Learning Outcomes-based Curriculum Framework (LOCF) for

Post-graduate Programme

M.Sc. Environmental Sciences

(Under credit and semester system w.e.f.2020 admissions)

UNIVERSITY OF KERALA

2020

UNIVERSITY OF KERALA

Syllabus for M.Sc. Environmental Sciences

Programme Specific Outcomes (PSO) for M.Sc. Environmental Sciences	
PSO 1	Create a broad base of knowledge about environmental systems, including the Earth's atmosphere, hydrosphere, lithosphere, and biosphere
PSO 2	Enable students in identification of environmental problems at local, regional and global scale
PSO 3	Empower the candidate to acquire knowledge of various techniques and training on modern instrumentation for environmental analyses
PSO 4	Sensitize the students towards environmental issues, impacts, management strategies and policies adopted for conservation.
PSO 5	Expose the students to multi-faceted environmental issues through field visits and study tour and equip them to solve real-life problems
PSO 6	Provide practical and hands on training in environmental techniques through green skill training programme.
PSO 7	Train the candidate to take up roles as environmental analysts, environmental auditors and environmental mangers with an emphasis on environmental monitoring and pollution control.
PSO 8	Help students to prepare for a successful career in environmental departments, research institutes, industries, academic institutes and NGOs.
PSO 9	Orient the students for entry to M.Phil / Ph.Dprogrammes by assuring research background.

Sem. No.	Course Code	Name of the Course	No. of hours per week			Credits
			L	T	P/F/I	
I	**Core Courses (CC)**					
	ENS-CC-511	Ecology and Ecosystem Dynamics	3	1	2	4
	ENS-CC-512	Environmental Toxicology	3	1	2	4
	ENS-CC-513	Environmental Chemistry	3	1	2	4
	ENS-CC-514	Environmental Geology	3	1	2	4
	ENS-CC-515	Meteorology and Climate Change	3	1	0	3
	Discipline-Specific Elective (DE)					
	ENS-DE-516	Biochemistry and Nanobiology	2	1	0	2
II	**Core Courses**					
	ENS-CC-521	Environmental Techniques	2	1	2	3
	ENS-CC-522	Environmental Microbiology	3	1	2	4
	ENS-CC-523	Environmental Genetics and Biotechnology	4	1	0	4
	ENS-CC-524	Remote Sensing and GIS	2	1	2	3
III	**Core Courses**					
	ENS-CC-531	Environmental Engineering and Pollution Control	4	1	0	4
	ENS-CC-532	Environmental Economics and Policies	4	1	0	4
	ENS-CC-533	Environmental Impact Assessment and Disaster Management	3	1	0	3
	ENS-CC-534	Field Study	0	0	4	2
	Discipline-Specific Elective (DE)					
	ENS-DE-535	Integrated Waste Management	2	1	0	2
	ENS-CC-541	Natural Resources and Energy Management	4	1	0	4
IV	ENS-CC-542	Internship	0	0	4	2
	ENS-CC-543	Green Skill Programme	0	0	4	2
	ENS-CC-544	Dissertation	0	0	12	6
Generic Courses (GC)						
Any Semester (I-IV)	ENS-GC-501	Disaster Management	2	1	0	2
	ENS-GC-502	Environmental Health Perspectives	2	1	0	2
	ENS-GC-503	Human Health Management	2	1	0	2
	ENS-GC-504	Waste Management Techniques	2	1	0	2

Skill Enhancement Elective (SE)						
Any Semester	ENS-SE-501	Communication and writing skills	2	0	0	2

Programme Structure of M.Sc. Environmental Sciences

Note: L- Lecture, T- Tutorial, P- Practical, F- Field, I- Internship; Credits for Core course: 60 (Including field study, green skill program, internship and dissertation); Credits for Electives (Internal + External): 12; Total Credits: 72. 1 hour of Lecture=1credit hour, 2 hours of practical =1credit, 3 to 4 sessions of field visit=1 credit.

Semester I

SEMESTERI	CourseCode:ENS-CC-511	Credits:4

NAME OF THE COURSE: ECOLOGY AND ECOSYSTEM DYNAMICS

Sl. No.	Course outcome (CO) *At the end of the course, the student will be able to:*	Taxonomic Level (TL)
1.	**CO1**: Articulate the basics and fundamentals of the Environmental Sciences and related aspects of different ecosystem habitats.	Un
2.	**CO2:** Understand ecological energetics and thereby explore the interdependent relationships within ecosystems, between organisms and resources.	Un
3	**CO3:** Develop knowledge on the patterns of bio-geochemical interactions within and between the ecosystems for a stable and sustainable environment.	Cr
4	**CO4:** Understand the interactions of organisms with their environments and the consequences of these interactions for population, community, and ecosystem dynamics.	Un
5	**CO5:** Develop skill on a mathematical or conceptual modelof population or community dynamics to understand the factors of population growth and regulation.	Cr
6	**CO6:** Understand the concepts and limiting factors of theenvironment and the role of eco-informatics for the management and analysis of ecological information.	Un

COURSE CONTENT

MODULE 1: Concept and scope of Environmental Science, Environmental Biology, ecosphere and biosphere; ecological factors and variables. Concepts of Habitat, Niche and Guild . Habitat, microhabitat and niche. Different types of niches: spatial niche, trophicniche,speciesniche,multidimensionalniche,fundamentalandrealisedniche.
Niche overlap, Gause's principle-Lotka -Voltera model, resource partitioning, compression hypothesis, character displacement, ecologicalequivalents.
Biomes and Habitats : Classification of biomes–Terrestrial biomes–tundra, taiga, grassland, desert, evergreen and deciduous forests, tropical rain forests and their characteristics– flora and fauna. Classification of aquatic habitats – fresh water : ponds, rivers, lakes, wetlands– their characteristics, flora and fauna; marine habitats – pelagic, benthic, inter-tidal, estuarine, Mangroves – their characteristics, flora and fauna.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Define the basic terms in environmental sciences (Re)

MO2: Differentiate types of niches and relate different models and principles on niche (An)

MO3: Outline the concept of habitat (Re)

MO4 : Explain, distinguish and compare different biomes (Un, An, Ev)

MO5 : Relate the characteristic features of fresh water and marine habitat (Ap)

MO6: Know about mangroves and its characteristic flora and fauna (Re)

MODULE 2: Ecosystem dynamics: Introduction - Concept, characteristics, kinds and structure, ecosystem functioning – food chain, food web, ecological pyramids of numbers, biomass, energy, inverted pyramids, ecological energetics – Solar energy and photosynthetic production, efficiency of energy capturing, chemosynthesis, Energy flow - features of energy flow (unidirectional flow and loss of energy as heat) and pathways of energy flow, ecological efficiency. Productivity - primary production and production efficiency, secondary production, standing crop. Classification of ecosystems based on energy input (natural unsubsidised and subsidized solar powered ecosystems, human subsidised solar powered ecosystem and fuel powered urban and industrial systems.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Explain the basic terms in ecosystem dynamics (Un)

MO2: Summarize the different types of ecological pyramids (Un)

MO3: Construct different types of food web patterns (Ap)

MO4: Outline the pathways of energy flow (An)

MO5: Evaluate primary productivity and production efficiency (Ev)

MO6: Generate knowledge on ecosystems based on energy inputs(Cr)

MODULE 3: Development and evolution of ecosystems–biogeochemical cycles– gaseous and sedimentary cycles- Carbon cycle, Oxygen cycle ,Water cycle, Nitrogen cycle, Phosphorus cycle, Sulphur and Rock cycles; ecotone, edge effects, ecosystem stability – types- Dynamic stability, Persistence stability, structural stability.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: List the different types of biogeochemical cycles (Re)

MO2: Construct a flow chart of biogeochemical cycles (Ap)

MO3: Discriminate gaseous and sedimentary cycles (An)

MO4 : Compare ecotone and edge effect (An)

MO5 : Outline about ecosystem stability (Re)

MO6: Summarize the development and evolution of ecosystem (Un)

MODULE 4: Ecological interactions - Neutralism, symbiosis, commensalism, mutualism,antagonism,antibiosis,parasitism,predatism,competition–intra-specific and inter- specific, Ecological and environmental significance ofinteractions.

Module Outcome:

After Completion of this module, the student should be able to:
MO1: Match the ecological interactions with their examples (Re)
MO2: Summarize the different types of ecological interactions (Un)
MO3: Differentiate the ecological interactions (An)
MO4 : Relate parasitism and predatism An)
MO5 : Compare intra-specific and inter- specific interactions (An)
MO6: Conclude the ecological and environmental significance of interactions. (Ev)

MODULE 5: Population dynamics–concept of population, population growth– density, natality, mortality and growth curves, life curves, age structure, function and equilibrium; population regulation – biotic potential and environmental resistances; Factors of population regulation – density dependent and density independent; population crash and carrying capacity; the laws of population growth.

Module Outcome:

After Completion of this module, the student should be able to:
MO1: Recall the concept of population dynamics (Re)
MO2: Explain the characteristic features of population growth (Un)
MO3: Prepare different types of growth curves (Ap)
MO4 : Compare mortality and natality (An)
MO5 : Differentiate density dependent and density independent population (An)
MO6: Articulate the laws of population growth. (Un)

Module 6: Limiting factors of environment: Concept of limiting factors, laws of limiting factors–laws of minimum and tolerance, combined concept of limiting factors, Earth's carrying capacity. Ecoinformatics : concepts and principles.

Module Outcome:

After Completion of this module, the student should be able to:
MO1: Describe the limiting factors of environment (Re)
MO2: Explain the law of limiting factor (Un)
MO3: Outline the laws of minimum and tolerance (An)
MO4 : Analyze the concept of limiting factors (An)
MO5 : Evaluate Earth's carrying capacity (Ev)
MO6: Articulate the concepts and principles of Ecoinformatics (Un)

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments based on thetheory

- Seminar Presentation on selectedtopics
- Debates on selectedtopics
- Quiz based ontheory
- Demonstration of simple experiments based ontheory
- Field work and field visit

LEARNING RESOURCES

References

- Botkin,DanielB.2011.EnvironmentalScience:EarthasaLivingPlanet,JohnWiley and Sons, NewDelhi.
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- Groom. B. and Jenkins. M. 2000.*Global Biodiversity: Earth's Living Resources in the 21stCentury.* World Conservation Press, Cambridge,UK.
- Gurevitch, J., Scheiner, S. M., & Fox, G. A. 2002. *The Ecology of Plants*. Sinauer associatesincorporated.
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- Loreau,M.&Inchausti,P.2002.*BiodiversityandEcosystemfunctioning:Synthesisand Perspectives.* Oxford University Press, Oxford,UK.
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- Odum,E.P. 1971. Fundamentals of Ecology, W.B.Saunders Company, Philadelphia.
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On-line Sources

- http://complexitylabs.io/ecosystem-dynamics/
- http://www.tern.org.au/Eco-informatics-pg17733.html
- http://www.uwyo.edu/wygisc/ecoinformatics_initiative/
- https://earthobservatory.nasa.gov/Experiments/Biome/
- https://utmsi.utexas.edu/research/ecosystem-dynamics
- https://www.nationalgeographic.org/encyclopedia/biome/
- https://www2.estrellamountain.edu/faculty/farabee/biobk/BioBookcommecosys.html

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

MODEL QUESTION PAPER BASED ON OBE FORMAT

UNIVERSITY OF KERALA
FIRST SEMESTER M.SC. (CSS) DEGREE EXAMINATION BRANCH: ENVIRONMENTAL SCIENCES
ENS. CC. 511: ECOLOGY AND ECOSYSTEM DYNAMICS

Time:3Hours **Max. Marks:60**

I. Answer **any ten** questions (10x2=20Marks)

1. Define Biosphere. (MI,Re)
2. Distinguish between the Pelagic and Benthic habitat. (M1,Un)
3. What is Shelford's Law of Tolerance? (M6,Re)
4. What is Population Explosion? (M5,Re)
5. Define an Energy Pyramid. (M2,Re)
6. What is Edge Effect? (M3,Re)
7. What is Ecosystem Stability? (M3,Re)
8. What is Compression Hypothesis? (M1,Re)
9. What is Standing Crop? (M2,Re)
10. Distinguish between Parasitism and Predatism (M4,Un)
11. What is Growth Curve? (M5,Re)
12. What is Production Efficiency? (M2,Re)

II. Answer **any four** questions (4 x5 = 20Marks)

13. Differentiate the types of Niches with its related principles (M1,An)
14. Comment on the different aspects of Habitat(M1,Re)
15. Construct a pattern of Food web and comment on its significance in an ecosystem (M2 ,An)
16. What are the concepts of Eco informatics? (M6,Re)
17. Explain the Hardy Weinberg Equilibrium? Comment on its necessary for the maintenance of disequilibrium in a population (M5,Un)
18. Illustrate the Carbon and Oxygen cycle and explain its importance in an ecosystem (M3,An)

III. Answer **any two** questions (2x10= 20Marks)

19. Explain the types of Biomes and their characteristics (M1,Un)
20. Demonstrate the Energy flow and its pathways in an ecosystem (M2,Ap)
21. ExplaintheEcologicalinteractionanditssignificanceintheecosystem(M4, Un)

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SEMESTERI	CourseCode:ENS-CC-512	Credits:4

NAME OF THE COURSE: ENVIRONMENTAL TOXICOLOGY

Sl. No.	Course outcome (CO) At the end of the course, the student will be able to:	Taxonomic Level (TL)
1.	**CO1**: Articulate the basic concepts of toxicology	Un
2.	**CO2:** Explain the distribution of pollutants in the environment, their entry, movement, storage and transformation within the environment	Un
3	**CO3:** Understand the detoxification mechanism in human body	Un
3	**CO4:** Critically evaluate and understand chemical hazards, as well as potential health risks for both humans and wildlife.	Ev
4	**CO5:** Differentiate the impact of toxic metals on individuals and on populations	Ap
5	**CO6:** Uunderstand the effects of chemicals on human and environmental health	Un

COURSE CONTENT

MODULE 1: Toxicants in the Environment: History of toxicants - Principles of toxicology – Definition of xenobiotics, toxins, toxicants; synergism, antagonism and other interactions; classification of toxicants, toxicity-factors affecting toxicity, toxic substances in the environment:their types–degradableandnon-degradable;sources and entry routes. Persistent organic pollutants (POPs) and their generaleffects..

Module Outcome:

After Completion of this module, the student should be able to: MO1:.Differentiate toxins and toxicants (Un)
MO2:Identify the factors affecting toxicity(Un)
MO3: Define xenobiotics (Re)
MO4: Distinguish degradable and non degradablepollutant(Un)
MO5: List the sources and entry routes of toxicants (Re)
MO6: Describe the effects of exposure to POPs (Re)

MODULE 2: Eco-toxicology: Introduction to eco-toxicology - Ecosystem influence on the fate and transport of toxicants, Transport of toxicants by air and water;

Degradable and non-degradable toxic substances; Influence of ecological factors on the effects of toxicology. Transport through food chain: bio-transformation and bio-magnification; Biomarkers: major types of biomarkers. Information management system ineco-toxicology.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Define eco-toxicology(Re)
MO2: Describe the transport of toxicants by air and water (Un)
MO3: Compare the degradable and non-degradable toxic substances (Un)
MO4: Differentiate bio-transformation and bio-magnification (Un)
MO5: List the different categories of biomarkers.(Re)
MO6: Explain the role of information management system in eco-toxicology (Un)

MODULE III: Environmental fate of pollutants – Transport pathways of pollutants in the environment, Exposure pathway and exposure route; Global dispersion of toxic substances - dispersion and circulating mechanisms of pollutants.
Acute and chronic toxicity; Lethal and sub-lethal doses, NOEL, $LC_{50,}$ LD_{50} and MLD. Dose-response relationship, Carcinogens, mutagens and teratogens. Toxicity testing procedures- Acute and chronic toxicity experiments and $LC_{50.}$

Module Outcome:

After Completion of this module, the student should be ableto:

MO1: Describe the environmental fate of pollutants(Un)
MO2:Explainthedispersionandcirculatingmechanismsofpollutants(Un) MO3:
Illustrate the effects of lethal and sublethal doses(Re)
MO4: Define MLD (Re)
MO5: Differentiate carcinogens, mutagens and teratogens (Un)
MO6: Distinguish acute and chronic toxicity tests (An)

MODULE IV: Man and Environmental Toxins - Routes of toxicants to human body - inhalation, skin absorption, oral, injection. Detoxification in human body - detoxificationmechanisms,organsofdetoxification.ADME–adsorption,distribution, metabolism and excretion. Response to toxin exposures – types of dose-response relationship, frequency and cumulativeresponse.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Define environmental toxins (Un)
MO2: Describe the routes of toxicants to human body (Un)
MO3: Explain the detoxification mechanisms and organs of detoxification (Un)
MO4: List and explain the types of dose-response relationship (Re)
MO5: Define cumulative response (Re)

MODULE V: Chemical toxicology - Toxic chemicals in the Environment. Impact of

Toxic chemicals on enzymes - biochemical effect of toxic metals in humans - arsenic, cadmium, lead, mercury; detoxification methods for heavy metal toxicity, effects of gaseous pollutants- carbon monoxide, nitrogen oxides, sulphur dioxide and biochemical effects of cyanide in humans.

Module Outcome:

After Completion of this module, the student should be able to:

MO1:Define chemical toxicology(Un)
MO2: List the toxic chemicals in the Environment (Un)
MO3: Describe the impact of toxic chemicals on enzymes (Re)
MO4: Evaluate the biochemical effects of arsenic, cadmium, lead, mercury (Ap)
MO5: Compare the effects of gaseous pollutants in humans (Un)
MO6: Articulate the biochemical effects of cyanide intake in humans (Ev)

MODULE VI: Environmental Health - Concept and scope, global and regional perspectives, basic requirements for healthy environment, environmental quality, human exposure and health impact, Types of Environmental diseases - Lifestyle disease; Disease caused by physical factors in the environment; Disease caused by exposure to toxic or irritant chemicals in the environment -Asbestosis, silicosis, siderosis, asthma, fluorosis and allergies. Epidemiology and Epidemiological issues in health –vector borne diseases, water borne diseases, water related diseases, airbornediseases.

Environmental Health Risk Assessment (EHRA) -An overview: Introduction to Risk, Environmental risk assessment, Risk management, safety.

Module Outcome:

After Completion of this module, the student should be able to:

MO1:List the effects of chemicals on human and environmental health (Re).
MO2: Define environmental quality (Un)
MO3: List the environmental diseases (Re)
MO4: Describe the diseases caused by exposure to toxic chemicals in the environment (Re)
MO5: Define Epidemiology (Un)
MO6: Explain Environmental Health Risk Assessment (Un)

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Seminar Presentation on selectedtopics
- Debates
- Quiz
- Demonstration of simpleexperiments

LEARNING RESOURCES

References

- Celentano,D.D.andSzklo,M(2019).GordisEpidemiology.6thEdn.Elsevier(Pub.).
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- http://www.sciencedirect.com/science/journal/02697491?sdc=1
- https://en.wikipedia.org/wiki/Ecotoxicology
- https://en.wikipedia.org/wiki/Toxicology
- https://kidsenvirohealth.nlm.nih.gov/generic/11/what-is-environmental-health
- https://link.springer.com/journal/10646
- https://www.journals.elsevier.com/environmental-pollution/
- https://www.journals.elsevier.com/toxicology
- https://www.journals.elsevier.com/toxicology/most-downloaded-articles

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

MODEL QUESTION PAPER BASED ON OBE FORMAT

First Semester M.Sc. (CSS) Degree Examination ENS-CC-512 ENVIRONMENTAL TOXICOLOGY

Time:3Hours **Max. Marks:60**

I. Answer **any ten** of the following. (10 x 2 = 10Marks)

1. What are POPs? (M-5,Un)
2. Differentiate toxins and toxicants. (M-1,Ap)
3. What is Epidemiology? (M-6,Re)
4. Define Environmental Quality. (M-6,Re)
5. What are teratogens? (M-3,Re)
6. What is risk management? (M-6,Re)
7. Difference between exposure pathway and exposure route. (M-2,Ap)
8. What is BAL? What is its use in detoxification? (M-3,Ap)
9. What is the impact of toxic chemicals on enzymes? (M-3,Un)
10. What are emerging contaminants? (M-6,Un)
11. How toxicants enter biological organisms? (M-2,Un)
12. What are the major biochemical changes due to carbon monoxideinhalation? (M-5,Re)

II. Answer **any four** of the following. (4x5=20 Marks)

13. Why excess of lead and mercury are bad for human health? (M-5,Un)
14. Explain the biochemical effects of cyanide in take in humans.(M-5,Re)
15. Describe the acute and chronic toxicity tests. (M-3,Re)
16. Describe the transport and distribution of toxicants by air and water. (M-3, Re)
17. What is Environmental risk assessment? Explain. (M-6,Un)
18. What is toxicity and what are the factors that affect it? (M-1,Re)

III. Answer **any two** of the following. (2x10=20 Marks)

19. Describe the biochemical effects and health impacts of arsenic and cadmium in humans. (M-5,Re)
20. Explain the occupational health hazards and mention its impacts on humans. (M-6,Un)
21. Briefly explain the detoxification mechanisms and organs of detoxification. (M-3,Re)

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SEMESTERI	CourseCode:ENS-CC-513	Credits:4

NAME OF THE COURSE: ENVIRONMENTAL CHEMISTRY

Sl. No.	Course outcome (CO) *At the end of the course, the student will be able to:*	Taxonomic Level (TL)
1.	**CO1**: Understand the nature, reactivity and environmental fates of toxic organic chemicals, pollution due to pesticides	Un
2.	**CO2:** Define the basic environmental conversion units	Re
3	**CO3:** Understand the chemistry of the stratospheric and tropospheric processes	Un
3	**CO4**: Address major environmental issues such as ozone depletion, green house effect, anthropogenic climate change and air pollution	Un
4	**CO5:** Recognize the importance of environmental changes, demonstrate an understanding of theoretical and practical environmental issues	An
5	**CO6:** Explain the concept of green chemistry and compare the synthetic and natural insecticides	Ap

COURSECONTENT

MODULE I: Concept and Scope of Environmental Chemistry: Major environmental segments, Natural cycles - Hydrological cycle, Carbon cycle, Oxygen cycle, Nitrogen cycle, Phosphorous cycle, Sulphurcycle.

