

SYLLABUS
AND
RULES AND REGULATIONS
FOR
TWO YEARS FULL-TIME P.G. DEGREE COURSE
M. Sc. (ENVIRONMENTAL SCIENCE)
Based on
Choice Based Credit System
(Effective from Academic Session 2023-2024)



DEPARTMENT OF ENVIRONMENTAL SCIENCE
Himachal Pradesh University
Summer Hill, Shimla – 171005

M.Sc. (Environmental Science)

M.Sc. (Environmental Science) programme is relevant to young students/ professionals who are looking to develop their analytical and research skills regarding important issues in environment. The course has been designed to meet the demand of growing needs of professionals in the fields of environment management, environment laws, environment governance and policy, impact assessment, natural resource management, pollution control, etc. This course is of two years duration and is being run on semester basis. The course comprises Four Semesters. There are four theory papers and four practical / field studies in first three semesters and three courses, two practical/field studies and dissertation in the fourth semester besides, class seminars, field visit and viva-voce etc. The course has following career Opportunities:

- Industry (Environmental Impact Assessment, Sustainable Resource Management, Waste Management, Environmental Biotechnology, Eco-technology)
- Government and Business Sector (Environmental Manager, Environmental Planner, Environment Consultant, Analysts)
- Universities, Colleges and Research Institutes (teaching and research)
- Non-governmental Organizations at National and International Levels

The probable learning outcomes of the M.Sc. (Environmental Sciences) shall include the following:

Knowledge & Understanding

- Establish systematic knowledge of Environmental Science.
- Insightfully address the contemporary environmental issues both of national and global importance.
- Engage in the field of Environmental Sciences and associated areas.

Skills & Techniques

- Show the aptitude to apply the knowledge in an organized way for the evaluation and clarification of environmental issues pertaining to ecosystems, air, water, and soil pollution, human health hazards; biodiversity loss, food security and agricultural issues.
- Establish the ability to recognize the role of Environmental Sciences in evolving sustainable solutions to the environmental issues
- Demonstrate the skill to plan and develop eco-friendly solutions and processes for realizing the goals of sustainable.

Competence

- Communicate efficiently
- Skilled to work as in team and contribute for effective planning, management, and

implementations of projects/programme

- Exhibit capability to think and implement independent research projects/programme and evaluate the outcomes

Programme Outcomes (PO)

After completion of this program, the learners will have:

1. Thorough understanding of environmental problems at local, regional and global level;
2. Gained skills to apply the knowledge to the environmental challenges before the society
3. Expanded research insight and developed critical thinking on contemporary instrumentation and analytical techniques related to environmental sciences;
4. Acquired exposure and articulation to disseminate the information about environmental concerns, issues, their impacts and mitigation plans
5. Acquired the sense of responsibility to safeguard the environment and application of knowledge for effective decision-making with regard to environmental problems
6. Knowledge about different facets of local, regional and global environmental problems.
7. Acquired environmental monitoring and data analysis skills with exposure to the environmental pollution control know-hows
8. Knowledge and skills desirable for the environmental management with abilities and aptitudes in the preparation, planning and implementation of environmental projects

The students after completing M.Sc. (Environmental Science) will have the job opportunity in the field of teaching, research projects, industries /municipal bodies, pollution control boards, environmental monitoring projects, consultations, NGOs, and numerous fields linked with the field of environment.

Program Specific Outcomes (PSO)

The course will help in understanding the:

1. Basic concepts of environment and its elements and their interface through study of ecology, biodiversity, green chemistry, disaster management etc.
2. Different kinds of pollutions and their sources including the hazardous waste & Eco-toxicology and different laws about pollution
3. Tools for the management of environment, remote sensing, energy resources, biodiversity conservation, environmental analytical techniques, like water and wastewater treatment, solid wastes, biostatistics etc.

COURSE OUTCOMES

SEMESTER I

MES-101 Environmental Geology and Atmospheric Science

- Ability to demonstrate comprehensive understanding of environment and environmental geo-science
- Ability to establish comprehensive understanding of Geomorphological processes
- Ability to recognize and describe environmental geochemistry, atmosphere, weather and climate
- Ability to exhibit complete understanding of geo-physical phenomena

MES-102 Environmental Biology

- Ability to recognize the concept and scope of ecology
- Ability to establish comprehensive understanding of origin and evolution of biological diversity
- Ability to demonstrate comprehensive understanding of ecosystem concepts its types and dynamics
- Ability to identify the latest advances in the field of ecology

MES-103 Waste Management

- Ability to appreciate the concept and scope of waste management
- Ability to comprehend the concept of handling the waste
- Understand the latest applications of technology in waste management
- Ability to understand the role of the regulations in waste management

MES-104 Current Environmental Issues and their Management

- Ability to recognize the concept of global warming, greenhouse effect and ozone problems
- Ability to demonstrate sound understanding of the concept of acid rain, atmospheric turbidity and nuclear
- Ability to Summarize the relevant environmental policies, regulations, environmental treaties and conventions
- Ability to identify the latest advances in contemporary environmental issues and their management

SEMESTER II

MES-201 Environmental Pollution

- Ability to demonstrate sound understanding of definition of pollution, sources of pollution, different types of pollution
- Ability to address the global and regional scenario of pollution
- Ability to integrate and use knowledge of air pollution, water pollution, noise and land pollution, thermal and radiation pollution
- Ability to identify the latest advances in the field of pollution research

MES-202 Natural Resources: Conservation and Management

- Ability to demonstrate comprehensive understanding of natural resources, natural resources, characteristics and classification
- Ability to recognize and describe water, soil, minerals and energy resources
- Ability to identify the latest advances in Natural Resource Management
- Ability to realize the usefulness of natural resources-conservation strategies and management

MES-203 Ecotoxicology and Radiation Impacts

- Ability to demonstrate understanding of the concept and historical background of ecotoxicology
- Ability to apply the basic concepts of toxicology, types of toxicity, acute and chronic toxicity
- Ability to identify the latest advances in ecotoxicology research
- Building the foundation for understanding the mode of action and effects of toxicants, occupational health, radiation impacts and effects of radiations

MES-204 Environment Impact Assessment and Environmental Audit

- Develop capability to understand the concept of Environment Impact Assessment
- Obtain basic capability in skills and functional knowledge to carry out EIA
- Ability to recognize the latest advances in EIA and evaluate the process linked with Environmental Audit
- Develop capability in prediction and assessment of impacts, public participation, environmental management and ISO certification

SEMESTER III

MES-301 Remote Sensing and GIS

- Ability to demonstrate sound understanding of Remote Sensing
- Ability to deal with microwave sensing, aerial photographs and satellite imageries, digital image processing
- Develop capability to handle remote sensing and GIS tools in environmental management
- Understand the applications of GIS in Environmental Sciences

MES-302 Environmental Chemistry and Green Technology

- Ability to appreciate the concept and scope of environmental chemistry
- Ability to demonstrate sound understanding of the fundamentals of Environmental Chemistry
- Understand the recent advances in the field of environmental chemistry and green technology
- Ability to critically examine the issues environment and global warming, principles and applications of Green Technology

MES-303 Techniques in Environmental Monitoring and Analysis

- Ability to demonstrate sound understanding of analytical techniques applied in environmental analyses
- Ability to design of monitoring and sampling methods using analytical instruments
- Ability to deal with advanced microscopy and chromatographs, radiation detectors and monitors
- Ability to use the high-tech tools in monitoring and analysis of environmental problems

MES-304 (i) Environment Economics (Elective Paper)

- Comprehend the fundamental concepts of economy and the environment
- Recognize the utility of environmental policy
- Ability to demonstrate understanding and appreciate the concept of green economy
- Understand the emerging concepts in the area of environment economics

MES-304 (ii) Environmental Disasters: Mitigation and Management (Elective Paper)

- Ability to demonstrate sound understanding on disasters, their types and nature
- Ability to examine the details of earthquake and seismic hazards, volcanic eruptions, landslides, snow avalanches, floods, cyclones, tsunami, droughts, heat and cold waves;
- Learn the mitigation approaches, concept of disaster management and preparedness

- Understand the latest advancements in the field of disaster management

MES-304 (iii) Climate Change and Clean Technology (Elective Paper)

- Ability to demonstrate systematic understanding of science of climate change, greenhouse gases
- Ability to realize the emerging trends in climate change and clean technology
- Ability to understand the impacts of climate change
- Ability to appreciate clean technology

MES-304 (iv) Biodiversity and Wildlife (Elective Paper)

- Ability to appreciate the basic concepts, importance and biodiversity conservational needs
- Ability to understand environmental degradation and wildlife
- Ability to comprehend on the status and distribution of wildlife in India
- Ability to identify the issues related to the conservation of biodiversity and ecology

SEMESTER IV

MES-401 Environmental Law, Governance, Ethics and Policy

- Ability to demonstrate understanding of environmental laws
- Ability to apply critical mind in policy and approach aimed at environmental protection, judicial activism and environmental protection
- Ability to comprehend the pollution abatement laws, natural resource conservation laws and recent trends in International Law
- Ability to understand the role of the regulations in the good environmental governance

MES-402 Research Methodology, Statistics and Computer Applications

- Ability to demonstrate sound understanding of research and scientific writing
- Ability to appreciate basic concepts of statistics, probability distribution and statistical tests
- Understand the application of statistical tools in environmental research
- Ability to understand the computer application and environment system analysis

MES-403 (i) Environmental Health (Elective Paper)

- Understand the general knowledge of environmental factors affecting health, environmental health problems and its causes
- Understand the processes and mechanisms of environmental health hazards (Biological, chemical, physical, mechanical and psychological hazards)
- Develop critical thinking in the matter of health problems viz. water-borne diseases, vector-borne diseases, diseases caused by chemical and physical agents
- Ability to understand the emerging areas of research in the field of occupational research

MES-403(ii) Principles of Climatology (Elective Paper)

- Ability to appreciate the definition, sub-divisions and scope of climatology
- Ability to demonstrate understanding of pressure, wind system, climate of the World
- Ability to analyze the process and impacts of climate change
- Ability to identify the recent trends in climatology research

MES-403 (iii) Environmental Biotechnology (Elective Paper)

- Ability to demonstrate understanding of Environmental biotechnology
- Understand the latest advances in environmental biotechnology
- Understand the role of biotechnology in management of environment
- Understand the applications of Biotechnological tools in monitoring the environment

MES-403 (iv) Nanotechnology (Elective Paper)

- Ability to demonstrate understanding of nanotechnology
- Understand the concept of nanotechnology and its applications
- Understand the role of nanotechnology in environmental monitoring
- Understand the applications of nano-devices in environmental conservation

MES-406 Dissertation

- The students will be equally distributed among the faculty members for supervision of the dissertation. The criteria for distribution of students will not take into account the elective paper; rather the students will be divided equally among the faculty members. The students will be given the topic for the field study/ experimental study to be completed and submitted by the end of forth semester as dissertation. Ability to identify the gap based to a survey of the relevant literature
- Skill to undertake field study in a systematic way
- Ability to understand the problems and limitations of carrying out research in the field.
- Capacity to work independently on a scientific question and arrive at a conclusion

Mapping of Course with Program Outcomes (POs)

Programme Outcomes	P01	P02	P03	P04	P05
MES-101 Environmental Geology and Atmospheric Science					
MES-102 Environmental Biology					
MES-103 Waste Management					
MES-104 Current Environmental Issues and their Management					
MES-201 Environmental Pollution					
MES-202 Natural Resources: Conservation and Management					
MES-203 Ecotoxicology and Radiation Impacts					
MES-204 Environment Impact Assessment and Environmental Audit					
MES-301 Remote Sensing and GIS					
MES-302 Environmental Chemistry and Green Technology					
MES-303 Techniques in Environmental Monitoring and Analysis					
MES-304 (i) Environment Economics (Elective Paper)					
MES-304 (ii) Environmental Disasters: Mitigation and Management (Elective Paper)					
MES-304 (iii) Climate Change and Clean Technology (Elective Paper)					
MES-304 (iv) Biodiversity and Wildlife Ecology (Elective Paper)					
MES-401 Environmental Law, Governance, Ethics and Policy					
MES-402 Research Methodology, Statistics and Computer Applications					
MES-403 (i) Environmental Health (Elective Paper)					
MES-403 (ii) Principles of Climatology (Elective Paper)					
MES-403 (iii) Environmental Biotechnology (Elective Paper)					
MES-403 (iv) Nanotechnology (Elective Paper)					
MES-406 Dissertation					

**Employability /Entrepreneurship/Skill development of courses taught
inM.Sc. Environmental Sciences**

TITLE OF COURSE	Marks		
	Employability	Entrepreneurship	Skill Development
Environmental Geology and Atmospheric Science	X	✓	✓
Environmental Biology	X	X	X
Waste Management	✓	✓	✓
Current Environmental Issues and their Management	✓	X	X
Environmental Pollution	✓	✓	✓
Natural Resources: Conservation and Management	X	X	X
Ecotoxicology and Radiation Impacts	X	X	X
Environment Impact Assessment and Environmental Audit	✓	✓	✓
Remote Sensing and GIS	✓	✓	✓
Environmental Chemistry and Green Technology	X	X	✓
Techniques in Environmental Monitoring and Analysis	X	X	✓
Environment Economics (Elective Paper)	✓	X	✓
Environmental Disasters: Mitigation and Management (Elective Paper)	✓	✓	✓
Climate Change and Clean Technology (Elective Paper)	✓	X	✓
Biodiversity and Wildlife Ecology (Elective Paper)	✓	X	✓
Environmental Law, Governance, Ethics and Policy	✓	✓	✓
Research Methodology, Statistics and Computer Applications	X	X	✓
Environmental Health (Elective Paper)	X	X	✓
Principles of Climatology (Elective Paper)	✓	X	✓
Environmental Biotechnology (Elective Paper)	✓	✓	✓
Nanotechnology (Elective Paper)	✓	✓	✓
Dissertation	✓	✓	✓

RULES AND REGULATIONS

Introduction: The M.Sc. (Environmental Science) programme is relevant to young students/ professionals who are looking to develop their analytical and research skills regarding important issues in environment. The course has been designed to meet the demand of growing needs of professionals in the fields of environment management, environment laws, environment governance and policy, impact assessment, natural resource management, pollution control, etc.

