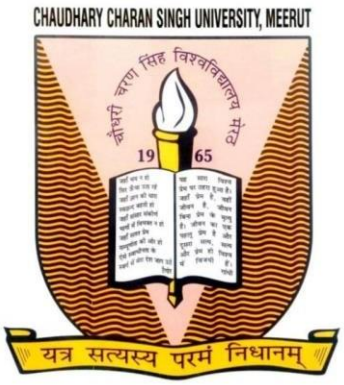
Course Structure and Syllabus

M.Sc. Environment Science

(2 Years)



Academic Session 2024-25 onwards

(Updated syllabus in accordance with NEP 2020)

Department of Environment Science

Ch. Charan Singh University, Meerut

Program Objectives:

1. Impart basic knowledge about the environment and its allied problems at the local, regional

and global scale.

2. Train the students in scientific analyses of environmental components and its management.

3. Provide practical training on modern instrumentation and analytical techniques for environmental analyses.

4. Prepare for global competence for career options in research fellowship program, education, research, industries, consultancy, environmental journalism, etc.

5. Understanding the impacts of climate change, environmental pollution and mitigation strategies.

Program Outcomes:

After completion of the program, students will be able to:

1. Use the concepts and methods of ecological, biological, chemical, geological, glaciological and geospatial sciences to solve environmental problems.

2. Apply environmental concepts and methodologies to analyse and understand the interactions between social and environmental processes.

3. Evaluate environmental impacts and assessment using multidisciplinary and advanced approaches.

4. Achieve proficiency in conducting interdisciplinary research and communication skills.

5. Demonstrate an understanding of legal policies, regulatory and ethical considerations relating to the environment.

6. Understand essential mathematical and statistical approaches used to analyse environmental data and apply analytical techniques to solve environmental problems

7. Communicate complex analyses, interpretations and significance effectively in the relevant domain to varied communities.

8. Create moral and ethical awareness to identify ethical issues related to environmental and social aspects.

9. Collaborate in teams with peers and mentors and work with others in diverse group settings, developing flexibility and leadership skills.

M.Sc. Environment Science (2 Year programme) Course Structure

Semester I

Course code	Course	Core Compulsory/elective/Value added	Theory/ Practical	Credits	Max. Marks
	I. Fundamental of Ecology & Environmental Science	Core compulsory	Theory	**4**	100
	II. Environmental Chemistry & Analytical Techniques	Core compulsory	Theory	**4**	100
	III. Statistical Analysis, Research Methodology & Research Ethics	Core compulsory	Theory	**4**	100
	IV. Biodiversity & Wildlife Conservation	Core compulsory	Theory	**4**	100
	Environmental Lab -I (Based on I- IV) **Practical**	Core compulsory	Practical	**4**	100
	Minor Elective (Other Faculty)	Elective	Theory	**4**	100
	Total semester credits			**24**	
	EXAMINATION SCHEME: **Internal Assessment: 30 Marks** **End of Semester: 70 Marks**				

Semester II

Course code	Course	Core Compulsory/elective/Value added	Theory/ Practical	Credits	Max. Marks
	V. Environmental Geoscience & Natural Disaster	Core compulsory	Theory	**4**	100
	VI. Natural Resources Management	Core compulsory	Theory	**4**	100
	VII. Environmental Biotechnology & Microbiology	Core compulsory	Theory	**4**	100
	VIII. Environmental Laws & Policies	Core compulsory	Theory	**4**	100
	Environmental Lab -II (Based on V- VIII) **Practical**	Core compulsory	Practical	**4**	100
	Research project- Literature review/Question formulation	Core compulsory	Project	**4**	100
	Total semester credits			**24**	
	EXAMINATION SCHEME: **Internal Assessment: 30 Marks** **End of Semester: 70 Marks**				

Semester III

Course code	Course	Core Compulsory/elective/Value added	Theory/ Practical	Credits	Max. Marks
	IX. Environmental Impact Assessment andManagement	Core compulsory	Theory	**4**	100
	X. Environmental Pollution	Core compulsory	Theory	**4**	100
	XI. Environment& Public health	Core compulsory	Theory	**4**	100
	XII. Water & Wastewater treatment	Core compulsory	Theory	**4**	100
	Environmental Lab -III (Based on IX- XII) **Practical**	Core compulsory	Practical	**4**	100
	Total semester credits			**20**	
	EXAMINATION SCHEME: **Internal Assessment: 30 Marks** **End of Semester: 70 Marks**				

Semester IV

Course code	Course	Core Compulsory/elective/Value added	Theory/ Practical	Credits	Max. Marks
	XIII. Fundamental of Remote sensing & GIS	Core compulsory	Theory	**4**	100
	XIV. Pollution abatement & Green technology	Core compulsory	Theory	**4**	100
	XV. Carbon Capture and Sequestration Technology	Core compulsory	Theory	**4**	100
	XVI. Agrometeorology	Core compulsory	Theory	**4**	100
	Environmental Lab -IV (Based on XIII- XVI) **Practical**	Core compulsory	Practical	**4**	100
	Research project- Dissertation writing & assessment	Core compulsory	Project	**4**	100
	Total semester credits			**24**	
	EXAMINATION SCHEME: **Internal Assessment: 30 Marks** **End of Semester: 70 Marks**				

M.Sc. Environment Science (2 years programme) Course Structure

COURSE: Fundamental of Ecology and Environmental Sciences

Program: M.Sc. Environment Science (2 years) SEMESTER I			
COURSE I: Fundamental of Ecology and Environmental Sciences			
Course status	**TEACHING SCHEME**	**EXAMINATION SCHEME**	**CREDITS ALLOTTED**
Core	**Theory:** 3 hours/week	**Internal Assessment: 30 Marks** **End of Semester: 70 Marks**	4
Course Pre-requisite: Student should have basic knowledge of Biology and Environmental Science.			
COURSE OBJECTIVES	1. Impart knowledge on the different ecological concepts and disciplines of ecology 2. Understand the ecosystem, population and community ecology and its relevance for the environmental segments and factors. 3. Understand the interactions of organisms and their environments and, the consequences of these interactions for population, community, and ecosystems functional dynamics. 4. Apply the fundamentals of ecology for forming the foundation of ecological theories.		
COURSE OUTCOMES (CO)	By the end of the course, students will be able to: **CO1**. Raise an awareness about the living organisms and their interaction with the environment **CO2.** Understand ecological concepts and major disciplines of ecology **CO3**. Build central ideas behind the ecology of individuals, populations, communities and ecosystems **CO4.** Develop critical thinking through scientific evidences to understand ecological patterns, processes and ecological problems **CO5**. Apply the basic knowledge in ecological assessment and research. **CO6**. Get the opportunities of employment in the sector of Ecology and ecological monitoring		

COURSE CONTENT	**Total No. of Lectures (60)**
Unit -I Basic concepts of Environmental Science: Definition, Principle, Scope, Structure and function of environment. Abiotic and biotic factors: Earth as Eco-system: changes and equilibrium in system. Interaction between man and environment; Components of environment (atmosphere; hydrosphere; lithosphere and biosphere). Scope and Importance of Environmental Science.	12
Unit -II Population and Community dynamics: Population dynamics and population regulations, concept of carrying capacity, population fluctuations, population dispersion, r and k selection, ecotypes and ecophene, keystone species, habitats and niches. Community concept: Definition, types and interaction - predation, herbivory, parasitism and allelopathy, biological invasions; Qualitative and quantitative characters of community: Ecological niche, Methods of studying	12

vegetation, Species diversity and its measurement.		
Unit III Ecology: Definition, types, Structure and components; Energy in ecosystem: Primary and secondary production, Biomass, Methods of measuring productivity, Pattern of primary production in the major ecosystems of the world, Energy flow in ecosystems, Feedback and control mechanism, Pathways of energy transfer, grazing and detritus food chain, Ecological efficiency and ecological pyramids.		12
Unit IV Biogeochemical cycles: nutrient cycling in the ecosystems, Gaseous cycles (Carbon and Nitrogen) and sedimentary cycles (Phosphorus and Sulphur): Impact of man on nutrient cycles: Major ecosystems of the world: A general idea of forest, grassland, desert, wetland, freshwater and marine ecosystems.		12
Unit V Ecological Restoration: Definition & concept; Disturbance causes and impact on terrestrial & aquatic ecosystem; Ecosystem Reconstruction Biodiversity and Conservation: Concept and value of biodiversity; Biodiversity at different levels (genetic, species and ecosystem); Threats to biodiversity; Hotspots of biodiversity; Biodiversity and ecosystem stability.		12
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 15 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks	

Suggested Reading:

Text/Reference Books:

1. Odum, E. P. (1991). Fundamentals of Ecology, W. B. Saunders, USA. Indian Reprint 1996 Natraj Publishers, Dehradun.
2. Sharma, P.D. (2015). Ecology and Environment. Rastogi Publications.
3. Singh, J.S., Singh, S.P. & Gupta S. R. (2014). Ecology, Environmental Science & Conservation, S Chand & Company Limited, Delhi.
4. Krebs, C. J. (2008). The Ecological World View. CSIRO Publishing. Calling wood, Australia.
5. Daniel, B. B. & Edward, A.K. (2007). Environmental Science: Earth as a Living Planet. 6th ed. John Wiley & Sons, USA.
6. Odum, E.P. (1997). Ecology: A Bridge between Science and Society. Sinauer Associates, Inc., USA

M.Sc. Environment Science (2 years programme) Course Structure

Course: Environmental Chemistry& Analytical Techniques

Program: M.Sc. Environment Science (2 years) SEMESTER I			
COURSE II: Environmental Chemistry& Analytical Techniques			
Course status	**TEACHING SCHEME**	**EXAMINATION SCHEME**	**CREDITS ALLOTTED**
Core	**Theory:** 3 hours/week	**Internal Assessment: 30 Marks** **End of Semester: 70 Marks**	**4**
Course Pre-requisite: Student should have basic knowledge of Biology and Chemistry.			
COURSE OBJECTIVES	1. Understand the role of chemistry in environmental science. 2. Develop an understanding of the principles of sampling, chemical analysis, and instrumentation which is more important than knowing 'specific how'. 3. Introduce the students with the basic aspects of the environmental chemical data collection process, such as systematic planning, sensible field procedures, and solid analytical chemistry. 4. Evaluation of data quality in the context of their intended use. 5. Expose students to the fundamental instrumental techniques that are part of environmental projects.		
COURSE OUTCOMES (CO)	By the end of the course, the student will be able to: **CO1.** Understand the interconnections between environmental matrices **CO2.** Apply fundamental concepts of chemistry to analyse chemical processes underlying the operation of the natural environment. **CO3.**Learn the effective role of obtaining data of scientifically reliable and legally defensible nature by exercising good laboratory practices. **CO4.**Comprehend the basics of various instrumentation techniques related to electroanalytical and potentiometric applications in environmental analysis. **CO5.**Know the basics of various instrumentation techniques related to spectrophotometry and application. **CO6.**Understand chromatography and its application in environmental analysis.		