Stoichiometry, Units of concentration of solutions- Molarity, Molality ,Normality, Equivalent weight, ppm, ppb, ppt,Partsperthousand, NumberDensity(n),Parts-Per Notation by Mass by Mass, Mass by Volume Unit for Trace Gases in Air: Microgram per Cubic Meter, Interconversion of units of concentrations.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Describe concepts and scope of environmental chemistry (Un)

MO2: Exemplify the major environmental segments(Un)

MO3: Define the solution concentration units (Re)

MO4: Describe the natural cycles of the environment (Un)

MO5: Estimate mass by volume unit for trace gases in air and mass by volume unit for aqueous media (Ap)

MO6: Calculate the interconversion of concentration units (Ap)

MODULE II: Atmosphere- Chemical composition of the atmosphere, Regions of the atmosphere, Earth's radiation balance. Vertical temperature profile, Adiabatic lapse rate, Temperature/thermal inversion. Particles, radicals and ions in the atmosphere. Stratospheric chemistry – Oxygen and ozone chemistry, Green house effect/ global warming, chlorofluoroarbons, Ozone depletion, Minimizing future emissions of green house gases. Tropospheric chemistry - The principle of reactivity in the troposphere, The tropospheric oxidation of methane, Photochemical smog, Rain , snow and fog chemistry, Formation and composition of acid rain, Atmospheric aerosols, Oxidation of atmospheric SO2. Chemistry of urban and indoor atmosphere.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Define the composition and regions of atmosphere(Re)

MO2: Describe earth's radiation balance, particles, radicals and ions in the atmosphere (Re)

MO3: Outline vertical distribution of temperature and thermal inversion(Re)

MO4: Explain green house effect, global warming, chlorofluro carbons and ozone depletion and apply methods to minimize future emissions of green house gases (Un)

MO5: Explain tropospheric oxidation of methane,photochemicalsmog,acid rain ,atmospheric aerosols and oxidation of atmospheric SO_2 (Un)

M06: Define chemistry of urban and indoor atmosphere (Re)

MODULE III: Hydrosphere - Water resources, Global distribution of water, Gases in water, Organic matter in water. Physical chemistry and composition of sea water and fresh water on land. pH, pE and pH- pE diagrams of selected elements. Complexation in natural water and wastewater.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Describe hydrosphere (Re)

MO2: Define global distribution of water (Re)

MO3: Know gases and organic matter in water(Re)

MO4: Explain physical chemistry and composition of sea water and fresh water on land (Un)

MO5: Demonstrate pH,-pE diagrams of selected elements (Ap)

MO6: Outline complexation in natural water and waste water (Re)

MODULE IV: Lithosphere - Weathering of rocks- physical, chemical and biological processes. Factors controlling the formation of soil, soil profile and classification of soil. Composition of soil-organic and inorganic components in soil, water and air in soil. Micro and macro nutrients, nitrogen pathways and NPK in soil. Acid base and ion exchange reactions in soil.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Know about physical, chemical and biological processes in weathering of rocks (Re)

MO2: Outline factors controlling formation of soil (Re)

MO3: Describe soil profile and classification of soil (Re)

MO4: Outline composition of soil with respect to organic and inorganic components (Re)

MO5: Define water and air as well as acid base and ion exchange reactions in soil (Re)

MO6: Generalise micro and macro nutrients in soil, nitrogen pathways and NPK in soil (Un)

MODULE V: Toxic organic chemicals and heavy metals - Emerging contaminants: Pesticides- classification, degradation, pollution due to pesticides. Organochlorine pesticides - structure and chemistry, DDT, bioaccumulation and biomagnification. Organophosphates and carbamate insecticides - structure and chemistry, Natural and Green insecticides -sources, target insects. Integrated Pest Management. Heavy metals - Speciation and toxicity of heavy metals, Bioaccumulation of heavy metals. Non pesticide Toxic Organic Compounds of Environmental concern - Dioxins, Furans, Polychlorinated Biphenyls (PCBs), Polynuclear Aromatic Hydrocarbons (PAHs) - sources, structure, , health impacts. Concept of green chemistry.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Describe pesticide classification, structure and chemistry (Re)

MO2: Distinguish organochlorine, organophosphate and carbamate pesticides (Un)

MO3: Explain bioaccumulation and biomagnification of pesticides (Un)

MO4: Recognise natural and green insecticides, sources and target pests and demonstrate Integrated Pest Management and concept of green chemistry (Re,Ap)

MO5: Explain speciation and toxicity of heavy metals (Un)

MO6: Explain non pesticide organic compounds of environmental concern, dioxins, furans, PCBs, PAHs, its sources and health effects (Un)

MODULE VI: Radioactivity and Nuclear Energy - Types of radiation, Units of radioactivity, Detection and measurements of radioactivity, Radioactive nucleus decay- Radon from U 238 decay sequence, Health threat from environmental radiation. Fission and Fusion Reactors, The future of fission based nuclear power, Nuclear accidents and environmental impacts.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Describe types of radiation and units of radio activity (Re)

MO2: Explain radioactive nucleus decay and Radon from U 238 decay sequence (Un)

MO3: Compare fission and fusion reactors (Ap)
MO4: Describe monsoon system of India (Re)
MO5: Evaluate future of fission based nuclear power (Ev)
MO6: Analyze nuclear accidents and environmental impacts (An)

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Seminar Presentation on selectedtopics
- Debates
- Quiz
- Demonstration of simpleexperiments
- Field work and field visit

LEARNING RESOURCES

References

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On-line Sources

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- http://www.ecy.wa.gov/puget_sound/toxicchemicals/effects.html
- http://www.newworldencyclopedia.org/entry/Atmospheric_chemistry
- https://link.springer.com/journal/10874
- https://www.epa.gov/environmental-topics
- https://www.nature.com/

- https://www.nrdc.org/issues

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

MODEL QUESTION BASED ON OBE FORMAT

First Semester M.Sc. Environmental Sciences Examination
ENS. CC. 513. ENVIRONMENTAL CHEMISTRY

Time:3Hours **Max. Marks:60**

I. Answer **any ten** of the following. (10x2=20 Marks)

1. Differentiate PAHs, PCBs and PAN (M5,An)
2. Write short notes on DDT (M5,Un)
3. Differentiate smoke and smog (M2,An)
4. Comapare ppmv, ppbv and pptv (M1,An)
5. What is cultural eutrophication? (M3,Re)
6. What is meteoric water? (M1,Re)
7. Calculate the concentration of NO_2 in μg/m^3 if NO_2 was found to be 1×10^{-6}g/ L of air**(**M1,Ap)
8. Define the layers of earth (M1,Re).
9. Explain salinity of sea water (M3,Un)
10. What is meant by complexation reaction? (M3,Re)
11. Why water is a universal solvent?(M2,Un)
12. What are dioxins?(M2,Re)

I. Answer **any four** of the following. (4x5=20 Marks)

13. Explain chemistry of acid rain (M2,Un)
14. What is radon? Describe U238 decay sequence(M6,Re)
15. Describe sulphur cycle with diagram (M1,Re)
16. Explain green insecticides with example (M5,Un)
17. Explain the chemical reactions in forming of photochemical smog(M2,Un)
18. Describe environmental impacts of lead and cadmium. (M5,Re)

II. Answer **any two** of the following. (2x10=20 Marks)

19. Write an essay on organochlorines with reference to biomagnification and bioaccumulation (M5,Un)
20. Describe in detain the chemical composition of atmosphere with emphasis on vertical distribution of temperature and thermal inversion(M1,Re)
21. What is a pH-pE diagram? Describe with an example(M3,Re)

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SEMESTERI	CourseCode:ENS-CC-514	Credits:4

NAME OF THE COURSE: ENVIRONMENTAL GEOLOGY

Sl. No	Course outcome (CO) *At the end of the course, the student will be able to:*	Taxonomic level (TL)
1.	**CO1:** Understand the fundamentals of physical earth and related different earth processes.	Understand (U)
2.	CO2: Develop knowledge on the physical properties of minerals,rocks,soilformingprocessesandpropertiesof soil.	Understand (U)
3.	CO3: Articulate and critically evaluate on the scientific aspectsofvariousnaturalhazardsandtheirmanagement strategies	Evaluate (E)
4.	CO4: Understand various earth surface processes	Understand (U)
5.	CO5: Develop skill on how to use toposheets and other maps in environmentalstudies	Analyse (An)
6.	CO6: Develop knowledge on occurrence of groundwater in earthanditsaffectingenvironmentalproblemsandapply to get probablesolutions	Evaluate (E) Apply (Ap)

COURSE CONTENT

MODULEI: Introduction–definitionandrelevanceofenvironmentalgeology.Origin and evolution of the earth, geological time scale. Concept of Plate tectonics - sea floor spreading and continentaldrift. Forces acting on the surface of the earth-tectonic and diastrophic forces.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Understand the scope of environmental geology (Re)
MO2: Articulate and interpret geologic time scale (Re)
MO3: Acquire knowledge about the origin and evolution of earth (Un)
MO4: Understand the concept of plate tectonics (Re)
MO5 : Know about the forces acting on earth (Un)
MO6: Gain an overall understanding of the dynamism of earth (Un)

MODULEII: Minerals, Rocks and Soils-Definition of mineral,physical properties of minerals; brief overview of formation, forms, textures, structures, classification of igneous,sedimentary and metamorphic rocks.Overview of important mineral

resources and fossil fuels of India. Environmental impacts of mining and various mitigatory measures. Study of interior of earth - crust, mantle and core. Geothermal energy. Soil - Chemical and mineralogical composition, physical properties of soil-texture, bulk density, permeability. Chemical properties - cation exchange capacity and pH. Soil erosion- types, causes and remedial measures.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Articulate and distinguish minerals and rocks (Un)
MO2: Understand physical properties of minerals (Un)
MO3: Articulate and evaluate three basic rock types (An)
MO4: Articulate and exemplify basic knowledge in mineral resources (Un)
MO5: Compare and contrast about the layers of interior structure of earth (Ev)
MO6: Develop an overall understanding of properties of soils (Un)

MODULE III: Natural hazards - Earthquakes- causes, effects, distribution and prediction. Volcanoes-types, products of volcanic eruption and its environmental impact. Landslides-slope stability, factors affecting slope stability, causes and prevention of landslides.Brief note on tsunami.Coastal erosion-causes,processes and protective measures.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Articulate and critically evaluate science of earthquake and its management options (Un/Ev)
MO2: Articulate and critically evaluate science of volcanoes (Un/Ev)
MO3. Articulate and critically evaluate Landslide hazard (Un/Ap)
MO4: Articulate and critically evaluate tsunami (Un)
MO5: Understand coastal erosion and analyse the processes (Un)
MO6 : Critically evaluate major disasters in India (Un/Ap)

MODULE IV: Earth's surface processes - erosion, transportation and deposition of earth's materials by streams, wind and glaciers. Glaciers - physical and chemical aspects, recession of Himalayan glaciers, glaciers as an index of climate change.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Understand basic difference between geological process (Ap)
MO2: Evaluate the geological functions of streams (Un, Ev)
MO3. Understand and evaluate geological functions of wind (Un)
MO4: Understand geological functions of glaciers (Un)
MO5: Explain and critically discuss Himalayan glaciers (An)
MO6: Articulate and exemplify the use of glaciers as paleoclimatic index (An)

MODULE V: Ecohydrology - Definition and concept of eco-hydrology. Hydrologic cycle and hydrologic budget, inventory of the earth's water, global water balance. Drainage basin – definition, characteristics, drainage pattern, stream classification

and ordering. Use of topographic maps and environmental geologic maps in environmental studies.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Define the basic term ecohydrology (Re)
MO2: Recognise concept of ecohydrology (Un)
MO3. Outline the hydrological cycle (Re)
MO4: Analyze and Interpret water balance study (An)
MO5. Explain the concept of drainage basin (Un)
MO6: Identify topographic features and apply toposheets and other maps in environmental studies (An)

MODULE VI: Groundwater - Source, occurrence and movement of groundwater. Definition of water table and factors influencing water table fluctuations. Geologic formations as aquifer, aquiclude and aquitard, Types of aquifers - unconfined, confined, semi-confined, semi-unconfined. Quality criteria of groundwater for drinking and irrigation purpose. Overview of groundwater contamination. Concept of seawater intrusion in the coastal area. Concept of Coastal Regulation Zone (CRZ) in India. Groundwater recharging and rain water harvesting. Isotope Hydrology- Definition and classification of isotopes- stable and unstable (radioactive) isotopes, environmental (natural) and artificial isotopes. Isotopes of H_2, O_2, N_2, S. Isotopic composition of water. Application of isotope hydrology in remediating issues - origin and age of groundwater, groundwater recharge, surface water-groundwater interconnection, discrimination of water pollution due to nitrate,phosphate,sulphate and salinization of water resources.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Describe various aspects of groundwater(Re)
MO2: Identify various groundwater bearing formations (An)
MO3. Critically discuss groundwater pollution(Ev)
MO4: Compare and contrast coastal regulation zones (An)
MO5. Articulate basic knowledge of isotope hydrology (Un)
MO6: Evaluate isotope hydrology applications(Ev)

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments based on the theory
- Seminar Presentation on selected topics
- Screening short videos related to natural calamities
- Debates on selected topics
- Quiz based on theory
- Extensive field visit to demonstrate selected theory part.

LEARNING RESOURCES

References

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- Todd, D.K. and Mays, L.W. 2005. *Ground Water Hydrology*. Wiley India Private Limited.236p.

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- http://eschooltoday.com/pollution/water-pollution/types-of-water-pollution.html
- http://esminfo.prenhall.com/takealook2007/keller/pdf/ch05.pdf
- http://www.groundwater.org/get-informed/groundwater/contamination.html
- https://www.environmentalpollutioncenters.org/soil/causes/
- ww.slideshare.net/saurabhmaheshwari944/surface-water-pollution-45275427

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

MODEL QUESTION BASED OB OBE FORMAT

UNIVERSITY OF KERALA
FIRST SEMESTER M.SC. DEGREE EXAMINATION (CSS) ENS. CC. 514.
ENVIRONMENTAL GEOLOGY

Time:3Hours **Max. Marks:60**

I. Answer **any ten** of the following **(10x2=20Marks)**

1. What are Eons in geological time scale? (M1,R)
2. What is an Orogenic movement? (M1,R)
3. Distinguish between Phosphorescence and Fluorescence (M2,U)
4. Define igneous texture (M2,R)
5. Distinguish between continental crust and oceanic crust (M2;Ap)
6. Identify the different types of seismic waves (M2,Ap)
7. Define bulk density and cation exchange capacity of soil (M2;R)
8. Glaciers as an index of climate change-explain (M3;An)
9. What is the concept of ecohydrology? (M4;U)
10. Define drainage basin (M5;R)
11. Distinguish between aquifer and aquiclude (M6;Ap)
12. What is an environmental isotope? Cite two examples (M6,U)

II. Writes notes on **any four** of the following **(5x4= 20marks)**

13. Discuss briefly three prominent theories on origin of earth (M1;Ap)
14. Texture and structure of sedimentary rocks (M2;Ap)
15. Write note on mantle and core of the earth (M2;U)
16. Discuss the causes and mitigatory measures of coastal erosion (M2;E)
17. Depositional features of stream and wind (M2;Ap)
18. Any three application of environmental isotopes in hydrology (M6;An)

III. Answer **any two** of the following **(2x10= 20 marks)**

19. Give an account of seafloor spreading and continental drift of earth (M1;U)
20. Discuss the causes, perception and mitigatory measures of landslides(M3; E)
21. Enumerate the environmental impacts of mining (M2;An)

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SEMESTER I	Course Code:ENS-CC-515	Credits: 3

NAME OF THE COURSE: METEOROLOGY AND CLIMATE CHANGE

Sl. No	Course outcome (CO) *At the end of the course, the student will be able to:*	Taxonomic level (TL)
1.	CO1: Articulate and exemplify basic knowledge of environmental meteorology and new concepts of climate change	Un
2.	CO2: Summarise enhanced greenhouse effect, global warming El nino and ENSO	Un
3.	CO3: Explain the fundamental principles of meteorological instrumentation and measurements	Un
4.	CO4: Define vertical variation in temperature, lapse rate and inversions	Re
5.	CO5: Acquire knowledge on fundamentals of climatology	Un
6.	CO6: Recognise the phenomenon of climate change and address problems of pollution climatology with emphasis on India	Ap

COURSE CONTENT

MODULE I: Fundamentals of Meteorology - Motions of the earth and seasons. Earth-sun relationship. Insolation and its latitudinal and seasonal variation.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Know the fundamentals of meteorology (Re)
MO2: Recall motions of the earth and seasons (Re)
MO3: Describe earth-sun relationship (Re)
MO4: Define insolation and its latitudinal and seasonal variation (Re)
MO5: Define vertical variation in temperature, lapse rate and inversions (Re)

MODULE II: Air temperature- warming and cooling of air near ground, measurement of temperature. Vertical variation of temperature and pressure, Air mixing, lapse rate and inversions. Humidity-expressions of humidity, measurement of humidity. Clouds- classification and types. Precipitation- process, types of precipitation, measurement of precipitation-recording, non-recording, radar, satellite, estimation of precipitation, averaging techniques- thiessen polygon and isohyets. Wind - forces affecting wind, types of wind and measurement of wind.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Define air temperature, its measurement, vertical variations in temperature and inversions (Re)
MO2: Describe humidity (Re)
MO3: Outline clouds classification and types (Re)

MO4: Measurement and estimation of precipitation (Un)
MO5: Analyse precipitation using averaging techniques thiessen polygon and isohyets(An)
MO6: Define forces affecting wind and measurement of wind (Re, Ap)

MODULE III: Scales of meteorology. Micrometeorology-applications to vegetated surfaces, urban areas, human beings and animals, impact on the physiology of plants and animals, stress induced changes.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Understand the effects of micrometeorology to vegetated surfaces (Un)
MO2: Relate micro meteorology to human beings and animals(Ap)
MO3: Explain impact of micrometeorology on the physiology of plants and animals and stresss induced changes(Un)
MO4: Define scales of meteorology (Re)

MODULE IV: Pollution meteorology - Application of metorological principles to transport and diffusion of pollutants. Diffusion and turbulence, mixing height.Effect of meteorological factors on air pollution, size and structure of plume, dispersion of air pollutants - Gaussian model, reaction of pollutants in air forming smog, PAN, Acid rain. Pollution Climatology - Preliminary concepts of climate change, Seasons in India, Monsoons*, El Nino* and ENSO, Enhanced greenhouse effect – global warming, GHGs in the atmosphere,Effects of globalwarming.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Apply meteorological principles to transport and diffusion of pollutants (Ap)
MO2: Demonstrate effect of meteorological factors on air pollution (Ap)
MO3: Design Gaussian plume model (Cr)
MO4: Evaluate reaction of pollutants in air(Ev)
MO5: Explain pollution climatology and climate change (Un)
MO6: Summarise enhanced greenhouse effect, global warming *El nino*and ENSO (Un)

MODULE V: Climatology - Elements of weather and climate, climatic controls, energy balance in atmosphere, elementary ideas about weather systems, climatic classifications, climates in India, monsoons of India. Boundary layerclimates-effects of topography, energy and mass exchange, climates of vegetated surface, urban climatology. Science of Climate Change - Drivers of climate change- Greenhouse gases, aerosols - reflective and black carbon, land use changes. Energy balance, feed-back processes in climate system, concepts of global warming potential (GWP), radiativeforcing.