Nomenclature of the Course: The course is termed as **M. Sc. (Environmental Science)**

Time Frame: This course is of two years duration and is being run on semester basis. The course comprises Four Semesters. There are four theory papers and four practical / field study in first three semesters and three courses and dissertation in the fourth semester besides, class seminars, field visit, project reports and viva-voce etc. Teaching of this course was started from July, 2013.

Criteria for Admission and Age Limit: Normal entry requirement is a Bachelor Degree under 10+2+3 pattern of education in Sciences (Medical and Non-Medical), MBBS/B.V. Sc. or its equivalent from any Institute/University recognized by the HPU, Shimla / UGC, New Delhi with at least 50 percent (45 percent in case of SC/ST) marks in aggregate will be eligible for admission to this course. The Maximum age limit for the course is 26 years for boys and 28 years for the girl students on 1st July of the year concerned. In case of schedule caste/tribe the upper age limit will be raised by three years (for boys and girls) provided that, the Vice-Chancellor, HPU have the power to permit the age relaxation for the reason to be recorded in writing up to a maximum of six months.

However, the reservation of seats and the age limit for non-subsidized seats will be followed as applicable in other departments/institute.

The admission to this course is on the basis of the entrance examination. This exam basically tests the scientific attitude of the students. A brief description and knowledge based on the environment is tested to find out whether the candidate is really interested in the subject. The entrance test consists of 100 multiple-choice questions.

Career Opportunities

- Industry (Environmental Impact Assessment, Sustainable Resource Management, Waste Management, Environmental Biotechnology, Eco-technology)
- Government and Business Sector (Environmental Manager, Environmental Planner, Environment Consultant, Analysts)
- Universities, Colleges and Research Institutes (Teaching and Research)
- Non-governmental Organizations at National and International Levels

Tentative Modalities and Requirements for the Course:

Eligibility for enrolment:	Bachelor Degree under 10+2+3 pattern of education in Sciences (Medical and Non-Medical), MBBS/B.V. Sc. or its equivalent.
Duration of Programme:	Two years
Medium of Instruction:	English
Programme Structure:	Total number of courses will be 29; there are four theory papers and four practical / field studies in first three semesters and three courses, two practical and dissertation in the fourth semester besides, class seminars, field visit, project reports and viva-voce etc.
Mode of instruction:	Semester System

Exposure Visit/ Field Visit/Field Study: Field study is carried out in each semester in the areas having environmental significance (Zoological Park/Botanical Park/ Hydropower project site/ industrial visit for studying the Effluent water treatment plant/ natural hazards site/ Solid waste water treatment plant/ Pollution Control Board, etc.) as decided by the department. The students are required to submit a report after the field visit. The students will also be taken for exposure visit to the sites of environmental importance.

Dissertation After the completion of third semester the students opt for special paper in the fourth semester. The students are equally distributed among the faculty members for supervision of the dissertation. The students are be given the topic for the field study/ experimental study to be completed and submitted by the end of forth semester as dissertation.

INTERNAL ASSESSMENT MARKS

Internal assessment for theory papers is assessed on the basis of the class tests, seminars, and attendance of the student. Each student is given topic to make a power-point presentation during the class seminar, which is conducted every Saturday. In addition to this, there are class test of each subject which is mandatory for all the students.

COURSE OUTLINE

FIRST SEMESTER							
Course Code	Title of Course	Type	Allocation of time and credits		Marks		
			Instruction Hours per Week	No. of Credits	Theory	Internal Assessment	Total
MES-101	Environmental Geology and Atmospheric Science	CPT	4	4	60	20	80
MES-102	Environmental Biology	CPT	4	4	60	20	80
MES-103	Waste Management	CPT	4	4	60	20	80
MES-104	Current Environmental Issues and their Management	CPT	4	4	60	20	80
MES-105	Practical I based on MES 101	CPP	4	2	20	-	20
MES-106	Practical II based on MES 102	CPP	4	2	20	-	20
MES-107	Practical III based on MES 103	CPP	4	2	20	-	20
MES-108	Practical IV/ Field Study based on MES 104	-	4	2	20	-	20
	Total	-	32	24	320	80	400
Note: MES 101 to MES 104 will be of 80 marks (Theory-60, Internal Assessment-20 marks and MES-105 to MES-108 Practical/ field study-20 marks)							
CPT: Core Paper Theory; CPP: Core Paper Practical							

SECOND SEMESTER

Course Code	Title of Course	Type	Allocation of time and credits		Marks		
			Instruction Hours per Week	No. of Credits	Theory	Internal Assessment	Total
MES-201	Environmental Pollution	CPT	4	4	60	20	80
MES-202	Natural Resources: Conservation and Management	CPT	4	4	60	20	80
MES-203	Ecotoxicology and Radiation Impacts	CPT	4	4	60	20	80
MES-204	Environment Impact Assessment and Environmental Audit	CPT	4	4	60	20	80
MES-205	Practical I based on MES 201	CPP	4	2	20	-	20
MES-206	Practical II based on MES 202	CPP	4	2	20	-	20
MES-207	Practical III based on MES 203	CPP	4	2	20	-	20
MES-208	Practical IV /Field Study based on MES 204	-	4	2	20	-	20
	Total	-	32	24	320	80	400

Note: MES 201 to MES 204 will be of 80 marks (Theory-60, Internal Assessment-20 marks and MES-205 to MES-208 Practical/ field study-20 marks)

CPT: Core Paper Theory; CPP: Core Paper Practical

THIRD SEMESTER

Course Code	Title of Course	Type	Allocation of time and credits		Marks		
			Instruction Hours per Week	No. of Credits	Theory	Internal Assessment	Total
MES-301	Remote Sensing and GIS	CPT	4	4	60	20	80
MES-302	Environmental Chemistry and Green Technology	CPT	4	4	60	20	80
MES-303	Techniques in Environmental Monitoring and Analysis	CPT	4	4	60	20	80
MES-304 (i)	Environmental Economics	OEPT	4	4	60	20	80
MES-304 (ii)	Environmental Disasters: Mitigation and Management						
MES-304 (iii)	Climate Change and Clean Technology						
MES-304 (iv)	Biodiversity and Wildlife Ecology						
MES-305	Practical I based on MES 301	CPP	4	2	20	-	20
MES-306	Practical II based on MES 302	CPP	4	2	20	-	20
MES-307	Practical III based on MES 303	CPP	4	2	20	-	20
MES-308 (i)	Practical IV based on MES-304 (i)	OEPP	4	2	20	-	20
MES-308 (ii)	Practical IV based on MES-304 (ii)						
MES-308 (iii)	Practical IV based on MES-304 (iii)						
MES-308 (iv)	Practical IV based on MES-304 (iv)						
	Total	-	32	24	320	80	400

Note: MES 301; MES 302; MES 303; MES 304 (i-iv) will be of 80 marks (Theory-60, Internal Assessment-20 marks) and MES-305; MES-306; MES-307; MES-308 (i-iv) (Practical -20 marks)

CPT: Core Paper Theory; CPP: Core Paper Practical; OEPT: Open Elective Paper Theory; OEPP: Open Elective Paper Practical

FOURTH SEMESTER							
Course Code	Title of Course	Type	Allocation of time and credits		Marks		
			Instruction Hours per Week	No. of Credits	Theory	Internal Assessment	Total
MES-401	Environmental Law, Governance, Ethics And Policy	CPT	4	4	80	20	100
MES-402	Research Methodology, Statistics and Computer Applications	CPT	4	4	60	20	80
MES-403 (i)	Environmental Health	OEPT	4	4	60	20	80
MES-403 (ii)	Principles of Climatology						
MES-403 (iii)	Environmental Biotechnology						
MES-403 (iv)	Nanotechnology						
MES-404	Practical I based on MES 402	CPP	4	2	20	-	20
MES-405 (i)	Practical II based on MES-403 (i)	OEPP	4	2	20	-	20
MES-405 (ii)	Practical II based on MES-403 (ii)						
MES-405 (iii)	Practical II based on MES-403 (iii)						
MES-405 (iv)	Practical II based on MES-403 (iv)						
MES-406	Dissertation	-	4	4	100	-	100
	Total	-	20	20	340	60	400
Note: MES 401 will be of 100 marks (Theory-80, Internal Assessment-20) and MES 402; MES 403 (i); MES 403 (ii); MES 403 (iii); MES 403 (iv) will be of 80 marks (Theory-60, Internal Assessment-20 marks; and MES-404; MES- 405 (i-iv) (Practical -20 marks) and MES-406 will be dissertation of 100 marks							
CPT: Core Paper Theory; CPP: Core Paper Practical; OEPT: Open Elective Paper Theory; OEPP: Open Elective Paper Practical							
GRAND TOTAL (First to fourth Semester)					1600		

SEMESTER – I

MES-101: ENVIRONMENTAL GEOLOGY AND ATMOSPHERIC SCIENCE

UNIT-1 ENVIRONMENT AND ENVIRONMENTAL GEO-SCIENCE

- 1.1 Definition, evolution, characteristics principles and history of Environment and environmental Sciences.
- 1.2 Fundamental concepts, Primary differentiation and formation of core, mantle, crust, magma generation, dynamics of earth, Plate tectonics – sea floor spreading, mountain formation, Continental drift theory, Earth's Magnetic field, types of seismic waves and their role in the study of earth's interior.

UNIT -2 GEOMORPHOLOGICAL PROCESSES

- 2.1 Formations and classification of rocks rock cycle, Fold, and Fault, Major types of old and faults,
- 2.2 Weathering and their types, Mass wasting and its types Volcanism, types, volcanic materials, process and effects of volcanism
- 2.3 Soil profile, soil classification, soils of India.

UNIT -3 ENVIRONMENTAL GEOCHEMISTRY

- 3.1 Concept of major, minor and trace elements. Mobility of elements, geochemical cycles.
- 3.2 Geo-indicators. Resources and reserves, Mineral resources and reserves.
- 3.3 Oceans as new areas for exploration of mineral resources. Mineral resources of Himachal Pradesh

UNIT -4 ATMOSPHERE

- 4.1 Different layers and their characteristics; meteorological aspects- inversions, mixing height, wind-rose, electromagnetic radiations, solar radiation and terrestrial radiation
- 4.2 Heat budget, Temperature measurements and controls, Environmental lapse rate, humidity, mixing ratio, dry and wet adiabatic lapse rate, clouds-types and their characteristics and atmospheric stability.
- 4.3 Atmospheric transport, diffusion and dispersion.