COURSE CONTENT	**Total No. of Lectures (60)**
UNIT I Environmental Chemistry: Classification of elements (emphasis on heavy metals); Biogeochemical cycles; Saturated and unsaturated hydrocarbons in environment; Stoichiometry; Gibb's energy; Chemical Potential and Chemical equilibrium; Laws of thermodynamics, Heat transfer process, Acid - Base-reactions, Solubility products; Solubility of gases in water; Chemistry of hydrocarbons and its decay. Green Chemistry: Concept, Basic principles and tools, zero waste technology.	12
UNIT II Chemistry of air pollutants, Thermochemical and Photochemical reactions in Atmosphere, Photochemical Smog, Chemistry of water, concept of D.O., B.O.D., and C.O.D, water treatment: Sedimentation, Coagulation, Filtration, tertiary and	12

advanced treatment, redox potential. Inorganic and organic components of soil, nitrogen pathways and NPK in soils.		
UNIT III Separation techniques: Adsorption, centrifugation, chromatography, crystallization, decantation, distillation, drying, electrophoresis, elutriation, evaporation, leaching, flotation, flocculation, filtration, reverse osmosis, dialysis (biochemistry), fractional distillation, fractional freezing, magnetic separation, precipitation, crystallization, sedimentation, sieving, stripping, sublimation, vapour-liquid separation, winnowing and zone refining.		12
UNIT IV Chromatography and Mass spectroscopy: Principle, instrumentation and application of gas, liquid, adsorption, paper, gel, size exclusion, HPLC, TLC, electrophoresis and ion exchange chromatography. Mass spectroscopy: Principle, instrumentation and application of mass spectroscopy, types of mass spectroscopy, fragmentation, ionization and characterization of organic and inorganic materials.		12
UNIT V Miscellaneous methods Principle, instrumentation and application of classical analytical methods: Titrimetry; Gravimetry; Colorimetry; Spectrophotometry; Flame photometry; Atomic absorption spectrophotometry; Electrophoresis; X-Ray fluorescence, X-Ray diffraction.		12
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 15 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks	

Suggested Reading:

Text/Reference Books:

1. Stanley, M. E. (2011). Fundamentals of environmental chemistry. CRC press.

2. Baird C. & Cann, M. (2008). Environmental Chemistry. W.H. Freeman and Company.

3. De, A.K. (2000). Environmental Chemistry, New Age International (P) Ltd. Publishers, New Delhi.

4. Chatwal, G. R., & Anand, S. K. (2007). Instrumental Methods of Chemical Analysis, Himalaya Publishing House, Delhi.

5. Skoog, D. A., Holler, F.J., &Crouch, S.R. (2006) Principles of Instrumental Analysis, Brooks Cole.

6. Macalady, D.L. (1999). Perspectives In Environmental Chemistry, J. Chem. Educ.

7. Yen, T.F. (1998). Environmental Chemistry: Essentials of chemistry for Engineering Practice, Prentice Hall.

8. vanLoon, G.W. & Duffy, S.J. (2017). Environmental Chemistry: A Global Perspective, 4th Edition, Oxford.

9. Keith, L. H. (2017). Environmental sampling and analysis: a practical guide. Routledge.

10. Csuros, M. (2018). Environmental sampling and analysis: lab manual. Routledge.

M.Sc. Environment Science (2 years programme) Course Structure

Course: Statistical Analysis, Research Methodology & Research Ethics

Program: M.Sc. Environment Science (2 years) **SEMESTER I**			
COURSE III: Statistical Analysis, Research Methodology & Research Ethics			
Course status	**TEACHING SCHEME**	**EXAMINATION SCHEME**	**CREDITS ALLOTTED**
Core	**Theory:** 3 hours/week	**Internal Assessment: 30 Marks** **End of Semester: 70 Marks**	**4**
Course Pre-requisite: Student should have basic knowledge of Biology and Environmental Science.			
COURSE OBJECTIVES	1. Understand the role of statistics in environmental science. 2. Gain a clear concept of different Statistics, Research methodology and Sampling techniques. 3. Understand the methods of data collection and analysis, interpretation and presentation and report writing 4. Understand the Ethical issues in Environmental Research		
COURSE OUTCOMES (CO)	By the end of the course, students will be able to: **CO1**. Develop a comprehensive detailed procedure for common field sampling tasks, and practical tips for all project tasks. **CO2**. Learn the effective role of obtaining data of scientifically reliable and legally defensible nature by exercising good laboratory practices. **CO3**. Recognize the environmental data acquisition and be able to obtain data of intended quality. **CO4**. Understanding regarding environmental sampling, analysis and the various techniques associated. **CO5**. Know the basics of statistics, Tests of significance and experimental layout **CO6**. Understand the methods of data collection and analysis, interpretation and presentation and report writing		
COURSE CONTENT			**Total No. of Lectures (60)**
Unit- I Definition of applied science and research, Classification of research. Critical appraisal of research studies, Planning research projects, Advance planning and its value, Methods of data collection and analysis, interpretation and presentation and report writing.			12
UNIT II			

Sampling techniques: Sampling of air, water and soil, sampling of plant and animal populations, concept of species area curve, concept of random and stratified sampling, Methods of Social Science research: PRA.		12
UNIT III Basic statistics: Population and sample, frequency table; measures of central tendency- mean, median, mode; measures of dispersion- standard deviation, variance; Correlation- Karl Pearsons co-efficient of correlation.		12
UNIT IV Tests of significance and experimental layout: Z test, Types of Z test (one sample and two sample), Standard error for Z test; Tests of significance for small samples: T-test (One sample, Two Sample: Independent and Dependent), F-test for comparison of variance; Goodness-of-fit test – Chi-Square test; Basic principles of field experimentation- randomization, replication and local control.		12
UNIT V Environmental Ethics Ethical Conduct: Honesty, Objectivity, Integrity, Carefulness, Openness, Respect for Intellectual Property, Confidentiality, Responsible Publication, Social Responsibility; Ethical issues in Environmental Research: Sustainability, Ecosystem Health, Responsiveness, Accountability, Location specificity, Capacity building.		12
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 15 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks	
Suggested Reading:		
Text Books *1. Chadda, A. (1989) Agricultural Statistics in India, Suman Book House, New Delhi.* *2. Date, C. J. (1986). An Introduction to data base system, Addison Wesley, U. K.* *3. Dear, K. J. B., Mead, R and Rilay, J. (1987) Statistical Tools for Agroforestry Research, ICRAF, Kenya.* *4. Medhi, J. (1992) Statistical Methods. Wiley Eastern, New Delhi.* *5. Gurumani, N. (2006) Research Methodology for Biological Sciences, M J P Publishers, Chennai.* *6. Vic Barnett (2006) Environmental Statistics: Methods and Applications, John Wiley and Sons, New Delhi.* **Reference Books** *1. Vic Barnett (2006) Environmental Statistics: Methods and Applications, John Wiley and Sons, New Delhi.* *2. Gurumani, N. (2006) Research Methodology for Biological Sciences, M J P Publishers, Chennai.*		

M.Sc. Environment Science (2 years programme) Course Structure

Course: Biodiversity and Wildlife Conservation

Program: M.Sc. Environment Science (2 years) SEMESTER I			
COURSE IV: Biodiversity and Wildlife Conservation			
Course status	**TEACHING SCHEME**	**EXAMINATION SCHEME**	**CREDITS ALLOTTED**
Core	**Theory:** 3 hours/week	**Internal Assessment: 30 Marks** **End of Semester: 70 Marks**	**4**
Course Pre-requisite: Student should have basic knowledge of Biology and Environmental Science.			
COURSE OBJECTIVES	1. Impart knowledge to become part of professional organizations working in the field of conservation and environmental protection. 2. Generate a skilled postgraduate who can research in the field of Biodiversity, Wildlife biology, and nature conservation. 3. Provide an alternate avenue for students to specialize as "environmental entrepreneurs" in areas such as environmental audits, Environmental Education, Ecotourism, etc. 4. Develop critical and analytical thinking for decision-making in biodiversity and wildlife management.		
COURSE OUTCOMES (CO)	By the end of the course, the student will be able to: **CO1.** Raising awareness about the biodiversity and their conservation with in environment. **CO2.** Enhance the understanding of wildlife conservation and human conflicts. **CO3**. Build central ideas behind the conservation of biodiversity and wildlife populations, communities and ecosystems. **CO4**. Develop of critical thinking through scientific evidences to understand biodiversity and wildlife patterns. **CO5**. Apply the basic knowledge in ecosystem assessment, management and research. **CO6**. Get the opportunities of employment in the sector of ecological management.		
COURSE CONTENT			**Total No. of Lectures (60)**
Unit I Biodiversity - Concept and definition, Causes of Biodiversity, Values of Biodiversity, Threats to Biodiversity, Taxonomy and the future of Plant Diversity, Species Diversity and Conservation, Ecosystem concept, Landscape heterogeneity, Restoration Ecology, Protected Areas and management.			12
UNIT II Biodiversity Conservation and Climate Change - Introduction to Conservation,			

Importance of conservation, Conservation challenges in the Twenty first century, Evaluation of priorities for conservation of habitats and species, Climate and Climate Change, Global Biological Impacts of Climate Change, Conservation Planning and Climate Change, Geo-informatics and Biodiversity Assessment, Ecosystems and Wetlands.		12
UNIT III Introduction and History of Wildlife Conservation, Global as well as Indian Prospective, Values and Ethics in Wildlife Conservation, Habitat Ecology, Field Techniques, Wildlife Behaviour, Avian ecology, Sampling designs for population estimation, Current issues in wildlife conservation with case studies.		12
UNIT IV Biodiversity Conservation, Human Society and Ethics, Humans and sustainability, Economics and biodiversity, Biodiversity and Human Health, Biodiversity and Traditional Health Systems. Conservation Policies and Law, Protection of Forest and Wildlife, Biodiversity and Patent, Laws Concerning Forest, Wildlife and People, International Law and Constitutional Frame for Conservation Policies.		12
UNIT V Climate change mitigation & adaptation, Basic concepts and mechanisms, Climate Change Policy-Mitigation, Climate Change Policy-Adaptation, International response, linking biodiversity, environment and human being, Ethical issues related to biodiversity and environment, Corporate Social Responsibility, Sustainable Ecotourism.		12
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 15 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks	
Suggested Reading:		

Text/Reference Books:

1. *Dyke, F.V. (2008). Conservation Biology Foundations, Concepts, Applications, 2nd Edition. Springer.*
2. *Singh, G. (2008). Plant Systematics: Theory and Practice. Oxford & IBH Publishing Co. Pvt. Ltd.*
3. *Primack, R. (2014). Essentials of Conservation Biology, 6th Edition. Sinauer Associates, Inc., USA*
4. *Groom, M. J., Meffe, G. R. & Carroll, C. R. (2006). Principles of conservation biology. Sinauer associates, Inc., USA.*
5. *Stuart, C., Spalding, M. & Jenkins, M. (2008). The world's Protected Areas: Status, Values and prospects in 21st century.*
6. *Chivian, E. & Bernstein, A. (2008). Sustaining life: How human health depends on biodiversity. Oxford University Press.*
7. *Narendran, T. C. (2006). An Introduction to Taxonomy. Zoological Survey of India, Kolkata*

M.Sc. Environment Science (2 years programme) Course Structure

Course: Environmental Lab-I

Program: M.Sc. Environment Science (2 years) SEMESTER I			
Environmental Lab-I			
Course status	**TEACHING SCHEME**	**EXAMINATION SCHEME**	**CREDITS ALLOTTED**
Core	**Practical:** 8hours/week	**Internal Assessment: 30 Marks** **End of Semester: 70 Marks**	**4**
Environmental Biology & Wildlife Biology • Measurement of climatic factors such as Temperature & relative humidity • Numerical Problems based on Biostatistics: Central tendency, Student's t- test, Standard deviation, Chi -square test, regression Analysis, ANOVA • Determine texture of various soil samples. • A field study of any one of the habitats to be assigned to the group of students • Tour Of any Wildlife sanctuary/ Park/ Reserve to study behavioural activities of animals and prepare a short report • Projects on wildlife- a. about Ganges Dolphin. b. Migratory birds in Hastinapur Bird Sanctuary (on animals listed as endangered species). Determination of abundance, dominance and frequency of a grassland ecosystem; Determination of diversity index of aquatic ponds and terrestrial ecosystem			
Air analysis: Oxides of Nitrogen, Ozone and Sulphur, SPM and RSPM			
Water analysis: pH, Electrical Conductivity, Turbidity, Total Suspended Solids, Total Dissolved Solids, Dissolved Oxygen, Acidity and Alkalinity			
Soil analysis: Moisture content, Organic carbon, Organic matter, Water holding capacity, Particle size analysis; Bulk density; Loss-on ignition			
Know-how and demonstration of instruments, calibration and standard curves for spectrophotometry and chromatography. Visiting the analytical instrumentation facility			

M.Sc. Environment Science (2 years programme) Course Structure

Course: Environmental Geosciences & Natural Disasters

Program: M.Sc. Environment Science (2 years) **SEMESTER II**			
COURSE V: Environmental Geosciences & Natural Disasters			
Course status	**TEACHING SCHEME**	**EXAMINATION SCHEME**	**CREDITS ALLOTTED**
Core	**Theory:** 3hours/week	**Internal Assessment: 30 Marks** **End of Semester: 70 Marks**	4
Course Pre-requisite: Student should have basic knowledge of Biology and Environmental Science.			
COURSE OBJECTIVES	1. Understand fundamentals of geoscience and the evolution of earth and its interiors 2. Understand the geological processes and related hazards, geological division, physical geology of India 3. Understand primary mineralogy and mining processes 4. Understand the impacts of mining on the environment and human health		
COURSE OUTCOMES (CO)	By the end of the course, the student will be able to: **CO1**. Understand the fundamentals of geoscience and evolution of earth and its interiors **CO2**. Gain knowledge about the geological division and physical geology of India **CO3**. Learn the mechanism of surface process and their agents like weathering, erosion, transportation, natural disasters etc. **CO4**. Link geological processes and related hazards like earthquakes, landslides, avalanches, GLOF, etc. **CO5.** Understand the concepts of groundwater processes and groundwater flow mechanism **CO6**. Gain basic understanding of mineralogy and mining processes and impacts of mining on environment and human health		
COURSE CONTENT			**Total No. of Lectures (60)**
Unit I Environmental Geology: Internal structure of earth-crust, mantle and core; surface features of the earth; Gross composition, physical properties and distribution of important minerals and rocks; Processes responsible for mineral concentrations; Different Rock types – igneous, metamorphic and sedimentary; Weathering ofrocks - physical, chemical and biological; Mass wasting; Erosion, Transportation and deposition of earth's materials by running water, wind and glaciers;			12

UNIT II Earth's geodynamic processes: Elemental ideas of folds, faults, joints, foliation, lineation, cleavage and schistosity; Physicochemical and seismic properties of Earth's interior, Palaeomagnetism; Continental drift, sea floor spreading, plate tectonics and mountain building processes		12
UNIT III Physiography: Development of land forms, land use pattern, land use policy of India; Glaciers: Physical and chemical aspects; Mass balance; Recession of Himalayan glaciers; Glaciers as index of climate change; Physiographic features andriver basins in India.		12
UNIT IV Natural Disasters I: Landslides – Types; causes; control and mitigation measures and of landslide Earthquakes– Seismology; causes; intensity and magnitude; geographic distribution of earthquakes zones (seismic belts); nature of destruction; earthquake mitigation for buildings and dams, Tsunami. Volcanoes– Nature; types and extent; causes; volcanic materials; geographic distribution of volcanoes.		12
UNIT V Natural Disasters II: Floods – Types, causes, drainage basins and pattern, nature and frequency, flood hydrographs, flood management and control, Cyclones and anticyclone, Tornadoes, Typhoons. Snow Avalanches- Types and impact. Clouds– Formation& types; c l o u d burst and their impacts; Types of precipitation. Drought – types, assessment, impact and mitigation; drought proofing. Forest Fire– Causes; types; consequences; monitoring and mitigation.		12
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 15 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks	
Suggested Reading:		
Text /Reference Books: 1. *Johnson, C., Matthew, D., Affolter, P.I., & Mosher, C. (2017). An Introduction to Geology. Salt Lake Community College.* 2. *William L. (2012). Fundamentals of Geophysics. Cambridge university Press.* 3. *Mahapatra G. B. (2019). A Textbook of Geology.* 4. *Grotzinger, J., & Thomas, H.J. (2007). Understanding the Earth, 5 th Edition. FRANK PRESS and RAYMOND SIEVER, W. H. Freeman& Co.* 5. *Monroe, J.S. & R. Wicander (2001). Physical Geology, 4th edition. Brooks/Cole Pacific Grove CA, 2001*		

6. *Keller, E.A. (2007). Introduction to Environmental Geology, 4th Edition. Prentice Hall of India.*

M.Sc. Environment Science (2 years programme) Course Structure

Course: Natural Resources Management

Program: M.Sc. Environment Science (2 years) **SEMESTER II**			
COURSE VI: Natural Sustainability Development			
Course status	**TEACHING SCHEME**	**EXAMINATION SCHEME**	**CREDITS ALLOTTED**
Core	**Theory:** 3hours/week	**Internal Assessment: 30 Marks** **End of Semester: 70 Marks**	**4**
Course Pre-requisite: Student should have basic knowledge of Biology and Environmental Science.			
COURSE OBJECTIVES	1. Understand fundamentals of natural resources and their management 2. Understand the hydrological cycle and water resource management 3. Understand soil biota and soil nutrient 4. Understand the type of energy and Resource Management		
COURSE OUTCOMES (CO)	By the end of the course, the student will be able to: **CO1**. Understand the fundamentals of natural resources and their management **CO2**. Gain knowledge about the natural resources and Resource Management of India **CO3**.Learn the process of precipitation, evaporation, Eva-transpiration, Ecohydrology etc. **CO4**. Gain basic understanding of Soil biota, soil nutrients & mineral reserves. **CO5**. Understand the type of energy and Resource Management. **CO6**.To make students appreciate the role of natural resources in the sustenance of life on earth		
COURSE CONTENT			**Total No. of Lectures (60)**
Unit I Natural Resources: Definition, types (water, land, soil, minerals, plants & animals), renewable & non-renewable resources, Concept of endemic, extinct and threatened species Plants: general account with reference to timber, food & medicines. Animal: general account with reference to game, wildlife & food; Depletion of Animal resources: Causes & consequences.			**12**
UNIT II Water: Hydrological cycle, hydro-meteorology & climate (precipitation, evaporation, Eva-transpiration), Ecohydrology, urban-hydrology, Integrated Water Resource Management (IWRM), Water Resources and Management in India.			**12**

UNIT III Soil: Soil biota & nutrients; Role of agricultural practices in soil degradation and conservation; Mineral: Distribution; occurrence; prospects; types & uses of economic minerals; Exploitation and their impact. Mineral reserves: Ores, coal, petroleum, natural gas, oil and conservation.		**12**
UNIT IV Energy Types: Coal, Oil, Natural gas and hydro, wind, tidal; solar, nuclear; Biogas, Petro plants, ocean's surface waves used as wave power, geothermal power. Biofuels (Energy from biomass, biodiesel, biofilters, biofuel cells).		**12**
UNIT V Sustainability indices; Strategies and debates on sustainable development; Concept of Sustainable Agriculture; India's environment action programme: issues, approaches and initiatives towards Sustainability; Sustainable development in practice; Urbanization; Urban sprawling and urban growth; Concept and characteristics of smart city; Urban resources and environmental problems; Carrying capacity analysis; Concept of ecological footprints.		**12**
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 15 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks	
Suggested Reading:		

Text /Reference Books:

1. *Biswas, A.K. (2007). Water resources: Environmental Planning, Management and Development, McGraw, Hill, New Delhi.*
2. *Flintan, F. and Tedla, S. (2010) Natural Resource Management: The impact of gender and Social Issues, IDRC, New Delhi.*
3. *Kesler, P. (2002) Mineral resources: Economics and Environment, CBS Publishers & Distributors, New Delhi.*
4. *Ravindranath, N. H., Usha Rao, K., Natarajan, B. and Monga, P. (2002) Renewable Energy and Environment - A Policy Analysis for India, Tata-McGraw Hill, New Delhi*
5. *Kumar, Arun, Sati, J. P., Tak, P.C., and Alfred, J.R.B. (2005) Handbook on Indian Wetlands and Their Conservation, Zoological Survey of India, Kolkata.*
6. *Singh N. Irabanta (2008) Endemic Bio-resources of India, Bishan Singh Mahendra Pal Singh, Dehradun*
7. *Daniel D. Chiras and Reganold, John P. (2009) Natural Resource Conservation: Management for a Sustainable Future (X Ed.), Addison Wesley, Boston.*
8. *Quentin Grafton, R. and Hussey, Karen (2011) Water Resources Planning and Management, Cambridge University Press, London.*