Module outcome

After Completion of this module, the student should be able to:

MO1: Define elements of weather and climate, energy balance in atmosphere, and climatic classifications (Re)
MO2: Describe climates and monsoons of India (Re)

MO3: Explain effect of boundary layer climate to topography, energy and mass exchange (Un)
MO4: Generalize drivers of climate change - Greenhouse gases and aerosols (Un)
MO5: Comprehend concepts of global warming potential, radiative forcing and feed-back processes in climate system (Un)

MODULE VI: Climate change scenarios of India - impact of climate change on agriculture, forest, water resources, monsoon system of India.

Module Outcome:

After Completion of this module, the student should be able to:
MO1: Describe climate change scenarios of India (Re)
MO2: Estimate impact of climate change on agriculture(Un)
MO3: Predict impact of climate change on forest and water resources(Un)
MO4: Outline monsoon system of India(Re)

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz
- Demonstration of videos relating to monsoon and climate change
- Field work

LEARNING RESOURCES

References

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- Arya. P.S. (1988). Introduction to Micrometeorology . AcademicPress.
- Barry, R.G. and Chorley, R.J. (2009). Atmosphere, Weather and Climate. 9thEdition,Routledge
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On-line Sources

http://unfccc.int/2860
.phphttp://www.imd.gov.in/Welcome%20To%20IMD/Welcome.
phphttp://www.ipcc.ch/http://www.isro.gov.in/applications/
meteorologyhttps://climate.nasa.gov/https://www.nationalgeog
raphic.org/encyclopedia/meteorology/

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

MODEL QUESTION BASED ON OBE FORMAT

UNIVERSITY OF KERALA

FIRST SEMESTER M.Sc. (CSS) DEGREE EXAMINATION BRANCH: ENVIRONMENTAL SCIENCES

ENS. CC. 515. METEOROLOGY AND CLIMATE CHANGE

Time:3Hours **Max. Marks:60**

I. Answer **any ten** of the following. (10 x 2 = 20Marks)

1. Define Earth's axis (M1,Re)
2. What is PAN? How it affect human health? (M4,Re)
3. What is mixing height? (M4,Re)
4. Explain global warming potential (M4, Un)
5. Write a brief outline of urban heat island (M3, Un)
6. What is radiative forcing? (M3,Re)
7. What are aerosols? (M5,Re)
8. What is ENSO? (M4,Re)
9. Describe temperature lapse rate (M4,Re)
10. What is hygrometer? (M2,Re)
11. What are solstice? (M1,Re)
12. List the various motions of earth (M1,Re)

II. Answer **any four** of the following. (4x5=20Marks)

13. Discuss about major climatic regions of India. (MO6Re)
14. Write a short note on the stress induced changes in the physiology of plants and animals. (M3,Un)
15. Write a short on classification of Clouds and its formation (M2,Un)
16. Comment on different instruments used for the measurement of temperature (M2,Re)
17. Explain chemical reactions in forming of photochemical smog (M4,Un)
18. Describetheapplicationofmeteorologicalprinciplestotransportanddiffusion of air pollutants (M4,Re)

III. Answer **any two** of the following. (2 x 10 = 20Marks)

19. Write an essay on causes and effects of global warming and climate change (M4, Un)
20. Discuss the various motions of earth (M1,Re)
21. Write an essay on boundary layer climate, climate of vegetated surfaces and urban climatology (M5,Un)

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SEMESTER I	Course Code: ENS-DE-516	Credits: 2

NAME OF THE COURSE: BIOCHEMISTRY AND NANOBIOLOGY

Sl. No.	Course outcome (CO) *At the end of the course, the student will be able to:*	Taxonomic Level (TL)
1.	**CO1**: Explain the structure and classification of biomolecules like nucleic acids, amino acids, proteins, carbohydrates and lipids.	Un
2.	**CO2:** Describe Intra and intermolecular interactions in biological systems	Re
3	**CO3:** Comment on the principles of thermodynamics and bioenergetics	Un
4	**CO4:** Articulate knowledge about role of free radicals in biological systems	Un
5	**CO5:** Differentiate the concepts of Nanoscience, Nanobiology and Nanotechnology	An
6	**CO6:** List the applications of nano materials in various fields like medicine and environment	Un

COURSECONTENT

MODULE I: Chemical structure of biologically important macromolecules - Nucleotides and nucleic acids, covalent polynucleotide structure, double helical structure of DNA, properties of DNA, amino acids, peptides and proteins, covalent structure of proteins-secondary structure, tertiary and quaternary structure. Major classes of carbohydrates and their structure. Storage and structural lipids.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Describe the structure and role of nucleotides and nucleic acids (Un)
MO2: Illustrate the double helical structure of DNA (Re/Un)
MO3: Write note on properties of DNA (Re)
MO4: Describe the classification and properties of amino acids (Un)
MO5: Comment on structural organization of Proteins (Re)
MO6: Articulate knowledge of Structure and classification of carbohydrates (Re)
MO7: Explain different types of lipids (Un/Re)

MODULE II: Intra and intermolecular interactions - ionic covalent and hydrogen bonds, Vander vaal's forces. Polar and non-polar compounds, polyelectrolytes.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Explain different types of Intra and intermolecular interactions (Un)
MO2: Define the different types of bonds (Re)
MO3: Differentiate polar and non-polar compounds (An)

MO4: Understand what polyelectrolytes are (Un)

MODULE III: Bioenergetics and thermodynamics - Concept of free energy and entropy, enthalpy, standard free energy change.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Understand the concepts of free energy and enthalpy (Un)
MO2: State the laws of thermodynamics (Re)
MO3: Differentiate entropy and enthalpy (An)

MODULEIV: Free radicals in Biological systems-Oxygen as a free radical in the auto-oxidation of fats,antioxidants.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Understand the formation of free radicals in biological systems (Un)
MO2: Explain the action of free radicals in biological system (Un)

MODULE V: Definition of nanoscience, nanotechnology and nanobiology. Diffusion mechanisms in membranes and cells. Interactions of biological systems with natural and engineered nanomaterials., Molecular nanotechnology - Scanning probe microscopy, Atomic Force Microscopy and Scanning Tunnelling Microscopy. DNA microarray - principle and applications.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Define nanoscience, nanotechnology and nanobiology (Re)
MO2: Explain diffusion mechanisms in membranes and cells (Un)
MO3: Comment on interactions of biological systems with natural and engineered nanomaterials (Un)
MO4: Explain the working of different microscopic methods used in molecular nanotechnology (Un)
MO5: Explain the principle and applications of DNA microarray (Un)

MODULE VI: Nanodots – Biological Applications. Quantum Devices - Carbon Nanotubes. Nanoparticles in pharmaceutical and medicinal field, biomedical applications of nanoparticles, Health risks of nanoparticles. Nanomaterials-Environmental applications Zerovalent iron nanoparticles, titanium dioxide, silver nanoparticles - nanomembrane process, nanosorbants- mesoporous silica - ground water remediation; airpurifier - nano photocatalysis, nanocoating- corrosion prevention, nano technology based drinking water and waste water treatment.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Describe the applications of nano-dots (Re)
MO2: Explain the applications of nanoparticles in biomedical and pharmaceutical field (Un)
MO3: Comment on the health risks of nanoparticles (Un)
MO4: Articulate knowledge of Environmental applications of nanomaterials (Un)

MO5: Describe the applications of nanomembrane processes (Re)
MO6: Elucidate nanotechnology based drinking water and waste water treatment methods (Un)

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Seminar Presentation on selectedtopics
- Debates
- Quiz
- Class tests

LEARNING RESOURCES

References

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- https://www.grc.nasa.gov/www/k-12/airplane/thermo.html
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ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

MODEL QUESTION BASED ON OBE FORMAT

UNIVERSITY OF KERALA
FIRST SEMESTER M.Sc. (CSS) DEGREE EXAMINATION BRANCH: ENVIRONMENTAL SCIENCES
ENS.DE.516. BIOCHEMISTRY AND NANOBIOLOGY

Max.Marks:60 **Time : 3Hours**

I. Answer **any ten** of the following. (2x10=20 Marks)

1. What is a tripeptide? Write an example. (M1,Re)
2. What are free radicals? Write two examples. (M4,Re)
3. Name three special amino acids. (M1,Re)
4. What is a nucleoside? Give two examples. (M1,Re)
5. What is phospho-lipid? Give an example. (M1,Re)
6. What is Auto oxidation? (M4,Re)
7. Comment on Secondary structure of proteins (M1,Re)
8. Write the principle of scanning probe microscopy (M5,Re)
9. Differentiate entropy and enthalpy (M3,Ap)
10. What is DNA micro array? (M5,Re)
11. Write note on carbon nanotube (M6,Re)
12. Write examples for covalent and hydrogen bonds in biomolecules. (M2,Re)

II. Answer **any four** of the following . (4x5=20 Marks)

13. What are structural polysaccharides? Give examples (M1,Re)
14. Describe the characteristics of the double helical structure of DNA (M1,Re)
15. Explain the applications of nanoparticles in biomedical and pharmaceutical field (M6,Un)
16. Describe the structural organization of proteins with special reference to the different bonds involved (M1,Re)
17. Write a note on simple lipids (M1,Re)
18. Explain the working of different microscopic methods used in molecular nanotechnology (M5,Re)

III. Answer **any two** of the following . (2x10=20 Marks)

19. Write the classification of carbohydrates based on sugar units. Mention the structure and functions of three most common disaccharides. (M1,Re)
20. Mention the different divisions of antioxidants, their sources and their therapeutic benefits. (M4,Re)
21. ExplainthehealthrisksandEnvironmentalapplicationsofnanomaterials.(M6, Re)

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Semester II

SEMESTER II	Course Code: ENS-CC-521	Credits: 3

NAME OF THE COURSE: ENVIRONMENTAL TECHNIQUES

Sl. No.	Course outcome (CO) *At the end of the course, the student will be able to:*	Taxonomic Level (TL)
1.	**CO1**: Describe the different types of sampling procedures, microscopy and statistical methods to interpret the results of environmental sample analysis	Un
2.	**CO2:** Articulate knowledge of environmental analysis using the principles of titrimetry and gravimetry.	Un
3	**CO3:** Apply knowledge on environmental analysis of samples using the principles of techniques like chromatography, centrifugation and electrophoresis.	Un/Ap
4	**CO4:** Explain the use of spectrometric assays in environmental analysis.	Un
	CO5: Understand the use of electro-analytical methods.	Un
6	**CO6:** Communicative of different types of radiometric analysis.	Re

COURSECONTENT

MODULE I: Sampling of air, water, soil and sediments - Preservation, storage and processing. Biostatistics- Introduction, Frequency distribution, Diagrammatic representations. Measures of Central tendency – Mean - arithmetic, geometric and harmonic mean, Median, Mode. Measures of Dispersion - Range, Standard deviation, Mean deviation, Quartile deviation; Variance, Skewness, Kurtosis, Normal, Binomial and Poisson distribution. Correlation, Regression. Tests of significance – F and Chi-square (X^2) tests. Microscopy and related techniques - Principles of light and electron microscopes, different types and theirapplications.

Module Outcome:

After Completion of this module, the student should be ableto:

MO1: Describe different types of sampling methods(Un)
MO2: Do statistical analysis using measures of central tenancy and measures of dispersion (Ap)
MO3: Perform statistical tests of significance using F and Chi-square tests (Ap)
MO4: Articulate knowledge of different microscopic techniques (Un)

MODULE II: Titrimetry - General theory, Classification of reactions in titrimetry, Acid-base titration indicators, Acidity, Alkalinity. Environmental applications of titrimetric analysis. Principle and determination - Free CO_2, Organic carbon, DO, BOD,COD,Organiccarboninsoil.Complexometrictitrations-EDTAtitrations,Metal ion indicators, Permanent and temporary hardness. Determination of hardness in water. Determination of Ca and Mg in soil. Estimation of CO_2, SO_2, NO_2 in air. Gravimetric

Analysis - Principle, stoichiometry of gravimetric reactions, formation and properties of precipitates, precipitation from homogeneous solution, nucleation, organic precipitations, applications of gravimetric analysis.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Explain different types of titrimetric analysis (Un)
MO2:Apply knowledge of titrimetry in environmental analysis(Ap)
MO3: Estimate CO_2, SO_2, NO_2 in air(Ap)
MO4: Articulate the principle and application of gravimetric analysis (Un)

MODULE III: Chromatographic methods - Definition and theory of chromatographic separation,classificationandtypesofchromatography.Planarchromatography–thin layer and paper chromatography. Liquid chromatography – HPLC - instrumentation and applications, Gel permeation chromatography. Gas chromatography – instrumentation, types of detectors – FID, TCD, ECD. GCMS – advantages. Sedimentation - Centrifuge - types and applications. Density gradient methods. Electrophoresis - theory, classification andapplications.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Describe different chromatographic methods and its applications (Un)
MO2: Articulate the use of different detectors use in gas chromatography (Un)
MO3: Describe principle and use of sedimentation and centrifugation(Un/ Re)
MO4: Communicate the principle and application of Electrophoresis (Un)

MODULE IV: Colorimetry and Spectrophotometry – Principle, interaction of electromagnetic spectrum with matter. Beer-Lambert's Law. Spectrophotometers –

types and applications. NDIR, NMR, ESR, Rotational diffusion and Flow birefringence – CD, ORD. Turbidimetry, Nephelometry - Principle, Instrumentation and applications. Emission Spectroscopy - Elementary idea of emission spectroscopy, introduction, elementary theory, instrumentation, types of flames, interferences. Flamephotometer-factorsaffectingflamephotometry,applicationstoqualitativeand quantitative analysis, limitations. Absorption spectroscopy-AAS, Fluorimetry - Fluorescence and Phosphorescence. Theory of fluorescence and phosphorescence, quantum yield, factors affecting fluorescence and phosphorescence, Fluorometer and Spectrofluorometers, instrumentation,applications.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Explain the use of Colorimetry and spectrophotometry (Un)
MO2: Articulate Beer- Lambert's law (Un/Re)
MO3: Describe the principle, instrumentation and application of Nephelometry and turbidimetry (Un)
MO4: Explain the principle and application of Emission spectroscopic methods (Un)
MO5: Articulate knowledge of Absorption spectroscopy (Un)
MO6: Describe the use of fluorimetry in environmental analysis (Un)

MODULE V: Electro-analytical Methods - Fundamentals, Electrochemical cells,

Solution structure, Potential in electroanalytical cells, Nernstequation.Potentiometry - Introduction,Reference electrodes,Indicator electrodes,Ionselective electrodes and their applications in chemical analysis.Instrumentation and measurement of cell unit. Direct potentiometry, Potentiometric titration, Applications. Elementary idea of Stripping voltammetry. Polarography - Direct current polarography, basic principle, instrumentation applications of polarography to inorganic and organic compounds. Amperometric titrations.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Explain the principles of electro-analytical methods (Re)
MO2: Acquire applied knowledge about potentiometic and voltametric analysis (Un)
MO3: Describe the principle and application of polarography (Un)
MO4: State the principle of amperometric titrations (Re/Un)

MODULE VI: Radiometric Analysis - Types of radiation, radioactive decay, decay rates, laws of radioactive decay, half life, determination of radioactivity. Neutron Activation Analysis - Principle, theory and instrumentation, applications in environmental analysis. Isotopic Dilution Analysis - Principle, theory, instrumentation and applications.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: State the radioactivity related terms like decay, laws of decay, half life (Re)
MO2: Explain the principle and procedures of radiometric analysis (Un)
MO3: Describe the principle, instrumentation and application of Neutron activation analysis (Un)
MO4: Understand the principle, instrumentation and application of Isotopic dilution analysis(Un)

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Seminar Presentation on selectedtopics
- Quiz
- Demonstration of simple experiments andinstruments
- Laboratory visits to understand the functioning of moderninstruments

LEARNING RESOURCES

References

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ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

MODEL QUESTION BASED ON OBE FORMAT

UNIVERSITY OF KERALA

SECOND SEMESTER M.Sc. (CSS) DEGREE EXAMINATION BRANCH: ENVIRONMENTAL SCIENCES

ENS. CC. 521. ENVIRONMENTAL TECHNIQUES

Time:3Hours **Max. Marks:60**

I. Answer **any ten** of the following. (10 x 2 = 20Marks)

1. What is COD? (M2,Re)
2. Write the principle of ESR spectroscopy? (M4,Re)
3. Differentiate primary and secondary air pollutants with example. (M2,Un)
4. State Beer- Lambert's Law (M4,Re)
5. What are the measures of Central tendency? (M1,Un)
6. What is Neutron activation analysis? (M6,Re)
7. Write the principle of titrimetric analysis. (M2,Re)
8. What is Particulate matter? Mention different categories of particulates.(M2, Re)
9. Write the principle of Fluorimetry. (M4,Re)
10. Differentiate between TEM and SEM (M1,Un)
11. What is Rf value? (M3,Re)
12. Differentiate Nephelometry and Turbidimetry. (M4,Un)

II. Answer **any four** of the following. (4x5=20 Marks)

13. Explain the principle, classification and application of centrifuges. (M3, Re)
14. What is carbonate hardness? Write the qualitative classification of water according to hardness. (M2,Re)
15. Give an account on the working of GLC. (M3,Un)
16. Explain the principle, working and applications of flame photometer. (M4, Un)

17. Describe the principle and application of polarography (M5,Un)
18. Write a short note on gravimetric analysis (M2,Re)

III. Answer **any two** of the following. (2x10=20 Marks)

19. Write the principle working and application of UV-visible spectrophotometer and AAS. (M4,Re)
20. Explaintheprinciple,classificationandapplicationsofelectrophoresis.(M3, Re)
21. (a) Write the classification of reactions in titrimetry with examples.
    (b) Mention the environmental applications of titrimetric analysis. (M2, Re)

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SEMESTER II	Course Code: ENS-CC-522	Credits: 4

NAME OF THE COURSE : ENVIRONMENTAL MICROBIOLOGY

Sl. No.	Course outcome (CO) *At the end of the course, the student will be able to:*	Taxonomic Level (TL)
1.	**CO1**: List the major groups of microorganisms and classify them	Re
2.	**CO2:** Describe the occurrence of microorganisms in various compartments	Re
3	**CO3:** Explain the aeromicrobial pathway	Un
4	**CO4:** Compare culture dependent and independent methods of diversity analysis	An
5	**CO5:** Illustrate the microbial pathways in biogeochemical nutrient cycles	An
6	**CO6:** Evaluate the microbial causes of food spoilage	Ev
7	**CO7**: Compare the ecology of various infectious diseases	An
8	**CO8:** Demonstrate the various techniques of microbial growth and isolation	Ap

COURSE CONTENT

MODULE I: Microorganisms in the environment - importance of microorganisms. Microbial evolution and classification. Major groups of microorganisms: Virus – characteristics, historical outbreaks, methods of infection and replication; Bacteria, Fungi, Algae, Protista – taxonomic diversity and lifestyles in the environment.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: List the various types of microbes in the environment (Re)
MO2: Describe the various historical outbreaks (Re)
MO3: Demonstrate the methods of infection and replication (Ap)
MO4: Compare the taxonomic diversity of various types of microorganisms (Ev)

MODULE II: Microbial ecology: Soil microbiology – Microbes in the soil and subsurface environments; role of microbes in soil formation.

Aeromicrobiology :Aeromicrobial pathway – launching, transport, deposition; sampling of bioaerosols; Extramural and Intramural aeromicrobiology; survival of microbes in air; control of bioaerosols. Space microbiology.

