition). Rastogi Publications, New Delhi.
2. Eugene P. Odum and Gary W. Barrett. (2004). Fundamentals of Ecology (5th Edition) Brooks/Cole Publishers.

References

1. Rana SVS (2005) Essentials of Ecology and Environmental Sciences, Prentice-Hall of India Private Limited, New Delhi, India.

Web references

1. http://www.newagepublishers.com/samplechapter/000964.pdf
2. www.ecosystem.org/types-of-ecosystems
3. www.ecologyconnections.ca/pop3research.php
4. http://ocw.korea.edu/ocw/college-of-life-sciences-and-biotechnology/general-biology/PDF/10-1GeneralBiol%20CH50.pdf
5. www.uic.edu/classes/bios/bios101/competitionmurray.PPT
6. india.gov.in/topics/environment-forest/natural-resources
7. www.jamaicachm.org.jm/BHS/conservation.htm

SUPPORTIVE II: 18UPEVS2S02

ENVIRONMENTAL HEALTH AND SAFETY

Course Objectives:

The purpose of this course is to understand the role of environmental health, protection, safety at work, occupational health and safety, compliance and best practices.

UNIT I - Environmental Health

Concept and scope; Global and regional perspectives; Basic requirements for healthy environment; Environmental quality, human exposure and health impact – impact of environmental factors on human health

UNIT II - Industrial Pollution and Chemical Safety

Extent of industrial pollution, Public exposure from industrial sources, Hazards by industry, Major chemical contaminants at workplace, Industrial environmental accidents

UNIT III - Environmental Diseases

Asbestosis, Silicosis, Sycosis, Asthma, Fluorosis and Allergies; Epidemiological issues - Malaria and Kala -azar

UNIT IV - Occupational Safety and Health

Occupational hygiene/ safety and disease; Principles and methods of occupational health, Health problem due to industrial dust, heat, chemicals, noise, toxic gases and metals, Health hazard in agriculture - Pesticides and environment, Pesticides and human health.

UNIT V - Environmental Health Hazard and Risk Assessment

Hazard and risk, Biological, chemical, physical and psychological health hazard; Health risk assessment and management

Learning Outcomes:

After completing this course, students will be able to:

- Understand the importance of maintaining a safe workplace.
- Understand that safety standards must be maintained in compliance with regulatory requirements and within limits.
- Acquire knowledge on the industrial pollution and environmental diseases
- Demonstrate an understanding of workplace injury prevention, risk management, and incident investigations.
- Understand the role of safety in the business community.
- Understand the acute and chronic health effects of exposures to chemical, physical and biological agents in the workplace.
- Demonstrate knowledge of different types of exposure and biological effects, exposure guidelines and basic workplace monitoring
- Understand the significance Occupational health, its issues and risk assessment.

Text Books

1. Shaw, J. Chadwick (1998) Principles of Environmental Toxicology, Taylor& Francis Ltd
2. AnnaleeYassi, TordKjellstr"om, Theo de Kok, Tee Guidotti (2001). Basic Environmental Health, Oxford University Press

References

1. Shaw, J. Chadwick (1998) Principles of Environmental Toxicology, Taylor& Francis Ltd
2. Annalee Yassi, Tord Kjellstr"om, Theo de Kok, Tee Guidotti (2001). Basic Environmental Health, Oxford University Press
3. Monroe T. Morgan (2003) Environmental Health, Third Edition, Thomson/Wadsworth Publishers.
4. Koren, H. (2002). Handbook of Environmental Health and Safety - Principle and Practices, Fourth Edition, Lewis Publishers, CRC Press.
5. Risk assessment- A Practical Guide, 1993, Institution of Occupational Safety and Health, United Kingdom

Web References:

1. www.ehs.ucsb.edu/
2. www.ifc.org/ehsguidelines
3. slintec.lk/wp-content/uploads/2011/08/HealthSafetyManual.pdf

SUPPORTIVE III: 18UPEVS3S03

ENVIRONMENTAL POLLUTION

Course Objectives:

The purpose of this course is to gain awareness of environmental pollution and its types, sources, effects, monitoring & control techniques and to understand the fundamental principles governing the interactions between transport of pollutants in the environment.