M.Sc. Environment Science (2 years programme) Course Structure

Course: Environmental Biotechnology & Microbiology

Program: M.Sc. Environment Science (2 years) **SEMESTER II**			
COURSE VII: Environmental Biotechnology & Microbiology			
Course status	**TEACHING SCHEME**	**EXAMINATION SCHEME**	**CREDITS ALLOTTED**
Core	**Theory:** 3 hours/week	**Internal Assessment: 30 Marks** **End of Semester: 70 Marks**	**4**
Course Pre-requisite: Student should have basic knowledge of Biology and Environmental Science.			
COURSE OBJECTIVES	1. Impart a working knowledge of the principles, techniques, and current applications of biotechnology to environmental quality evaluation, monitoring, remediation of contaminated environments and energy production. 2. Understand the principles of bioremediation and phytoremediation of synthetic organic pollutants and the basic physiology of a microorganism during bioremediation studies. 3. Know various techniques to modify and augment microorganisms in the laboratory and environment 4. Train the students about conservation of resources via recycling of waste materials and recovery of valuable products such as metals and oils.		
COURSE OUTCOMES (CO)	By the end of the course, the student will be able to: **CO1.** Understand the basic principles of microbiology, genetics, and biotechnology **CO2.** Understand the basic microbial processes of environmental engineering systems, natural/advanced environmental biotechnologies. **CO3**. Recognize and apply environmental biotechnology approaches in treatment and disposal of organic wastes. **CO4**. Apply this knowledge in production of biomaterials /biofuels and pollution control. **CO5**. To understand basic mechanisms of bioremediation. **CO6**. To develop methods for improved biological processes.		
COURSE CONTENT			**Total No. of Lectures (60)**
Unit I: Environmental Biotechnology & Biotechnological processes: Definition; history and scope of biotechnology; Bioconversion; Bioaccumulation; Biodegradation; Fermentation as a biotechnological process; Concept and Types of bioreactors.			12
Unit II: Biofertilizers; Biopesticides & Biofuels: Bacterial biofertilizers algal biofertilizers, aquatic fungi biofertilizers, vermiculture technology, biopesticides,			

and integrated pest management		12
Unit III: Biotechnology in environment protection: Role, current status; Biotechnology derived tools and processes; Industrial ecology and biotechnology; Bioplastics and biosensors for environmental monitoring; Genetically Modified Organisms (GMOs: transgenic animals, plants & fish) and their possible environmental implications, Stress tolerant plants and their significance.		12
Unit IV: Environmental Microbiology: Introduction, history and scope of environmental microbiology; Microbial diversity: Major groups of microbes; Microbiology of Soil and soil fertility, water and air; Microbes of extreme environment; Microbial pathogens. Microbial toxins and environmental hazards.		12
Unit V: Applied Microbiology: Biodegradation of organic and inorganic pollutants and pesticides; microbial treatment of oil pollution; production of vinegar, lactic acid, citric acid, antibiotics, vitamins and vaccines; microorganism in bioassays, Techniques related to isolation, purification and culture of microorganism		12
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 15 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks	
Suggested Reading:		
Text /Reference Books: *1. Michael P. J. (2001). Microbiology, 5th Edition. McGraw Hill Education.* *2. Pepper, I.L. & Gerba, C.P. (2005). Environmental Microbiology - Laboratory Manual. Elsevier, USA.* *3. Ratledge, C. & Kristiansen, B. (2002). Basic Biotechnology, 2nd edition. Cambridge University Press, Cambridge, UK.* *4. Rittman, B. & McCarty, P. L. (2000). Environmental Biotechnology: Principles and Applications, 2nd edition. Tata McGraw-Hill, USA.* *5. Christon J. H., Ronald, L. C., Guy R. K., & Michael J. M. (2001). Manual of Environmental Microbiology, 2nd edition. ASM Press.* *6. Jordening, H. J., & Winter, J. (Eds.). (2005). Environmental biotechnology: concepts and applications.* *7. Bhattacharyya, B. C., & Banerjee, R. (2007). Environmental biotechnology. USA: Oxford university press.*		

M.Sc. Environment Science (2 years programme) Course Structure

Course: Environmental Laws & Policies

Program: M.Sc. Environment Science (2 years) **SEMESTER II**			
COURSE VIII: Environmental Laws & Policies			
Course status	**TEACHING SCHEME**	**EXAMINATION SCHEME**	**CREDITS ALLOTTED**
Core	**Theory:** 3 hours/week	**Internal Assessment: 30 Marks** **End of Semester: 70 Marks**	**4**
Course Pre-requisite: Student should have basic knowledge of Biology and Environmental Science.			
COURSE OBJECTIVES	1. Acquaint the students with the environmental issues, pollution, and control and the measures taken for its protection along with the prevailing norms. 2. Develop an understanding of the prevailing national and international provisions of environmental policies and legislations. 3. Understand the environmental legislation procedures and applicability 4. Learn environmental treaties and conventions.		
COURSE OUTCOMES (CO)	By the end of the course, the student will be able to: **CO1**. Get basic knowledge of environmental law policies, its relevance, and various principles. **CO2**. Understand the environmental policies and their significance. **CO3**. Understand various acts and legislation in place and suggest solutions of the gaps in the existing policies and legislation. **CO4**. Know about Environmental treaties and conventions. **CO5**. Develop environmental ethics and its significance. **CO6**. Know the significance of various historical environmental movements.		

COURSE CONTENT	**Total No. of Lectures (60)**
UNIT I Origin of Environmental law; Concept of Environmental law and policy; Environment and Governance.	10
UNIT II Overview of International Environmental Laws; Fundamental Principles and Application of International Environmental Law; International Humanitarian Law and Environment.	12
UNIT III Acts, rules and regulations: Wildlife (Protection) Act 1972, Water (Prevention and Control of Pollution) Act 1974; Forest Conservation Act 1980, Environment (Protection) Act 1986, the Environmental Protection Act &	14

Environmental rules 1986. Air (Prevention and Control of Pollution) Act 1981; Bio-Medical Waste (Management & Handling) Rules, 1998; Hazardous Waste (Management, Handling Rules, 1989); Transboundary Movement Rules, 2008. Plastics manufacture, Sale and Usage Rules, 1999. Coastal Regulation Zones (CRZ), Rules 1991. Public Liability Insurance Act, 1991. Rules, Regulations and Guidelines for Municipal Solid Waste; Electronic Waste.		
UNIT IV Human Communities and the Environment: Environmental movements: Chipko, Silent valley, Bishnoi's of Rajasthan. Environmental ethics: Role of Indian and other religions and cultures in environmental conservation. Environmental communication and public awareness. Value education, individual, community, corporate social responsibility. Movements related to the environment – sacred groves, Bishnoi tradition, Chipko movement, tehri dam, sardar Sarovar, Narmada dam, Almatti dam, silent valley. Role of NGOs. sustainable development: definition and concepts		12
UNIT V Evolution and development of international environmental laws with reference to Stockholm conference on human environment, international conventions; Value education; Supreme court directive on the introduction of the subject of environmental studies at different levels, the introduction of CNG in public transport. compensatory afforestation.		12
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 15 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks	
Suggested Reading:		
Text /Reference Books: *1. Shelton, D. & Kiss, A. C. (2005). Judicial Handbook on Environmental Law, United Nations Environment Programme.* *2. Jaswal, P.S. & Jaswal, N. (2003). Environmental Law. Pioneer Publications, Delhi.* *3. Tiwari, R. K. (2007). Global Environmental Policies. ABD Publishers.* *4. Trivedy, R. K. (2004). Handbook of Environmental Laws, Guidelines, Compliance &Standards, Vol. 1 & 2 Environ – Media Karad, India.* *5. Kuttingayloan, G. M. (2009). Conventions, Treaties and other Responses to Global Issues, Vol. 1 & 2 EOLSS Publishers Co Ltd.* *6. Singh, G. & Singh, G. (2005). Environmental Law in India. Macmillan India.* *7. Sarkar, P.K. (2012). "Environmental ethics and environmental issues." International Journal of Multidisciplinary Educational Research 1.2.* *8. Reddy, R.V. (1997). Environmental movements in India: some reflections. FIA. Agricultural Meteorology by G.S.L.H.V. Prasad Rao: Published by –PHI Learning Private Ltd.*		

M.Sc. Environment Science (2 years programme) Course Structure

Course: Environmental Lab-II

Program: M.Sc. Environment Science (2 years) SEMESTER I			
Environmental Lab-II			
Course status	**TEACHING SCHEME**	**EXAMINATION SCHEME**	**CREDITS ALLOTTED**
Core	**Practical:** 8hours/week	**Internal Assessment: 30 Marks** **End of Semester: 70 Marks**	**4**
Sampling methods, physicochemical, biological parameters of water			
Analysis of DO, BOD, COD, Phosphate, Nitrate, fluoride, Heavy metals, etc.) in water			
Water quality assurance, advanced water treatment techniques, control of emerging pollutants, analytical techniques.			
Staining of isolated microorganisms, morphological identification, isolation of DNA from bacterial cells, multiplication of DNA by PCR technique.			
Sampling methods Practical Tips to Sampling, Sample Preparation, Media and glassware Preparation, handling instrumentation			
Various tools and techniques of environmental microbial biotechnology lab, a survey of microorganisms of water and soil			

M.Sc. Environment Science (2 years programme) Course Structure

Course: Environmental Impact Assessment and Management

Program: M.Sc. Environment Science (2 years) **SEMESTER III**			
COURSE IX: Environmental Impact Assessment and Management			
Course status	**TEACHING SCHEME**	**EXAMINATION SCHEME**	**CREDITS ALLOTTED**
Core	**Theory:** 3 hours/week	**Internal Assessment: 30 Marks** **End of Semester: 70 Marks**	**4**
Course Pre-requisite: Student should have basic knowledge of Biology and Environmental Science.			
COURSE OBJECTIVES	1. Explain the basic principles of environmental impact assessment 2. Understand the different steps within environmental impact assessment. 3. Discuss the implications of current jurisdictional and institutional arrangements in relation to environmental impact assessment 4. Understand how to liaise with and the importance of stakeholders in the EIA process		
COURSE OUTCOMES (CO)	By the end of the course, the student will be able to: **CO1**. Know the basics of EIA and legal implications **CO2.** Understand the strategic and organizational context of environmental management in different settings and design and deliver practical outcomes that contribute positively to environmental performance. **CO3**. Synthesize and prioritize information from desktop and field environmental assessments, rank the relative values identified, assess the risks imposed by the development, and determine appropriate environmental management strategies. **CO4.** Articulate and justify specific policies or courses of action on complex environmental issues using discipline-based knowledge and established management principles. **CO5**. Know the basic mechanisms of audits and audit procedures **CO6**. Assess the methods of LCA and standardization including ISO		
COURSE CONTENT			**Total No. of Lectures (60)**
Unit- I Introduction to EIA: Definition; Scope and development; Purpose, Objectives and Basic principles and Types; Strategic Environmental Assessment (SEA); Benefits of EIA, Indian directions of EIA. Rapid and comprehensive EIA perspectives. Sources and collection of data for EIA.			12
UNIT II			