Aquatic microbiology : Microbes in the aquatic environment : Freshwater, brackish and marine water. Planktonic and benthic habitat; Microbial mats and biofilms. Microbialindicators–Coliforms.,Extremophiles–Microbesinextremeenvironments : oxygen availability, temperature, pH, pressure

Module outcome

After Completion of this module, the student should be able to:

MO1: Comprehend the structure and functions of microbes in soil (Un)
MO2: Explain the aeromicrobial pathways (Re)
MO3: Distinguish extramural and intramural aeromicrobes (Un)
MO4: Compare the microbial structure in freshwater, brackish and marine water habitats (Ev)
MO5: Identify the extremophilic microorganisms (Re)

MODULE III: Methods of diversity analysis : Culture dependent methods : Isolation and plating methods, most probable number methods; general types of media used for culturing bacteria, fungi, algae.

Measurement of growth : substrate utilization, terminal electron acceptors, cell mass, carbon dioxide evolution; radiolabelled tracers, enzyme assays – dehydrogenase, esterase

Immunological methods : Antibody – diversity, specificity. Immunoassays – ELISA, Immunoaffinity chromatography assays.

Culture independent nucleic acid – based methods. Metagenomics - Extraction of nucleic acids from environment. Gene probes, PCR, Recombinant DNA techniques. Gene amplification, sequencing, molecular phylogeny and identification. DNA bar coding – DGGE. Functional diversity – Stable Isotope Probing.

Module outcome

After Completion of this module, the student should be able to:
MO1: Demonstrate the culture dependent methods (Ap)
MO2: Compare the various growth measurement methods (Ev)
MO3: Describe the immunological methods of microbial identification (Re)
MO4: Articulate the culture independent nucleic acid based methods of identification (Un)

MODULE IV: Microbial interactions: microbe and microbe; microbe and plants; microbe and animals; Geo-microbiology - role of microorganisms in biogeochemical cyclingofelements–carbon,nitrogen,sulphur,phosphorusandironcycles.Microbial influenced corrosion, Biomining – Acid Mine Drainage and metal recovery; Biomethylation ofmetals
Microbial degradation of natural and manmade compounds; Microbial pathways and enzymes involved in degradation of organic and inorganic pollutants.

Module outcome

After Completion of this module, the student should be able to:
MO1: Outline the microbial interactions in the environment (Re)
MO2: Illustrate the microbial pathways in biogeochemical nutrient cycles (An**)**
MO3: Comprehend the concepts and applications of MIC, Biomining, Biomethylation (Un)
MO4: Distinguish the degradation pathways of natural and manmade compounds (Un)
MO5: Compare the factors responsible for biodegradability (An)

MODULE V: Food and industrial microbiology - Food spoilage–causes and preservation, fermented foods, dairy products. Industrial uses of bacteria, yeast and fungi. Basic techniques in microbial genetic engineering – gene cloning, introduction of cloned genes into new hosts using plasmids and phage vector systems, expression of genes in new host, Genetically modified organisms (GMOs) and their environmental implications. Microbial fertilizers and pesticides – role in sustainable agriculture.

Module outcome

After Completion of this module, the student should be able to:
MO1: Evaluate the microbial causes of food spoilage (Ev)
MO2: Identify and list the industrial uses of microbes (Re)
MO3: Commprehend the genetic engineering techniques (Un)
MO4: Compare the pros and cons of GEMS in the environment (An)
MO5: Justify the role of microbes in sustainable agriculture (Ev)

MODULE VI: Ecology of infectious agents and diseases; vector-borne diseases – malaria, plagues; Food and water-borne diseases – cholera, typhoid, emerging

diseases; airborne infections. Disinfection – thermal; chemical – halogens, ozone; Ultraviolet disinfection, gamma and high-energy radiation.

Module outcome

After Completion of this module, the student should be able to:

MO1: Compare the ecology of various infectious diseases (An)

MO2: Identify and list the vector borne, water borne and food borne diseases (Re)

MO3: Comprehend the disinfection methods (Un)

MO4: Compare the various types of disinfection methods in microbial control (An)

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates in controversial topics
- Quiz
- Field visit and sampling for microbiology experiments
- Laboratory experiments and writing records
- Familiarize with equipments related to microbiology

LEARNING RESOURCES

References

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- https://www.cdc.gov/microbenet/index.htmlaem.asm.org
- https://www.gatc-biotech.com/en/expertise/genomics/metagenome-analysis.html
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ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

MODEL QUESTION BASED ON OBE FORMAT

UNIVERSITY OF KERALA

SECOND SEMESTER M.Sc. (CSS) DEGREE EXAMINATION BRANCH: ENVIRONMENTAL SCIENCES

ENS. CC. 522. ENVIRONMENTAL MICROBIOLOGY

Time:3Hours **Max. Marks:60**

I. Answer **any ten** of the following. (10 x 2 = 10Marks)

1. Define chemolithoheterotrophs with example (M1,Re)
2. Define a bacteriophage (M1,Re)
3. Compare the growth pattern of copiotrophs and oligotrophs (M2,An)
4. List the microbial bioaerosols (M2,Re)
5. State any two applications of ELISA (M3,Re)
6. Why is DGGE known as a DNA fingerprinting method? (M3,Ap)
7. Relate denitrification and global warming (M4,Ap).
8. Define biomethylation (M4,Re)
9. Name two microbial fertilizers and pesticides (M5,Re)
10. What are single cell proteins? (M5,Re)
11. Distinguish disinfection and sterilization (M6,Un)
12. Differentiate pandemic from epidemic with examples (M6,Ev)

II. Answer **any four** of the following.(4x5=20 Marks)

13. Compare the taxonomic diversity of fungi and algae (M1,Ap)
14. Illustrate the aeromicrobial pathway with examples (M2,Ap)
15. Describe the immunological methods of microbial identification (M3,Un).

16. Explain the biodegradation of any two natural compounds. Illustrate the pathways of biodegradation (M4,Re).
17. Compare the pros and cons of GEMS in the environment (M5,Ev).
18. Listthedisinfectionmethods.Explainthemechanismsofdisinfection(M6, Re)

III. Answer **any two** of the following.(2x10=20 Marks)

19. Compare the microbial structure in freshwater and marine habitats(M2, Ev).
20. (a)List the culture independent methods of microbial identification and characterization. (b) Explain PCR and gene amplification (M3,Re).
21. Microbes play an important role in sustainable agriculture. Justifythis statement with suitable facts and figures (M5,Ev)

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SEMESTER II	Course Code: ENS-CC-523	Credits: 4

NAME OF THE COURSE: ENVIRONMENTAL GENETICS AND BIOTECHNOLOGY

Sl. No.	Course outcome (CO) *At the end of the course, the student will be able to:*	Taxonomic Level (TL)
1.	**CO1**: Explain the processes involved in the expression of genetic information.	Un
2.	**CO2:** Comment on the source and action of mutagenic agents.	Un
3	**CO3:** Describe Chromosomal aberrations and their role in evolution.	Un
4	**CO4:** Explain the application of biotechnologyin biodiversity conservation and energy production	Un
5	**CO5:** Elucidate the application of biotechnology in environmental protection and pollution prevention	Un
6	**CO6:** Articulate knowledge of bioremediation and impacts of GMOs.	Un

COURSECONTENT

MODULE I: Central dogma of molecular genetics, Experiments to show DNA as the genetic material, DNA replication, Genes and chromosomes, Nature of Genetic code. Expressionofgeneticinformation:fromtranscriptiontotranslation.TheRelationship between genes and protein, the basic process, Transcription and RNA Processing, Encoding genetic information, Decoding the codons: the role of transfer RNAs, Inhibitors of transcription andtranslation.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Explain the central dogma of molecular biology (Un)
MO2: Comment on the replication of DNA (Re)
MO3: Explain the nature of the Genetic code (Un)
MO4: Communicate the structural organization of chromosomes (Re)
MO5: Articulate the knowledge of Expression of genetic information through Transcription and Translation (Un)
MO6: Spell out the inhibitors of transcription and translation (Un)

MODULEII: Mutation and Environmental mutagens:Occurrence,kindsofMutation, spontaneous and induced mutation, Mutagens, detection of mutation, Lethal mutations, Phenotypic effects of mutation, Mutation rate, Significance & Practical applications of Mutation. Molecular basis of Mutation, mutagenic agents - physical, chemical, biological, Effect on genetic material, Repairmechanisms.

Chromosomal variation in Number & Structure Euploidy, Position Effect, Non-disjunction &Aneuploidy, Aneuploid segregation in plants, Aneuploidy in Human, Polyploidy in Plants & Animals, Induced Polyploidy, applications of Polyploidy, Chromosomal Mosaics, Polytene chromosomes.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Explain the process of mutation and action of mutagens (Un)
MO2: Comment on the significance and practical applications of mutation (Un)
MO3: Elucidate the action of mutagenic agents on genetic materials and repair mechanism (Un)
MO4: Express in words chromosomal variation in number and structure (Un)
MO5: Give an explanation of Euploidy, aneuploidy and polyploidy (Un)
MO6: Describe Induced polyploidy and its applications(Un)
MO7: Explain what chromosomal mosaics are (Un/Re)
MO8: Define polytene chromososme (Re)

MODULE III: Population Genetics and Evolution: Synthetic theory of Evolution– Lamarckian evolution theory, Darwin's theory of evolution, Neo-Darwinism, modern synthesis theory of evolution, Macroevolution & Microevolution. Chromosomal

aberrations & evolution. Principles of Evolutionary Genetics: A brief history of evolutionary genetics, Epistasis and the conversion of genetic variances.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: State theories of evolution (Re)
MO2: Differentiate Micro evolution and macroevolution (Un)
MO3: Describe the relationship between chromosomal aberrations and evolution (Un)
MO4: Communicate the history of evolutionary genetics (Re)
MO5: Describe Epistasis and the conversion of genetic variance (Un)

MODULE IV: Environmental Biotechnology - Definition, principles, scope.
Role of biotechnology in biodiversity conservation, utilization of biodiversity, biotechnology vs biodiversity. Biotechnology andenergy production - Bioenergy, Biofuel, biodiesel, Biohydrogen. Bioenergy from wastes. Eco friendly products - Biopolymers and bioplastics.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Define the basic concepts and principle of biotechnology (Re)
MO2: Explain role of biotechnology in biodiversity conservation (Un)
MO3: Demonstrate environmental biotechnology in energy production (Ap)
MO4: Differentiate biofuel, biodiesel and biohydrogen (An)
MO5: Evaluate production of bio energy from waste (Ev)
MO6: Design ecofriendly products-biopolymers and bioplastics Cr)

MODULE V: Biotechnology for environmental protection and pollution prevention. Applications in solid waste management – biocomposting, biopiles, biomethanation. Biotechnology for wastewater treatment - Microbial processes in wastewater treatment, microbial biofilm and wastewater treatment, secondary treatment systems, nutrient removal through biomass production, applications in tannery, distillery and food industries. Biotechnology for air pollution abatement and odour control – deodorization process – bioscrubbers, biobeds, biotrickling filters.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Apply biotechnology for solid waste management using biocomposting (Ap)
MO2: Understand the various waste water treatment processes using microbial process (Un)
MO3: Explain microbial process in waste water treatment (Un)
MO4: Design bioscrubbers to abate air pollution (Cr)
MO5: Design biobeds and biotrickling filters for odour control (Cr)
MO6: Explain microbial biofilm and wastewater treatment (Un)

MODULE VI: Bioremediation – types, principles. Biostimulation and bioaugmentation. *In situ* and *ex situ* bioremediation. Intrinsic and engineered bioremediation. Application of bioremediation in treating ground water, petroleum, hydrocarbons and pesticides. Biomonitoring - Biosenors, biochips. Biosurfactants – microbial production and their role in bioremediation. Microbial transformation of heavymetals-heavymetaltolerance,metal-microbe interactions,immobilization and transformation of metals. Applications in metal removal - Bioleaching and biomining. Phytoremediation-Types and applications, Constructed wetlands. Phycoremediation. Factors affecting bioremediation.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Describe types and principles of bioremediation(Re)
MO2: Apply bioremediation in biodegradation of persistent organic pollutants (Ap)
MO3: Demonstrate biomonitoring with biosensors, biochips and biosurfactants (Ap)
MO4: Apply phytoremediation in wastewater treatment (Ap)
MO5: Apply bioremediation in heavy metal removal (Ap)
MO6: List the factors affecting bioremediation (Un)

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Seminar Presentation on selectedtopics
- Debates
- Quiz
- Preparation of recordbooks
- Classtests

LEARNING RESOURCES

References

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- http://www.ifsc.usp.br/~ilanacamargo/FFI0740/2.pdf
- http://www.sciencedirect.com/science/journal/01681656?sdc=1
- https://en.wikipedia.org/wiki/Environmental_biotechnology
- https://www.journals.elsevier.com/journal-of-biotechnology
- https://www.nature.com/subjects/genetics

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

MODEL QUESTION BASED ON OBE FORMAT

UNIVERSITY OF KERALA
SECOND SEMESTER M.Sc. (CSS) DEGREE EXAMINATION BRANCH:
ENVIRONMENTAL SCIENCES
ENS CC. 523: ENVIRONMENTAL GENETICS AND BIOTECHNOLOGY

Time:3Hrs. **Total Marks :60**

Answer **any ten** ofthefollowing: **(10 x 2 = 20marks)**

1. Describe Polytene chromosomes. (M2,Re)
2. What is Initiation codon? (M1,Re)
3. Differentiate aneuploidy and polyploidy. (M2,Re)
4. What are Okazaki fragments? (M1,Re)
5. Comment on Bioscrubbers. (M5,Re)
6. Give the names of inhibitors of Transcription. (M2,Re)
7. What is the function of DNA polymerase? (M1,Re)
8. Write note on Phytoremediation. (M6,Re)

9. What is central dogma of molecular biology? (M1,Re)
10. What is neodarwinism? (M3,Re)
11. Comment on biobeds. (M5,Re)
12. Differentiate spontaneous and induced mutation (M2,Un)

II. Answer **any four** of the following: **(4 x 5 = 20Marks)**

13. Explain post transcriptional modifications (M1,Re)
14. Comment on epidemiological approach to evaluate genetic hazards (M2,Re)
15. Give a note on Chromosomal aberrations (M2,Re)
16. Comment on biosurfactants with specific examples (M6,Re)
17. Accounts on the biological significance of DNA replication (M1,Un)
18. Write a brief note on bioenergy production from wastes (M4,Re)

III. Answer **any two** of the following: **(2 x 10 = 20Marks)**

19. Account on the environmental mutagens and their effect on genetic material. Add a note on the mechanism of mutation and its rate (M2,Un)
20. Explain the role of Biotechnology in pollution abatement (M5,Re)
21. Write an essay on Protein synthesis and post translational modifications (M1, Re)

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SEMESTER II	Course Code: ENS-CC-524	Credits: 3

NAME OF THE COURSE : REMOTE SENSING AND GIS

Sl. No	Course outcome (CO) *At the end of the course, the student will be able to:*	Taxonomic level (TL)
1.	**CO1:** Knowledge of the principles and concepts of Remote Sensing Technology	Un
2.	**CO2:**Develop knowledge on the aerial remote sensing and the various sensors on board	Un
3.	**CO3:** Develop knowledge on the aerial remote sensing and the various sensors on board	Un
4.	**CO4:** Develop knowledge on the satellite remote sensing and the various sensors on board	Un
5.	**CO5:** Develop knowledge of the principles and conceptsof GIS and GPS technology.	An
6.	**CO6:** Obtain experience in utilization of Geomatics Science in Resource management and thus to monitoring the spatial and temporal environmental changes.	Ev

COURSE CONTENT

MODULEI: Concepts and Foundation of RemoteSensing-Basic processes in remote sensing-data acquisition - energy sources and radiation principles, propagation of energy through atmosphere, energy interaction with earth's surface features, retransmission of energy into the atmosphere, generation of sensor data, data analysis. Active and Passive Remote Sensing, Special features of remotesensing.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Understand the basic concept of Remote sensing (Re)
MO2: Articulate and interpret electromagnetic spectrum (Re)
MO3. Acquire knowledge about the generation of sensor data (Un)
MO4: Understand basic difference between passive and active remote sensing (Re)
MO5: Know about the salient features of remote sensing (Un)
MO6: Understand higher levels in remote sensing (Un)

MODULE II: Aerial Remote Sensing - advantages of aerial remote sensing,elements of photographic systems - films, aerial cameras, filters. Classification of aerialphotos and processes of aerialphotos,elements of aerial photo interpretation,interpretation keys, aerial photo interpretation for terrain analysis. Photogrammetry- geometric characteristics of aerial photographs, scale of photographs, stereo models, principles of stereo-photos, relief displacement, parallax and measurement of height and slope, convergence and evidence, aerial mosaics, ortho-photos, photogrammetric instruments.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Understand the advantages of aerial remote sensing (Un)
MO2: Understand the elements of photographic system (Un)
MO3: Acquire knowledge about process of vertical photography (Ap)
MO4: Understand photo interpretation for terrain evaluation (An)
MO5: Understand fundamentals of photogrammetry (Un)
MO6: Understand various measurements from aerial photos(Un)

MODULE III: Types of Sensors - Sensors, Platforms and Scanners. Basic definition and principles, general characteristics, spectral resolution and interpretation, applications in environmental monitoring of Thermal, Multispectral (MSS), Microwave and Lidar. Overview of hyperspectral remotesensing.

Module Outcome:

After Completion of this module, the student should be able to: MO1: Understand the general aspects of sensors (Un)
MO2: Articulate and understand thermal sensing (Un)

MO3: Acquire knowledge about MSS sensor (Un)
MO4: Understand the concept of microwave sensor (Re)
MO5: Analyse the difference between Lidar and Radar (An)
MO6: Gain an understanding on hyper spectral remote sensing (Un)

MODULEIV: Satellite RemoteSensing-advantages of satellite remotesensing,types of satellite orbits - polar and geostationary, Satellite characteristics - Orbit, swath, resolution, scale. Overview of satellites - Landsat, SPOT, IRS, NOAA, Cartosat, Oceansat, IKONOS, QUICKBIRD, ERS, RADARSAT, INSAT satellites - their sensors, geometry, radiometry, orbital characteristics, data products and applications.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Understand advantages of satellite remote sensing (Un)
MO2: Differentiate polar and geostationary satellite orbits (Un, Ev)
MO3: Understand and evaluate low resolution satellites (Un, Ev)
MO4: Understand and compare high resolution satellites (Un, Ev)
MO5: Explain and critically discuss INSAT (An)
MO6: Articulate and exemplify the application of satellites (An)

MODULE V: Digital Image Processing (DIP) - Digital Image formats, file structures, Image Rectification and Restoration, Image enhancement, Image classification – supervised, unsupervised, ground truth data and training set manipulation, data merging.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Define the basic term DIP (R)
MO2: Recognise various processing stages (U)
MO3: Outline various image rectification process (R)
MO4: Analyze image enhancement processes (An)
MO5: Distinguish supervised and unsupervised classification (U)
MO6: Critically analyse the data merging process (An)

MODULE VI: Geographical Information System (GIS) - definition, historical evolution, components, basic principles. Data models - vector and raster data, spatial and non-spatial data, Map projection, defining spatial relationships, Spatial Analysis, measurements, queries, buffering and neighbourhood functions, map overlay, networkanalysis,spatialinterpolation–TIN,DEM,DSM.AdvancesinGIS–WebGIS, Open Geospatial Consortium (OGC), FOSS in GIS, Data mining, Bhuvan Geoportal. Global Positioning System (GPS) - System segments, GPS satellite signals, GPS error sources, calculating locations, differential GPS and GPS in differential mode, applications of GPS in environmental studies. IRNSS GPS. Application of Remote SensingandGIS:Applications in forestry and wildlifemanagement;monitoring of

land use/land cover; soil and agriculture; water resources; urban planning; disaster management; health studies.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Define the term GIS (R)

MO2: Recognise various components of GIS (U)

MO3. Identify various data types in GIS (U)

MO4: Articulate and understand various analysis in GIS (An)

MO5. Analyse the principles and functions of GPS (U)

MO6: Critically analyse the applications of GIS and GPS (An)

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments based on the theory
- Seminar Presentation on selected topics
- Debates on selected topics
- Quiz based on theory
- Extensive field visit to demonstrate selected theory part.