UNIT -5 WEATHER AND CLIMATE

- 5.1 Elements of Weather and Climate, classification, energy balance in atmosphere, greenhouse effect, Atmospheric general circulation,
- 5.2 Precipitation and types of storms, Indian monsoon, El Nino , La Nina effect, and western disturbances, Geostrophic wind and gradient wind, cyclones
- 5.3 Atmospheric moisture: Forms of cloud condensation; Precipitation, Thunderstorms, floods and droughts.
- 5.4 Global Climate variability and climate change. Introduction to Weather forecasting models.

SUGGESTED READINGS

1. Bennett, M. R. and Doyle, P. Environmental geology: - Geology and the Human Environment. John Wiley and Sons.1997.

2. Botkin, Daniel B. and Keller, Edward A. Environmental Science: Earth as a Living Planet. 6th ed. John Wiley and Sons, USA. 2007.
3. Bouwer, H. Groundwater Hydrology. McGraw-Hill, New York. 1978.
4. Butz, S. D. Science of Earth Systems. 2nd ed. Thomson Delmar Learning, USA 2004.
5. Eby, N. Principles of Environmental Geochemistry. Brooks Cole, USA. 2003.
6. Joseph, G. Fundamentals of Remote Sensing. Universities Press (India) Pvt. Ltd. 2007.
7. Keller, E.A. Environmental Geology. 8th ed. Prentice Hall of India 1999.
8. Keller, E.A. Introduction to Environmental Geology. 4th ed. Prentice Hall of India 2007.
9. Kemp, M. J. Environmental Science. The McGraw-Hill Companies. 1997.
10. Raven, Peter H., Berg, Linda R. and Hassenzahl, David, M. Environment. 6th ed. John Wiley and Sons., USA. 2008.
11. Schwartz, F.W. and H. Zhang. Fundamentals of Ground Water. John Wiley and Sons, USA. 2003.

NOTE FOR PAPER SETTER: The question paper will contain TWO QUESTIONS from each unit (Total TEN questions in all) and the candidate will be required to answer ONE QUESTION from each unit (total questions to be attempted will be FIVE) i.e. there will be internal choice within each unit.

MES-102: ENVIRONMENTAL BIOLOGY

UNIT -1 CONCEPT AND SCOPE OF ECOLOGY

- 1.1 Definition and scope of ecology, branches of ecology
- 1.2 Human ecology and human settlement
- 1.3 Historical background of ecology, relevance of ecology to humankind, level of organization in ecology
- 1.4 Relationship of ecology with other branches of science

UNIT -2 ORIGIN AND EVOLUTION OF BIOLOGICAL DIVERSITY

- 2.1 General classification of biological diversity (plants and animals)
- 2.2 Growth and morphogenesis in plants and animals
- 2.3 Basics of photosynthesis, transpiration, biological nitrogen fixation, Physiological, biochemical and genetic mechanisms associated with adaptations of plants and animals.

UNIT -3 ECOSYSTEM CONCEPTS AND DYNAMICS

- 3.1 Principle and concept of ecosystem, types of ecosystems
- 3.2 Biotic and abiotic components of ecosystem, biomes, ecotones and edge effect, ecological niche and equivalents, ecotype, ecophene and ecological indicator
- 3.3 Biogeochemical cycling Carbon, Nitrogen, Phosphorus and Sulphur and Hydrological cycles and microbial ecology, C3 and C4 pathways and their significance
- 3.4 Ecological pyramids of number, biomass and energy, food chain, food web and trophic levels, ecological amplitude and ecological niches, ecological energetics, Decomposition, Ecosystem stability, Ecological Succession.
- 3.5 Primary and secondary productivity of different ecosystems in the world methods of measurements of productivity and the factors affecting productivity

UNIT -4 POPULATION AND COMMUNITY DYNAMICS

- 4.1 Characteristics of Population, concept of carrying capacity, Population growth and regulation, Population fluctuation, dispersion and meta- population. Concept of r and k species, key stone species.
- 4.2 Definition of community, its characteristics, diversity, dominance, structure, stratification, periodicity, fluctuation within community, Interdependence within community

UNIT -5 STUDY OF DIFFERENT ECOSYSTEMS

- 5.1 Forest ecosystem- Forest as an ecosystem, distribution of forests, types of forests, economics and ecology of forest, role of forests in protection of species regulation of climate and production of various produce
- 5.2 Grassland ecosystem - Distribution and types of grasslands, rangelands and biodiversity in grassland, and productivity in grasslands
- 5.3 Desert Ecosystem and Wastelands-Desert as ecosystems, hot and cold deserts, productivity, characteristics and global distribution of deserts; Desertification process; Types and distribution of wastelands in India

- 5.4 Aquatic Ecosystem: Lentic and lotic ecosystem, structure, energy flow and productivity in estuaries, marine ecosystem, structure biodiversity and productivity in, marine ecosystem
- 5.5 Wetland Ecosystem: Distribution, energetics and productivity in wetlands. Biodiversity and economic importance of wetlands

SUGGESTED READINGS

1. Agrawal, K. C. Environmental Biology, Nidhi Pub, New Delhi. 2008.
2. Benton, A.H. and Werner, W.E. Field Biology and Ecology, Tata Mc. Graw Hill Publishing Company Ltd. New Delhi.1976.
3. Chapman, J. L. and Reiss, M. J. Ecology- Principles and applications, Cambridge University Press, New York. 1995.
4. Claude F., Ferra, C., Medori, P. and Devaux, J. Ecology. Sciences and Practice, Oxford and IBH Pub. Co. Pvt. Ltd. New Delhi. 2001
5. Dash, M. C. Fundamentals of Ecology. Tata Mc.Graw Hill Publishing Company Ltd.New Delhi. 1993.
6. Grover, I. S. and Thukval, A. K. Environmental Development, Scientific Publishers,New Delhi. 1998.
7. Kormondy, E. J. Concept of Ecology. Prentice Hall of India, New Delhi. 1986
8. Odum, E. P. Fundamentals of Ecology. Natraj Publishers, Dehradun. 1996
9. Prasad, S. N. Environmental Biology, Campus Book International. 2009.
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11. Sharma, R. D. Himalayan Eco-System Development, Concept Publishing Company,New Delhi. 1994.

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MES-103: WASTE MANAGEMENT

UNIT -1 INTRODUCTION

- 1.1 Classification of different type of Waste; its generations and characterization. MSW – Sources and generation, chemical and physical characterization and classification
- 1.2 Different methods of disposal and management, land filling, incineration, composting, vermicomposting, energy and resource recovery.
Hazardous waste –Definition, sources, effects and management. Biomedical wastes – Definition, categories, and management.

UNIT -2 INDUSTRIAL WASTE TREATMENT

- 2.1 Principles of Industrial waste treatment - sources of pollution physical chemical, organic and biological properties.
Manufacturing processes, flow sheets, characteristics and composition of wastes including waste reduction, treatment and disposal methods for Food Industries: Sugar, Fermentation, Meat, dairy and Rice- milling; Material Industries: Paper, Steel - Metal - plating and petroleum refineries; Miscellaneous Industries: Textile, Tanning, Fertilizers and Atomic energy plants.

UNIT -3 BIOTECHNOLOGY IN WASTE MINIMIZATION

- 3.1 Role of Biotechnology in waste minimization; Recovery of by-products and raw material from wastewater conversion: waste recovery and reuse, reclamation by ground water recharge, agriculture reuse of effluent; sludge as fertilizer; recovery of protein, carbohydrates, biogas, biomass for energy, oil and fats, metal recovery, bio-scrubbing.

UNIT -4 ENVIRONMENTAL REGULATION FOR WASTE MANAGEMENT

- 4.1 Hazardous waste (management and handling) rules 1989, amendments 2000 and 2003,2016; Batteries (management and handling) rules, 2001; Biomedical waste (management and handling) rules, 1998; Municipal solid waste (management and handling) rules, 2016; Plastic waste (management and recycling) rules, 1999 (Recent amendements).

SUGGESTED READINGS

1. Crites R.W., Reed S.C. and Bastion R. Land Treatment Systems for Municipal & Industrial Wastes” McGraw Hill Companies Inc. 2000
2. Eckenfelder W.W. (Jr.) Industrial Water Pollution Control. McGraw Hill Publications. 1966
3. Lal, B. and Reddy, M.R.V.P. Wealth from waste: trends and technologies, Teri Press, New Delhi, 2005
4. Neal K. Ostler Industrial Waste Stream Generation”, Prentice Hall. 1998
5. Sidwick J. M. and Holdom R. S. Biotechnology waste treatment and exploitation, Ellis horwood limited, England. 1987

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MES-104: CURRENT ENVIRONMENTAL ISSUES AND THEIR MANAGEMENT

UNIT -1 GLOBAL WARMING, GREENHOUSE EFFECT AND OZONE PROBLEMS

- 1.1 Global Warming Potential, Possible Impact of Global Warming
- 1.2 Greenhouse Effect – Policy Response, Kyoto Protocol, El-Niño- Climate Cycle
- 1.3 Ozone in the Atmosphere, Ozone Depletion Process, Ozone Hole, Worldwide, Ozone Trends, the Montreal Protocol, Consequence of Ozone Depletion

UNIT -2 ACID RAIN, ATMOSPHERE TURBIDITY AND NUCLEAR

- 2.1 Introduction, Nature and Development of Acid Rain, Acid Rain and Geology
- 2.2 Acid Rain and Aquatic Environment, Acid Rain and Terrestrial Environment, Acid Rain and Built Environment
- 2.3 Acid Rain and Human Health, Mitigation of Acid Rain Problems, Aerosol types, Production and Distribution

UNIT -3 OTHER ENVIRONMENTAL ISSUES

- 3.1 Introduction, Consequences of global CO₂ changes; Strategies for Conservation of Environmental Changes Induced by CO₂ Rise
- 3.2 Water conservation- Development of watershed, Rain water harvesting and ground water recharge
- 3.3 Environmental Disasters: Minnamata, Love Canal, Bhopal gas Disaster, 1984, Chernobyl Disaster, 1986, Fukushima Daiichi nuclear Disaster, 2011.
- 3.4 Environmental problems in India (Narmada Dam, Tehri Dam, Almetti Dam, Soil erosion, Formation and reclamation of usar land, alkaline and saline soil; Unsustainable Agricultural Practices and Land Use Planning); recent problems like Delhi smog, crop burning

UNIT -4 ENVIRONMENTAL POLICES AND REGULATIONS

- 4.1 Fundamental principles of environmental protection
- 4.2 Constitutional perspective: Fundamental right to wholesome environment, directive principles of state policy
- 4.3 National Environmental Policy
- 4.4 Environmental regulatory framework in India
- 4.5 Role of international Environmental Agencies-UNEP, GEF, UNFCCC and IPCC

UNIT -5 ENVIRONMENTAL TREATIES AND CONVENTIONS

- 5.1 Stockholm Convention (1972); Basel Convention (1989, 1992)
- 5.2 Earth Summit at Johannesburg (2002); Earth Summit Rio De Janeiro (1992, 2012)
- 5.3 Kyoto Protocol, 1997; Montreal Protocol, 1987; Ramsar Convention on Wetland, 1971; Paris Agreement (2015)
- 5.4 Rotterdam Convention on Prior informed consent procedure for certain hazardous chemicals and pesticides in international schedule
- 5.5 Agenda 21, sustainable development goals, India's role in various conventions and contributions

SUGGESTED READINGS

1. Bridgeman, Howard, Global Air Pollution: Problems for the 1990's, Belhaven Press, New York. 1991.
2. Joner, J. A. A. Global Hydrology: Processes, Resources and Environment", Longman, Essenx, England. 1997.
3. Mauahan, S. E. Environmental Chemistry, Willaw Grant Press, Beston, USA. 1983.
4. Moeller, Dave W. Environmental Health, Mass: Harvard University Press, Cambridge. 1992.
5. Santra, S. C. Environmental Science, 2nd Edition, New Central Book Agency (P)Ltd, Kolkata, India. 2005.
6. Tudge, Colin, Global Ecology, Oup, New York. 1991.
7. Wilson, E.O. Biodiversity, National Academy Press, Washington, DC. 1988.