UNIT I - Environmental Pollution

Environmental pollution – Types, causes and effects - Sources of pollution – Point and non-point sources - Classification of pollutants - Contaminant types - Control measures and management perspectives for environmental pollution

UNIT II - Air Pollution

Air pollution - Natural and anthropogenic sources of pollution - Primary and secondary pollutants - Transport and diffusion of pollutants - Behavior of pollutants in the atmosphere - Methods of monitoring and control of air pollution - SO_2, NOx, CO, SPM.

UNIT III - Water Pollution

Water pollution – Types, sources and consequences of water pollution - Physico-chemical and bacteriological sampling - Water quality and standards - Sewage and wastewater treatment and recycling. *Marine Pollution*: Sources of marine pollution and its control - Effects of pollutants on human beings, plants, and animals

UNIT IV - Soil Pollution

Soil pollution - chemical and bacteriological sampling as analysis of soil quality - Effects and remediation techniques for Soil pollution.

UNIT V - Noise, Thermal & Radiation Pollution

Noise pollution - Sources of noise pollution - Measurement and indices – Effects and Control measures. *Thermal Pollution* – Sources & Effects. *Radiation Pollution* – Sources, Measurement, Units and control techniques.

Learning Outcomes:

After completing this course, the students will be able to:

- Learn about the air, water and soil pollutants, sources and its effects.
- Have clear understanding on the air, water, noise and radiation standards and its techniques.
- Apply relevant techniques, skills and modern engineering tools to solve the environmental problems.

Text Book

1. Shafi, S.M. (2005) Environmental Pollution. Atlantic Publishers & Dist.,

References

1. Khitoliya, R.K. (2012) Environmental Pollution, 2nd edition, S.Chand Publishing.
2. Khopkar, S.M. (2013) Environmental Pollution: Monitoring and Control, New Age International Publishers.
3. Cunningham W. P and Cunningham M.A (2004) Principles of Environment Science. Enquiry and Applications. 2nd ed. Tata McGraw Hill, New Delhi.
4. Sharma, B.K. (2000) Environmental Chemistry, Goel Publishing House, Meerut.

Web References

1. www.uccee.org/Environmental_Pollution.html
2. www.who.int/topics/environmental_pollution/en/
3. www.nrdc.org/water/
4. environment.nationalgeographic.com/environment
5. www.noisecontrol.com/the-common-causes-of-noise-pollution
6. www.conserve-energy-future.com/causes-and-effects-of-soil-pollution.php

SUPPORTIVE IV: 18UPEVS4S04

GLOBAL ENVIRONMENTAL ISSUES AND MANAGEMENT

Course Objectives:

The purpose of this course is to focuses on major global environmental issues including population explosion, biodiversity loss, pollution, energy use, climate change and best environmental technologies for a sustainable development and how they are managed in various settings around the world.

UNIT I – Human Population and Environment

Basic demographic concepts: Growth, fertility, mortality and migration - Overview of population growth – Population distribution and Urbanization - Poverty, food security and environmental degradation – Development vs Environment

UNIT II – Global Atmospheric Changes

Global Air Quality and CO_2 concentration scenario - Role of air pollutants in climate change – Sources of greenhouse gases - Ozone depleting substances – Facts and figures of current global warming scenarios in the world - El Niño and La Niña – Recent extreme events in the world – Global consequences of El Niño

UNIT III – Overexploitation of Biological Resources

Overexploitation of natural resources: Ecological footprint – Earth Overshoot Day - Water resources: Status of groundwater quality in India – Desertification. Soil Resources: Global threats for soil quality - Loss of organic carbon. Biodiversity Resources: Biodiversity Hot spots in India – Bioprospecting – Factors influencing biodiversity loss

UNIT IV – Global Disaster Episodes

Geological Disasters: Earthquake: Origin of Earthquake, its magnitude and intensity - Earthquake prone zones in India - Effects of earthquake. Volcanoes: Types of volcanic eruptions - Active volcanic belts in the world - Nature and magnitude of volcanic hazards. Hydrological hazards: Flash flood - Flood management strategies - Regions of flood prone zones in India – Flood forecasting and warning – Man -made disasters: Oil spills – Forest fire - Global Outlook on Disaster Science