LEARNING RESOURCES

References

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On-line Sources

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- www.esri.com
- www.geospatialworld.net
- www.geospatialworld.net.
- www.ncgia.org
- www.nnrms.gov.in
- www.nrsc.gov.in
- www.surveyofindia.gov.in

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

MODEL QUESTION BASED ON OBE FORMAT

UNIVERSITY OF KERALA

SECOND SEMESTER M.Sc. (CSS) DEGREE EXAMINATION BRANCH: ENVIRONMENTAL SCIENCES ENS.CC.524. REMOTE SENSING AND GIS

Time:3Hours **Max. Marks :60**

I. Answer **any ten** of the following **(10 x 2 = 20Marks)**

1. What is mean by SPOT? (M1,Re)
2. What is GPS? (M6,Re)
3. Which are the sources of spatial data? (M6,Un)
4. What is spectral reflectance curve? (M1,Un)
5. What is push broom scanning? (M3,Un)
6. What are the different types of filters used in the aerial camera? (M2,Re)
7. What are the sources of error in GPS? (M6,Un)
8. What is the difference between polar satellite and geostationary satellite? (M4,Ap)

9. What is thermal scanning? (M3,Un)
10. What is QUICKBIRD? (M4,Un)
11. What do you understand by 'Georeferencing'? (M6,Un)
12. What is the difference between spatial data and attribute data? (M6,Ap)

II. Answer **any four** of the following **(4 x 5 = 20Marks)**

13. Describe Digital image processing (M5,Un)
14. Explain the components of GIS (M6,Un)
15. Comment on the scale of aerial photographs (M2,Un)
16. Write note on Electromagnetic radiation (M1,Re)
17. Explain relief displacement and resolution (M2,Un)
18. Write note on stereoscope (M2,Re)

III. Answer **any two** ofthefollowing **(2 x 10 = 20 Marks)**

19. Explain the application of remote sensing in land use studies and geologic mapping (M6,An)
20. Describe different types of platforms and sensors in remote sensing (M3, Un)
21. Give the principle of GPS and its applications (M6,Ap)

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Semester III

SEMESTER III	Course Code: ENS-CC-531	Credits: 4

NAME OF THE COURSE: ENVIRONMENTAL ENGINEERING AND POLLUTION CONTROL

Sl. No.	Course outcome (CO) *At the end of the course, the student will be able to:*	Taxonomic Level (TL)
1.	**CO1**: Explain the sources, impact and control measures of air pollution.	Un
2.	**CO2:** Articulate knowledge about Sources, impact and control measures of air pollution.	Un
3	**CO3:** Describe different water treatment methods and specific pollution control with respect to a few chemical industries	Un
4	**CO4:** Expound water quality modelling methods with special reference to MODFLOW, DMR and AQUATOX.	Un
5	**CO5:** Elucidate soil properties and sources, impact and remediation measures of Soil pollution.	Un
6	**CO6:** Articulate knowledge of Radioactive pollution and radioactive waste management methods	Un

COURSECONTENT

MODULE I: Air Pollution - Atmospheric pollution, Classification of air pollutants, Sources of air pollution, Impacts of ozone layer depletion, Chlorofluorocarbons, Effects of air pollution on human health, Sampling of aerosols, Sampling and analysis of particulates and gaseous pollutants, Removal of gaseous pollutants, Ambient air quality and emission standards, Air pollution indices, Air Act legislation and regulations,Particulateemissioncontrol,bioscrubbers,biofilters.Indoorairpollution-effects of air pollutants on animals and humans, Indoor air quality. Noise Pollution - Sources, measurement, health impacts, effects andcontrol.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Describe the classification of air pollutants and their sources (Un)
MO2: Comment on the impacts of ozone layer depletion (Re/Un)
MO3: Write note on the effects of air pollution on human health (Re)
MO4: Apply knowledge on sampling and analysis of particulate and gaseous pollutants (Ap)
MO5: Comment on Ambient air quality and emission standards and air pollution indices (Re)
MO6: Articulate knowledge about Air Act legislation and regulations (Re)
MO7: Explain the mechanism of particulate emission control devices (Un)
MO8: Communicate about Indoor air pollution (Un)
MO9: Explain sources effects and control of noise pollution

MODULE II: Water Pollution - Types of water pollution, water pollutants, sources and storages of water -ground water and surface water, and consequences of water pollution. Ecological and biological effects of domestic, industrial and agricultural wastes on water bodies. Responses of plants and animals to changes in physico-chemical characteristics of water. River Action plans. Biological monitoring of water pollution. Sampling, physical, chemical and bacteriological analysis of water, Water quality standards. Control and prevention of water pollution. State and Central pollution control boards, Tolerance limits and specifications, Thermal pollution-sources, causes, effects and control.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Comment on types, sources and impact of water pollution (Re)
MO2: Explain ecological and biological effects of domestic, industrial and agricultural wastes on water bodies (Un)
MO3: Describe responses of plants and animals to changes in physico-chemical characteristics of water.
MO4: Comment on River action plans in India (Re)
MO5: Explain sampling methods and physico-chemical and bacteriological analysis of water (Un/Ap)
MO6: Elucidate Water Quality Standards (Un)
MO7: Communicate on Control and prevention methods of water pollution (Un)
MO8: Explain the role of Pollution Control Board in water pollution prevention (Re)
MO9: State sources, causes, effects and control of thermal pollution (Un)

MODULEIII: Water treatment-Quality of water, Standards of raw and treated water, Objectives of waste water treatment, Wastewater collection and treatment principles: sewerage system, storm water collection, combined sewer overflow design, Unit processes for waste water treatment- septic tanks. Primary treatment: preliminary treatment such as barscreen,gritchamber,coagulation and flocculation,filtration and sedimentation tank methods. Secondary treatment - design principles - activated sludge, trickling filters, oxidation ponds. Tertiary/ advanced treatment - Removal of toxic compounds and refractory organics, removal of dissolved inorganic substances, Ionexchangemethods,Electrodialysis,Softeningofwater-Reverseosmosis,nitrogen and phosphorus removal. Disinfection of water, Sludge treatment and disposal. Conventional methods of effluent treatment. Water pollution management and control. General and specific pollution control with respect to a few chemical industries such as tanneries, textile, fertilizer and electroplating industries.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Comment on the Standards of raw and treated water (Re).
MO2: Describe the objectives of waste water treatment (Un/Re).
MO3: Explain different stages and types of wastewater treatment methods (Un).

MO4: Explain the conventional methods of effluent treatment (Re)
MO5: Comment on water pollution management and control (Re)
MO6: Elucidate pollution control methods with respect to a few chemical industries (Un)

MODULE IV: Water Quality Modelling: Formulations for water quality modeling - MODFLOW. Discharge Monitoring Report (DMR) Pollutant Loading Tool – AQUATOX.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Describe water quality modelling methods (Re)
MO2: Explain what MODFLOW is (Un)
MO3: Comment on Discharge Monitoring report (Un)
MO4: Articulate knowledge of Pollutant Loading Tool- AQUATOX

MODULE V: Soil Pollution - Physical and chemical properties of soil, Soil microorganismsandtheirfunctions,Wastes and pollutants in soil, Pesticides and their effects on soil components, residual toxicity, and pollution. Different kinds of synthetic fertilizers and their interactions with soil components. Industrial effluents of different kinds, their interactions with soil components. Changes in characteristics of soil by waste disposal. Toxic heavy metals. Trace element analysis in soil. Control of soil pollution: sanitary and secured landfills. Remediation of contaminated soils.

Module Outcome:

After Completion of this module, the student should be ableto:

MO1: Explain physical and chemical properties of soil (Un)
MO2: Describe the functions of soil microorganisms(Un)
MO3: Comment on the pollutants in soil and their effects on soil components (Re)
MO4: Communicate the knowledge of changes in characteristics of soil by waste disposal (Un)
MO5: Apply the knowledge of trace element analysis of soil (Ap)
MO6: Describe soil pollution control methods (Un)
MO7: Explain the remediation methods of contaminated soil (Un)

MODULE VI: Radioactive Pollution: Radionuclides- sources, types of radiation, radioactive fallout, ecological risks from radiation, effects on humans, exposure standards. Control measures: radioactive waste treatment.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Explain the sources and types of radiation (Un).
MO2: Describe what radioactive fallout is (Un).
MO3: Communicate on ecological and human risks from radiation (Un)
MO4: List out exposure standards and control measures (Re)

MO5: Describe different types of radioactive waste treatment methods (Un)

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Seminar Presentation on selectedtopics
- Debates
- Quiz
- Classtests

LEARNING RESOURCES

References

- Baxter, M. (2013). Social and Ethical Aspects of Radiation Risk Management, Vol.19, Editors: Deborah Oughton Sven Hansson. Elsevier (Pub.). Series: Radioactivity in theEnvironment.
- Brady, N.C. (1996).The Nature and Properties of Soil, 10thEd., Prentice Hall of India Pvt.Ltd.
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- http://www.bis.org.in/
- http://www.science.uwaterloo.ca/~cchieh/cact/applychem/watertreatment.ht

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- http://www.sciencedirect.com/science/journal/02697491?sdc=1
- http://www.water-pollution.org.uk/types.html
- https://en.wikipedia.org/wiki/Water_pollution
- https://link.springer.com/journal/11270
- https://www.journals.elsevier.com/atmospheric-pollution-research/
- https://www.journals.elsevier.com/environmental-pollution/
- https://www.sciencedaily.com/terms/water_pollution.htm

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

MODEL QUESTION BASED ON OBE FORMAT

UNIVERSITY OF KERALA
THIRD SEMESTER M.SC. (CSS) DEGREE EXAMINATION BRANCH: ENVIRONMENTAL SCIENCES
ENS. CC. 531: ENVIRONMENTAL ENGINEERING AND POLLUTION CONTROL

Time:3Hours **Max. Marks:60**

I. Answer **any Ten** ofthefollowing. (10 x 2 = 20Marks)

1. What is Air Pollution Index? (M1,Re)
2. What is 'CEC'? (M5,Re)
3. What is soil sickness? (M5,Re)
4. What are atmospheric aerosols? (M1,Re)
5. Write the names of any four heavy metals associated diseases. (M5,Re)
6. What are High Volume air samplers? (M1,Re)
7. What is the difference between bioscrubbers and biofilters. (M1,Re)
8. Write the functions of soil microbes. (M5,Re)
9. What is electro-dialysis? (M3,Re)
10. Differentiate grey water and black water (M2,Un)
11. What is water quality modeling? (M2,Re)
12. Write the method of determination of colour of water and its unit. (M2,Re)

II. Answer **any four** ofthefollowing. (4 x 5 = 20Marks)

13. Explain briefly ambient air quality and emissionstandards.
14. Write note on DMR and Aquatox. (M4,Re)
15. Write note on radioactive wastes and their management methods. (M6,Re)
16. Explain different sources of soil pollutants. (M5,Re)
17. Explain gaseous and particulate air pollutants with example. (M1,Un)
18. Mention the sources and impacts of Thermal pollution. (M2,Re)

III. Answer **any two** ofthefollowing. (2x10=20Marks)

19. Explain thefollowing:
    a. Properties ofsoil

b. Various solid waste treatment and management methods. (M5,Re)

20. Mention with diagrams the secondary waste water treatment methods.Write the advantages and disadvantages of these treatment methods. (M3,Re)
21. Explain in detail the Sources, measurement and impact of Noise pollution (M1,Re)

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SEMESTER III	Course Code: ENS-CC-532	Credits: 4

NAME OF THE COURSE: ENVIRONMENTAL ECONOMICS AND POLICIES

Sl. No.	Course outcome (CO) *At the end of the course, the student will be able to:*	Taxonomic Level (TL)
1.	**CO1**: Comprehend the economics of natural resources exploitation	Un
2.	**CO2:** Identify the methods of economic valuation	Re
3.	**CO3:** Articulate the economics of climate change	Un
4.	**CO4:** Analyze the issues of food, energy and social security to climate change	An
5.	**CO5:** Apply the concept of Environmental Auditing for auditing of environment	Ap
6.	**CO6:** Articulate the environmental policies in India	Re
7.	**CO7:** List the international environmental laws	Re
8.	**CO8:** Describe the concept of sustainable development and list the SDGs	Re
9.	**CO9:** Analyze the impacts of ecotourism	An
10.	**CO10:** Differentiate formal and non-formal environmental education	An

COURSE CONTENT

MODULE I: Economy and the Environment - Nature and scope of Environmental economics; economics and ecology; Economics of Natural Resources exploitation – methods of valuation of environmental costs and benefits, market value approach of environmental costs and benefits. Economics of Pollution - optimum level of pollution.

Module outcome:

After Completion of this module, the student should be able to:

MO1: Comprehend the economics of natural resources exploitation (Un)

MO2: Identify the methods of economic valuation (Re)

MO3: Demonstrate the optimum level of pollution (Ap)

MO4: Compare the market value approaches of costs and benefits (Ev)
MO5: Evaluate the cost-benefit ratio (Ev)

MODULE II: Economics of climate change – Kyoto Protocol – Flexibility mechanisms - CDM concept. CDM scenario in India. National Action Plan on Climate Change, sustainable habitat, Concept of Green architecture, Carbon sequestration methods, CarbonFoot-print,Ecologicalfoot-print.IssuesofEnergysecurity,FoodSecurityand Socialsecurity.

Module outcome:

After Completion of this module, the student should be able to:

MO1: Articulate the economics of climate change (Un)
MO2: Describe the methods of carbon sequestration (Re)
MO3: Evaluate carbon and ecological foot-print (Ev)
MO2: Analyze the issues of food, energy and social security to climate change (An)

MODULEIII: Environmental Auditing and Management-Objectives, frequency and criteria audit team, Environmental appraisal, accounting and environmental audit. Environmental guidelines for siting of industry, Green Balance Sheet (GBS). Environmental Management - Concept and scope, systems and approaches, Environmental standards – international and national, Intellectual Property Rights, Scheme of labelling of environmentally friendly products (eco-mark), Public Liability Insurance Act, 1991. Environmental Management and ISO Certification: Environmental Management Systems (EMS), ISO 14000(EMS).

Module outcome:

After Completion of this module, the student should be able to:

MO1: Apply the concept of Environmental Auditing for auditing of environment (Ap)
MO2: Comprehend the components of green balance sheet (Un)
MO3: Compare the international and national environmental standards (An)
MO4: Identify the Environmental Management Systems (EMS) (Re)

MODULEIV: Environmental policies in Ancient India–MedievalIndia,BritishIndia during post independent era. National Environmental Policy and Regulatory framework - Rules and regulations of Central and State Government and Pollution Control Boards for Environmental Protection. International and National Conservation agencies. Major environmental movements in India – Chipko movement, Appiko movement; Narmada dam, TehriDam.

Module outcome:

After Completion of this module, the student should be able to:

MO1: Articulate the environmental policies in India (Re)
MO2: Describe the features of NEP (Re)
MO3: Compare the regulations of Central and State PCBs (An)
MO4: Explain the environmental movements in India (Un)

MODULE V: International Environmental Laws : Evolution and development of International Environmental Laws with reference to Stockholm conference, Nairobi Declaration, RioConference, Rio+5 and Rio+10, etc. Globalenvironmental issues and International Laws to control global warming, climate change, ozone depletion, acid rains, hazardous wastes. Role of UN authorities in protection of global environment, convention on biodiversity.
Environmental Laws in India: Legal, administrative and constitutional provisions for environmental protection in India, Constitutional and Statutory laws in India, statutoryprotectionofhumanenvironment–Factoriesactof1948,MotorVehicleAct,
Indian Forest act of 1927, the mines and minerals act of 1957, Hazardous Waste Legislation for pollution abatement, Anti Pollution Acts – The Water Act, 1974, The Air Act 1981, The Environment Protection Act, 1986, The national environment appellate authority act of 1997, The wildlife protection act 1972; The forest conservation act of 1980, Biodiversity Act2002.

Module outcome:

After Completion of this module, the student should be able to:

MO1: List the international environmental laws (Re)
MO2: Explain the salient features of Environmental laws in India (Un)
MO3: Critically analyse the policies relating to global environmental issues (An)

MODULE VI: Sustainable Development - Concept and growth of the idea, indications of sustainability, models of sustainable development, sustainable development scenario – global, national; sustainable agriculture. Sustainable Development Goals. Ecotourism - Definition, concept and principles, types of ecotourists, Scope for ecotourism in Kerala, India, Benefits of ecotourism. EnvironmentalEthics-Concep t of Environmental Ethics,philosophies of biocentrism and ecocentrism, application of ethics to environmental issues. Ecofeminism- Environmental equity and justice. Environmental Education - Meaning and scope– principles and objectives, environmental awareness strategies, formal and non- formaleducation.

Moduleoutcome:

After Completion of this module, the student should be able to:

MO1: Describe the concept of sustainable development and list the SDGs (Re)
MO2: Analyze the impacts of ecotourism (An)
MO3: Differentiate formal and non-formal environmental education (An)
MO4: Comprehend the environmental effects of sustainable agriculture (Un)
MO5: Articulate the concepts of environmental ethics and ecofeminism (Un)

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Seminar Presentation on selectedtopics
- Debates
- Quiz
- Class tests

LEARNING RESOURCES

References

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- Daly,H.E. 1997. Beyond Growth: The Economics of Sustainable Development. BeaconPress.
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On-line Sources

- http://www.downtoearth.org.in/
- http://www.epa.vic.gov.au/our-work/environmental-auditing
- http://www.investopedia.com/terms/e/environmental-economics.asp
- http://www.legalservicesindia.com/article/article/environmental-laws-and-constitutional-provisions-in-india-1926-1.html
- http://www.undp.org/content/undp/en/home/sustainable-development-

goals.html
- https://link.springer.com/referenceworkentry/10.1007%2F1-4020-4494-1_116
- https://www.epa.gov/environmental-economics
- https://www.journals.elsevier.com/journal-of-environmental-management
- www.epa.gov/environmental-economics
- www.investopedia.com/terms/e/environmental-economics.asp

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

MODEL QUESTION BASED ON OBE FORMAT

UNIVERSITY OF KERALA
THIRD SEMESTER M.SC. (CSS) DEGREE EXAMINATION BRANCH: ENVIRONMENTAL SCIENCES
ENS. CC. 532: ENVIRONMENTAL ECONOMICS AND POLICIES

Time:3Hours **Max. Marks:60**

I. Answer **any ten** of the following. (10 x 2 = 10Marks)

1. Define pollution cost(M1,Re)
2. List the methods of resource valuation(M1,Re)
3. State the flexibility mechanisms of Kyoto protocol(M2,Re)
4. What are the components of green architecture? (M2,Re)
5. Define green balance sheet(M3,Re)
6. Distinguish biocentrism from eco-centrism (M3, Ev)
7. State any two functions of central PCB (M4,Re).
8. What is NBA? When did it start?(M4,Re)
9. Name two salient features of Environment Protection Act(M5,Re)
10. What is Agenda 21?(M5,Re)
11. What are the SDGs related to poverty and human health?(M6,Un)
12. Write any two characteristics of genuine ecotourists(M6,Re)

II. Answer **any four** of the following. (4 x 5 = 20Marks)

13. Compare the market value approaches of costs and benefits(M1-Ev)
14. Describe the methods of carbon sequestration(M2-Re)
15. A distillery industry is proposed to be sited in your state. Analyze the suitablility of siting the industry based on the environmental guidelines (M3-An).
16. Justify the role of environmental movements in India in protecting natural resources(M4).
17. What is the outcome of Earth Summit. Discuss on the highlights and drawbacks(M5).
18. What are the components of sustainable agriculture.(M6)

III. Answer **any one** of the following. (1 x 10 = 10 marks)

19. Explain the salient features of Environmental laws in India(M3-Un)

20. Critically analyze the issues of food, energy and social security to climate change(M3-An)
21. (a) Estimate the cost and benefits of optimum level of pollution. (b)Explain the methods of economic valuation of natural resources(M1

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SEMESTER III	Course Code: ENS-CC-533	Credits: 3

NAME OF THE COURSE: ENVIRONMENTAL IMPACT ASSESSMENT AND DISASTER MANAGEMENT

Sl. No.	Course outcome (CO) *At the end of the course, the student will be able to:*	Taxonomic Level (TL)
1.	**CO1**: Understand the goal, type and participants of EIA	Un
2.	**CO2:** Understand the various stages in environmental impact analysis	Ap
3.	**CO3:** Identify basic steps for environmental impact analysis of various domains of environment and study of EIA of selected case studies	Ap, An, Cr
4.	**CO4:** Understand the basic aspects of disaster	An
5.	**CO5:** Identify the components and sectors of disaster management	Ap
6.	**CO6:** Critically discuss important natural disasters and their management	Re

COURSE CONTENT

MODULE I: Environmental Impact Assessment (EIA) - Definition, purpose and characteristics of EIA, global development of EIA, participants in EIA process, stages of EIA, types of EIA. Environmental inventory. Baseline data on EIA- environmental data, project data and project alternative data. Measurement of impact– physical, social, economic, natural. Public participation in EIA, Framework of environmental assessment, Description of environmental setting, Environmental impact factors and area consideration. A note on Environmental Impact Statement (EIS) and Environmental Management Plan (EMP).