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MES-105: PRACTICAL I
(MES 101: ENVIRONMENTAL GEOLOGY AND ATMOSPHERIC SCIENCE)

1. Study and Identification of hand specimens of rock and mineral samples.
2. Sketch of earth system and different geological hazards
3. Determination of soil texture
4. Familiarization with meteorological instruments and their uses.
5. Presentation and interpretation of wind data – wind direction and speed and wind rose for 24 hours, month and season.
6. Preparation of hydro-thermal charts on an area.
7. Predication of weather by using meteorological data of specific area.
8. Land slide studies in Himalayan region
9. Slope stability analysis and Landslide zoning

MES-106: PRACTICAL II
(MES 102: ENVIRONMENTAL BIOLOGY)

1. Ecological sampling of an area (line transect and quadrant method)
2. Species-area Curve, measurement of biomass and productivity
3. Population structure and regeneration status of ecosystem
4. Collection of litter, soil and plant samples
5. Nutrient and vegetation analysis
6. Calculation of species diversity, similarity index and evenness
7. Visit to aquatic ecosystem and methods for water and plankton collection
8. Study the biodiversity of water and identification of different species
9. Identification and staining of Microorganisms from different effluents.

MES-107: PRACTICAL III
(MES 103: WASTE MANAGEMENT)

1. Visit to the nearby locality to understand the waste generation trends, disposal mechanism and problems people encounter in the same.
2. Visit to the nearby Wastewater/ Solid Waste Treatment Plant to understand the mechanism followed for the same and make a report
3. Evaluation of water disinfection methods.
4. Case studies on novel and successful solid waste and water treatment protocols.

MES-108: PRACTICAL IV/ FIELD STUDY
(MES 104: CURRENT ENVIRONMENTAL ISSUES AND THEIR MANAGEMENT)

1. Describing the: a) climate of an urban area; b) yearly variation in the meteorological data
2. Prepare a report on the environmental problem in the nearby area and suggest remedial measures

SEMESTER – II

MES-201: ENVIRONMENTAL POLLUTION

UNIT-1 AIR POLLUTION

- 1.1 Types and sources of air pollutants. Reaction of pollutants in atmosphere; atmospheric diffusion and stack performance, Mixing Height /Depth lapse rates, Gaussian plume model. Air quality standards.
- 1.2 Introduction of basic instruments for sampling and analysis of air pollutants
- 1.3 Control devices for particulate matter: Principle and working of settling chamber, centrifugal collectors, wet collectors, fabric filters, ESP. Control of Gaseous pollutants
- 1.4 Effects of air pollutants on flora and fauna, biological indicators of air pollution, Bio-monitoring of air pollutions

UNIT -2 SOIL POLLUTION

- 2.1 Physico- Chemical and biological properties of soil (Texture, structure, inorganic and organic components Analysis of soil Quality.
- 2.2 Soil pollution; effects on flora and fauna; control of pollution.
- 2.3 Soil micro-organisms and their functions- degradation of pesticides and synthetic fertilizers.
- 2.4 Industrial effluents and their interaction with soil components

UNIT-3 WATER POLLUTION

- 3.1 Sources and kinds of water pollution, water quality standards
- 3.2 Effects of water pollutants on plants; animals and human beings
- 3.3. Eutrophication and its impacts on organisms and communities.
- 3.4 Impact of heavy metals, halogens, radio-nuclides on aquatic flora and fauna.

UNIT -4 NOISE AND LAND POLLUTION

- 4.1 Physiological, social and psychological effects of noise
- 4.2 Methods of noise abatement; shock waves and SST; Noise control in vehicles
- 4.3. Industrial noise control and effects
- 4.4 National and International standards

UNIT -5 THERMAL and RADIATION POLLUTION

- 5.1 Thermal pollution: Concept of thermal pollution, sources of thermal pollution, thermal power plant pollution, thermal effects on aquatic life, impacts on water quality, prevention of thermal pollution.
- 5.2 Radiation pollution: Causes, effects (health hazards) and control measure of radiation pollution.
- 5.3 Applications of ionizing isotopes in waste water and air pollution analysis and treatment

SUGGESTED READINGS

1. Bretsehnedder, B. and Kurfurst, J. Air Pollution, Elsevier Scientific Pub. Co. Amsterdam, Oxford, New York. 1987.
2. Bridgman, H. Global Air Pollution, CBS Pub. New Delhi. 1992.
3. Bush, M. B. Ecology of a changing planet, Prentice Hall, USA. 1997.
4. Dassber, H. S. and Bortitz, S. Air pollution and its influence on vegetation, Dr. W. Junk Pub. Dordrencht-Bostan Lancaster. 1988.
5. Davis, M.L. and Cornwell, D. A. Introduction to Environmental Engg, McGraw Hill International Edition. 1991.
6. Dhaliwal, G. S., Sawgha, G. S. and Ralhan, P. K. Fundamentals of Environmental Science, Kalyani Pub., Ludhiana. 1996.
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9. Odum, E. P. Fundamentals of Ecology, Natraj Pub. Dehradun. 1996.
10. Patrick, R. Dugan The Water pollution problems (Part-I), Plenum Publishing corporation New York. 1972.
11. Prasad, O. and Choudhary, M. C. Environmental Pollution Radiation, Venus Publishing House, New Delhi. 1992.
12. Rana, S. V. S. Essentials of Ecology and Environmental Sciences, Prentice Hall of India, New Delhi. 2003.
13. Rao, M. N. and Rao, H. U. Air Pollution, Tata McGraw Hill Pub. Company, New Delhi. 1998.
14. Tripathi, A. K. Air pollution, Vol. I. Ashish Publishing House, New Delhi. 1992.

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MES-202: NATURAL RESOURCES: CONSERVATION AND MANAGEMENT

UNIT -1 NATURAL RESOURCES - FLORA

- 1.1 Natural resources: introduction, characteristics and classification
- 1.2 Concept of endemic, extinct and threatened species (endangered, rare, vulnerable and indeterminate species)
- 1.3 Plants as a natural resource: a general account with reference to timber, food and medicines
- 1.4 Degradation of plant resources: Causes and Consequences

UNIT -2 NATURAL RESOURCES - WATER AND ANIMALS

- 2.1 Wild life as natural resources: A general account with special reference to game wildlife and food, wildlife of India
- 2.2 Depletion of wildlife: causes and consequences
- 2.3 Fisheries: Status and conservation with special reference to Himachal Pradesh

UNIT -3 NATURAL RESOURCES - SOIL AND MINERALS

- 3.1 Soil as a natural resource, a general account with reference to nutrients and soil biota
- 3.2 Role of agricultural practices, wind and water erosion in soil degradation
- 3.3. Origin, distribution and uses of economically important minerals; exploitation of mineral resources from oceans with special reference to India
- 3.4 Impact of exploitation of minerals on environment, methods of conserving the mineral resources

UNIT -4 NATURAL RESOURCES - ENERGY

- 4.1 Environmental implications of energy use; energy use pattern in India.
- 4.2 Coal, oil and natural gas (physico-chemical characteristics and energy content of coal, petroleum and natural gas)
- 4.3. Principles of generation of Hydro energy, wind energy, tidal energy, solar energy, nuclear energy, Biogas, petero-plants, and their application; impacts of large scale exploitation of different forms of energy

UNIT -5 NATURAL RESOURCES-CONSERVATION STRATEGIES and MANAGEMENT

- 5.1 In-situ conservation of plants and animal species: Natural Parks, Biosphere reserves and sanctuaries
- 5.2 Ex-situ conservation: Botanical gardens, Zoological parks, tissue culture techniques, cryo-preservation of pollen, seeds and sperms
- 5.3 Conservation of forests, social forestry and agro-forestry, carbon sequestration
- 5.4 Conservation of soil and management of grasslands and wetlands

SUGGESTED READINGS

1. Bandhu, D. Environment Education for conservation and Development, Indian Environment, Society New Delhi. 1987.

2. Chaturvedi, A. N. Management of India's forest resources. Khanna Bandhu, Dehradun.1994
3. Dar, G. H., Bhagat, R. C. and Khan, M. A. Biodiversity of the Kashmir Himalaya, Anmol Publication, Pvt. Ltd. New Delhi. 2002.
4. Dasmann, R. F. Wildlife Biology, 2nd edition, John Wiley and Sons, New York. 1981.
5. Gautam, A. and Rastogi, S. Resource Geography, International Publishing House, Meerut. 2003.
6. Gupta, K. C. Energy and Environment in India - A study of Energy Management, Gyan Publishing House, New Delhi.2002.
7. Heywood, V. H. Global Biodiversity Assessment, Cambridge University Press, UK. 1995.
8. Jadhav, H. V. Energy and Environment, Himalaya Publishing House. Delhi. 1997.
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10. Kathiresan, S. B. Essentials of forest management, Natraj Publishers, Dehradun.1986.
11. Kumar, H.D. Modern concepts of Ecology, Vikas Pub. House, Pvt. Ltd. New Delhi. 1995.
12. Owen, O. S. and Chiras, D.D. Natural Resources Conservation. Prentice Hall India. 1995.
13. Rana, S. V. S. Essentials of ecology and Environmental sciences, Prentice Hall of India. 2003.
14. Singh, M. P. Natural Resources and renewable Energy, Daya Publishing House, Delhi. 2004.
15. Tiwari, P.C. Natural Resources and sustainable development in Himalaya, Shree Almora Book Depot., India. 1995.

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MES-203: ECOTOXICOLOGY AND RADIATION IMPACTS

UNIT -1 CONCEPT AND HISTORICAL BACKGROUND

- 1.1 Origin and scope of toxicology, relationship with other sciences
- 1.2 Development of environmental toxicology (Historical and evolutionary Perspective)
- 1.3 Classification of toxicants, natural and synthetic toxins, sources of toxicants
- 1.4 Basic concepts of toxicology, types of toxicity, acute and chronic toxicity
- 1.5 Toxicants and toxicity, factors affecting toxicity, types of toxins and basic mechanism of action

UNIT -2 MODE OF ACTION AND EFFECTS OF TOXICANTS

- 2.1 Environmental Toxicants: Mode of action of toxicants, factors affecting the metabolism of xenobiotics; transport process mechanism of toxicants, mode of action and impacts of Arsenic, Cadmium, Lead, Mercury, Carbon-Monoxide, Nitrous Oxide, Sulphur Dioxide, Ozone, Cyanide, mode of action of pesticides
- 2.2 Toxicity impacts: Health impacts of toxicants on human and aquatic life, long-term effects- chronic, carcinogenic, mutagenic and teratogenic effects

UNIT -3 OCCUPATIONAL HEALTH

- 3.1 Health problems related to occupation (due to dust, heat, stresses, chemicals, toxic gases, insecticides and pesticides and metals) Risk Assessment and Management in the Workplace (Workplace Exposure Assessment, Risk Management in the Workplace)
- 3.2 Dose response relationship, LD 50, LC 50, toxicity testing, acute toxicity tests
- 3.3 Sub-acute and chronic toxicity tests, heavy metal toxicity tests

UNIT -4 RADIATION IMPACTS

- 4.1 Natural and man-made radiation, application of radiations, sources of ionizing radiation, types of ionizing radiation, radiation dose and units, direct and indirect effects
- 4.2 Dose limits, radiation hazard
- 4.3. Personal protection and house-keeping and safety rules

UNIT -5 EFFECTS OF RADIATIONS

- 5.1 Molecular and cellular radiobiology: Biological effects of radiation, Radiation lesions in DNA, Major types of DNA repair, DNA damage and repair, chromosomal aberrations and gene mutations, cell death, cell survival curve, consequences of unrepaired DNA damage, radiobiological definition of cell death, cell cycle effects
- 5.2 Impact of radiations on biological molecules (proteins, nucleic acids, lipid and carbohydrates)
- 5.3 Radio-protectors and Industrial safety requirements, industrial radio-protector

SUGGESTED READINGS

1. Ansari, A. Radiation threats and your Safety. Chapman and Hall/CRC. 2009.
2. Banerjee, S. K. Environmental Chemistry. Prentice Hall of India Pvt. Ltd., Delhi. 2001.

3. De, A. K. Environmental Chemistry. New Age Int. Ltd. New Delhi. 2003.
4. Donald, G. G. Environmental Toxicology and Chemistry. Oxford University Press: New York and Oxford. 1998.
5. Henriksen, T. Radiation and Health. Taylor and Francis, New York. 2002.
6. Ian C. Shaw and John Chadwick Principal of Environmental Toxicology. Taylor and Francis, London. 1998.
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10. Sood, A. Toxicology. Sampand Songs, New Delhi. 1999.
11. Wright, D. A. and Welbowin, P. Environmental Toxicology. Cambridge Univ. Press,U.K. 2002.
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MES-204: ENVIRONMENT IMPACT ASSESSMENT AND ENVIRONMENTAL AUDIT

UNIT -1 OVERVIEW OF EIA

- 1.1 Objectives and developmental Concept, origin of EIA, Benefits of EIA, Indian directions guidelines (GOI different notification of EIA).
- 1.2 Rapid and comprehensive EIA perspectives.
- 1.3 Sources and collection of data for EIA. Measurement of Impact (Physical, social, economic, natural)
- 1.4 EIA in Indian context, EIA Notification 2006, Prior environmental clearance requirements, EIA authority - State and Central government, Committees for Environmental Clearance, Application for EC, Form 1- contents. Categorization of Projects, list of projects, activity, financial overlays, conditions and specifications.

