DR. RAM MANOHAR LOHIA AVADH UNIVERSITY, AYODHYA
FORMAT FOR DEVELOPING SYLLABUS FOR A SUBJECT
Proposed Structure of Syllabus for the
PROGRAM (M.Sc.), SUBJECT (Environmental Sciences)

Structure of Syllabus Developed by					
S.No.	Name of BoS Members	Designation	Department	College/ University	Signature
1.	Prof. C. K. Mishra	Dean, Science	Mathematics	Dr. RMLAU, Ayodhya	Online
2.	Prof. Siddhartha Shukla	Convener	Environmental Sciences	Dr. RMLAU, Ayodhya	S.Shukla 23.12.22
3.	Prof. Shikha Pandey	Member	Environmental Science	BBAU, Lucknow	Shikha 23/12/2022
4.	Prof. Jaswant Singh	Member	Environmental Sciences	Dr. RMLAU, Ayodhya	J.Singh 23/12/22
5.	Dr. V. K. Choudhary	Member	Environmental Sciences	Dr. RMLAU, Ayodhya	V.K.Choudhary 23/12/22

Course Code		Course Title	Credits	T/P	Evaluation	
					CIE	ETE
A	B	C	D	E	F	G
SEMESTER I (YEAR I)						
B150701T	CORE	Ecology and Environmental Biology	5	T	25	75
B150702T	CORE	Environmental Chemistry	5	T	25	75
B150703T	CORE	Natural Resource Management & Conservation	5	T	25	75
B150704T	FIRST ELECTIVE (Select any one)	Elementary Math	5	T	25	75
B150705T		Elementary Biology	5	T	25	75
B150706P	SECOND ELECTIVE (Select any one)	Lab Course I	5	P	50	50
B150707P		Field Visit: Report and Presentation	5	P	50	50
SEMESTER II (YEAR I)						
B150801T	CORE	Environmental Meteorology and Remote Sensing	5	T	25	75
B150802T	CORE	Environmental Microbiology and Biotechnology	5	T	25	75
B150803T	CORE	Environmental Geosciences	5	T	25	75
B150804T	THIRD ELECTIVE (Select any one)	General Environmental Aspects	5	T	50	50
B150805T		Community Health & Safety	5	T	50	50
B150806P	FOURTH ELECTIVE	Lab Course II	5	P	50	50

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B150807P	(Select any one)	Field Visit: Report and Presentation	5	P	50	50
		SEMESTER III (YEAR II)				
B150901T	CORE	Environmental Impact Assessment	5	T	25	75
B150902T	CORE	Environmental Policies & Laws	5	T	25	75
B150903T	CORE	Modern Analytical Techniques	5	T	25	75
B150904T	FIFTH ELECTIVE (Select any one)	Waste Treatment Design	5	T	25	75
B150905T		Solid & Hazardous Waste Management	5	T	25	75
B150906P	SIXTH ELECTIVE (Select any one)	Lab Course III	5	P	50	50
B150907P		Industrial Visit	5	P	50	50
		SEMESTER IV (YEAR II)				
B151001T	CORE	Environmental Engineering	5	T	25	75
B151002T	CORE	Forest and Wildlife Ecology	5	T	25	75
B151003P	SEVENTH ELECTIVE (Select any one)	Lab Course IV (Environmental Engineering)	5	P	50	50
B151004P		Lab Course V (Geo-informatics)	5	P	50	50
B151005P	RESEARCH PROJECT/ DISSERTATION	Major Research Project/ Dissertation	10	P	50	50

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Program Outcomes (POs):

- The program has been designed in such a way so that the students acquire strong theoretical and practical knowledge in various domains of environmental sciences.
- The programme includes detail information on Ecology and Environment, Various Environmental Pollutions, Wildlife, Environmental Impact Assessment, Geo Science, Climate Change, Environmental Biology, Bio-informatics, Instrumentation and Environmental Ethics. All these domains are supported with more comprehensive study along with deep knowledge on subject as its urgent requirement in society to develop a better future through formal way.
- The practical courses have been designed to equip the students with the laboratory skills in environmental sciences. Students will able to design and conduct experiments, as well as to analyze and interpret scientific data in useful form.
- The program will offer students with the knowledge and skill base that would enable them to undertake advanced studies in environmental sciences and related areas or in multidisciplinary areas that involve environmental sciences.
- The students will get exposure of wide range of careers that combine environmental management & impact assessment, remote sensing, Hazard management, Industrial safety, biodiversity & Wildlife management.
- The students will gain domain knowledge and know-how for successful career in academia, industry and research.
- Moreover, students will learn values for lifelong learning to meet the ever-evolving professional demands by developing ethical, inter personal and team skills.