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Define EIA and list the goals of EIA (Re)

MO2: Articulate and interpret participants in EIA (Un)

MO3. Acquire knowledge about the stages and types of EIA (Un)

MO4: Understand the measurement of impacts (Un)

MO5: Know the role of public participation in EIA (Un)
MO6: Understand the terms EIS and EMP (Un)

MODULE II: Stages in Environmental Impact Analysis - Impact identification and methods of impact identification (adhoc, checklist, matrix, network, overlay and index methods), Impact prediction and predictive methodologies (mathematical modelling), impact evaluation (assessment) and impact mitigation.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Identify various stages in EI Analysis (Un)
MO2: Articulate and interpret impact assessment methods (Un)
MO3. Acquire knowledge about the stages and types of EIA (Un)
MO4: Understand the measurement of impacts (Un)
MO5: Know the role of public participation in EIA (Un)
MO6: Understand the terms EIS and EMP (Un)

MODULE III: Basic steps for impact identification, prediction and evaluation (assessment) of air, water, vegetation and wildlife environment. EIA in India - An overview of history, current procedures, practices and guidelines. EIA of water resource projects, industries, mining and quarrying, highway constructions, tourism developments with casestudies.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Identify basic steps for environmental impact analysis of air, water envt (Ap)
MO2: Identify basic steps for environmental impact analysis of vegetation envt (Ap)
MO3. Identify basic steps for environmental impact analysis of wildlife envt (Ap)
MO4: Acquire knowledge about current procedure of environmental clearance in India (An)
MO5: Critically discuss the EIA of five case studies like water resource project (Ev)
MO6: Develop an EIA report to various proposed projects (Cr)

MODULE IV: Basic Concept of Disaster- Definition of hazard, vulnerability, risk, disaster. Causative factors of disaster, Classification of disasters. Hazard Mitigation - Identification of hazard prone belts, hazard zonation and risk assessment, risk reduction in vulnerable areas, developing warning systems, forecasting, emergency preparedness, education and training activities, planning for rescue and relief works.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Define the concept of disaster (Re)
MO2: Differentiate between hazard and disaster (Un)
MO3: Define the concept of vulnerability and risk (Re)
MO4: Classify the types of disaster (Un)

MO5: Identify the causative factors of disaster (Un)

MODULE V: Disaster Management (DM) - Definition of disaster management. Components of disaster management cycle - crisis management and risk management. Crisis management- quick response and relief, recovery, rehabilitation and development. Risk management- risk identification and risk assessment, risk reduction (preparedness, prevention and mitigation) and risk transfer. Disaster management- act and policy. Important sectors in disaster management- health and medical care, communications, insurance, social work, NGOs, media, fire services, police and paramilitary services, armed forces etc. Levels of disasters in India.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Define disaster management (Re)
MO2. Identify components of DM (Un)
MO3: Articulate and interpret the components of crisis management (Ap)
MO4: Articulate and interpret the components of risk management (Ap)
MO5: Identify important sectors in DM (Ap)
MO6: Identify levels of disasters in India (Ap)

MODULE VI: Natural Hazards - earthquakes, tsunami, volcanoes, floods, landslides, avalanche, cyclone, drought, fire – causes, perception, mitigation and management. Man made hazards -hazards due to dams and reservoirs, nuclear power plants, industrial hazards, occupational hazards, mitigation measures. Environmental health hazard and risk assessment: biological, chemical, physical and psychological health hazard; health risk assessment and management.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Critically discuss the earthquake, tsunami hazards and its management (Ev)
MO2: Critically discuss the volcano hazard and its management(Ev)
MO3: Critically discuss the landslide hazard and its management (Ev)
MO4: Critically discuss the cyclone hazard and its management(Ev)
MO5: Critically discuss selected man made hazard and its management (Ev)
MO6: Acquire knowledge about health risk assessment (Ap)

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz
- Class tests

LEARNING RESOURCES

References

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- Bregman, J.I. and Mackenthum, K.M. 1992. *Environmental impact statements*. Chelsia Michigan:Lewis.
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On-line sources

- www.cesindia.org
- www.ecprocess.nic.in
- www.indiaenvironmentalportal.org
- www.moef.nic.in
- www.wikipedia.org

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

MODEL QUESTION BASED ON OBE FORMAT

UNIVERSITY OF KERALA
THIRD SEMESTER M.SC. (CSS) DEGREE EXAMINATION BRANCH: ENVIRONMENTAL SCIENCES
ENS. CC. 533: ENVIRONMENTAL IMPACT ASSESSMENT AND DISASTER MANAGEMENT

Time:3Hours **Max. Marks:60**

I. Answer **any ten** of the following. (10 x 2 = 20Marks)

1. Environmental Impact statement (M1,Re)
2. Impact mitigation (M1,Re)
3. Overlay method of impact identification (M2,Un)
4. Disaster management (M5,Un)
5. Hazard zonation (M4,Re)
6. Risk Assessment (M4,Re)
7. Levels of Disasters in India (M5,Re)
8. Tsunami (M6,Un)
9. Occupational Health Hazards (M6,Un)
10. Land Slide (M6,Re)
11. Risk Transfer (M5,Un)
12. Industrial Hazards (M5,Re)

II. Answer **any four** of the following: (4 x 5 = 20Marks)

13. Hazards in Relation to nuclear power plants (M6,Ap)
14. Disaster management in a Cyclone hit area (M6,Ap)
15. Importance of Communication sector in Disaster management (M5,U)
16. EIA for water resource project (M3,E)
17. Components of Disaster management cycle (M5,U)
18. Significance of Warning Systems in Hazard Mitigation (M5,An)

III. Answer **any two** of the following: (2 x 10 = 20Marks)

19. Explain the basic steps for the impact identification, prediction and assessment of a Wild life Environment (M6,An)
20. Briefly explain the status of EIA in India, giving current procedures, practices and guidelines (M3,An).
21. Prepare terms of reference for coal based Thermal Power Plant having a capacityof2x330 MW which is located at Nagapattinam district. Andra Pradesh (M2,An)

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SEMESTER III	Course Code: ENS-CC-534	Credits: 2

NAME OF THE COURSE: FIELD STUDY

Sl. No.	Course outcome (CO) *At the end of the course, the student will be able to:*	Taxonomic Level (TL)
1.	**CO1**: Understand and evaluate theoretical perspectives of environment learned in the classroom with experiences gained in the field	Un, Ev
2.	**CO2:** Achieve insight into the processes and functioning of various ecosystems and their services	Un, An
3.	**CO3:** Integrate cognitive and experiential learning, and to employ various decision making process in environmental science	Ap, An, Cr
4.	**CO4:** Understand threats to various ecosystems and proper management measures for the restoration of affected areas	An, Ap
5.	**CO5:**Turnoutfieldreportbasedontheexperiencesandactivities during the field visit.	Ap, Cr

ASSESSMENT

40% for attending the field study.
60% for Field report

SEMESTERIII	Course Code: ENS-DE-535	Credits: 2

NAME OF THE COURSE: INTEGRATED WASTE MANAGEMENT

Sl. No	Course outcome (CO) *At the end of the course, the student will be able to:*	Taxonomic level (TL)

1.	**CO1:** Articulate the waste generation in India and the world	Un
2.	**CO2:** Identify the different types of solid wastes	Re
3.	**CO3:** Describe the solid waste management methods	Re
4.	**CO4:** Articulate the source and characteristics waste water treatment	Un
5.	**CO5:** Compare the various waste water treatment methods	An
6.	**CO6:** Comprehend the reuse of wastewater	Un
7.	**CO7:** Explain the source, characteristics and management of hospital wastes	Un
8.	**CO8:** Articulate the source of e-wastes and their management	Un
9.	**CO9**: List the waste management policies	Re
10.	**CO10:** Compare waste management practices in various industries	Ev
11.	**CO11:** Explain the methods of converting wastes to useful products	Un

COURSE CONTENT

MODULE I: Wastes and Management: Definition, concept. Principles of waste management; The changing nature, quantity, composition in urban and rural areasof India and World. (Households, Vegetable Markets, Street Cleaning, Recreational places and Parks, Education Institutions, Corporate and Business Centers, Religious Institutions, Function Halls/Grounds,Hotels)

Module outcome:

After Completion of this module, the student should be able to:

MO1: Articulate the waste generation in India and the world (Un)
MO2: List the source of wastes (Re)
MO3: Define the concepts of waste management (Re)
MO4: Compare the nature of waste in urban and rural areas (An)

MODULE II: Solid wastes: types of wastes; Residential and Commercial, Municipal solid waste Management: Source and types of municipal solid wastes – factors affecting generation, characteristics, methods of sampling. Storage methods, Collection and transfer. MSW management – processing: mechanical volume reduction – necessary equipments MSW treatment methods: composting, vermi- composting, biomethanation, Landfilling : sanitary landfill- methods of operation – advantages and disadvantages of sanitary land fill - site selection – gas and leachate movement and control.

Module outcome:

After Completion of this module, the student should be able to:

MO1: Identify the different types of solid wastes (Re)

MO2: Describe the solid waste management methods (Re)
MO3: Comprehend the methods of storage, collection and transfer of MSW (Un)
MO4: Illustrate MSW management structure based on type of waste (An)
MO5: Analyze the suitable methods for MSW treatment and disposal (An)

MODULE III : Resource recovery : Incineration, Pyrolysis, Gasification, Plasma, Hydrothermal Carbonization, Paving Blocks, Road Construction, CHP concept,Metal Recovery, Plastic to Fuel; Management of plastic wastes : Reuse and recycling; Elementsofmanagement–social,financialaspects.MSWmanagementcasestudies– Developing and developed countries. MSW management rules; Present scenario of solid waste management in ULBs – Current practices and deficiencies in SWM; Role of rag pickers – Public awareness

Module outcome:

After Completion of this module, the student should be able to:
MO1: List the various resource recovery processes (Re)
MO2: Explain the social and financial aspects of waste management (Un)
MO3: Outline the scenario of waste management in ULBs (An)
MO4: Interpret the reasons for mismanagement of MSW (Un)

MODULE IV: Waste water: Nature and types; sources and characteristics; Waste water generation in India; treatment methods – physical, chemical, biological and advanced treatment methods. Natural treatment systems-constructed wetlands, wastewater reclamation and reuse. Selection of suitable treatment methods for municipal and industrial waste water.

Module outcome:

After Completion of this module, the student should be able to:
MO1: Compare the various waste water treatment methods (An)
MO2: Comprehend the reuse of wastewater (Un)
MO3: Explain the constructed wetland system (Un)
MO4: Demonstrate the methods of wastewater reclamation and reuse (Ap)

MODULE V: Hazardous wastes: Definition, source and characteristics; Management of medical and hospital wastes, Nuclear and radioactive wastes – classification, sources and disposal; e-waste and their management.

Module outcome:

After Completion of this module, the student should be able to:
MO1: Explain the source, characteristics and management of hospital wastes (Un)
MO2: Articulate the source of e-wastes and their management (Un)
MO3: Identify the sources and types of radioactive wastes (Re)
MO4: Outline the management options of e-wastes (An)

MODULEVI: Waste management policies;(Actandrules–legislations)polluter pays principle; wealth from waste -compost, single cell protein; waste to energy – ethanol, biogas, hydrogen. Waste audit; waste management economics

Module outcome:

After Completion of this module, the student should be able to:
MO1: List the waste management policies (Re)

M02: Compare waste management practices in various industries (Ev)
MO3: Explain the methods of converting wastes to useful products (un)
MO4: Calculate the economics of waste management (Ap)

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments based on the theory
- Seminar Presentation on selected topics
- Debates on selected topics
- Quiz based on theory
- Demonstration of simple experiments based on theory
- Field work and survey based on theory.

LEARNING RESOURCES

References

- Agarwal,S.K. 2005. Green Management, APH Publishing corporation, New Delhi.
- Agarwal,S.K. 2005. Wealth from waste, APH Publishing corporation, New Delhi
- Bhatia,S.C.2007.SolidandHazardousWasteManagement.Atlantic Publishers and Distributors, NewDelhi
- Bide,A.D.andR.R.Sundaresan.2001.SolidWasteManagement: Collection, processing and disposal. INSDOC, NewDelhi
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- Manser A.G.R. and Keeling A.A.," Practical Handbook of Processing and Recycling of Municipal solid Wastes", Lewis Publishers, CRC Press,1996

On-line Sources

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

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

MODEL QUESTION BASED ON OBE FORMAT

UNIVERSITY OF KERALA
SECOND SEMESTER M.Sc. (CSS) DEGREE EXAMINATION BRANCH: ENVIRONMENTAL SCIENCES
ENS. DE. 535. INTEGRATED WASTE MANAGEMENT

Time:3Hours **Max. Marks:60**

I. Answer **any ten** of the following. (10 x 2 = 10Marks)

1.Differentiate garbage and trash (M1,An)
2.List the types of household wastes (M1, Re)
3.Name the stages of composting (M2,Re)
4.What are the advantages of solid waste volume reduction? (M2, Re)
5.Compare incineration and pyrolysis (M3, An)
6.What is gasification? (M3, Un)
7.Differentiate black and grey water (M4, An).
8.State two characteristics of constructed wetlands (M4,Re)
9. List the coloured bins used for biomedical waste storage (M5,Re)
10. Write any two salient features of e-waste management rules (M5,Re)
11. What are single cell proteins? (M6,Un)
12. Define waste audit (M6,Re)

II. Answer **any four** ofthefollowing. (4 x 5 = 20Marks)

13. Compare the nature of waste in urban and rural areas (M1,An)
14. Illustrate MSW management structure in Kerala (M2,An)
15. Explain the social and financial aspects of waste management (M3,Un).
16. Explain the structure and functions of constructed wetland system (M4,Un)
17. Outline the management options of e-wastes (M5,An)
18. Explain the methods of converting wastes to useful products (M6,Un)

III. Answer **any two** ofthefollowing. (2 x 10 = 10Marks)

19. Describe the waste management methods for biodegradable solid wastes (M2, Re)
20. Critically analyze the issues of MSW management in developing countries. Compare the management practices with developed countries (M3,An)
21. (a) Explain the characterisics of municipal sewage (b) Describe themethods treatment with illustrations (M4,Un)

Semester IV

SEMESTER IV	Course Code: ENS-CC-541	Credits: 4

NAME OF THE COURSE: NATURAL RESOURCES AND ENERGY MANAGEMENT

Sl. No	Course outcome (CO) *At the end of the course, the student will be able to*:	Taxonomic level (TL)
1.	**CO1:**Understand the use, management, and protection of land and natural resources and prepare for careers in environmental management	Un
2.	**CO2:** Promote responsible and conscientious stewardship of soil and mineral resources and thereby the reducethe deleterious effects of mining and soil erosion.	Ap
3.	**CO3:** Develop an appreciation of the major types of forest resources of the country/state and promote the knowledge of preservation and management strategies of natural resources.	An
4.	**CO4:**Develop an understanding of the protection of biodiversity and conserve the habitats upon which they depend in order to maintain balanced, biologically productive ecosystems and natural communities for the use and benefit of future generations.	Un
5.	**CO5:** Develop knowledge on the values and importance of water resources and thereby inculcate awareness on the detrimental effects of overuse and depletion of water resources in order to ensure proper health, safety, and welfare of the public.	Ap
6.	**CO6:** Understand the different forms/patterns and sources of energy and to analyze and appreciate the importance of energy efficiency and energy conservation strategy for sustainable environment.	Ev

COURSE CONTENT

MODULE I. Natural Resources : concept and major types of natural resources, land resources; land use and land cover, land use change and land degradation, biological and physical phenomena in land degradation , drivers of land degradation, impact of land use change on environment.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Define the basic terms related to natural resources (Re)
MO2: Differentiate different types of natural resources (An)
MO3:Outline the features of land use change and land degradation (Re)
MO4: Explain land use and land cover (Un)
MO5: Compare biological and physical phenomena in land degradation (An)
MO6: Summarize the impact of land use change on environment (Un)

MODULE II: Soil and mineral resources : overview of major soil types and mineral deposits in India with special reference to Kerala, Environmental effects of mining; acidic, alkaline and saline soils – reclamation techniques. Soil resistance and resilience; nature and types of soil erosion; non-erosive and erosive soildegradation; losses of soil moisture and its regulation; nutrient depletion.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: List the major soil types and mineral deposits in India (Re)

MO2: Explain the Environmental effects of mining (Un)
MO3: Discriminate between Soil resistance and resilience (An)
MO4: Compare non-erosive and erosive soildegradation (An)
MO5: Evaluate the losses of soil moisture and its regulation (An)
MO6: Appraise the knowledge on nutrient depletion (Ev)

MODULE III: Forest resource : over view of major forest types in India with special reference to Kerala – their characteristics; Social forestry – multipurpose tree species (MPTs), Nitrogen fixing Tree species (NFTs) – characteristics; community participation; pattern of planting; eco-restoration of eroded hill slopes and degraded Jhum land. Agroforestry - origin and definition, types; Tree and crop management, models for hill farming – three tier system, contour-tree-green hedge-crop farming system; Role of forests in carbon sequestration.

Module Outcome:

After Completion of this module, the student should be able to:
MO1: Match the major forest types in India with their examples (Re)
MO2: Summarize about Social forestry (Un)
MO3: Differentiate between multipurpose tree species and Nitrogen fixing Tree species (An)
MO4: Generate knowledge on origin and types of Agroforestry (Cr)
MO5: Outline the different models for hill farming (An)
MO6: Evaluate the role of forests in carbon sequestration (Ev)

MODULE IV: Biodiversity: Introduction, levels, importance; Organisms–evolution and distribution in space and time; hotspots of biodiversity, gene pool, climate and its impact on biodiversity; diversity of flora and fauna; Threats to biodiversity: Endangered, endemic species and threatened species; IUCN threatened species of plants and animals; Red data book. Biodiversity conservation: Convergence and divergence in species; sustainable exploitation; strategies for conservation; global agreements and national concerns; RAMSAR sites, CBD, quarantine regulations; Biodiversity Act, IPRs, Biopiracy – cause and effect; Protection of wildlife – role of WWF, WCU, CITES, TRAFFIC, Wildlife Protection Act.

Module Outcome:

After Completion of this module, the student should be able to:
MO1: Know the importance of biodiversity (Re)
MO2: Explain about the hot spots of biodiversity (Un)
MO3: Compute IUCN threatened species of plants and animals (Ap)
MO4: Justify theBiodiversity conservation strategies (Ev)
MO5: Generate an idea on biopiracy (Cr)
MO6: Create knowledge on Protection of wildlife (Cr)

MODULE V: Water resource : Distribution and extent-global, national and regional; water resources types – surface water, ground water; water availability and uses, freshwater shortages, impact of climate change on freshwater resources, Management and conservation of water resources. Watershed management: Concept, Objectives, planning and measures; Land use planning for watershed management; Water harvesting and recycling; Flood control and watershed management; Socio-economic aspects of watershed management.Demand for water (agriculture, industrial, domestic); overuse and depletion of surface and ground water resources; water quality standards in India; hot spots of surface water; role of state in water resources management.