UNIT -2 EIA METHODOLOGY

- 2.1 Outline of EIA process, Screening, Scoping, Purpose of scoping, impact implications, Baseline studies and superimposition of projected plant emission impacts; reliability of database; intrinsic and external database supports and interpretation; checklist, matrices, Overlays and Geographical Information System, Impact analysis and Predictions, Environmental Impact Statement [EIS]; Public hearing as part of EIA; EIA report.
- 2.2 Generic structure of Environmental Impact Assessment document – Executive summary of Project, Introduction, Project description, Project benefits, Policy legal and administrative framework, EIA methodology, Description of Environment, prediction of environmental impacts, evaluation of impacts, Environmental Impact Statement (EIS), Impact evaluation, Environmental Management Plan (EMP), Disclosure of Consultants engaged.

UNIT -3 PREDICTION AND ASSESSMENT OF IMPACTS

- 3.1 Prediction and Assessment of Impacts on Water Environment, Air Environment, Noise Environment, Biological Environment, Cultural and Socio-cultural Environment.
- 3.2 EIA of River valley project, Hydro power project, Cement plants and Mining
- 3.3 Prediction and assessment of: Impact of tourism on environment, impact on flora and fauna in Himalayan region
- 3.4 Social impact assessment (SIA), Strategic Environmental Assessment (SEA), types of impacts, Public involvement, Public Hearing compulsion, restoration and rehabilitation methodologies, Mitigation criteria, Project modification, Post project analysis.

UNIT -4 ENVIRONMENTAL AUDIT

- 4.1 Objectives, frequency and criteria audit team, Environmental appraisal, accounting and environmental audit. Environmental guidelines for siting of industry, Green Balance Sheet (GBS), Status of compliance of mandatory and

voluntary requirements for industries.

UNIT -5 ENVIRONMENTAL MANAGEMENT AND ISO CERTIFICATION

- 5.1 Environmental Management Systems (EMS), ISO 14000 (EMS). Components of Environmental Management System-Objectives, Policies, Implementation and Review.
- 5.2 Life Cycle Analysis –LCA. Waste minimization and product augmentation.

SUGGESTED READINGS

1. Anjaneyulu, Y. and Manickam, V. Environmental Impact Assessment Methodologies. B.S.Publications.2002.
2. Boland, R.G.A. (Ed) Environmental Management Training. Sterling Publishers Pvt. Ltd.New Delhi, 1993.
3. Canter, L. Environmental Impact Assessment.2nd Edition. McGraw-hill Book Company,New York.1996.
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12. Rao, P. S. and Rao, P. M. Environmental Management and Audit. Deep and Deep Publications.2000.

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MES-205: PRACTICAL I
(MES 201: ENVIRONMENTAL POLLUTION)

1. Comparative analysis of air sampling from clean and polluted area using key parameters.
2. Demonstration of noise pollution monitoring equipment.
3. Measurement of sounds by db meter in silent, industrial, residential and commercial zones.
4. Estimation of pH, phosphate, sulphate, acidity, alkalinity, conductivity, hardness, turbidity.
5. Field visit to the Pollution Control Board for demonstration of using different apparatus/ equipment for studying different types of pollution (report to be submitted)

MES-206: PRACTICAL II/FIELD STUDY
(MES 202: NATURAL RESOURCES: CONSERVATION AND MANAGEMENT)

1. To study the dependence of rural community on the natural resources in the nearby locality
2. To study the biodiversity of birds and insects in nearby locality
3. To undertake collection of economically important plants from nearby locality and fix them herbarium sheets

MES-207: PRACTICAL III
(MES 203: ECOTOXICOLOGY AND RADIATION IMPACTS)

1. Determination of different toxic element in air, water, and soil
2. Protocols to evaluate pollutant toxicity
3. Protocol to evaluate the radiation toxicity
4. Visit to nearest industrial areas for evaluating the working conditions of the workers and documentation of safety measures
5. List the sources of toxic substances from nearby industrial area
6. Identifying the sources of toxins in water obtained from different sources.

MES-208: PRACTICAL IV
(MES 204: ENVIRONMENTAL IMPACT ASSESSMENT AND ENVIRONMENTAL AUDIT)

1. Analysis of Socioeconomic survey in the concern village
2. SIA of any project in the nearby village and urban areas
3. Hypothetical EIA of Hydro power project.
4. Hypothetical EIA of Cement plants/ mining
5. Impact study of Tourism in particular city /town /area
6. Impact study of National highways/road construction
7. Hypothetical EIA of Different industries
8. Hypothetical EIA of River valley project
9. Impact study of urbanization/ real estate project.

SEMESTER – III

MES-301: REMOTE SENSING AND GIS

UNIT-1 INTRODUCTION TO REMOTE SENSING

- 1.1 Definition of remote sensing; introduction to concepts and systems, Scope of remote sensing
- 1.2 Electromagnetic Spectrum; Radiation principles; image characteristics
- 1.3 Remote sensing systems; remote sensing platform
- 1.4 Sources of remote sensing information; advantages of remote sensing

UNIT -2 MICROWAVE SENSING

- 2.1 Types of microwave systems, advantages, band designation, range resolution, azimuth resolution, real and synthetic aperture systems
- 2.2 Radar equation, radar return and image, Signatures, dielectric properties and interaction with vegetation Surveying
- 2.3 Leveling, Triangulation, Geo-datic survey

UNIT -3 AERIAL PHOTOGRAPHS AND SATELLITE IMAGERIES

- 3.1 Interaction between light and matter
- 3.2 Characteristics of aerial photographs
- 3.3 Visual interpretation of aerial photographs and satellite imageries
- 3.4 Instruments used in interpretation
- 3.5 Path and Row Index Maps; selecting and ordering images

UNIT -4 DIGITAL IMAGE PROCESSING

- 4.1 Introduction to digital image processing, basic concept and principle, image rectification and restoration
- 4.2 Image enhancement; manipulation; image classification; the output stage; data merging; conclusion

UNIT -5 APPLICATION OF REMOTE SENSING IN ENVIRONMENTAL MANAGEMENT

- 5.1 Remote sensing in natural resource management - forest resources, water resources, land resources and mineral resources
- 5.2 Hazard and disaster mapping and management
- 5.3 Introduction to GIS; principle of GIS; terminology used in GIS; space and time in GIS
- 5.4 Maps and its characteristics, map scale, map symbology; spatial relationship; data structure and spatial analysis in GIS; GIS data; software used in GIS

SUGGESTED READINGS

1. Burrough, P. A. Principles of Geographical Information System for Land Resource Assessment, Oxford Univ. Press. 1986
2. Curran, P. J. Principles of Remote Sensing, ELBS, Longman Inc. 1988.
3. Jensen, J. R. Digital Image Processing, Prentice Hall, New York. 1986
4. Jensen, J. R. Remote Sensing of the Environment, Pearson Education, Singapore.

2003.

5. Lillesand T.M. and Kiefer R.W. Remote Sensing and Image Interpretation, Second Ed. John Wiley and Sons, New York. 1987.
6. Rao, U. R. Space Technology for Sustainable development. Tata McGraw Hills Co. Ltd., New Delhi. 1996

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MES-302: ENVIRONMENTAL CHEMISTRY AND GREEN TECHNOLOGY

UNIT -1 CONCEPT AND SCOPE OF ENVIRONMENTAL CHEMISTRY

- 1.1 Nomenclature, segments of environment, Concept and scope of Environmental Chemistry
- 1.2 Chemistry of biologically important molecules, chemistry of water, hydrogen bonding in biological systems
- 1.3 Chemistry of various organic and inorganic compounds
- 1.4 Chemistry of hydrocarbon decay, environmental effects

UNIT -2 FUNDAMENTALS OF ENVIRONMENTAL CHEMISTRY

- 2.1 Stoichiometry, Gibb's energy, chemical potential
- 2.2 Chemical equilibrium, Acid-base reaction, solubility product, solubility of gases in water
- 2.3 Solubility product, solubility of gases in water the carbonate system unsaturated and saturated hydrocarbons
- 2.4 Surfactants: Cationic, anionic and nonionic detergents, modified detergents
- 2.5 Pesticides: Classification, degradation, analysis, pollution due to pesticides and DDT problems, organochlorides, organophosphates, organo-carbamates, herbicides
- 2.6 Synthetic Polymers: Microbial decomposition, polymer decay, ecological and consideration, Photosensitize additives.

UNIT -3 ENVIRONMENT AND GLOBAL WARMING

- 3.1 Chemical composition of Air: Classification of Elements, Chemical speciation
- 3.2 Chemical process for formation of inorganic and organic particulate matter
- 3.3 Thermo-chemical and Photochemical reaction in the atmosphere, Oxygen and Ozone chemistry, Chemistry of Air pollutants; photochemical smog. O₃, NO_x, HC, CFCs and PAN
- 3.4 Chemistry of greenhouse gases, emission of CO₂, Consequences of greenhouse gases, their control and remedial measures, threats of Global warming

UNIT -4 PRINCIPLES OF GREEN TECHNOLOGY

- 4.1 Overview of green chemistry, principles of sustainable and green chemistry
- 4.2 Waste minimization and climate change
- 4.3 Introduction to nano-materials and green nanotechnology
- 4.4 Nano-medical application of green nanotechnologies

UNIT -5 APPLICATION OF GREEN TECHNOLOGY

- 5.1 Green technology in industries, fuel cell and electric vehicles, solar energy and hydrogen production, energy from alternate sources, solar photovoltaic technology; biofuel production (bio-ethanol and biodiesel)
- 5.2 Biomass, prevention/ minimization of hazardous/ toxic products, production of biodegradable materials, concept of green building

SUGGESTED READINGS

1. Baird, C. Environmental Chemistry, W. H. Freeman and Company, USA. 2000.
2. Banerji, S. K. Environmental Chemistry, Prentice-Hall of India Private Ltd., New Delhi. 1993.
3. De, A. K. Environmental Chemistry, New Age International Ltd., New Delhi. 2003.
4. Eisenbund, M. and Gesell, T. Environmental Radioactivity-from natural, industrial and military sources, Acad. Press, USA. 1997.
5. Girard, J. E. Principals of Environmental Chemistry, Jones and Bartlett Publishers, Inc. 2005.
6. Harrison, R. M. and Mora, S. J. De. Introductory chemistry for the Environmental Chemistry. Cambridge University, Press. 1996.
7. Mido, Y. and Satake, M. Chemicals in the environment, Discovery Pub. House, New Delhi. 1995.
8. Sharma, B. K. Environmental Chemistry, Krishna Prakashan Media Pvt. Ltd. Meerut. 2001
9. Sharma, B. K. and Kaur, H. Environmental Chemistry, Goel Publishing House, New Delhi. 1990
10. Sodhi, G. S. Fundamental concepts of environmental Chemistry, Narosa Publishing House, New Delhi. 2006.

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MES-303: TECHNIQUES IN ENVIRONMENTAL MONITORING AND ANALYSIS

UNIT -1 SAMPLING METHODS

- 1.1 Sampling methodologies for Air, Water, and Soil in environmental matrices. Sampling protocols- Selection of sites, Time and frequency for sampling.
- 1.2 Preservation, Storage and Handling of samples. Good Laboratory Practices.

UNIT -2 ANALYTICAL INSTRUMENTS

- 2.1 Principles, working and applications of High volume sampler, Respirable Sampler, Impactors, Cyclones, Particle Size Analyser, Gas Analysers, Spectrophotometer (UV-Visible), Flame Photometer, Atomic Absorption spectrophotometer (AAS). Head space analysis, leaching tests, and immunoassay.

UNIT -3 ADVANCED MICROSCOPY AND CHROMATOGRAPHS

- 3.1 Principles, working and applications of Phase contrast, fluorescent, polarization Microscopes, SEM. Gas Chromatograph (GC), GC-MS, HPLC, Ion chromatograph, X-ray diffraction, ED-XRF, WD-XRF, ICP-MS, ICP-AES

UNIT -4 RADIATION DETECTORS AND MONITORS

- 4.1 Principles and working of radiation detectors- gas filled, scintillation (inorganic and organic) and semiconductor. Principles and working of Alpha Counter, Beta Counter, Gamma-ray Spectrometer, Liquid scintillation Counter, Beta-Gamma survey meters, Alpha, Beta and Gamma contamination Monitors.