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Semester wise Paper Titles with Details					
Year	**Semester**	**Paper**	**Paper Title**	**Prerequisite for Paper**	**Elective for Major Subjects**
Master in Environmental Sciences					
FIRST	SEMESTER I	Theory Paper – I (CORE) B150701T	Ecology and Environmental Biology	B.Sc. (Botany, Zoology, Environmental Science, Chemistry, Biochemistry, Biotechnology, Microbiology, Agriculture, Maths), B.tech / BE(civil , chemical	M.Sc. (Microbiology, Biotechnology, Biochemistry, Chemistry, Botany, Zoology, Geology, Geography)
		Theory Paper – II (CORE) B150702T	Environmental Chemistry	B.Sc. (Botany, Zoology, Environmental Science, Chemistry, Biochemistry, Biotechnology, Microbiology, Agriculture, Maths), B.tech / BE(civil , chemical)	M.Sc. (Microbiology, Biotechnology, Biochemistry, Chemistry, Botany, Zoology, Geology, Geography)
		Theory Paper – III (CORE) B150703T	Natural Resource Management & Conservation	B.Sc. (Botany, Zoology, Environmental Science, Chemistry, Biochemistry, Biotechnology, Microbiology, Agriculture, Maths), B.tech / BE(civil , chemical)	M.Sc. (Microbiology, Biotechnology, Biochemistry, Chemistry, Botany, Zoology, Geology, Geography)
		FIRST ELECTIVE (Select any one)	Elementary Math B150704T Elementary Biology B150705T	B.Sc. (Botany, Zoology, Environmental Science, Chemistry, Biochemistry, Biotechnology, Microbiology, Agriculture, Maths), B.tech / BE(civil , chemical)	M.Sc. (Microbiology, Biotechnology, Biochemistry, Chemistry, Botany, Zoology, Geology, Geography)
		SECOND ELECTIVE (Select any one)	Lab Course I B150706P Field Visit: Report and Presentation B150707P	B.Sc. (Botany, Zoology, Environmental Science, Chemistry, Biochemistry, Biotechnology, Microbiology, Agriculture, Maths), B.tech / BE(civil , chemical)	M.Sc. (Microbiology, Biotechnology, Biochemistry, Chemistry, Botany, Zoology, Geology, Geography)

	SEMESTER II	Theory Paper – I (CORE) B150801T	Environmental Meteorology and Remote Sensing	B.Sc. (Botany, Zoology, Environmental Science, Chemistry, Biochemistry, Biotechnology, Microbiology, Agriculture, Maths), B.tech / BE(civil, chemical)	M.Sc. (Microbiology, Biotechnology, Biochemistry, Chemistry, Botany, Zoology, Geology, Geography)
		Theory Paper – II (CORE) B150802T	Environmental Microbiology and Biotechnology	B.Sc. (Botany, Zoology, Environmental Science, Chemistry, Biochemistry, Biotechnology, Microbiology, Agriculture, Maths), B.tech / BE(civil, chemical)	M.Sc. (Microbiology, Biotechnology, Biochemistry, Chemistry, Botany, Zoology, Geology, Geography)
		Theory Paper– III (CORE) B150803T	Environmental Geosciences	B.Sc. (Botany, Zoology, Environmental Science, Chemistry, Biochemistry, Biotechnology, Microbiology, Agriculture, Maths), B.tech / BE(civil, chemical)	M.Sc. (Microbiology, Biotechnology, Biochemistry, Chemistry, Botany, Zoology, Geology, Geography)
		THIRD ELECTIVE (Select any one)	General Environmental Aspects B150804T Community Health & Safety B150805T	B.Sc. (Botany, Zoology, Environmental Science, Chemistry, Biochemistry, Biotechnology, Microbiology, Agriculture, Maths), B.tech / BE(civil, chemical)	M.Sc. (Microbiology, Biotechnology, Biochemistry, Chemistry, Botany, Zoology, Geology, Geography)
		FOURTH ELECTIVE (Select any one)	Lab Course II B150806P Field Visit: Report and Presentation B150807P	B.Sc. (Botany, Zoology, Environmental Science, Chemistry, Biochemistry, Biotechnology, Microbiology, Agriculture, Maths), B.tech / BE(civil, chemical)	M.Sc. (Microbiology, Biotechnology, Biochemistry, Chemistry, Botany, Zoology, Geology, Geography)
SECOND	**SEMESTER III**	Theory Paper – I (CORE) B150901T	Environmental Impact Assessment	B.Sc. (Botany, Zoology, Environmental Science, Chemistry,	M.Sc. (Microbiology, Biotechnology, Biochemistry, Chemistry, Botany,