Environmental Clearance Screening, Scoping, Purpose of scoping, Baseline studies intrinsic and external database supports and interpretation; checklist, matrices, Overlays and Geographical Information System, Impact analysis and Predictions, Environmental Impact Statement [EIS]; EIA report.		12
UNIT III Environmental Management Systems (EMS), ISO 14000 (EMS). HACCP, Life Cycle Analysis (LCA), Components of Environmental Management System-Objectives, Policies, Implementation and Review. Environmental appraisal, accounting and environmental audits		12
UNIT IV Public Participation; Concept and significance of Public Hearing, Social impact assessment (SIA), Strategic Environmental Assessment (SEA), Case studies of specific industries.		12
UNIT V Post project analysis restoration and rehabilitation methodologies, Mitigation criteria, Project modification, concept of COE & COO, Risk assessment.		12
Suggested Continuous Evaluation Methods:	Total Marks: 25 House Examination/Test: 15 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks	
Suggested Reading:		
Text /Reference Books *1. Anjaneyulu, Y. & Manickam, V. (2002).Environmental Impact Assessment Methodologies. B.S. Publications.* *2. Cutter, S. L. (1999). Environmental Risks and Hazards. Prentice Hall of India, New Delhi.* *3. Glasson, J., Therivel, R. & Chadwick, A. (2006). Introduction to Environmental Impact EIA. Routledge, London.* *4. Rao, P. S. & Rao, P.M. (2000). Environmental Management and Audit. Deep and Deep Publications.* *5. Morgan, R. K. (2012). Environmental impact assessment: the state of the art. Impact assessment and project appraisal, 30(1), 5-14.* *6. Morris, P. & Therivel R. (2001). Methods of Environmental Impact Assessment. 2nd edition. Spon Press London.*		

M.Sc. Environment Science (2 years programme) Course Structure

Course: Environmental Pollution

Program: M.Sc. Environment Science (2 years) **SEMESTER III**			
COURSE III: Environmental Pollution			
Course status	**TEACHING SCHEME**	**EXAMINATION SCHEME**	**CREDITS ALLOTTED**
Core	**Theory:** 3hours/week	**Internal Assessment: 30 Marks** **End of Semester: 70 Marks**	**4**
Course Pre-requisite: Student should have basic knowledge of Biology and Environmental Science.			
COURSE OBJECTIVES	1. Understand air pollution, types and sources of air pollutants, including various impacts on the environment and human health 2. Provide a thorough concept on factors affecting water quality, major water pollutants, global water crisis, and treatment of wastewater 3. Enable students to understand types of soil, impact of industrialization and urbanization on soil quality and control measures 4. Understand present environmental pollutions and impacts at national and international conventions. In addition, knowledge of various control measures adopted for the abatement of pollution.		
COURSE OUTCOMES (CO)	By the end of the course, students will be able to: **CO1.** Understand the concept of pollution and its impacts on humans, society and the environment **CO2.** Link air pollution, types and sources of air pollutants with various impacts on the environment and human health **CO3.** Gain familiarity with meteorological implications on the dispersion of air pollution and reasons for conversion from local to global scale **CO4.** Learn about water pollution, sources, causes and its effect on humans and the environment **CO5.** Recognize soil pollution, sources, its consequences, and mitigating measures **CO6.** Understand solid waste classification, its sources and methods of disposal		
COURSE CONTENT			**Total No. of Lectures (60)**
Unit I Definition and Types of pollution, General discussion on the pollution perception, Causes and Sources of Pollution, Effect of pollution on the global, regional and local scale; Impacts of pollution on human health and environment;Primary and Secondary Pollutants, Automobile Pollution, Industrial Pollution, Ambient Air Quality Standards and indices; Effect of pollution on the global, regional and local			**12**

scale		
UNIT II Meteorological parameters (temperature, relative humidity, wind speed and direction, precipitation); meteorological aspects of air pollution- Temperature profiles in the atmosphere, Lapse rate, stability and mixing heights, temperature inversion, wind profiles, turbulent diffusion, topographic effects, Plume behaviour, dispersion of air pollutants, Gaussian plume model, line source model and area source model		**12**
UNIT III Point and non-point sources of pollution, significant water pollutants, Water Quality requirements for different uses; Water quality standards Indian standards for drinking water, Drinking water treatment, Wastewater Treatment, global water crisis Issues, effects of water pollution and its control		**12**
UNIT IV Soil composition, Classification of soil types, Causes of soil degradation, Urbanization and land degradation; Impact of Modern Agricultural Practices on Soil, Effect on Environment and Life sustenance; Abatement measures, Effects and Control measures		**12**
UNIT V Solid waste Classification, Sources of Solid waste, Different methods of Disposal, Control methods- incineration, landfill, the effect of urban and industrial solidwaste on the environment		**12**
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 15 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks	
Suggested Reading:		
Text/ Reference Books: *1. Reddy, M.A. (2010). Textbook of Environmental Science and Technology, BS Publications.* *2. Wright, R. T. (2008). Environmental Science- Towards a sustainable future, PHI Learning, New Delhi.* *3. De, A.K. (2000). Environmental Chemistry, New Age International (P) Ltd. Publishers, New Delhi.* *4. Peirce, J.J., Vesilind, J.J., & Weiner, R. (1997). Environmental Pollution and Control, 4th Edition, Publisher Butterworth-Heinemann.* *5. Pepper, I., Gerba, C., & Brusseau, G. (2006). Environmental and Pollution Science, 2nd Edition, Academic Press.* *6. Rao, C.S. (2018). Environmental Pollution Control Engineering, 3rd Edition, New Age International Publishers.*		

M.Sc. Environment Science (2 years programme) Course Structure

Course: Environment & Public Health

Program: M.Sc. Environment Science (2 years) SEMESTER III			
COURSE XI: Environment & Public Health			
Course status	**TEACHING SCHEME**	**EXAMINATION SCHEME**	**CREDITS ALLOTTED**
Core	**Theory:** 3hours/week	**Internal Assessment: 30 Marks** **End of Semester: 70 Marks**	**4**
Course Pre-requisite: Student should have basic knowledge of Biology and Environmental Science.			
COURSE OBJECTIVES	1. Introduce the basic concepts, approaches and principles of toxicology 2. Understand the dose-response relationship and the main parameters derived from it. 3. Explain the mechanisms of action of environmental toxicants in causing a toxic response in living organisms. 4. Understanding of the relatedness of occupations and public health. 5. Impart knowledge on various concepts of prevention/protection to occupational Health and safety mechanisms.		
COURSE OUTCOMES (CO)	By the end of the course, the student will be able to **CO1**. Describe the major components and elements of the occupational health and safety; **CO2**. Relate health protection concepts to the occupational health and safety program. **CO3**. Identify the ways in which physical, chemical and other hazardous agents in the work environment can affect human health. **CO4**. Acquire knowledge of the types of diseases which can arise from work **CO5**. Learn how scientific method and epidemiology can be applied in disease recognition **CO6**. Apply different prevention and control measures to ensure safety against occupational hazards		
COURSE CONTENT			**Total No. of Lectures(60)**
Unit I Environmental Toxicants: Definition; Common environmental toxicants; Heavy metals: Sources and their effects on life and environment; Pesticides & Harmful Chemicals: Types, uses and harmful effect of pesticides; Mutagenic and Carcinogenic Chemicals, Polyaromatic hydrocarbons, nitrosamines, organic solvents, alcohol, carbon tetrachloride, anaesthetic (chloroform, ether, xylocaine); Tobacco chewing and smoking.			12
UNIT II Toxicity Assessment: Principles, Toxicity testing (Holistic and numeric approach), in-			

vivo and in-vitro toxicity assessment; Acute, sub-acute, sub chronic and chronic toxicity test; Neurotoxic; Reproductive; Mutagenic and Carcinogenic test; LD50, LC50, EC50 and IC50; Factors affecting toxicity.		12
UNIT III Systemic Toxicity: Absorption, Translocation and Excretion; Membrane permeability and Mechanism of chemical transfer; Absorption & translocation of Xenobiotics; membrane barriers, Binding & excretion of Xenobiotics; Neurotoxicity, Hepatotoxicity, Immunotoxicity, Cardio-vascular toxicity, Respiratory dysfunction and Hypersensitivity. Microbial toxicity: Food contamination.		12
UNIT IV Environmental Occupational Health: Concept; Indicator & Determinants of health (Physical, Chemical & Biological); Dust Diseases (Pneumoconiosis with reference to silicosis, absestosis, anthracosis, bagassosis & byssinosis), Occupational hazards: lead poisoning (plumbism), Occupational cancer, Occupational dermatitis, Radiation hazards.		12
UNIT V Epidemiology: Definition; history and Scope, Epidemiology of selected communicable diseases, Water borne diseases (diarrhoea, cholera, dysentery, typhoid), Foodborne disease (Salmonellosis, Campylobacteriosis, E. coli infection, Listeriosis, Clostridial infection and intoxication etc.), Vector borne diseases (Malaria, filariae, Dengue, Chicken guinea, etc.), Air Borne infections (tuberculosis, influenza, diphtheria, COVID-19), AIDS.		12
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 15 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks	
Suggested Reading:		
Text /Reference Books: 1. *Burroughs, P. A. & Rachael, M. (1998). Principles of Geographical Information Systems" Oxford University Press, New York.* 2. *Jensen, J.R. (1996). Introductory Digital Image Processing, A remote sensing perspective. Prentice Hall Series in GIS, USA.* 3. *Lillesand, T. M. & Kiefer, R. W. (2007). Remote Sensing and Image Interpretation, 4th Edition. John Wiley and Sons, New York.* 4. *Burgess, W.A. (1995). Recognition of Health Hazards in Industries: A Review of Materials and Processes. 2nd Edition. New York, NY: John Wiley and Sons, Inc.* 5. *Wald, P. & Gregg, M.S. (2001). Physical and Biological Hazards in the Workplace. New York, NY: Van Nostrand Reinhold.* 6. *Dinardi, S. (2003). The Occupational Environment Its Evaluation and Control. 2nd Ed. Fairfax, VA: American Industrial Hygiene Association.*		