SUGGESTED READINGS

1. Baird, C. and Cann, M. Environmental Chemistry. W.H. Freeman and Company 2008.
2. Chatwal, G. R., and Anand, S. K. Instrumental Methods of Chemical Analysis. Himalaya Publishing House, Delhi. 2007.
3. De, A.K. Environmental Chemistry, New Age International, New Delhi. 2000.
4. Keith, L. H. Principles of Environmental Sampling. American Chemical Society. 1988.
5. Murphy, W.J. Analytical Chemistry, American Chemical Society, USA. 1977
6. Reeve, R. Introduction to Environmental Analysis. John Willey and Sons. 2002.
7. Shukla, S. K. and Srivastava, P. R. Methodology of Environmental monitoring and Assessment. Commonwealth Publishers. 1992.

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MES-304 (i): ENVIRONMENT ECONOMICS (ELECTIVE)

UNIT -1 ECONOMY AND THE ENVIRONMENT

- 1.1 World environmental history and economic development, valuation of natural resources, Inter-linkages between the economy and the environment
- 1.2 Economics of Natural Resource Exploitation – Renewable and Non-Renewable Resources – Methods of valuation of Environmental Costs and Benefits. Entropy-Principle and law of entropy. Material flow in economy.

UNIT -2 ENVIRONMENTAL POLICY

- 2.1 Design of Environmental Policy. Economic Instruments for Environmental Protection: Command and Control versus Incentives and Subsidies. Effectiveness of these instruments. Indian scenario and comparisons with developed countries.

UNIT -3 SUSTAINABLE DEVELOPMENT

- 3.1 Concept and objectives. Strategic Planning for Sustainable Development, Natural resource based economic and social development.
- 3.2 Climate Change and India: Vulnerability of regions and populations – Adaptation options.

UNIT -4 GREEN ECONOMY

- 4.1 New model for development, Green economy and green economy initiatives, Role of UNEP. Brundtland Commission. Ecological economics Economic Growth and the Environment: Environmental Kuznets' curve, Foreign Direct Investment and the Environmental quality.

SUGGESTED READINGS

1. Allen V. Kneese and James L. Sweeney, eds. Handbook of Natural Resource and Energy Economics, Chapters 2,12,14,17, North Holland, 1985.
2. Bohm, P. and Russell, C., Comparative Analysis of Alternative Policy Instruments', Chap. 10 in Handbook of Natural Resource and Energy Economics, Vol. I Ed. A.V.
3. Field, B.C., Environmental Economics: An Introduction, McGraw Hill, 1994
4. Fisher, A.C., Environment and Resource Economics, Selected readings, New Horizon in Environmental Economics, Ed. W.E. Oates, 1995.
5. Hanley, Nick, Jason F. Shogren and Ben White: Environmental Economics in Theory and Practice, New Delhi: Macmillan –India, 1997.
6. James, D.E., Economic Approaches to Environmental Problems: Techniques and Results of Empirical Analysis, Elsevier Scientific Publishing Co., 1978.
7. Kolstad Charles., Environmental Economics, New Delhi: Oxford University Press, 2010 14
8. Oates, W.E., Economics of the Environment, 1992.
9. Sankar, U. (ed.) Environmental Economics, New Delhi: Oxford University Press, 2001.

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MES-304 (ii): ENVIRONMENTAL DISASTERS: MITIGATION AND MANAGEMENT(ELECTIVE)

UNIT -1 INTRODUCTION TO DISASTERS

- 1.1 Disasters: Meaning and definitions, difference between disaster and hazard, causal factors, development leading to disaster, characteristics of disasters, forecasting and warning of disasters, elements of early warning systems
- 1.2 Classification of Disasters: Natural and man-made hazards, hazard zonation and risk assessment, mitigation strategies
- 1.3 Man- Made Disasters: Types and nature of man-made disasters, general effects and mitigation strategies for manmade disasters
- 1.4 Biological Disasters: Meaning, types, vulnerability, effects, preparedness and mitigation of Biological disasters
- 1.5 Chemical and Radiological Disasters: Causes, impacts and management of chemical and radiological disasters

UNIT -2 NATURAL DISASTERS- I

- 2.1 Natural Disasters: Introduction, meaning, nature and types of natural disasters, general effects of natural disasters
- 2.2 Earthquake and Seismic Hazards: Origin and severity of earthquakes, effects of earthquakes, risk evaluation, seismic zonation of India with special reference to Himalayan Region, earthquake mitigation measures
- 2.3 Volcanic Eruptions: Nature, causes, monitoring and mitigation of volcanoes
- 2.4 Landslides: General characteristics, causes, vulnerability, effects, prediction and warning and risk reduction mitigation measures
- 2.5 Snow Avalanches: Formation of avalanches, classification, mitigation and management of avalanches

UNIT -3 NATURAL DISASTERS- II

- 3.1 Floods: Causes of flood, flood and draught, erosion and sedimentation, flood prone areas of India and associated hazards, assessment and management of flood
- 3.2 Cyclones: Nature and genesis, anticyclones, weather associated with cyclones, Geological changes and other effects
- 3.3 Tsunami: Origin and nature, causes of tsunamis, wave propagation, impact on coastal areas, warning and prevention, tsunami mitigation measures
- 3.4 Drought: Meaning, types, general characteristics, causes and impacts, prediction and warning and mitigation measures
- 3.5 Heat and Cold Waves: Causes and impacts, prevention, preparedness and response

UNIT -4 DISASTER MANAGEMENT

- 4.1 Disaster Management: Definition, objectives and scope of disaster management, elements of disaster management, role of professionals in the management of disasters, disaster management cycle
- 4.2 Disaster Response: Response plans, search, rescue and evacuation, community health and casualty management

UNIT -5 DISASTER MITIGATION AND PREPAREDNESS

- 4.1 Disaster Preparedness: Disaster preparedness plans, pre-requisites of preparedness planning, role of Information Technology, education, communication, and awareness in preparedness
- 4.2 Rehabilitation and Reconstruction (R and R): Social and economic aspects of R and R, Housing, relocation, retrofitting, repairing and strengthening of houses, reinstating livelihoods, national policy on disaster management

SUGGESTED READINGS

1. Bryant, E. A. Natural Hazards. Cambridge University Press, Cambridge, New York. 1991.
2. Cuny, F. Disasters and Development. Oxford University Press, England. 1983.
3. Cutter, S. L. Environmental Risks and Hazards. Prentice Hall of India Pvt. Ltd. NewDelhi. 1999.
4. Green, S. International Disaster Relief towards a Responsive system. Mc. Graw HillBook Co. New York. 1980.
5. Gupta, H. Disaster Management. University Press, Hyderabad. 2003.
6. Sahini, P. and Ariabandu, M. N. Disaster Risk Reduction in South Asia. Prentice Hall of India Pvt. Ltd. New Delhi. 2003.
7. Sinha, P. C. Encyclopedia of Disaster Management series. Anmol Pub., New Delhi. 1998.
8. Singh, S. R. Disaster Management. APH Publishing Corporation, New Delhi. 2011.
9. Smith, K. Environmental Hazards: Assessing risk and reducing disaster. Routledge, London. 1996.

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MES-304 (iii): CLIMATE CHANGE AND CLEAN TECHNOLOGY (ELECTIVE)

UNIT -1 SCIENCE OF CLIMATE CHANGE

- 1.1 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), radiative forcing

UNIT -2 GREEN HOUSE GASES

- 2.1 Trends of Emission of Carbon dioxide, Nitrous Oxide, methane, CFCs, Sulphur hexafluoride. GHG inventories. Sectoral emissions. Time series plots of GHGs and temperature.

UNIT -3 CLIMATE CHANGE IMPACTS

- 3.1 Impact of Climate Change on weather and climatic patterns, ice caps, glaciers, agriculture, vegetation, biodiversity, sea level, tourism and their implications.

UNIT -4 CLEAN TECHNOLOGY

- 4.1 Imperatives of clean technology in the context of mitigation and adaptation measures. CDM concept, CDM scenario in India, CDM projects sector-wise, National Action Plan on Climate Change, sustainable habitat, concept of Green architecture. Carbon trading; carbon credits; Carbon sequestration; Carbon Footprint. Issues of Energy security, Food Security and Social security.

SUGGESTED READINGS

1. Botkin, Daniel B. and Keller, Edward A. Environmental Science: Earth as a Living Planet. 6th ed. John Wiley and Sons, USA. 2007.
2. Burroughs, W.J. Climate Change: A Multidisciplinary Approach. 2nd ed. Cambridge University Press. 2007.
3. Chasek, P. S. The Global Environment in the Twenty-First Century - Prospects for International Co-operation. Indian Reprint by Manas Publications, New Delhi. 2004.
4. Claussen, E. ed. Climate Change: Scenario, Strategies and Solutions. Arlington VA. 2001.
5. Dodds, F. (Ed.). Earth Summit. 2002. A New Deal. Earthscan Publications Ltd., UK. 2002.
6. Enger, E.D. and Smith, B. F. Environmental Science: A Study of Interrelationships. 11th ed. McGraw Hill Inc., USA. 2006.
7. Hardy, John T. Climate Change: Causes, Effects, Solutions. Wiley and Sons, USA. 2003.
8. Harris, F. Global Environmental Issues. Wiley and Sons, Inc., USA. 2004.
9. Harvey L. D. D. Global Warming: The Hard Science. NY: Prentice-Hall. 2000.
10. IPCC, Emission Scenarios, Inter Governmental Panel on Climate Change, Cambridge University Press, 2000.
11. Silver C. S. and DeFries, R. S. One Earth one Future: - Our Changing Global Environment. East-West Press Edition, 1991.
12. Singh, J.S., Singh, S.P. and Gupta, S.R. Ecology, Environment and Resource Conservation. Anamaya Publishers, New Delhi, India. 2006.
13. Speth, J. C. Global Environmental Challenges – Transitions to a Sustainable World. Orient Longman Pvt. Ltd., New Delhi. 2004.

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MES-304 (iv): BIODIVERSITY AND WILDLIFE ECOLOGY (ELECTIVE)

UNIT -1 INTRODUCTION

- 1.1 Biodiversity: Basic concepts, importance and conservational needs
- 1.3 Factors for decline of biological diversity
- 1.4 Approaches for conservation of biological diversity
- 1.5 Protection of wild flora, fauna and natural habitats, concept of threatened species, threatened and endangered animals of India

UNIT -2 CONCEPT OF BIODIVERSITY

- 2.1 Biodiversity Convention, international and national efforts to conserve biodiversity
- 2.2 Concept of genetic diversity, gene and germplasm banks
- 2.3 Socio-cultural aspects of biodiversity, traditional knowledge and biodiversity conservation

UNIT -3 WILDLIFE AND WILDLIFE HABITAT

- 3.1 Wildlife: definition, concept and importance of wildlife in biological studies
- 3.2 Methods of studying wildlife (birds and mammals) in their natural habitat
- 3.3 Wildlife habitat: Forest, desert and Grassland with their characteristics

UNIT -4 ENVIRONMENTAL DEGRADATION AND WILDLIFE

- 4.1 Wildlife damages: Assessment and impact of environmental pollutants on wildlife
- 4.2 Changed land use pattern and its effects on wildlife
- 4.3 Man-wildlife conflict
- 4.4 Wildlife management principles

UNIT -5 STATUS and DISTRIBUTION OF WILDLIFE IN INDIA

- 5.1 Zoo-geographic subdivisions of India based on important mammalian fauna.
- 5.2 Endangered Wildlife species (Birds and Mammals) of India
- 5.3 Important Wildlife species of HP State
- 5.4 Conservation sites of HP with characteristic Wildlife
- 5.5 Important National Parks, Wildlife Sanctuaries and Biosphere Reserves in India with characteristic Wildlife

SUGGESTED READINGS

1. Berwick, S. H. and Sharma, V. B. Wildlife Research and Management, Oxford Univ.Press, Delhi. 1995
2. Champion, H. C. and Sheth, S. K. A revised Survey of the Forest Types of India, Pub.Manager, Col. Press- Nasik /Manager of Publication Delhi. 1968
3. Dassman, R. F. Wildlife Biology (II Ed.), Wiley Eastern Ltd., New Delhi. 1982
4. Giles, R. H. Wildlife Management Techniques, The Wildlife Society, Washington,D.C. 1984
5. Leopold, A. Game Management, Charles Scribner's Sons, New York, London. 1933.
6. Odum, E. P. Fundamentals of Ecology, W.B. Saunder Co. / Toppan Co. Ltd. 1971.