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				Biochemistry, Biotechnology, Microbiology, Agriculture, Maths) , B.tech / BE(civil , chemical)	Zoology, Geology, Geography)
		Theory Paper – II (CORE) B150902T	Environmental Policies & Laws	B.Sc. (Botany, Zoology, Environmental Science, Chemistry, Biochemistry, Biotechnology, Microbiology, Agriculture, Maths) , B.tech / BE(civil , chemical)	M.Sc. (Microbiology, Biotechnology, Biochemistry, Chemistry, Botany, Zoology, Geology, Geography)
		Theory Paper– III (CORE) B150903T	Modern Analytical Techniques	B.Sc. (Botany, Zoology, Environmental Science, Chemistry, Biochemistry, Biotechnology, Microbiology, Agriculture, Maths) , B.tech / BE(civil , chemical)	M.Sc. (Microbiology, Biotechnology, Biochemistry, Chemistry, Botany, Zoology, Geology, Geography)
		FIFTH ELECTIVE (Select any one)	Waste Treatment Design B150904T Solid & Hazardous Waste Management B150905T	B.Sc. (Botany, Zoology, Environmental Science, Chemistry, Biochemistry, Biotechnology, Microbiology, Agriculture, Maths) , B.tech / BE(civil , chemical)	M.Sc. (Microbiology, Biotechnology, Biochemistry, Chemistry, Botany, Zoology, Geology, Geography)
		SIXTH ELECTIVE (Select any one)	Lab Course III B150906P Industrial Visit B150907 P	B.Sc. (Botany, Zoology, Environmental Science, Chemistry, Biochemistry, Biotechnology, Microbiology, Agriculture, Maths) , B.tech / BE(civil , chemical)	M.Sc. (Microbiology, Biotechnology, Biochemistry, Chemistry, Botany, Zoology, Geology, Geography)
	SEMESTER IV	Theory Paper – I (CORE)	Environmental Engineering B151001T	B.Sc. (Botany, Zoology, Environmental Science, Chemistry, Biochemistry, Biotechnology, Microbiology, Agriculture, Maths) ,	M.Sc. (Microbiology, Biotechnology, Biochemistry, Chemistry, Botany, Zoology, Geology, Geography)

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				B.tech / BE(civil , chemical)	
		Theory Paper – II (CORE)	Forest and Wildlife Ecology B151002T	B.Sc. (Botany, Zoology, Environmental Science, Chemistry, Biochemistry, Biotechnology, Microbiology, Agriculture, Maths) , B.tech / BE(civil , chemical)	M.Sc. (Microbiology, Biotechnology, Biochemistry, Chemistry, Botany, Zoology, Geology, Geography)
		SEVENTH ELECTIVE (Select any one)	Lab Course IV (Environmental Engineering) B151003P	B.Sc. (Botany, Zoology, Environmental Science, Chemistry, Biochemistry, Biotechnology, Microbiology, Agriculture, Maths) , B.tech / BE(civil , chemical)	M.Sc. (Microbiology, Biotechnology, Biochemistry, Chemistry, Botany, Zoology, Geology, Geography)
			Lab Course V (Geo-informatics) B151004P		
		RESEARCH PROJECT/ DISSERTATION	Major Research Project Dissertation B151005P	B.Sc. (Botany, Zoology, Environmental Science, Chemistry, Biochemistry, Biotechnology, Microbiology, Agriculture, Maths) , B.tech / BE(civil , chemical)	M.Sc. (Microbiology, Biotechnology, Biochemistry, Chemistry, Botany, Zoology, Geology, Geography)

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Program/Class: Master in Environmental Sciences	Year: First	Semester: I
Subject: Environmental Sciences		
Course Code: B150701T	Course Title: Ecology and Environmental Biology	

Course Objectives:

The aim of this course is to enable students to understand the basic concepts of ecology, ecosystem and the environment. Students will be able to learn about the ecological processes at all levels and how the environment and its resources are affected by the anthropogenic activities. They will be able to apply the basic ecological principles and concepts in order to meet the resource management and conservation goals. This course will provide students a sound knowledge and background for careers in research, conservation, resource management, consultation and teaching.