M.Sc. Environment Science (2 years programme) Course Structure

Course: Water and Wastewater Treatment

Program: M.Sc. Environment Science (2 years) SEMESTER III			
COURSE XII: Water and Wastewater Treatment			
Course status	**TEACHING SCHEME**	**EXAMINATION SCHEME**	**CREDITS ALLOTTED**
Core	**Theory:** 3hours/week	**Internal Assessment: 30 Marks** **End of Semester: 70 Marks**	**4**
Course Pre-requisite: Student should have basic knowledge of aquatic chemistry.			
COURSE OBJECTIVES	1. Learn about available waste resources and its distribution on earth 2. Understand the science and technologies of wastewater treatment processes and operations. 3. Understand the basic design criteria and the operation of waste water treatment facilities/plants. 4. Learn the sampling and analytical techniques required for the wastewater characterization and the monitoring of the wastewater treatment plants.		
COURSE OUTCOMES (CO)	By the end of the course, the student will be able to: **CO1**. Understand water resources, components of water budget and its linkage with energy and chemical budgets. **CO2**. Acquire knowledge on the water quality standards, potential sources of pollution and their corresponding qualities **CO3**. Gain knowledge of water regulations and standards required to protect public health and ensure compliance **CO4**. Link the water quality standards with the basic objectives of wastewater treatment **CO5**. Describe the purpose and operational steps of key water treatment processes used to improve water quality **CO6**. Understand the main physical, chemical and biological processes used for wastewater treatment		

COURSE CONTENT	**Total No. of Lectures(60)**
UNIT I Global distribution of water resources; Precipitation; Water needs and consumption; Water resource planning and management; Water budget; National Water Policy	12
UNIT II Water quality, water quality standards for drinking water and wastewater, water quality indices, physic-chemical indicators, composite indicators; legislative and regulatory frameworks for water pollution control.	12

UNIT III Major sources of wastewater; physicochemical and biological characteristics of wastewater- domestic sewage and industrial effluents.		12
UNIT IV Treatment Technologies- pre-treatment, primary, secondary and tertiary treatment methods, sewage treatment plant (STP); effluent treatment plant (ETP). Aerobic treatment methods-Activated sludge, oxidation ponds, trickling filter, rotating biological contactors, Anaerobic treatment methods- UASB reactors		12
UNIT V Sludge management facilities, sludge thickening, sludge digestion, Biogas generation, sludge dewatering		12
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks	

Suggested Reading:

Text /Reference Books:

1. *Tchobanoglous, G., Burton, F.L. & Stensel, H. D. (2003). Wastewater Engineering: treatment and Reuse, 4th edition. Metcalf and Eddy Inc., New York, NY: McGraw-Hill.*
2. *Qasim S.R., Motley, E.M. & Zhu. G. (2002). Water works Engineering – Planning, Design and Operation, Prentice Hall, New Delhi.*
3. *Hendricks D. (2006). Water Treatment Unit Processes – Physical and Chemical, CRC Press, New York.*
4. *Staff, M.W.H. (2005). Water Treatment: Principles and Design. 2nd edition. New York, NY: Wiley.*
5. *Lee C.C. & Shun dar Lin, S.D. (1999). Handbook of Environmental Engineering Calculations, Mc Graw Hill, New York.*
6. *Sedlak., D. W. (2014). 4.0: The Past, Present, and Future of the World's Most Vital Resource, Yale University Press.*
7. *Holden, J. (2019). Water Resources- An Integrated Approach, 2nd edition. Routledge.*

M.Sc. Environment Science (2 years programme) Course Structure

Course: Environmental Lab-III

Program: M.Sc. Environment Science (2 years) SEMESTER I			
Environmental Lab-III			
Course status	**TEACHING SCHEME**	**EXAMINATION SCHEME**	**CREDITS ALLOTTED**
Core	**Practical:** 8hours/week	**Internal Assessment: 30 Marks** **End of Semester: 70 Marks**	**4**
Environmental ethics, Movements related to the environment.			
Air analysis: Oxides of Nitrogen, Ozone and Sulphur, SPM and RSPM			
Soil analysis: Moisture content, Organic carbon, Organic matter, Water holding capacity, Particle size analysis; Bulk density; Loss-on ignition			
Water analysis: pH, Electrical Conductivity, Turbidity, Total Suspended Solids, Total Dissolved Solids, Dissolved Oxygen, Acidity and Alkalinity			
Qualitative and quantitative determination of environmental toxicants in different environmental matrices			
Preparation/drafting of EIA Report (Chemical Industry, Fertilizer Industry, hydropower station), Report on Eco-tourism.			
Water quality standards for drinking water and wastewater			
Environmental Occupational Health, Epidemiology of selected communicable diseases, Water borne diseases (diarrhoea, cholera, dysentery, typhoid), Food borne disease (Salmonellosis, Campylobacteriosis, E. coli infection, Listeriosis, Clostridial infection and intoxication etc.), Vector borne diseases (Malaria, filariae, Dengue, Chicken guinea, etc.), Air Borne infections (tuberculosis, influenza, diphtheria, COVID-19), AIDS.			

M.Sc. Environment Science (2 years programme) Course Structure

Course: Fundamentals of Remote sensing & GIS

Program: M.Sc. Environment Science (2 years) SEMESTER IV			
COURSEXIII: Fundamentals of Remote sensing & GIS			
Course status	**TEACHING SCHEME**	**EXAMINATION SCHEME**	**CREDITS ALLOTTED**
Core	**Theory:** 3hours/week	**Internal Assessment: 30 Marks** **End of Semester: 70 Marks**	**4**
Course Pre-requisite: Students should have basic knowledge of computer/ software.			
COURSE OBJECTIVES	1. Train the students in practical and executable solutions to the challenges of the emergent field of Remote Sensing and GIS. 2. Impart the students with a strong base of knowledge that makes them suitable both for industries, teaching, and research. 3. Apply the fundamental principles for a successful profession and/or for higher technical education based on mathematical, scientific and engineering principles, to solve realistic and field problems that arise in engineering and non-engineering sectors. 4. Students will be installed with ethical feeling, encouraged to make decisions that are safe and environmentally-responsible and also innovative for societal improvement.		
COURSE OUTCOMES (CO)	By the end of the course, the student will be able to: **CO1**. Carry out research/developmental work to solve real-world geospatial problems. **CO2**. Identify specific data and methodologies for effective mapping and evaluation of natural resources. **CO3.** Illustrate spatial and non-spatial data features in GIS and understand the map projections and coordinates systems **CO4**. Design systems for decision making and work in a team using geospatial tools to achieve project objectives. **CO5**. An ability to share theoretical and practical knowledge in both teaching and research as well as in industries. **CO6**. Apply knowledge of GIS and understand the integration of Remote Sensing and GIS.		
COURSE CONTENT			**Total No. of Lectures (60)**
Unit I			

Remote Sensing Concepts, Electromagnetic Radiation (EMR), Atmospheric Windows, Spectral Signatures, Resolutions, Platforms, Satellites, Sensors, and Specifications Digital Image Processing System, Image Enhancement, Transformation and Image Classifications, Image Interpretations (Optical, Thermal & Radar)		14
UNIT II Components of GIS, Spatial vs. Non-Spatial Data, Coordinate System, Map Projections, Spatial Data Quarries, Data Formats, Raster & Vector Data Models (Topology, Grid, TIN, Network), Data Input & Geo-Corrections, Spatial Interpolations, Buffering, Overlay Analysis, Terrain Mapping-DEM/DTM.		12
UNIT III GPS-An Overview, Positioning, System Segmentation, Augmentation, DGPS, & GNSS/IRNSS Applications.		10
UNIT IV Geospatial Applications, Application of RS & GIS in Monitoring and Management of Natural Resources: Forest, Agriculture, Water, Urban, Ocean, Coastal. Concept of Health GIS, E-Governance & Disaster Management		12
UNIT V Advances in Remote sensing: Thermal and Microwave Remote sensing, Sensor Technology, Platforms and Data Types, Urban Heat Island, Hyperspectral and LASER Remote sensing, Classification and Spectral Library Creation, Applications of RADAR, Hyperspectral & LiDAR, Geospatial Modelling, UAV applications, Basics of web GIS.		12
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 15 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks	
Suggested Reading:		

Text /Reference Books:

1. *Burroughs, P. A. & Rachael, M. (1998). Principles of Geographical Information Systems" Oxford University Press, New York.*
2. *Jensen, J.R. (1996). Introductory Digital Image Processing, A remote sensing perspective. Prentice Hall Series in GIS, USA.*
3. *Lillesand, T. M. & Kiefer, R. W. (2007). Remote Sensing and Image Interpretation, 4th Edition. John Wiley and Sons, New York.*
4. *Chang, Kang-tsung (2000) Introduction to GIS, Tata McGraw Hill, New Delhi.*
5. *Bhatta, B. (2011) Remote Sensing and GIS, Oxford University Press, New York.*
6. *Susan. L. Ustin (2004) Remote Sensing for Natural Resource Management and Environmental Monitoring, John Wiley & Sons,*
7. *Wing, Michael G., Pete Bettinger (2008) Geographic Information Systems: Applications in Natural Resource Management, Oxford University Press, New York.*
8. *Johnson, Arnold Ivan, C. Bernt Petterson (2008) Geographic Information Systems (GIS) and Mapping: Practices and standards, ASTM International.*

9. *Reddy, Manji (2008) Text book of Remote Sensing and Geographical Information Systems (2nd edition), Book Syndicate*
10. *Sabin, F.F. J. (2007). Remote Sensing – Principles and Interpretation", W.H. Freeman & Co.*
11. *Chang, K. (2007). Introduction to Geographic Information Systems, Tata McGraw Hill, New Delhi.*
12. *Gopi, S. (2005). Global Positioning System: Principles and Applications. McGraw Hill Publishers.*