Module Outcome:

After Completion of this module, the student should be able to:
MO1: Identify the global, national and regional water resources (Re)
MO2: Explain the types of water resources (Un)
MO3: Interpret the impact of climate change on freshwater resources (Un)
MO4: Appraise knowledge on Water harvesting and recycling programmes (Ev)
MO5: Solve problems of overuse and depletion of surface and ground water resources (Ap)

MO6: Compile the role of state in water resources management (Cr)

MODULE VI: Energy and Environment : Human energy requirement, energy use pattern indifferent parts of the world and its impact on the environment; energy use pattern in India, sources of energy and their classification; Fossil fuels – classification, composition; energy content of coal, petroleum and natural gas; exploration/ mining. Bioenergy: Biomass composition and types; conversion processes; biogas production – anaerobic digestion, Energy from wastes; Nuclear energy : Fission and Fusion, Nuclear fuels - Refining, enrichment, fuel fabrication and fuel cycle; Solar energy : Harnessing of solar energy, solar collectors and concentrators, solar electricity generation, solar heaters, dryers, cookers – photo- voltaic; solar energy utilization in India; Wind energy : Wind power, harnessing of wind energy, power generation – wind mills; wind energy potential in India; Geothermal energy, Wave & Tidal power. Alternative fuels: Gasoline, Natural Gas and Propane, Oxygenated fuels, Biofuels, Hydrogen.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: List the energy use pattern in different parts of the world.(Re)
MO2: Summarize the different sources of energy and their classification (Un)
MO3: Outline the composition and types of bioenergy (An)
MO4: Analyze the characteristics of solar energy (An)
MO5: Evaluate the properties of Wind energy (Ev)
MO6: Devise models for alternative fuels of energy. (Cr)

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments based on the theory
- Seminar Presentation on selected topics
- Debates on selected topics
- Quiz based on theory
- Demonstration of simple experiments based on theory
- Field work and survey based on theory.

LEARNING RESOURCES

References

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On-line Sources

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

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

MODEL QUESTION BASED ON OBE FORMAT

UNIVERSITY OF KERALA
SECOND SEMESTER M.Sc. (CSS) DEGREE EXAMINATION
BRANCH: ENVIRONMENTAL SCIENCES
ENS. CC. 525. NATURAL RESOURCES AND ENERGY MANAGEMENT

Time: 3 HoursMax. Marks: 60

I. Answer **any ten** question (10x2=20 Marks)

1. Differentiate between Land cover and Land use. (M1, An)
2. What are the benefits of Land cover mapping? (M1, Re)
3. Distinguish between Rill erosion and Gully erosion. (M2, Un)
4. What are Soil Horizons? (M2, Re)
5. Differentiate between Alluvial soil and Black soil (M2, An)
6. What is Agro Forestry? (M3, Re)
7. What is Biopiracy? (M4, Re)
8. What is Social forestry? (M3, Re)

9. Define Red Data Book? (M4, Re)
10. Define Biodiversity Hotspots (M4, Re)
11. What are Biofuels? (M6, Re)
12. What is Natural Gas? (M6, Re)

II. Answer **any four** questions (4x5 = 20 Marks)

13. Write down the classification of Natural Resources? (M1, Re)
14. Explain the Drivers of Land use change. (M1, Un)
15. Explain Soil erosion and the causative agents of soil erosion. (M2, Un)
16. Describe the role of Fossil fuel in the energy use pattern. (M6, Un)
17. Comment on Mineral resources in India (M2, Un)
18. Explain the role of forest in Carbon Sequestration (M3, Un)

III. Answer **any two** questions (2x10= 20 Marks)

19. Explain the types of Mining and its impact on environment (M2, Un)
20. Describe the reclamation techniques of Acidic, Alkaline and Saline soils (M2, Re)
21. Elaborate on the major forest types in India (M3, Un)

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SEMESTER IV	Course Code: ENS-CC-542	Credits: 2

NAME OF THE COURSE: INTERNSHIP

Sl. No.	Course outcome (CO) *At the end of the course, the student will be able to:*	Taxonomic Level (TL)
1.	**CO1**: Apply the knowledge of waste treatment methods to understand the real industrial application	Ap, Un
2.	**CO2:** Understand the industrial operations of mining and other related activities and the environmental impacts of them	Un
3.	**CO3:** Observe the sustainability functions of the various departments of an industry	Un
4.	**CO4:** Apply the knowledge of various environmental processes in the management and operation of different industries	Ap
5.	**CO5**: Prepare project reports based on their experiences in the industrial site.	Cr

ASSESSMENT

40% for attending the Internship
60% for Internship report

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SEMESTER IV	Course Code: ENS-CC-543	Credits: 2

NAME OF THE COURSE: GREEN SKILL PROGRAMME

Sl. No.	Course outcome (CO) *At the end of the course, the student will be able to:*	Taxonomic Level (TL)
1.	**CO1**: Share knowledge and develop suitable methods in management of waste	Un, Ap
2.	**CO2:** Articulate knowledge of wastewater treatment using constructed wetland	Un, Ap
3.	**CO3:** Analyse and interpret air quality in a place by comparing the air quality data with standards	An, Ap
4.	**CO4:** Conduct Environmental impact assessment by preparing Environmental impact statement of any developmental activity	Ap, Cr
5.	**CO5**: Evaluate the carbon foot print by means of analysing the greenhouse gas emission from an institution	Un, Ev

6	**CO6:** Create a biodiversity register and can analyse the threats to biodiversity	Cr, An
7	**CO7:** Evaluate the environmental impacts of a particular operation and develop an environmental audit report	Ev, Cr

1. **Solid Waste management technologies:**

   Hands on exercise will be given to categorise the solid waste generated in the department into biodegradable and non-biodegradable waste. Quantification of each category will be done and training will be given to convert biodegradable waste into biocompost using bioport and inoculum method. A visit to a nearby solid waste management site will be made to get a perception of large scale solid waste management. Further, training will be given to students to write project proposal of solid waste management for an organization.

2. **Waste water treatment using phytoremediation:**

   Using box type constructed wetland method. A model constructed wetland is available in the department to treat the wastewater. Students will be given training to understand this technique, followed by treating of wastewater.

3. **Air quality monitoring and assessment:**

   Students will be taken to the air PCB funded quality monitoring station of Kariavattom campus and will be asked to monitor the air quality displayed in the LED screen for a week time. They will analyse the data and present the results by comparing with ambient air quality standards. Further, Hands on training will be given to students to assess air quality of a particular place using High Volume Sampler available in the department.

4. **Environment Impact assessment:**

   Students will be taken to a developmental project site (proposed / ongoing project site) to understand the probable environmental impact due to the implementation of the project. Based on the field visit and the available literature related to the project, they will be asked to prepare the terms of reference (TOR), Environmental management Plan (EMP) and the draft Environmental Impact Report(EIS). This learning exercise will be useful to the students to work in the preparation of environmental impact of any developmental activity.

5. **Carbon Foot Print analysis:**

   Students are trained to evaluate Carbon foot print. Carbon footprint analysis, also known as a greenhouse gas (GHG) emissions assessment, evaluates the greenhouse gas emissions caused by the manufacture of a product or any given activity that contributes to global warming. This begins with the assessment of emission of carbon, sulfur hexafluoride,

and methane. These emissions quantities are then converted into carbon dioxide equivalents(CO_2e).

6. **Biodiversity Register Preparation**

   A biodiversity register can be used to maintain records of all living beings in their locality. The register may include minute details about plants and animals, both wild and domesticated in a particular area and knowledge regarding use of the various species. It allows us to analyze the reasons for depletion of biodiversity and plan conservation measures. Students will get training on the preparation of standard biodiversity register of a particular area.

7. **Environmental Auditing**

   Environmental auditing is essentially an environmental management tool for measuring the effects of certain activities on the environment against set criteria or standards. This is used to help improve existing human activities, with the aim of reducing the adverse effects of these activities on the environment. Students should study an organisation's environmental effects in a systematic and documented manner and will produce an environmental audit report.

8. **Economic Valuation and Cost Benefit Analysis(CBA)**

   Students will be trained in various methods of economic valuation of environmental resources like contingent valuation, hedonic price method, choice experiments and travel-cost method. They will also be exposed to several case studies of CBA.

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: Skill evaluation

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SEMESTER IV	Course Code: ENS-CC-544	Credits: 6

NAME OF THE COURSE: DISSERTATION

Sl. No.	Course outcome (CO) *At the end of the course, the student will be able to:*	Taxonomic Level (TL)
1.	**CO1**: Understanding the scope of research in various fields of environmental sciences.	Un, Ap
2.	**CO2:** Identify environmental problems which e socially important and relevant	Ap, An

3.	**CO3:** Conduct independent research on a specific environmental problem by means of laboratory analysis orfield study.	Ap, An
4.	**CO4:** Appraise and conclude the results of the research analysis and suggest a solution for the problem	An, Ev, Cr
5.	**CO5**: Make the project in to a dissertation framework and able to present the results in the public	Cr
6.	**CO6:** Be concern with similar type of problems happening in the environment and suggest solution and remedial measures for the same	Ap

ASSESSMENT

- Dissertation evaluation-80%
- Open Viva-voce-20%

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Generic Courses

Course Code: ENS-GC-501	Credits: 2

NAME OF THE COURSE: DISASTER MANAGEMENT

Sl. No.	Course outcome (CO) *At the end of the course, the student will be able to:*	Taxonomic Level (TL)
1.	**CO1**: Understand the basic aspects of disaster	Un
2.	**CO2:** Identify the components of disaster management	Un
3.	**CO3:** Understand the important sectors in disaster management	Un
4.	**CO4:** Understand the role of remote sensing in disaster management	Un
5.	**CO5**: Critically analyse and acquire important natural disasters and their management	An

COURSE CONTENT

MODULE I: Basic concept of disaster- definition of hazard, vulnerability, risk, disaster. Causative factors of disaster. Classification of disasters.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Define disaster (Re)
MO2: Differentiate between hazard and disaster (Un)
MO3: Define the concepts of vulnerability, risk (Re)
MO4. Classify the types of disaster (Un)
MO5: List the causative factors of disaster (Un)

MODULE II: Disaster management (DM):- definition of disaster management; components of disaster management cycle- crisis management & risk management. Crisis management-quick response & relief, recovery, development. Risk management- risk identification & risk reduction- preparedness, prevention and mitigation.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Define disaster management (Re)
MO2. Identify components of DM (Un)
MO3: Articulate and interpret the components of crisis management (Ap)
MO4. Articulate and interpret the components of risk management (Ap)
MO5: Differentiate between risk identification and risk reduction (Ap)
MO6: Understand risk transfer (U)

MODULE III: Important sectors in disaster management- health and medical care, communications, insurance, social work, NGO's, media, fire services, police and paramilitary services, armed forces etc.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Identification of sectors in DM (Ap)
MO2: Characterise the health sector (Un)
MO3: Understand the role of communication sector (Un)
MO4: Understand the role of NGO in disaster management (Un)
MO5: Understand the role of media in disaster management (Un)
MO6: Understand the role of military in disaster management Un)

MODULE IV: Role of Remote Sensing and GIS in disaster management. Levels of disasters in India. Survey and assessment of after-effects of a disaster.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Understand the role of remote sensing in disaster management (Un)
MO2. Understand the role of GIS in disaster management (Un)
MO3: Understand the levels of disasters in India (Un)
MO4: Conduct Survey and assessment of after-effects of a disaster (Ap)
MO5: Acquire knowledge on how to get the compensation from the government (Un)

MODULE V: Causes, perception, management of various natural disasters like flood, landslides, earthquakes, tsunami, coastal erosion, cyclones, volcanism, forest fire etc.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Critically discuss earthquake, tsunami hazards and its management (Ev)
MO2: Critically discuss volcano hazard and its management(Ev)
MO3: Critically discuss landslide hazard and its management (Ev)
MO4: Critically discuss cyclone hazard and its management(Ev)
MO5: Critically discuss selected man-made hazard and its management (Ev)
MO6: Acquire knowledge about health risk assessment (Ap)

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments based on the theory
- Seminar Presentation on selected topics
- Screening short videos related to natural calamities
- Debates on selected topics

LEARNING RESOURCES

References

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- Jha and Kumar, M. 2010. Natural and Anthropogenic Disasters; Vulnerability, Preparedness and Mitigation,Springer.
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- Vaidya, K.S. 1987.Environmental Geology, Tata McGraw-HillPublishers.
- White, G.F. (ed.) Natural hazards – local, national, global: Oxford University Press.

On-line resources

- http://www.ifrc.org/en/what-we-do/disaster-management/about-disaster-management/
- http://www.isro.gov.in/applications/disaster-management-support-programme
- http://www.ndmindia.nic.in/

MODEL QUESTION BASED ON OBE FORMAT

UNIVERSITY OF KERALA
FIRST SEMESTER M.SC. (CSS) DEGREEEXAMINATION BRANCH: ENVIRONMENTALSCIENCES
ENS. GC. 501: DISASTERMANAGEMENT

Time:3Hours **Max. Marks:60**

I. Answer **any ten** of the following: (10x2=20Marks)

Causative factors of Disasters. (M1,Re)

1. Crisis management (M2,Un)
2. Forest fire (M5,Re)
3. Components of GIS (M4,Un)
4. GIS in Disaster management (M4,Re)
5. After effects of an Earthquake (M5,Ap)

6. Role of paramilitary services in Disaster Management (M3,Un)
7. Levels of Disasters (M4,Re)
8. Risk management strategies (M2,Un)
9. Coastal erosion in Kerala (M5,Un)
10. Satellite remote sensing (M4,Un)
11. Indian Ocean Tsunami of 2004 (M5,Un)

II. Answer **any four** of the following: (4 x 5 = 20Marks)

12. Role of remote sensing in coping with cyclones (M4,Ap)
13. Various processes involved in risk management (M2,Un)
14. Explain why medical sector is most important among all the sectors of disaster management (M3,An)
15. Role of GIS in Post-disaster scenario (M4,Ap)
16. Proper assessment of the after effects of Disaster (M4,Un)
17. Role of climate in the landslide occurrence in Kerala.(M5,An)

III. Answer **any two** of the following: (2 x 10 =Marks)

18. Describe the role of Anthropogenic activities in magnifying the effects of flood (M5,An)
19. Explain how awareness creation will be helpful in mitigating the effects of natural disasters (M2,E)
20. Illustrateindetailthevariouscomponentsofthedisastermanagementcycles (M2,U)

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Course Code: ENS-GC-502	**Credits: 2**

NAME OF THE COURSE: ENVIRONMENTAL HEALTH PERSPECTIVES

Sl. No.	**Course outcome (CO)** ***At the end of the course, the student will be able to:***	**Taxonomic Level (TL)**
1.	**CO1**: Understand the effects of pollutants on ecosystem and human health	Un
2.	**CO2:** Aware on the causative agents of water borne and food borne diseases.	Un
3.	**CO3:** Understand the role of antioxidants in health and disease.	Un
4.	**CO4:** Aware of soil pollution and soil borne diseases.	Un
5.	**CO5**: Identify the impact of climate change on Human health.	Ap
6.	**CO6:** Aware of the healthy interrelationships between people and the environment.	Un

COURSE CONTENT

MODULE I: Environmental Health: Definition, Basic Principles, and Major Environmental Health Problems. Air pollution -Types of air pollution, major air pollutants and sources, Toxic chemicals in air. Emerging contaminants. Indoor Air pollution -sources and health hazards. National ambient air quality standards.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Identify the major Environmental health problems. (Re)
MO2: Understand the basic principles of Environmental Health (Un)
MO3: List the toxic pollutants in air (Un)
MO4: Appraise knowledge on indoor pollution (Ev)
MO5: Understand the National Ambient Air quality Standards (Un)

MODULEII: WaterPollution-Sourcesandtypesofwaterpollutantsandtheirhealth impacts. Standards for drinking water. Water borne diseases, Vector borne diseases, Drinking water disinfection methods - Carcinogenicity of disinfectionby-products.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Define water pollution (Re)
MO2: Identify the sources of water pollution (Un)
MO3: Articulate and exemplify the health impacts of water pollutants (Un)
MO4: List the vector borne diseases in humans (Un)
MO5: Distinguish various drinking water disinfection methods (Ap)
MO6: Illustrate the carcinogenicity of disinfection by-products (Un)

MODULE III: Soil Pollution: Soil pollutants and its sources, Properties of soil, Soil microorganisms and their functions, Toxic heavy metals in soil and its sources. Changes in characteristics of soil by waste disposal, Soil borne infectious diseases in humans and their causative agents.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Identify the soil pollutants (Un)
MO2: Describe sources of soil pollutants (Un)
MO3: Illustrate the properties of soil (Un)
MO4: Exemplify the soil microorganisms and their functions (Un)
MO5: Identify the toxic heavy metals in soil (Re)
MO6: Describe the soil borne diseases in humans and causative agents (Un)

MODULE IV: Food contamination: reasons for food contamination, types of food contaminants, Chemical contaminants in food- its sources and health implications. Pesticide residues and Heavy metals in food, Food borne diseases and causative

agents. Preventive measures to control food contamination.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Appraise the reasons for food contamination (Re)
MO2: Articulate the different types of food contaminants (Un)
MO3: List the sources of chemical contaminants in food (Un)
MO4: Identify the health implications of chemical contaminants in food (Un)
MO5: Describe the food borne diseases (Un)
MO6: Suggest measures to control food contamination (Ap)

MODULE V: Radiation and health impacts: Sources of Radiations - man made radiations and natural radiations, Radiation syndromes, Radiation effects. Radioactive materials in the environment and their effects on man. Occupational pollution and health hazards: Occupational exposure of workers to pollutants and health impacts.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Identify the sources of radiation(Un)
MO2: Describe the radiation syndromes (Un)
MO3: List the radioactive materials in the environment (Un)
MO4: Define occupational pollution (Re)
MO5: Explain the health impacts of occupational exposure of workers to pollutants(Un)
MO6: List the diseases associated with environmental exposures (Un)

MODULE VI: Climate change and Human health: Climate change and Chronic Respiratory Disease (CRD), Direct impacts and indirect impacts of climate change. Antioxidants in Health and Disease - Auto-oxidation and Free radicals, Reactive oxygen species, Natural and synthetic antioxidants, The role of antioxidants in health and disease, Therapeutic benefits of antioxidants.

Environmental Health Impact Assessment (EHIA) - Definition, Significance ofEHIA, Steps inEIA.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Relate climate and chronic respiratory disease**s** (Un)
MO2: Correlate direct impacts of climate on humans (An)
MO3: Explain the role of antioxidants in Health and disease (Un)
MO4: Define free radicals? (Un)
MO5: Outline the process of Environmental Health Impact Assessment (Un)
MO6: Explain the significance of EHIA (Un)

LEARNING RESOURCES

References

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On-line Sources

- http://www.who.int/phe/en/
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ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

MODEL QUESTION BASED ON OBE FORMAT

UNIVERSITY OF KERALA
SECOND SEMESTER M.SC. (CSS) DEGREE EXAMINATION BRANCH: ENVIRONMENTAL SCIENCES
ENS. GC. 502: ENVIRONMENTAL HEALTH PERSPECTIVES

Time:3Hours **Max. Marks:60**

I. Answer **any ten** of the following. (10 x 2 = 10marks)

1. What is occupational pollution? (M5,Re)
2. Differentiate natural and artificial antioxidants. (M6,Re)
3. What is Environmental Health? (M1,Re)
4. How radioactive decay occurs? (M5,Un)
5. Listthemajorwaterpollutants.(M2,Re)
6. What is indoor pollution? (M1,Re)
7. What are emerging contaminants? (M5,Re)
8. What are the pollutants in vehicular emissions. (M1,Re)
9. Identify the gaseous air pollutants which causes health hazards in humans. (M1,Re)
10. What are the preventive measures to control food contamination? 11.Identify the causes of soil pollution. (M3,Un)
12. Describe the drinking water disinfection methods. (M2,Un)

II. Answer **any four** of the following. (4 x 5 = 20marks)

13. Mention the natural and man made sources of radiation. (M5,Re)
14. Critically comment on the radiation effects in humans. (M5,Un)
15. Differentiate natural and chemical food contaminants (M4,Un)
16. What are the changes in soil characteristics due to waste water disposal? (M3, Re)
17. Mention the role of antioxidants in health and disease. (M6,Re)
18. What is climate change?Briefly mention the impacts of climate change.(M6, Un)

III. Answer **any two** of the following. (2 x 10 = 20marks)

19. What is EHIA? Describe the ten step model approach in EHIA (M6,Re)
20. Explain the occupational health hazards and mention its impacts on humans (M5,Re)
21. What are the types of soil borne infectious diseases in humans. Mention its causative agents. (M3,Re)

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Course Code: ENS-GC-503	Credits: 2

NAME OF THE COURSE: HUMAN HEALTH MANAGEMENT

Sl. No.	Course outcome (CO) *At the end of the course, the student will be able to:*	Taxonomic Level (TL)
1.	**CO1**: Describe the basic elements/composition of food and diet and explore knowledge on various deficiency diseases, their impact in human beings.	Un
2.	**CO2:** Explain the food components, dietary patterns for different groups, food adulteration and knowledge on healthy eating for disease prevention and wellness.	Un
3.	**CO3:**Acquireanunderstandingofthechemistryunderlyingthe properties of various food components, the role andimportance of different digestive enzymes in order to evaluate andimprove the nutritional health of individuals.	Ap
4.	**CO4:** Highlight the different types of life style related diseases, social health problems and familiarizes students with causes and dietary treatments of common ailments.	Ap
5.	**CO5**: Understand and appreciate the importance of food hygiene and their interface in shaping personal hygiene through the awareness of food and water born diseases.	Un
6.	**CO6: :**Acquire basic understanding of dietary immune stimulants and also the necessities of yoga and regular exercises in day to day life.	Un

COURSE CONTENT

MODULE I: Food; Diet; Nutrient; Vitamins; Disorders due to deficiency of vitamins, Synthetic foods and drinks. Functions of food.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Recall the different types of food items (Re)
MO2: Explain the different types of vitamins (Un)
MO3: Analyse the disorders due to deficiency of vitamins (An)
MO4: Evaluate the effects of synthetic foods and drinks (Ev)
MO5: Explain the functions of food (Un)
MO6: List the major types of diets and nutrients (Re)

MODULE II: Components of food; Nutrients (Macro and micronutrients): Food groups and the concept of a balanced diet. Nutrient needs and dietary pattern for various groups - adults, pregnant and nursing mothers, infants, preschool and school children, adolescents and elderly.