7. Prater, S.H. The Book on Indian Animals, BNHS, Bombay. 1980.
8. Schaller, G. B. The Deer and the Tiger, ZSI, Calcutta.1987
9. Sparke, J. Bird Behaviour, Govosset and Dulop, Inc. New York. 1970
10. Stoddart, A. I. Range Management, Pub. McGraw Hill, Col. Inc. New York. 1975.
11. Teague, R. D. A manual of Wildlife Conservation, Pub. The Wildlife Society, Washington, D.C. 1971
12. Tikader, B. K. Threatened Animals of India, ZSI, Calcutta.1983.

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MES-305: PRACTICAL I
(MES 301: REMOTE SENSING AND GIS)

1. Identification and principle techniques of different instrument used for meteorology
2. Identification and principle techniques of different software's used for remote sensing and GIS
3. Study of equipment and materials used in aerial photography and remote sensing
4. Case studies-aerial photography and satellite imageries

MES-306: PRACTICAL II
(MES 302: ENVIRONMENTAL CHEMISTRY AND GREEN TECHNOLOGY)

1. Soil sampling, determination of soil color, bulk density, porosity.
2. Estimation of pH, moisture, conductivity, organic carbon, organic matter, nitrogen, phosphorus and potassium in soil.
3. Visit to nearby Institute/ organization to study the initiative on green technology.

MES-307: PRACTICAL III
(MES 303: TECHNIQUES IN ENVIRONMENTAL MONITORING AND ANALYSIS)

1. Estimation of halides in water samples by potentiometry
2. Estimation of Co^{2+} and Ni^{2+} by colorimetry / spectrophotometry
3. Estimation of sulphates by turbidometry
4. Estimation of alkali metals in various samples by flame-photometry
5. Estimation of BOD, DO, COD, TOC, MPN, TSS, TDS in Water and Waste Water
6. Collection of water sample, analysis of water sample related to different elements/Metals
7. Principles of spectrophotometer
8. Principles of Flame photometer
9. Analysis of camions in solution
10. Estimation of iron (III) by photo chemical reduction method
11. Determination of calcium hardness and magnesium hardness of water sample
12. Determination of chloride in a sample of water (silver nitrate method)

MES-308(i-iv): PRACTICAL IV

(Practical/ field study based on MES-304(i-iv) Elective)

MES-308(i) Environmental Economics

1. Visit to the State Energy Department to gather information on government's initiatives on energy conservation, resource scarcity, energy security, etc. and prepare a report on the same.
2. To understand the government's interventions with regard to environmental protection, forest resources, water resources, hydropower generation, etc. and prepare a report on the same.

MES-308(ii) Environmental Disasters: Mitigation And Management

1. Sketching of earth system and different geological hazards
2. Preparation of hazard zonation maps with special reference to Himachal
3. Slope stability analysis and landslide zoning
4. Identification and observation of water scarcity area
5. Assignment/ field visit to disaster affected sites (Report)

MES-308(iii) Climate Change and Clean Technology

1. Gather information of the impact of climate change being faced by the people at local level and the coping/ adaptive mechanism being evolved for the same
2. Record the success stories of the NGOs/ individuals working for clean environment and how the same is achieved and prepare a report.

MES-308(iv) Biodiversity and Wildlife Ecology

1. Visit to a nearby Wildlife Sanctuary/ Forest Reserve/ National Park and understand the conservation mechanism being followed, besides the dependence of people on its resources and prepare a report on the same.
2. Visit to the Forest and Wildlife Department to gather information on existing laws of state government with regard to the wildlife protection, status of wildlife in the state and conservational measures being adopted and prepare a report on the same.

SEMESTER – IV

MES-401: ENVIRONMENTAL LAW, GOVERNANCE, ETHICS AND POLICY

UNIT-1 INTRODUCTION TO ENVIRONMENTAL LAWS

- 1.1 Historical background of Environmental Law and Policy in India
- 1.2 Constitutional mandate for environmental protection
- 1.3 Environmental Protection: Issues and Problems
- 1.4 Key International Efforts for Environmental protection
- 1.5 Sustainable Development: Essential features and Legal Implications
- 1.6 UN Framework Conventions on Climate Change, 1992, Kyoto Protocol, 1997

UNIT -2 ENVIRONMENTAL PROTECTION AND LAW

- 2.1 Environmental laws, environmental Policy in India, Indian Constitution and Environmental Protection
- 2.2 Environment (Protection) Act, 1986: Salient Features
- 2.3 Powers of Central Government under EPA
- 2.4 Prevention, Control and abatement of environmental pollution under EPA
- 2.5 Hazardous wastes (Management, Handling and Transportation) Rules, 2016
- 2.6 Public Liability Insurance Act, 1991

UNIT -3 POLLUTION ABATEMENT AND THE LAW

- 3.1 Water (Prevention and Control of Pollution) Act, 1974: Salient Features
- 3.2 Powers and Functions of CPCB and SPCB under Water Act
- 3.3 Air (Prevention and Control of Pollution) Act, 1981.
- 3.4 Powers and Functions of CPCB and SPCB under Air Act
- 3.5 Noise pollution (Regulation and Control) Rules, 2000 (Note: Only relevant provisions of the above Acts)

UNIT -4 NATURAL RESOURCE CONSERVATION AND THE LAW

- 4.1 Wildlife (Protection) Act, 1972: Salient Features
- 4.2 National Forest Policy
- 4.3 Forest Conservation Act, 1986
- 4.4 Biological Diversity Act, 2002

UNIT -5 JUDICIAL ACTIVISM AND ENVIRONMENTAL PROTECTION

- 5.1 Judicial Response towards Environmental Protection
- 5.2 Public Nuisance under IPC (Sections 268,277,278,284, 290,291)
- 5.3 Sections 133-143 of Criminal Procedure Code, 1973
- 5.4 Role of UN authorities in protection of Global Environment
- 5.5 Evolution of International Environmental Law, International Environmental Law and the Challenge of Globalization

SUGGESTED READINGS

1. Diwan, P. Environmental Administration - Law and Judicial Attitude, Vol. I, II. Deep and Deep Pub. New Delhi. 1997
2. Divan, S. and Roscencranj, A. Environmental Law and Policy in India, Oxford Pub. New Delhi. 2001.
3. Lal, S. Commentaries on Water, Air pollution and Environment (protection) Law, Law Pub. Pvt. Ltd. India. 1990.
4. Leelakrishnan, P. Environmental Law in India. Butterworths Publications, New Delhi. 1999
5. Singh, G. Environmental Law: International and National Perspectives. 1995.

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MES-402: RESEARCH METHODOLOGY, STATISTICS AND COMPUTER APPLICATIONS

UNIT-1 INTRODUCTION TO RESEARCH AND SCIENTIFIC WRITING

- 1.1 Characteristics and types of Scientific Research
- 1.2 Organizing Scientific Research: Experimental Design, Research Methodology, Sampling designs
- 1.3 Writing research proposals, research paper, reviews, thesis, conference reports, book reviews, project reports, reference writing and scientific abbreviations
- 1.4 Preparation and delivery of scientific presentations

UNIT-2 BASIC CONCEPTS OF STATISTICS

- 2.1 Importance and scope of Statistics
- 2.2 Primary and secondary data - collection of data
- 2.3 Sampling of data - random and non-random sampling
- 2.4 Diagrammatic (Line, bar, pie diagram) and Graphic (Histogram, frequency polygon, frequency curve, cumulative frequency curve) representation of data, Measures of central tendency – Mean (AM, GM and HM), Mode and Median.
- 2.5 Measures of dispersion, skewness and kurtosis

UNIT-3 PROBABILITY DISTRIBUTION

- 3.1 Probability distribution - Binomial distribution
- 3.2 Poisson distribution
- 3.3 Normal distribution
- 3.4 Test of hypothesis, two types of errors
- 3.5 T-Test for assumed population mean and comparison of two samples

UNIT-4 STATISTICAL TESTS

- 4.1 Chi square tests and its application
- 4.2 Co-relation and regression
- 4.3 Principles of design of experiments. Examples of CRD and RBD
- 4.4 Analysis of variance (one way and two way analysis of variance)

UNIT-5 COMPUTER APPLICATION AND ENVIRONMENT SYSTEM ANALYSIS

- 5.1 Basics of Computer: meaning, definition, types and main parts, structure of Central Processing Unit (CPU); Software: Meaning and types, Application of Software, System and customized software, software piracy; Booting: meaning and types
- 5.2 Operating System and Memory: meaning and types of operating systems, i.e. UNIX, LINUX, MS-DOS, Microsoft Windows; Memory: meaning and types, Storage capacity and Storage media
- 5.3 Computer Networking and Cybercrime: meaning, types of network, data security, password, firewall, encryption, backups, wireless networking; Internet: Benefits of internet, web browsing, Digital/Cybercrime.

- 5.4 Application of computers in Environmental Sciences, Environment System; Analysis, Meteorology and Climatology, Surface and Groundwater Hydrology, Environmental Management and Decision Analysis, Databases, Satellite Data, Image Processing and Remote Sensing; Software Models

SUGGESTED READINGS

1. Balagurusamy, E. Programming with C., Tata McGraw Hill Pub., New Delhi. 1995.
2. Gupta, S. C. Fundamentals of Statistics, Himalayan Pub. House New Delhi. 1999.
3. Hoshmand, A. R. Statistical methods for Env. and Agr. Science. CRS Press, New York. 1988
4. Jain, P. K. Fundamentals of Computers, BPB Pub., New Delhi. 1995
5. Khan, I. A. and Khanum, A. Biostatistics, Ukaaz Publications, Hyderabad. 1994
6. Rajaraman, I. Fundamentals of Computers, PHI Pub., New Delhi. 1989
7. Rao, P. S. S. and Richard, J. An Introduction to Biostatistics. Prentice Hall, New Delhi. 1996
8. Sharma, A. K. Computer Science, Dhanpat Rai and Sons, New Delhi. 1996.
9. Sinha S. C. and Dhiman, A. K. Research Methodology (2 Vols.-Set), Ess Ess Publications, New Delhi. 2002
10. Sinha, P. K. Computer Fundamentals, BPB Pub., New Delhi. 1995.
11. Sukhatma, P. I. and Amble, I. N. Statistical methods for Agricultural workers, ICAR, New Delhi. 1976

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MES-403 (i): ENVIRONMENTAL HEALTH (ELECTIVE)

UNIT-1 ENVIRONMENTAL HEALTH: INTRODUCTION

- 1.1 Health and Environment (Historical perspective, basic requirement of healthy environment, environmental quality, human exposure to noxious substances in environment)
- 1.2 Environmental factors affecting health, environmental health problems and its causes
- 1.3 Nature of Environmental Health Hazards (Biological, chemical, physical, mechanical and psychological hazards)
- 1.4 Psychology and work environment; emerging issues; place attachment, pro-environmental behavior, ecological consumerism

UNIT-2 ENVIRONMENTAL HEALTH PROBLEMS-I

- 2.1 Health problems linked with unsafe water (Toxic pollutants their impacts on health)
- 2.2 Water-borne diseases (National scenario of water-borne diseases in India)
- 2.3 Social and quality dimensions of water and sanitation, sanitations and health related challenges
- 2.4 Vector-borne diseases: Malaria, Kala azar, Japanese Encephalitis, Dengue, Plague, (causal agents, manifestation of disease, prophylactic measures); Airborne diseases: Chickenpox, Influenza, Measles, Smallpox, and Tuberculosis (causal agents, manifestation of disease, prophylactic measures)

UNIT-3 OCCUPATIONAL HEALTH PROBLEMS-II

- 3.1 Diseases caused by chemical agents (beryllium, phosphorus, cadmium, selenium, phosgene, ammonia)
- 3.2 Diseases caused by physical agents: Hearing impairment caused by noise, Diseases caused by vibration (disorders of muscles, tendons, bones, joints, peripheral blood vessels or peripheral nerves); diseases caused by compressed or decompressed air; diseases caused by optical (ultraviolet, visible light, infrared) radiations including laser; diseases caused by exposure to extreme temperatures
- 3.3 Occupational cancer: cancers caused due to Asbestos, Benzidine, Chromium, Nickel compounds, Arsenic, Cadmium

UNIT-4 OCCUPATIONAL SAFETY AND HEALTH

- 4.1 Occupational safety and health policy: General framework, employers' responsibilities, workers' duties and rights, safety and health committees
- 4.2 Management of occupational safety and health: Management commitment and resources, workers' participation, training, organizational aspects
- 4.3 Health promotion, education and training: Promotion of occupational safety and health; training and information at the national level; Training and information at the enterprise level; Training methods and materials

UNIT-5 ENVIRONMENTAL HEALTH MANAGEMENT

- 5.1 Priority areas for intervention (safe water supply, food safety, basic sanitation, solid waste management, vector control, public information and media), obstacles and opportunities for management of environmental health problems
- 5.2 Role of environment health professionals, environment and value education, biodiversity conservation and health education, health education for self-confidence and positive attitude

SUGGESTED READINGS

1. Goel, S. L. Environment Health and Value Education. Deep and Deep Publications. 2008.
2. Kumar, H. Environmental Health Hazards. IVY Publishing. 2001.
3. Sarkar, A and Panigrah, S. K. Water Borne diseases in India: Environmental health and policy perspective. Manak. 2007.
4. Yassi, A. Basic Environmental Health, Volume I. Oxford University Press. 2001.
5. Sarkar, A., Panigrah, S. K. and Anand, M. Vector Borne diseases in India: Environmental health and policy perspective. Manak. 2007.
6. Benjamin O. Alli. Fundamental Principles of Occupational Health and Safety. International Labour Office, Geneva. 2008.