M.Sc. Environment Science (2 years programme) Course Structure

Course: Pollution Abatement and Green Technology

Program: M.Sc. Environment Science (2 years) SEMESTER IV			
COURSE XIV: Pollution Abatement and Green Technology			
Course status	**TEACHING SCHEME**	**EXAMINATION SCHEME**	**CREDITS ALLOTTED**
Core	**Theory:** 3hours/week	**Internal Assessment: 30 Marks** **End of Semester: 70 Marks**	**4**
Course Pre-requisite: Students should have basic knowledge of science.			
COURSE OBJECTIVES	1. Understand air pollution, types and sources of air pollutants, including various impacts on the environment and human health 2. Provide a thorough concept on factors affecting water quality, major water pollutants, global water crisis, and treatment of wastewater 3. Enable students to understand types of soil, impact of industrialization and urbanization on soil quality and control measures 4. Understand present environmental pollutions and impacts at national and international conventions. In addition, knowledge of various control measures adopted for the abatement of pollution.		
COURSE OUTCOMES (CO)	By the end of the course, students will be able to: **CO1**. Understand the concept of pollution and its impacts on humans, society and the environment **CO2** Link air pollution, types and sources of air pollutants with various impacts on the environment and human health **CO3**Understand the concept, principle, concepts, applications and tools of Green technology **CO4** Learn about water pollution, sources, causes and its effect on humans and the environment **CO5** Recognize soil pollution, sources, its consequences, and mitigating measures **CO6** Understand solid waste classification, its sources and methods of disposal		
COURSE CONTENT			**Total No. of Lectures (60)**
Unit I **Water Pollution control technologies:** Sewage and waste water treatments systems; Primary, secondary and tertiary treatments; Measurement of treatment efficiencies; Biological treatments - aerobic versus anaerobic treatments; Environmental pollution control- Bioremediation, Bioaugmentation and Bio stimulation; Biofilms in treatment of waste water; Bioreactors for waste water treatments; Reactors types and design; Reactors in series; Development and			12

optimization of membrane bioreactor process for use in sanitary and industrial sewage treatment.		
UNIT II **Air pollution control technologies and devices:** Methods to control air pollution in the environment, Limestone injection and fluidized bed combustion, Desulfurization; Catalytic converter and control of vehicular emission, Gravity settling chamber, Centrifugal collectors- cyclone collector and dynamic precipitators; Electrostatic precipitators; Fabric filters.		12
UNIT III **Solid, Toxic, and Hazardous waste management:** solid waste disposal methods – open dumps, ocean dumping, Landfills, Incineration; Recycling and reuse. Organic pollutants and Hazardous waste disposal and management. Management of Radiation, noise, thermal, oil and e-wastes: recycling of waste. Biosorption - Biotechnology and heavy metal pollution; Oil field microbiology; Improved oil recovery; Biotechnology and oil spills; Hydrocarbon degradation.		12
UNIT IV **Overview, Principle, concepts and Tools of Green technology:** Overview of green chemistry, Chemistry of the atmosphere, principles of sustainable and green chemistry. Basic principles of green technology, concepts of atom economy and carbon trading, tools of green technology. waste minimization and climate change, Zero- waste technology, concept of environmentally balanced industrial complexing and industrial ecology, greenhouse effect, climate change, photochemical smog.		12
UNIT V **Green technology applications:** Biocatalysis, green chemistry 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), Biomass, prevention/minimization of hazardous/toxic products. Agricultural related practices and food processing, Production of biodegradable materials, concept of green building, Pollution free engineering processes.		12
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 15 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks	
Suggested Reading:		
Texts/References: *1. M.H.Fulekar (2010) Bioremediation technology recent advances, Springer.* *2. M.H.Fulekar. (2005) Environmental Biotechnology. Oxford IBH Publishing Corporation.* *3. N.P.Cheremisinoff (1996) Biotechnology for Waste and Wastewater Treatment, William Andrew Publishing, New York.* *4. Bruce Rittman, Perry L. McCarty. (2000). Environmental Biotechnology: Principles And Applications, 2nd Edition, McGraw-Hill.* *5. Raina M. Maierm Ian L. Peppar, Charles P. Gerba. (2000). Environmental Microbiology, Academic Press,*		

6. Gabriel Bitton. (1999) Wastewater Microbiology, 2nd Edition. Wiley-Liss.

7. Lawrence K. Wang, Yung-Tse Hung, Nazih K. Shammas. (2009) Handbook of Advanced Industrial and Hazardous Wastes Treatment. CRC Press.

8. Lawrence K. Wang, Norman C. Pereira, Yung-Tse Hung. (2005) Advanced Air and Noise Pollution Control. Springer.

9. Martin B. Hocking. (2005) Handbook of Chemical Technology and Pollution Control. Elsevier.

M.Sc. Environment Science (2 years programme) Course Structure

Course: Carbon Capture and Sequestration Technology

Program: M.Sc. Environment Science (2 years) SEMESTER IV			
COURSE XV: Carbon Capture and Sequestration Technology			
Course status	**TEACHING SCHEME**	**EXAMINATION SCHEME**	**CREDITS ALLOTTED**
Core	**Theory:** 3hours/week	**Internal Assessment: 30 Marks** **End of Semester: 70 Marks**	**4**
Course Pre-requisite: Student should have basic knowledge of Ecology, Environmental Science and Life Science.			
COURSE OBJECTIVES	1. Understand the carbon concentrating mechanisms and global carbon cycling in the context of climate change mitigation and the significance of carbon capture technologies 2. Give exposure to current and future CCS technologies with their merits and demerits 3. Provide a basic foundation of knowledge on the implication of the low carbon technologies and integration of CCS technologies for food, energy and environment. 4. Analyse available methods CCS to combat climate change.		
COURSE OUTCOMES (CO)	By the end of the course, students will be able to: **CO1**. Understand how carbon is regulated in different environmental components **CO2** Understand how carbon capture and sequestration/storage (CCS) fits into the energy space. **CO3** Evaluate the biological carbon capture and physico-geo-chemical sequestration procedures. **CO4** Distinguish carbon concentrating mechanisms in the biological world. **CO5** Analyse appropriate and available methods of CCS to integrate it with the green technologies. **CO6** Judge the appropriate methods of carbon capture and sequestration.		
COURSE CONTENT			**Total No. of Lectures (60)**
Unit I Introduction and scope of the CCS (Carbon capture and sequestration). CCS in the energy space- A nexus between energy, electricity, fossil fuel and carbon emission, Carbon budget of the Earth, Carbon emissions.			12
UNIT II Sequestration in different environmental segments, atmospheric, trends of historic CO2 levels and global changes in carbon, limitations of the natural carbon			12

sequestration. Carbon concentrating mechanisms of plants and algae.		
UNIT III Different physical and chemical technologies of carbon capture, storage and sequestration. Absorption- existing agents and technologies, selection of absorbing agents, optimizing on absorption process, Adsorption- Selection of adsorbent, Novel materials for adsorption.		12
UNIT IV Membranes- physical and chemical factors affecting the potential membranes for carbon sorption and transformation. Artificial photosynthesis.		10
UNIT V Geologic Carbon Sequestration: Introduction, Continuum Scale, Pore-Scale Phenomena, selection of CO2 storage sites, additional economical processes e.g enhanced oil recovery. Carbon sequestration using deep natural minerals, saline lands, lagoons, the process of CO2 injection and transportation, sorption and sequestration mechanisms. CO2 sequestration in seawater and saline reservoirs. Carbon sequestration in soil. Biotechnology for improvement in biological sequestration.		14
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 15 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks	
Suggested Reading:		
Texts/Reference Books: *1. Baird, C., & Cann, M. (2008). Environmental Chemistry, W.H. Freeman and company.* *2. Manahan, S. (2017). Environmental chemistry. CRC press.* *3. Rackley, S. A. (2017). Carbon Capture and Storage, 2nd edition. Butterworth- Heinemann – Elsevier.* *4. Jennifer, W. (2012). Carbon Capture, Springer.* *5. Hester, R.E., & Harrison, R.M. (2010). Carbon capture: sequestration and storage. Royal Society of Chemistry.* *6. Borowitzka, M.A., Beardall, J. & Raven, J.A. (2016). The physiology of microalgae (Vol. Cham: Springer)*		

M.Sc. Environment Science (2 years programme) Course Structure

Course: Agrometeorology

Program: M.Sc. Environment Science (2 years) SEMESTER IV			
COURSE XVI: Agrometeorology			
Course status	**TEACHING SCHEME**	**EXAMINATION SCHEME**	**CREDITS ALLOTTED**
Core	**Theory:** 3hours/week	**Internal Assessment: 30 Marks** **End of Semester: 70 Marks**	**4**
Course Pre-requisite: Student should have basic knowledge of biology and chemistry.			
COURSE OBJECTIVES	1. Learn meteorological and agrometeorological observations. 2. Understand the process of solar radiation and its influences on crop plants. 3. Learn meteorological hazards and their impact on crop plants and the prevailing solution. 4. Learn available agro-meteorological forecast and utilization in improving crop productivity.		
COURSE OUTCOMES (CO)	By the end of the course, students will be able to: **CO1**. Understand the meteorological observation and its specific use in agricultural purposes. **CO2** Evaluate the solar radiation and its utilization by the crop plants. **CO3** Conceptualize the meteorological hazards and impact on the crops as well as the preventive measure to improve the crop health. **CO4** Forecast the agro-meteorological parameters for improving the crop yield and judicious use of the natural resources in crop productivity. **CO5** Estimate the meteorological conditions to assess the requirements for crop productivity **CO6** Gain the information about the study site.		

COURSE CONTENT	**Total No. of Lectures (60)**
Unit I Meaning and scope of agricultural meteorology; components of agricultural meteorology; roles and responsibilities of agricultural meteorologists; importance of meteorological parameters in agriculture; important meteorological processes to agriculture-importance of various micro environments on plant growth and development.	12
UNIT II Earth and its atmosphere in relation to sun and seasons; solar radiation; heat balance of earth and atmosphere; radiation in the atmosphere-energy balance; agrometeorological observations: air, surface and soil temperature, air and soil	12

humidity, vapour pressure, wind, precipitation, sunshine, radiation intensity, El Nino, La Nina, ENSO.		
UNIT III Phenology and seasonal changes of weather conditions; crop climatology-thermoperiodism, photoperiodism, thermal indices and phenology: heat unit and growing degree day concepts for crop phenology, crop growth and development; insect-pest development; agro-climatic requirement of crops.		12
UNIT IV Light distribution in the plant canopy, phototropism and photoperiodism, effect of meteorological factors on photosynthesis; Hydrological cycle: precipitation intensity, evaporation, infiltration, runoff, soil storage and hydrological balance, multiple cropping patterns for different soil climatic zones in India; Frost and frost fighting methods, hail damage and hail modification methods, Wind damage and wind breakers.		12
UNIT V Risks in agricultural production, history of weather and climate as accepted risk factors in agriculture; Risks of droughts; monitoring, prediction and prevention of drought; mitigating practices. Agrometeorological forecasts systems, short, medium and long-range forecasts; yield forecasts model, system stimulation its concept, application and importance, agro-met advisory services.		12
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 15 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks	
Suggested Reading:		

Texts/Reference Books:

1. *Brown, D. M. (1981). Agrometeorology: J. Seemann, YI Chirkov, J. Lomas and B. Primault. Springer—Verlag Berlin—Heidelberg—New York, 1979, 324 pp., US $53.90, DM 98.00.*
2. *Bishnoi, O. P. (2007). Principles of Agricultural Meteorology. Oxford Book Co.*
3. *Lenka, D. (1998). Climate, weather and crops in India. Kalyani Publishers. Reference Books*
4. *Smith, L.P. (1975). Methods in Agricultural Meteorology (Developments in Atmospheric Science), 3rd volume. Elsevier Science Ltd.*
5. *Mavi, H.S.., & Tupper, G. J. (2004). Agrometeorology Principles and Applications of Climate Studies in Agriculture. Haworth Press, Inc., New York/London/Oxford press, Cambridge, New York, Melbourne, Madrid, Cape Town, Singapore, São Paulo*
6. *Rao, G. (2008). Agricultural Meteorology. PHI Learning Private Ltd.*