UNIT V – Sustainable Environmental Management

Utilization of renewable energy resources – Solar, Wind, Hydroelectric and Biomass energy resources – Phytotechnologies for soil and water decontamination programmes – Sustainable agricultural practices (Biofertilizers and Biopesticides) – National Action Plan on Climate Change (Eight missions) – Recent initiatives related to climate change adaptation and mitigation in India - The Global 200: Priority Ecoregions for Global Conservation – UNDP Sustainable Development Goals 2030 Agenda

Learning Outcomes:

After completing this course, students will be able to:

- Clearly identify important global, national, and local issues relating to population, food, and the environment
- Explain the causes and consequences of the issues identified above.
- Communicate environmental issues in a professional manner.
- Understand how to work in a team in a scholarly and professional setting.

Text Books

1. Frances Harris (2012) Global Environmental Issues, 2nd edition, John Wiley & Sons Ltd., UK.
2. Stavros G. Poulopoulos and Vassilis J. Inglezakis (2016) Environment and Development: Basic Principles, Human Activities, and Environmental Implications. Elsevier, Netherlands.

References

1. Donald Hyndman and David (2005) Hyndman Natural Hazards & Disasters, Cengage Learning, USA.
2. John V. Walther (2014) Earth's Natural Resources, Jones & Bartlett Learning, USA.
3. Prasad Modak (2018) Environmental Management towards Sustainability, CRC Press, FL, USA.
4. Prasenjit Mondal and Ajay K. Dalai (2017) Sustainable Utilization of Natural Resources, CRC Press, FL, USA.
5. Rajeev Pratap Singh, Anita Singh, Vaibhav Srivastava (2017) Environmental Issues Surrounding Human Overpopulation, IGI Global, USA.
6. Raveendranathan D (2018) Development lead to Pollution and Depletion of Natural Resources, Notion Press, Chennai.
7. Serge Morand, Claire Lajaunie, Rojchai Satrawaha (2017) Biodiversity Conservation in Southeast Asia: Challenges in a Changing Environment, Earthscan from Routledge, UK.
8. Thangavel P and Sridevi G (2015) Environmental Sustainability: Role of Green Technologies, Springer, India.

Web References

1. https://www.stateofglobalair.org/sites/default/files/soga-2018-report.pdf
2. www.who.int/airpollution/
3. https://unfccc.int/
4. re.indiaenvironmentportal.org.in/files/part%20II%20groundwater%20CPCB.pdf
5. https://www.footprintnetwork.org/our-work/earth-overshoot-day
6. https://www.elsevier.com/__data/assets/pdf.../ElsevierDisasterScienceReport-PDF.pdf
7. siteresources.worldbank.org/INTDISMGMT/Resources/0821363328.pdf
8. https://link.springer.com/chapter/10.1007/978-981-10-1866-4_2
9. www.ipcc.ch/
10. https://climate.nasa.gov/

PRACTICALS

SEMESTER I

PRACTICAL I: 18UPEVS1P01

Ecology, Biodiversity and Conservation, Environmental Chemistry and, GIS and Remote Sensing

Course Objectives:

The purpose of this course is to obtain the knowledge in handling and analyse the environmental samples for chemical experiments, to gain hands-on experience with study design, laboratory measurements, monitoring equipment and sophisticated instruments and will sample both in the laboratory and the ambient environment as part of this experiential course to gain practical experience at environmental measurements.

1. Estimation of primary productivity of an ecosystem.
2. Determination of minimum quadrat size for community study.
3. Estimation of pH, conductivity, acidity and alkalinity.
4. Estimation of Total Suspended Solids & Total Dissolved Solids.
5. Estimation of Dissolved Oxygen and Biological Oxygen Demand.
6. Estimation of Chemical Oxygen Demand.
7. Determination of specific gravity and moisture content of the soil.
8. Importing and geo referencing of satellite images.
9. Visual interpretation Digitization and editing of maps (topo sheets).
12. Staining techniques- Simple, Grams & Spore.
13. Enumeration of microbes from sewage, soil & air.
14. Most probable number (MPN) techniques.
15. Isolation and Identification of Mycorrhizae from Plant Root.