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MES-403 (ii): PRINCIPLES OF CLIMATOLOGY (ELECTIVE)

UNIT-1 INTRODUCTION

- 1.1 Definition, sub-divisions and scope of climatology
- 1.2 Composition and structure of the atmosphere
- 1.3 Insolation; Factors governing insolation; Heat budget of the Earth; Factors determining horizontal distribution of temperature

UNIT-2 PRESSURE AND WIND

- 2.1 Factors controlling pressure, horizontal distribution of pressure; Factors controlling wind
- 2.2 Wind system; Types of planetary winds; Local winds and types; Measurement of wind, air temperature and insolation

UNIT-3 AIR

- 3.1 Air masses, air fronts and their types; Climatic classification- Basis of classification; Koeppen's classification; Thornthwait's classification- 1931 scheme, 1948 scheme, concept of El-Nino, Southern oscillation (ENSO) and La-Nina
- 3.2 Weather Forecasting - Tools in weather forecasting; Weather Forecasting in India

UNIT-4 CLIMATE OF THE WORLD

- 4.1 Describing the climatic features and native vegetation of the following: Equatorial, Savanna, Hot Desert, Mediterranean, Steppe

UNIT-5 CLIMATE CHANGE

- 5.1 Hazards - Fog and thunderstorm; Effect of climate on vegetation; Bioclimatology -Climate and Human Health
- 5.2 Climate and House types; Climatic change-Indicators of past climate, Carbon dioxide theory, Volcanic dust theory

SUGGESTED READINGS

1. Cunningham, W.P. and Saigo, B.W. Environmental Science - A Global Concern WCBMC Graw- Hill, U.S.A. 1999.
2. Emiliani, C. Planet Earth. Cambridge University Press, U.K. 1992.
3. Fellmann, J., Getis, A. and Getis, J. Human Geography-Landscapes of Human activities, WCB McGraw-Hill, USA. 1996.
4. Houghton, J. Global Warming - The complete Briefing. Cambridge Univ. Press, U.K. 1997.
5. Lean, G. and Hinrichsen, D. Atlas of the Environment. Harper Perennial Pub., NewYork. 1994.
6. Lundgren, L. Environmental Geology. Prentice Hall, New Jersey. 1986.
7. Lunine, J. I. Earth-Evolution of a Habitable World. Cambridge Univ. Press, U.K. 1999.
8. McKnight, T. L. Physical Geography-A Landscape Appreciation. Prentice Hall, NewJersey. 1993.
9. Pearce,F. Climate and Man - From the Ice Ages to the Global Greenhouse. Ivison Books, London. 1989.

10. Rogers, J. J. W. and Feiss, P.G. People and the Earth - Basic Issues in the Sustainability of Resources and Environment. Cambridge University. Press, U.K. 1998.
11. Smithson, P., Addison, K. and Atkinson, K. Fundamentals of the Physical Environment. Routledge Publishers, London. 2002.
12. Wellburn, A. Air Pollution and Climate Change- The Biological Impact. Longman Publishers, Singapore. 1996.

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MES-403 (iii): ENVIRONMENTAL BIOTECHNOLOGY (ELECTIVE)

UNIT-1 INTRODUCTION

- 1.1 The scope of environmental biotechnology; Biodegradation of macromolecules; biodegradation of xenobiotics; Heavy metal pollution
- 1.2 Bioremediation of metal contaminated soils, spilled oil and grease deposits and synthetic pesticides; Biosensors to detect environmental pollutants; Fermentation technology (Bioreactors).

UNIT-2 BASIC TECHNIQUES IN GENETIC ENGINEERING

- 2.1 Genetic manipulation, Restriction endonucleases; Introduction of cloned genes into new hosts using plasmid and phage vector systems. RFLP, Polymerase chain reaction.
- 2.2 Environmental genomics/metagenomics - a general account; Microbes and environmental management; microorganisms and organic pollutants; Extremophiles.

UNIT-3 GENETIC ENGINEERING OF PLANTS

- 3.1 Basic concepts of genetic engineering of plants and its applications-herbicide and stress tolerant plant; biotechnological strategies in forestry and wasteland management.
- 3.2 Biotechnology in biodiversity conservation: gene banks, germplasm conservation and DNA banks; Genetically modified organisms and Biosafety- a general account.

UNIT-4 APPLICATIONS OF BIOTECHNOLOGY PART I

- 4.1 Bioenergy, ethanol fermentation; Liquid waste treatment; Bio-filters, activated sludge systems; membrane bioreactors.
- 4.2 Biotechnological approaches for solid waste management, Vermicomposting.

UNIT-5 APPLICATIONS OF BIOTECHNOLOGY PART II

- 5.1 Phytotechnology- terrestrial phytosystems, metal phytoremediation; Phytotechnology-aquatic phytosystems, nutrient film techniques, algal treatment systems. Vocational possibilities in field of Environmental Biotechnology.

SUGGESTED READINGS

1. Evans, G. M. and Furlong, J. C. Environmental Biotechnology: Theory and Application. John Wiley and Sons. 2003.
2. Glick, B. R. and Pasternak, J. J. Molecular Biotechnology: Principles and Applications of Recombinant DNA. Washington, D.C. ASN Press. 2007.
3. Horton, H. R., Moran L. A., Perry, M. D. and Rawn, J. D. Principles of Biochemistry, Pearson Education International. 2006.
4. Metcalf and Eddy Wastewater Engineering: Treatment and Reuse. Tata McGraw-Hill, New Delhi. 2003.
5. Sathyanarayanan, B. N. and Varghese, D. B. Plant Tissue Culture Practices and New Experimental Protocols. I.K. International, New Delhi. 2007.

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MES-403 (iv): NANOTECHNOLOGY (ELECTIVE)

UNIT-1 INTRODUCTION

- 1.1 Overview of Nanotechnology and nanoparticles; unique properties of nano-materials, and significance of nanotechnology toward human life.
- 1.2 Nanomaterials for Environmental Protection: Nano technology processes – Nano Engineering materials for Pollution Prevention, Green Chemistry, Energy efficient resources and materials

UNIT-2 NANO TECHNOLOGY PRODUCTS AND SYNTHESIS

- 2.1 Nano technology products- Nanomaterials (nanostructures) Nanodevices and nanosystems. Synthesis of Nanomaterials: Synthesis of nano-materials by Physico-chemical approaches.
- 2.2 Bionanocomposites : Nano particles and Microorganisms, Microbial Synthesis of Nano materials, Biological Methods for Synthesis of nano-emulsions using bacteria, Fungi and Actinomycetes, Plants based nanoparticle synthesis, Nano composite biomaterials – Fibers, Devices and Structures, Nano Bio systems.

UNIT-3 NANOTECHNOLOGY IN REMEDIATION

- 3.1 Identification and characterization of Hazardous waste, Nano Pollution, Air-Water - Soil Contaminants, Identification and Characterization of Organic and inorganics, Environmental cleanup technologies.
- 3.2 Nano Membranes, Nano Meshes, Nano Fibres, Nano Clays and Adsorbents, Zeolites, Nano Catalysts, Carbon Nano Tubes, Bio Polymers, Single Enzyme Nano particles, Bio Metallic Iron Nano Particles, Nano Semi-Conductors, Photo catalysis, Nano-sensors.

UNIT-4 NANO REMEDIATION TECHNOLOGIES

- 4.1 Environmental Nano Remediation Technology - Thermal, Physico-Chemical and Biological Methods, Nano Filtration for treatment of waste – removal of organics & inorganics and pathogens, Nanotechnology for water 5 remediation and purification. Treatment of hi-tech industrial waste waters using nano particles/modified structures/devices. Environmental Benefits of nano-materials.

UNIT-5 SUSTAINABLE NANOTECHNOLOGY

- 5.1 Application of industrial ecology to nanotechnology, Fate of nanomaterials in environment, environmental life cycle of nano materials
- 5.2 Environmental and health impacts of nano materials, toxicological threats, ecotoxicology, exposure to nano particles – biological damage, threat posed by nano materials to humans, environmental reconnaissance and surveillance
- 5.3 Corporate social responsibility for nanotechnology, Nano materials in future - implications

SUGGESTED READINGS

1. Wiesner, M.R., and Bottero, J.Y. (Ed.) "Environmental Nanotechnology: Applications and Impacts of Nanomaterials" McGraw-Hill, New York. 2007.
2. Diallo, M., Duncan, J., Savage, N., Street, A., and Sustich, R. (Eds). "Nanotechnology Applications for Clean Water" William Andrew. 2008.
3. Lead J., and Smith, E. "Environmental and Human Health Impacts of Nanotechnology" John Wiley & Sons. 2009.

4. Mao Hong fan, Chin-pao Huang, Alan E. Bland, Z. Honglin Wang, Rachid Sliman, Ian Wright. *Enviro-nanotechnology*. Elsevier, 2010.
5. Fulekar, M. H. *Nanotechnology: Importance and Application* by, IK International. 2010.
6. Steinfeldt, M., Gleich, A., Petschow, U., Haum, R. *Nanotechnologies, Hazards and Resource efficiency*. Springer. 2007.
7. Jo Anne Shatkin *Nanotechnology: Health and Environmental risk*. CRC press. 2008.
8. Wiederricht, G. *Handbook of Nanofabrication*. Elsevier, 2010.
9. Gabor, L. Hornyak, Dutta, J. Harry, Tibbals, F. and Rao, A. K. *Introduction to Nanoscience*. CRC Press, 2008.

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MES-404: PRACTICAL I
(MES 402: RESEARCH METHODOLOGY, STATISTICS AND COMPUTER APPLICATIONS)

1. To find out the mean, mode, median of the given data
2. To study random variables community
3. Application of chi-square and T-test for the given data
4. To study the use computer in analysis of environmental data

MES-405 (i-iv): PRACTICAL II
(Practical/ field study based on MES-403 (i-iv) Elective)

MES-405 (i) Environmental Health

1. Visit to nearby Health Centre and obtain data on incidence of diseases caused due to environmental factors.

MES-405 (ii) Principles of Climatology

1. Familiarization with meteorological instruments and their uses.
2. Describing the: a) climate of an urban area; b) yearly variation in the meteorological data.

MES-405 (iii) Environmental Biotechnology

1. Preparation of different types of microbial culture media
2. Gram staining techniques
3. Isolation, enumeration and identification of microorganisms in soil/water samples
4. MPN techniques for coliform analysis

MES-405 (iv) Nanotechnology

1. Field visit to study application of Nanotechnology in various fields.
2. To Prepare a Report on Nanotechnology In Remediation.

MES-406: DISSERTATION

In MES-406, the students will undertake field study/experimental study, which will be submitted as dissertation and will be evaluated by external/internal examiners. The viva- voce/presentations will be conducted by the external examiners.

DISTRIBUTION OF MARKS

Evaluation	70 Marks
Viva-voce	30 Marks
Total	100 Marks