Food adulteration, Causes of food spoilage.

Module Outcome:

After Completion of this module, the student should be able to:
MO1: List the major components of foods (Re)
MO2: Differentiate macro and micronutrients (An)
MO3: Compile the different food groups and balanced diets (Cr)
MO4: Evaluate nutrient needs and dietary pattern for various groups (An)
MO5: Generate an idea about food adulteration (Cr)
MO6: Appraise the knowledge on causes of food spoilage (Ev)

MODULE III: Nutritional Biochemistry - Carbohydrates, Lipids, Proteins, Minerals. Digestive enzymes – Salivary enzymes, Gastric enzymes, Intestinal enzymes, Liver and Pancreas.

Module Outcome:

After Completion of this module, the student should be able to:
MO1: Describe about nutritional biochemistry (Re)
MO2: Explain about carbohydrate rich diets (Un)
MO3: Compute the protein content in food items (Ap)
MO4: Summarize about digestive enzymes (Un)
MO5: Generate and idea on salivary enzymes and role in digestion (Cr)
MO6: Relate the function of liver and pancreas in the process of digestion (An)

MODULE IV: Life style related diseases- hypertension, diabetes mellitus, and obesity their causes and prevention through dietary or lifestyle modifications.
Social health problems- smoking, alcoholism, drug dependence and Acquired Immuno Deficiency Syndrome (AIDS);
Common ailments- cold, cough, fevers, diarrhoea, constipation: their causes and dietary treatment.

ModuleOutcome:

After Completion of this module, the student should be able to:
MO1: Identify the life style related diseases (Re)
MO2: Explain about social health problems (Un)
MO3: Interpret the impact of smoking and alcoholism in humans (Un)
MO4 : Appraise knowledge on Acquired Immuno Deficiency Syndrome (Ev)
MO5 : Solve problems of common ailments through dietary treatment (Ap)
MO6: Compile the causes of common ailments (Cr)

MODULE V: Food hygiene, Potable water- sources and methods of purification, Food and Water Borne Infections.

Module Outcome:

After Completion of this module, the student should be able to:
MO1: Explain the role of food hygiene in human health management (Un)
MO2: Identify the sources of potable water (Re)
MO3: Outline the methods of purification of potable water (An)

MO4: Analyze the Food and Water Borne Infections (An)
MO5: Evaluate the features of water born infections (Ev)
MO6: Devise methods for the purification of potable water (Cr)

MODULE VI: Awareness on Dietary immunostimulants – indigenous herbals, Vegetables and fruits with vitamins and minerals.
Yoga and exercises - Needs, importance, and role in daily life.

Module Outcome:

After Completion of this module, the student should be able to:

MO1: Create an awareness on Dietary immunostimulants (Cr)
MO2: Explain about indigenous herbals (Un)
MO3: Outline the importance of vegetables and fruits with vitamins and minerals in human health management (Re)
MO4: Generate knowledge on the importance of yoga in daily life (Cr)
MO5: Analyse the importance of yoga in human health management (An)
MO6: Summarize the role of exercises in day to day life (Un)

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments based on the theory
- Seminar Presentation on selected topics
- Debates on selected topics
- Quiz based on theory
- Demonstration of simple experiments based on theory
- Field work and survey based on theory.

LEARNING RESOURCES

References

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- nca2014.globalchange.gov/report/sectors/human-health
- en.wikipedia.org/wiki/Health
- ncbi.nlm.nih.gov/books/NBK99584/
- https://www.who.int/globalchange/summary/en/index2.html
- https://www.ipcc.ch/site/assets/uploads/2018/03/wg2TARchap9.pdf

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

MODEL QUESTION BASED ON OBE FORMAT

UNIVERSITY OF KERALA
SECOND SEMESTER M.SC. (CSS) DEGREE EXAMINATION BRANCH: ENVIRONMENTAL SCIENCES
ENS. GC. 503 : HUMAN HEALTH MANAGEMENT

Time:3Hours **Max. Marks:60**

I. Answer **any ten** questions (10x2=20Marks)

1. What is a Balanced Diet? (M1,Re)
2. Name the Basic constituents of food (M1,Re)
3. What is Hypervitaminosis? (M1,Re)
4. Differentiate between Macro and Micro nutrients (M2,An)
5. What is Bile Juice? (M3,Re)
6. What is Diabetes Mellitus? (M4,Re)
7. Name two protein enriched foods (M3,Re)
8. What is BMI? (M6,Re)
9. What is water borne diseases? Give two examples. (M5,Re)
10. What are Dietary immunostimulants. Give two examples. (M6,Re)
11. What are the main causes of potable water? (M5,Re)
12. What is Food hygiene? (M5,Re)

II. Answer **any four** questions (4x5 = 20Marks)

13. Give two examples of the different types of Vitamins (M1,Re)

14. What are Vitamin deficiency disorders? (M1,Re)
15. Elaborate on the causes of food Spoilage (M2,Un)
16. Explain the role of Gastric juice in digestion. (M3,Un)
17. What are the common Social health problems? (M4,Re)
18. Explain the role of Yoga and Exercise in human health management (M6,Un)

III. Answer **any two** questions (2x10= 20Marks)

19. Make a comparative evaluation of Dietary patterns various age groups (M2, Ev)
20. What is Food Adulteration? Describe various methods to evaluate food adulterants (M2,Re)
21. What are Life style diseases? Justify the corrective steps required in thelife style to prevent life style diseases (M4,Ev)

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Course Code: ENS-GC-504	**Credits: 2**

NAME OF THE COURSE: WASTE MANAGEMENT TECHNIQUES

Sl. No.	**Course outcome (CO)** ***At the end of the course, the student will be able to:***	**Taxonomic Level (TL)**
1.	**CO1**: Describe the nature and types of waste water	Re
2.	**CO2:** Articulate the source and characteristics waste water treatment	Un
3.	**CO3:** Compare the various waste water treatment methods	An
4.	**CO4:** Comprehend the reuse of wastewater	Un
5.	**CO5**: Identify the different types of solid wastes	Re
6.	**CO6:** Describe the solid waste management methods	Re
7	**CO7:** Explain the source, characteristics and management of hospital wastes	Un
8	**CO8:** Articulate the source of e-wastes and their management	Un
9	**CO9:** List the waste management policies	Re
10	**CO10:** Compare waste management practices in various industries	Ev
11	**CO11:** Explain the methods of converting wastes to useful products	Ev

COURSE CONTENT

MODULE I: Wastes and Management: Definition, concept. The changing nature, quantity, composition in urban and rural areas of India and World

Module outcome:

After Completion of this module, the student should be able to:

MO1: List the source of wastes (Re)
MO2: Define the concepts of waste management (Re)
MO3: Compare the nature of waste in urban and rural areas (An)

MODULE II: Waste water: Nature and types; sources and characteristics; treatment methods – physical, chemical, biological and advanced treatment methods. Natural treatment systems-constructed wetlands, wastewater reclamation and reuse.

Module outcome:

After Completion of this module, the student should be able to:

MO1: Compare the various waste water treatment methods (An)
MO2: Comprehend the reuse of wastewater (Un)
MO3: Explain the constructed wetland system (Un)
MO4: Demonstrate the methods of wastewater reclamation and reuse (Ap)

MODULE III: Solid wastes: types of wastes; Residential and commercial; collection, storage :coloured bins; transportation: volume reduction.

Module outcome:

After Completion of this module, the student should be able to:

MO1: Identify the different types of solid wastes (Re)
MO2: Describe the solid waste management methods (Re)
MO3: Comprehend the methods of storage, collection and transfer of MSW (Un)
MO5: Compare the methods of solid waste transportation (An)

MODULE IV : Municipal solid waste management : Biodegradable wastes – composting, vermicomposting, biomethanation. Non biodegradablewastes :Landfilling : sanitary landfill- methods of operation – advantages and disadvantages of sanitary land fill - site selection. Incineration: types of incinerators

Module outcome:

After Completion of this module, the student should be able to:

MO1: Differentiate biodegradable and non-biological wastes (An)
MO2: Explain the methods of composting and vermicomposting (Un)
MO3: Illustrate the biomethanation process (An)
MO4: Describe the incineration process (Un)

MODULE V: Hazardous wastes: Definition, source and characteristics; Management of medical and hospital wastes, Nuclear and radioactive wastes – classification, sources and disposal; e-waste and their management.

Module outcome:

After Completion of this module, the student should be able to:

MO1: Explain the source, characteristics and management of hospital wastes (Un)
MO2: Articulate the source of e-wastes and their management (Un)
MO3: Identify the sources and types of radioactive wastes (Re)
MO4: Outline the management options of e-wastes (An)

MODULE VI: Industrial wastes-management practices. Waste management policies; (Act and rules – legislations) polluter pays principle; wealth from waste -compost, single cell protein; waste to energy – ethanol, biogas, hydrogen.

Module outcome:

After Completion of this module, the student should be able to:

MO1: List the waste management policies (Re)
M02: Compare waste management practices in various industries (Ev)
MO3: Explain the methods of converting wastes to useful products (un)
MO4: Calculate the economics of waste management (Ap)

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments based on the theory
- Seminar Presentation on selected topics
- Debates on selected topics
- Quiz based on theory
- Demonstration of simple experiments based on theory
- Field work and survey based on theory.

LEARNING RESOURCES

References

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- Agarwal,S.K. 2005. Wealth from waste, APH Publishing corporation, New Delhi
- Bhatia,S.C.2007.SolidandHazardousWasteManagement.Atlantic Publishers and Distributors, NewDelhi
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- Metcalf and Eddy. 1991. Waste Water Engineering – Treatment, Disposal and Reuse. McGraw Hill International Edition, NewYork.

On-line sources

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

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

MODEL QUESTION BASED ON OBE FORMAT

UNIVERSITY OF KERALA
THIRD SEMESTER M.SC. (CSS) DEGREE EXAMINATION BRANCH: ENVIRONMENTAL SCIENCES
ENS. GC. 504: WASTE MANAGEMENT TECHNIQUES

Time:3Hours **Max. Marks:60**

I. Answer **any ten** of the following. (10 x 2 = 10 Marks)

1. Compare the per capita solid waste production based on economic status (M1,An)
2. List the types of household wastes (M1,Re)
3. Define a constructed wetland (M2,Re)
4. Differentiate black and grey water (M2,An)
5. Name any two disadvantages of the existing methods of waste collection (M3,Re)
6. What are the advantages of solid waste volume reduction? (M3,Un)
7. Name the stages of composting (M4,Re)
8. What are the toxic components in a landfill leachate? (M4,Un)
9. List the coloured bins used for biomedical waste storage (M5,Re)
10. Write any two salient features of e-waste management rules (M5,Un)
11. What are single cell proteins? (M6,Re)
13. Define polluter pays principle (M6, Re)

II. Answer **any four** of the following. (4 x 5 = 20Marks)

22. Compare the nature of waste in urban and rural areas (M1,An)
23. Explain the structure and functions of constructed wetland system (M2,Un)
24. Illustrate MSW management structure in Kerala (M3,An)
25. Explain the methods of composting and vermicomposting (M4,Un).
26. Outline the management practices of biomedical wastes (M5,An)
27. Describe the salient features of any two waste management policies (M6,Re)

III. Answer **any one** of the following. (1 x 10 = 10marks)

28. Describe the waste management methods for municipal waste water (M2,Re)
29. Critically analyze the issues of MSW management in developing countries. Compare the management practices with developed countries (M3,An)
30. (a) List the characteristics of hazardous wastes (b) Explain the methodsof biomedical waste management (M5,Un)

PRACTICALS

Semester I

Course code : ENS-P-511

Course Title : ECOLOGY AND ECOSYSTEM DYNAMICS

1. Identification of fauna and flora(4each) of terrestrial,freshwater and marine ecosystems.
2. Identification of phytoplankton and zooplankton (either freshwater or marine).
3. Qualitative estimation of phytoplankton by Lacky's Drop Method and Zooplankton by Sedgwick-Rafter Cell method.
4. Estimation of primary productivity–Light and dark bottle method–effects of depth and light.
5. Community study :quadrat method ; flora and fauna study by frequency, density and abundance – line transect method.

Semester I

Course code : ENS-P-513

Course Title : ENVIRONMENTAL CHEMISTRY

1. Toxicology tests(LC_{50})
2. Estimation of starch
3. Estimation of aminoacids
4. Estimation of protein
5. Estimation of reducing sugars
6. Estimation of chlorophyll
7. Analysis of DO, BOD, COD, NO_3 and PO_4 in water, Determination of potability of water using coagulant demand, chlorine demand and residual chlorine.
8. Analysis of heavy metals and pesticides.

Semester I

Course Code : ENS-P- 514

Course Title : ENVIRONMENTAL GEOLOGY

1. Megascopic identification of important rock bearing minerals.
2. Identification of diagnostic physical properties and naming the mineral.
3. Megascopic identification of important rocks – igneous, sedimentary and metamorphicrocks.
4. Brief description of the texture, structure and mineralogy of rock.

Semester II

Course code : ENS-P-521

Course Title : ENVIRONMENTAL TECHNIQUES

1. Methods of sampling - water, air,soil/sediment
2. Physico-chemical parameters of water - salinity, pH, conductivity, free carbon dioxide, alkalinity, TDS, TSS, total hardness,turbidity,
3. Air characteristics – analysis of particulates (dust fall method) and gaseous components – oxides of carbon/ nitrogen/sulphur
4. Estimationoforganiccarbon(titrimetricmethod),totalnitrogen(Kjeldahl method)
5. Estimations using Flame photometry – Na and K.
6. Chromatographic techniques – Paper, Thin layer : amino acids, plant pigments
7. Calculation of mean, median, mode and standard deviation, chi-square, ANOVA, regression, correlation, tests of significance

Semester II

Course code : ENS-P-522

Course Title : ENVIRONMENTAL MICROBIOLOGY

1. Sterilization techniques.
2. Culture media preparations.
3. Isolation techniques: serial dilution, plating.
4. Identification of bacteria and fungi: physiological and biochemical.
5. Staining – Simple and Gram's.
6. Microscopic counting of microbes using haemocytometer.
7. Measurement of microbes using ocular and stage micrometer.
8. Estimation of coliform bacteria in water by MPN method.

Semester IV

Course code : ENS-P-524

Course Title : REMOTE SENSING AND GIS

1. Study of topographic maps- identification of scale, latitude and longitude
2. Study of various geomorphic and environmental features in the maps
3. Interpretation of aerial photos using stereoscopes
4. Identification of various geomorphic and environmental features and the preparation of various thematic maps
5. Interpretation of satellite imageries
6. Brief description of the important geomorphic and environmental features
7. Preparation of photo-geologic maps
8. Map digitization and analysis

Skill Enhancement Elective(SE)

Course Code: ENS-SE-501	Credits: 2

NAME OF THE COURSE: COMMUNICATION AND WRITING SKILLS

Sl. No	Course outcome (CO) *At the end of the course, the student will be able to:*	Taxonomic level (TL)
7.	**CO1:** Realize the purpose of communication and understand the barriers of communication	Remember (R)
8.	CO2:Developskillsondifferenttypesofcommunication and	Apply (Ap)
9.	CO3:Articulateandcriticallyevaluateontheartand benefits of listening	Evaluate (E)
10.	CO4: Improve their writing skills and write good technical reports	Apply (Ap)
11.	CO5: Develop skill on oral communication and reading	Analyse (An)
12.	CO6: Develop knowledge on attending job interviews and develop good interview manners	Apply (Ap)

MODULE I*: Introduction to Communication:* Purpose of Communication; Process of Communication; Differences between Technical and General Communication; Barriers to Communication; Measures to Overcome the Barriers to Communication.

Module outcome:

After Completion of this module, the student should be able to:

MO1: Articulate the purpose of communication and understand the barriers of communication (Re)

MO2: Identify the different types of communication (Re)

MO3: Analyze the communication methods (An)

MODULE II*: Types of Communication:* Types of Communication; Verbal Communication- Importance of verbal communication- Advantages of verbal communication- Advantages of written communication; Significance of Non- verbal Communication

Module outcome:

After Completion of this module, the student should be able to:

MO1: Explain the importance of verbal communication (Un)

MO2: Articulate the advantages of written communication (Un)

MO3: Develop the art of written communication (Ap)

MODULE III*: Listening Skills:* Listening Process; Classification of Listening; Purpose of Listening; Common Barriers to the Listening Process; Measures to Improve Listening; Listening as an Important Skill in Work Place.

Module outcome:

After Completion of this module, the student should be able to:

MO1: Articulate and critically evaluate on the art and benefits of listening (Un)

MO4: Outline the importance of listeninge(An)

MODULE IV*: Language for Communication:* Language and Communication; General Principles of Writing; Improving Writing Skills, Essentials of good style, Expressions and words to be avoided; Grammar and Usage; Features of Writing a Good Report; Guidelines for Report Writing; Steps in Report Writing; Structure of Report; Types of Reports and Different Formats.

Module outcome:

After Completion of this module, the student should be able to:

MO1:Improve their writing skills and write good technical reports(Ap)
MO2: Articulate the usage of grammar(Un)
MO3: Outline the types and formats of reports (An)

MODULE V*: Oral Communication and reading Skills:* Oral Presentation- Purpose –Audience-Locale; Steps in Making a Presentation- planning-Structure and style-Preparation –Presentation; Delivering a Presentation. ReadingSkill; Purpose of Reading; Types of Reading; Techniques for Effective Reading.

Module outcome:

After Completion of this module, the student should be able to:

MO1: Develop skill on oral communication and reading (An)
MO3: Prepaer and deliver a presentation (Ap)

MODULE VI*: Employment Communication – Resume and job interviews*: Contents of Good Resume; Guidelines for Writing Resume; Different Types of Resumes; Different Typesof Cover Letters; Importance and Factors Involving Job Interview;CharacteristicsofJobInterview;JobInterviewProcess;JobInterview Techniques- Manners and etiquettes to be maintained during an interview; Sample Questions Commonly asked During Interview

Module outcome:

After Completion of this module, the student should be able to:

MO1: Develop knowledge on attending job interviews and develop good interview manners (Ap)
MO3: Identify the types of resumes and prepare a resume (Re, Ap)
MO4: Outline the manners and etiquettes to be maintained during an interview (An)

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments based on the theory
- Seminar Presentation on selected topics
- Debates on selected topics
- Newspaper reading and reporting
- Writing technical reports
- Preparing resumes
- Attempting mock interviews

LEARNING RESOURCES

References

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- Ajmani, J. C. Good English: Getting it Right. New Delhi: Rupa Pubications, 2012.
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- http://users3.ev1.net/~pamthompson/body_language.htm
- http://www.albion.com/netiquette/corerules.html
- http://www.bbc.co.uk/worldservice/learningenglish/radio/specials/15
- http://www.colostate.edu/Depts/Speech/rccs/theory44.html
- http://www.dailywritingtips.com/
- http://www.englishdaily626.com/c-errors.php
- http://www.indiabix.com/group-discussion/topics-with-answers/
- http://www.thehumorsource.com

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

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