Learning Outcomes:

After completing this course, the students will be able to:

- Design and carry out scientific experiments as well as accurately record and analyze the results of such experiments.
- Acquire skills in problem solving, critical thinking and analytical reasoning as applied to scientific problems.
- Acquire analytical skill to characterize the wastewater.
- Communicate the results of scientific work in oral, written and electronic formats to both scientists and the public at large.
- Prepare microbial culture media and isolate pure microbial cultures.

SEMESTER II

PRACTICAL II: 18UPEVS2P02

Environmental Pollution and Control Strategies, Environmental Biotechnology and Climate Change and Current Issues

Course Objectives:

The purpose of this course is to provide students with an understanding of important facts, concepts and the investigative procedures of a microbiology laboratory and to train future professionals with a deep understanding of the molecular processes of microbes.

1. Estimation of particulate matter (PM)
2. Estimation of SO_2 and NOx
3. Determination of noise levels at various sites
4. Isolation of Genomic DNA and
5. Agarose Gel Electrophoresis
6. PCR Techniques - Amplification of 16S rRNA gene.
7. Production of microbial enzymes - cellulase and xylanase
8. Production of bioflocculant.
9. Biodegradation of pollutants – PAHs.
10. Demonstration of greenhouse effect and global warming.

Learning Outcomes:

After completing this course, the students will be able to:

- Design and carry out scientific experiments as well as precisely record data.
- Perform molecular level analysis and understand the genetic mechanism.
- Produce enzymes from microbial sources and to perform biodegradation studies.
- Acquire skills in air pollution monitoring and bioremediation.
- Understand the greenhouse effect.

SEMESTER III

PRACTICAL III: 18UPEVS1CP03

Waste Management, Environmental Impact Assessment and Disaster Management, and Environmental Biochemistry and Toxicology and Environmental Engineering

Course Objectives:

The purpose of this course is to provide students with an understanding of waste management, EIA Procedures, and to provide practical knowledge on biochemistry, toxicology and environmental engineering experiments.

1. Segregation of municipal waste
2. Preparation of vermicompost
3. Preparation of EIA report for environmental clearance (EC)
4. Preparation of checklists for EIA study
5. Isolation of environmental mutants
6. Mitotic cell division – abnormalities - Onion root tip squash
7. Western blotting
8. Comet assay technique, estimation of protein, arbohydrate and fats.
9. LC_{50} and LD_{50} determination of pesticide
10. Calculation and designing of sedimentation tank and clariflocculator
11. Calculation and designing of sanitary landfills.
12. Calculation and designing of electrostatic precipitator

Learning Outcomes:

After completing this course, the students will be able to:

- Understand the waste management process.
- Acquire skills in recycling of organic wastes.
- Acquire knowledge in EIA procedure and to prepare EIA report.
- Perform experiments related to biochemistry, toxicology and environmental engineering.
- Perform experiments and design experiments efficiently.
- Emphasize practical experience through the use of cutting edge techniques in research laboratories.

PERIYARUNIVERSITY
DEPARTMENT OF ENVIRONMENTAL SCIENCE
PeriyarPalkalai Nagar, Salem-11.

Scheme of Practical Examination

I/II/III Semester M.Sc. Examination, ..MONTH …YEAR

ENVIRONMENTAL SCIENCE

Duration: 6 Hrs **Max. Marks : 60**

Q.1.	Conduct given Experiment, Write a procedure and Calculate the results - Major Practical	20 Marks
Q.2.	Minor Practical	15 Marks
Q.3.	Identify and Critical comment on. (Specimens / Spotters)	3 X 5 = 15 Marks

A.

B.

C.

Viva-Voce	5 Marks
Class Record	5 Marks

IV Semester

Industrial Visits / Study Tour **Max. Marks: 50**

Report of industrial visit, study tour and sampling	40 marks
Viva-Voce	10 marks

IV Semester

M.Sc. Examination Project work (Dissertation) **Max. Marks: 150**

Periodical Review	50 Marks
Dissertation Thesis	75 Marks
Viva-Voce	25 Marks