M.Sc. Environment Science (2 years programme) Course Structure

Course: Environmental Lab-IV

Program: M.Sc. Environment Science (2 years) SEMESTER I			
Environmental Lab-IV			
Course status	**TEACHING SCHEME**	**EXAMINATION SCHEME**	**CREDITS ALLOTTED**
Core	**Practical:** 8hours/week	**Internal Assessment: 30 Marks** **End of Semester: 70 Marks**	**4**
Introduction to Remote Sensing and GIS software, Geo-referencing, Mosaicing, Fusion (Merging of high and low spatial and spectral resolution images), Image Sub-setting, Digital Image Processing.			
Preparation of Land Use/Land Cover Maps using visual and digital interpretation, Image Classification Supervised Unsupervised, Vectorizing and different functions of vector data using open-source GIS software.			
Sampling methods, physicochemical, biological parameters of water			
Determination of CO2 in the atmosphere by volumetric method. 2. Determination of physical parameters of (I) Well water (ii) Industrial of given type effluent (iii) River water (iv) Sea water. 3. Determination of Dissolved Oxygen from Sea water by Winkler's method. 4. Determination of Chemical Oxygen Demand value for industrial waste effluent			

M.Sc. Environment Science (2 years programme) Course Structure

Open Elective- I: Climate Change Mitigation and Adaptation

Program: M.Sc. Environment Science (2 years) **SEMESTER I**			
COURSE: Open Elective- I: Climate Change Mitigation and Adaptation			
Course status	**TEACHING SCHEME**	**EXAMINATION SCHEME**	**CREDITS ALLOTTED**
Core	**Theory:** 3hours/week	**Internal Assessment: 30 Marks** **End of Semester: 70 Marks**	**4**
Course Pre-requisite: Students should have basic knowledge of science.			
COURSE OBJECTIVES	1. Understand the Science of climate change, Earth's energy and interaction with the environment. 2. Understand the Climate Change Policy-Mitigation 3. Learn the broader view of energy, environment and climate change impacts. 4. Learn related global and national issues and to recognize suitable energy resources		
COURSE OUTCOMES (CO)	By the end of the course, students will be able to: **CO1**. Understand the concept of pollution and its impacts on humans, society and the environment **CO2** Link air pollution, types and sources of air pollutants with various impacts on the environment and human health **CO3**Understand the Climate Change Policy-Mitigation **CO4**Learn the broader view of energy, environment and climate change impacts. **CO5**Learn related global and national issues and to recognize suitable energy resources		

COURSE CONTENT	**Total No. of Lectures (60)**
Unit I Basic concepts and mechanisms: Science of climate change, global warming and greenhouse effect, radiative balance, earth's carbon reservoirs and carbon cycle, El Nino and La Nino, greenhouse gases in the atmosphere – sources, levels and mechanisms of action. Effects: Rise in earth's temperature; effects on forests;effects on agro ecosystems; desertification; effects on freshwater ecosystems; effects on oceans; sea level rise; melting of polar ice and glaciers; effects on rainfall patterns; extreme events, socio-economic and public health consequences.	12
UNIT II Climate Change Policy-Mitigation: Carbon storage and sequestration, carbon management through a biotic sequestration; oceanic and geologic injection, scrubbing and mineral carbonation; carbon management through biotic	

sequestration; forest ecosystems, wetlands; soil carbon sequestration; bio fuels, carbon farming and carbon trading		12
UNIT III Climate Change Policy Adaptation: Climate change impact assessment – applications for agriculture, sea level rise and health; vulnerability assessment; economics of adaptation, measurement of adaptation cost; issues in financingadaptation; case studies		12
UNIT IV International response: Intergovernmental panel for climate change (IPCC) and its role; United Nations framework convention on climate change (UNFCCC), CDM and Kyoto Protocol; the bali road map; The Copenhagen Accord; future actions; ethics of climate change.		12
UNIT V The Indian Scenario: Projected impact of climate change on India; temperature, rainfall, forests, agriculture, water resources; India's response to climate change; National Action Plan on climate change; India's position and actions vis-a-vis international programmes (UNFCCC, CDM and Kyoto Protocol, REDD+, Copenhagen Accord, etc.).		12
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 15 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks	
Suggested Reading:		

Texts/References:

1. *Climate Change: Causes, effects and solutions by JT Hardy. Publisher: John Wiley and Sons*
2. *Environmental Science- Physical Principles and Applications by Egbert Boeker & Rienk van Grondelle. Publisher: John Wiley & Sons, Ltd., New York*
3. *Trace Gas Emission and Plants by S. Singh. Publisher: Kluwer Academic Publishers.*
4. *The economics of climate change – The Stern Review by N Stern. Publisher: Cambridge University Press*
5. *Managing the Global Commons: The Economics of Climate Change by WD Nordhaus. Publisher: MIT Press*
6. *India and Global Climate Change: Perspectives on Economics and Policy from a Developing Country by MA Toman, U. Chakravorty & S Gupta. Publisher: RFF Press*
7. *Adaptation and mitigation strategies for climate change by Akimasa Suni, F Kensuke & AI Hiramatsu. Publisher: Springer.*
8. *Ecosystem diversity and carbon sequestration: climate change challenge and a way out for ushering in a sustainable future by PL Gautam, V Singh & U Melkania (Eds.). Publisher: Daya Publishing House, Delhi.*
9. *Climate Change and Developing Countries by NH Ravindranath, N Ravindranath & JA Sathaye. Publisher: Kluwer*
   Academic Publishers.
10. *Emissions trading and carbon Management by AN Sarkar. Publisher: Pentagon earth.*

11. Climate Change: A Multidisciplinary Approach (2nd edition.) by WJ Burroughs). Cambridge University Press.

12. Climate Change: An Indian perspective by Sushil Kumar. Publisher: Cambridge University Press India Pvt. ltd. New Delhi.

M.Sc. Environmental Science (2 years programme) Course Structure

Open Elective- II: Disaster Risk Reduction and Management

Program: M.Sc. Environment Science (2 years) SEMESTER I			
COURSE: Open Elective- II: Disaster Risk Reduction and Management			
Course status	**TEACHING SCHEME**	**EXAMINATION SCHEME**	**CREDITS ALLOTTED**
Core	**Theory:** 3hours/week	**Internal Assessment: 30 Marks** **End of Semester: 70 Marks**	**4**
Course Pre-requisite: Students should have basic knowledge of science.			
COURSE OBJECTIVES	1. Understand fundamentals of geoscience and the evolution of earth and its interiors 2. Understand the geological processes and related hazards, geological division, physical geology of India 3. Understand primary mineralogy and mining processes 4. Understand the National Guidelines and Plans on Disaster Management		
COURSE OUTCOMES (CO)	By the end of the course, the student will be able to: **CO1**. Understand the fundamentals of geoscience and evolution of earth and its interiors **CO2**. Gain knowledge about the geological division and physical geology of India **CO3**. Learn the mechanism of surface process and their agents like weathering, erosion, transportation, natural disasters etc. **CO4**. Link geological processes and related hazards like earthquakes, landslides, avalanches, GLOF, etc. **CO5.** Understand the concepts of groundwater processes and groundwater flow mechanism **CO6**. Gain basic understanding of National Guidelines and Plans on Disaster Management		
COURSE CONTENT			**Total No. of Lectures (60)**
Unit I Introduction: Concepts and definitions of Hazard, disaster, vulnerability, resilience, and risks; classification of disasters; brief introduction of Geological Disasters (earthquakes, landslides, tsunami, mining), Hydro-Meteorological Disasters (floods, cyclones, lightning, thunderstorms, avalanches, droughts, cold and heat waves); Biological Disasters (epidemics, pest attacks, forest fire); Technological Disasters (chemical, industrial, radiological, nuclear) and Man-made Disasters (building collapse, rural and urban fire, road and rail accidents); Global Disaster Trends – Emerging Risks of Disasters; Climate Change and Urban Disasters			12
UNIT II			

Disaster Management Cycle, Risk Reduction and managing risks Disaster Management Cycle; Principles of risk management, hazard and vulnerability mapping and analysis (physical, social, organizational, economical, technological). Developmental projects (dams, power plants etc.) and risk management; Evacuation, Communication, Search and Rescue; Emergency Operation Centre – Incident Command System; Relief and Rehabilitation; Post-disaster Damage and Needs Assessment; Restoration of Critical Infrastructure; Early Recovery – Reconstruction and Redevelopment		12
UNIT III Disaster Risk Reduction tools and capacity building Prevention and Mitigation of Disasters, Early Warning System; Preparedness, adaptive ecosystems management for disaster risk reduction; awareness during Disasters; Geoinformatics in Disaster Management (RS, GIS, GPS); Disaster Communication Systems (Early Warning and Its Dissemination); Land Use Planning and Development; Structural and Non-Structural Mitigation of Disasters; Role of print and electronic media during disasters. Community based disaster risk reduction. Health issues and hospital preparedness and response; System approach in disaster management.		14
UNIT IV Disasters and Ecosystems: Climate change and ecosystems-based management for disaster risk reduction and resilience;		10
UNIT V Disaster Management in India Disaster Management Act 2005; National Guidelines and Plans on Disaster Management; Role of Government (local, state and national), Non-Government and Inter-Governmental Agencies; National Disaster Management Authority (NDMA); NIDM (National Institute of Disaster Management), State Disaster Management Authorities, National Disaster Response Force; Institutional arrangement during disasters; S&T Institutions for Disaster Management in India.		12
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 15 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks	
Suggested Reading:		
Texts/References: *1. Environmental Hazards and Disasters-Contexts, Perspectives and Management Bimal Kanti Paul. Publisher: John Wiley & Sons.* *2. The role of ecosystems in disaster risk reduction by Fabrice G. Renaud, Karen Sudmeier-Rieux and Marisol Estrella (Ed). Publisher: United Nations University Press.* *3. Environmental Knowledge for Disaster Risk Management, National Institute of Disaster Management, New Delhi by AK Gupta & Sreeja S Nair.* *4. Disaster Management Act 2005 Govt, of India.* *5. Publications of National Disaster Management Authority (NDMA), and National Institute of Disaster Management (NIDM).* *6. Health Adaptation and Resilience to Climate Change and Related Disasters: A Compendium of*		

Case Studies 2021 by National Institute of Disaster Management

7. Compendium of Task Force Report on Ndma Guidelines Management of Glacial Lake Outburst Floods (GLOFs) by National Disaster Management Authority.

8. Disaster management and risk reduction by Vishwambhar Prasad Sati.

9. The Role of Ecosystems in Disaster Risk Reduction by Fabrice G. Renaud, Karen Sudmeier-Rieux, Marisol Estrella

10. Nature-based Solutions for Resilient Ecosystems and Societies by Shalini Dhyani, Anil Kumar Gupta & Madhav Karki