Course Outcomes:

After completion of this course, a student will be able to:

CO1: Understand the concept of ecology, its processes, tools and relation with the environment. They can describe the application of the scientific method to ecological experimentation in relation to environment.

CO2: Understand the ecosystem concept, its structure and function and how various living organisms interact with the abiotic components or environmental factors.

CO3: Learn how various group of organisms living together interacts with each other within a particular habitat and with the environmental factors. They will also understand the basic and advanced ecological sampling techniques in different ecosystems.

CO4: Examine how the movement of nutrient and energy flows between the biotic and abiotic factors. In addition, they will study about the productivity patterns, food chains, food webs, energy transfer and nutrient transfer at various trophic levels, and ecosystem dynamics.

CO5: Learn about different biogeographical zones in the world and India and will also learn about the various types of ecosystems.

Credits: 5	Course: core
Total Marks: 25+75	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-1-0

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Unit	Topics	No. of Lectures
I	Introduction to ecology and environmental sciences: Definitions, Objectives subdivisions and scope. Basic ecological tools and techniques. Relation between ecology and environmental sciences. General concepts of level of organization. Biosphere, Autecology and Synecology	12
II	Environment and abiotic components of ecosystem: Atmosphere. lithosphere and hydrosphere. Abiotic environmental factors (temperature, light, water, etc.), Different environmental laws and limiting factors (Liebig's law of minimum, Shelford's law of Tolerance, Combined concept of limiting factors).	12
III	Biotic components of: ecosystem: Biotic community (General characteristics of a community, Interdependence in a community and community metabolism) and ecological niche (concept definition and types of niche, Gause's Principle), ecological succession and community evolution. Population ecology: Population characteristics and regulation of population size. Inter and intra specific interaction (Positive and negative interaction). Ecological genetics, Quantitative analysis of plant community, Quadrates, Frequency, Density, Important Value Index (IVI).	12
IV	Dynamics of Ecosystems: Bio-geochemical cycle, Food chain and energy flow in ecosystems. Concepts of productivity and standing crops, ecological indicators, Ecological efficiencies, edge effect	12
V	Diversity of Ecosystems: Bio geography and different ecosystems of the world (Lake, Pond, marine, estuarine and terrestrial ecosystems) Biome concept, classification &distribution, characteristics of different biome	8

Suggested Readings:

1. E.P. Odum and G.W. Barrett. 2005. Fundamentals of Ecology. Cengage Learning India Pvt. Ltd. 2.
2. J.S. Singh, S.P. Singh and S.R. Gupta. 2008. Ecology, Environment & Resource Conservation. Anamaya Publications.
3. Dash, M.C.and Dash, S.P. 2009. Fundamentals of Ecology (3rd edn.). Tata McGraw-Hill Publishing Co., New Delhi.
4. Introduction to Environmental Engg. - GM Masters, Prentice Hall of India, 1991
5. Santra, S.C. 2005. Environmental Science (2nd edn.). Central Book Agency, Calcutta.
6. Sharma, P.D. 2011. Ecology and Environment (11thedn.). Rastogi Publication, Meerut.
7. Smith, T.M. and Smith, R.L. 2015. Elements of Ecology, Pearson Education, India.
8. Miller. G.T. 2004. Environmental Science. Thomson, California. 538 pgs.

This course can be opted as an elective by the students of following subjects: M. Sc Microbiology, Biotechnology, Biochemistry, Geology, Chemistry, Botany, Zoology, Geography, Agriculture

Suggested Continuous Evaluation Methods:

Total Marks: 25
House Examination/Test: 10 Marks
Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 10 Marks
Class performance/Participation: 5 Marks

Course prerequisites: To study this course, a student must have had the Environmental Sciences/ Geography/ Agriculture/ Botany/ Zoology/ Chemistry/ Biochemistry/ Microbiology/ Biotechnology/Geology in B.Sc.

Suggested equivalent online courses:

swayam.gov.in; ugcmoocs.inflibnet.ac.in; epgp.inflibnet.ac.in

Further Suggestions: None

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Program/Class: Master in Environmental Science	Year: First	Semester: I
Subject: Environmental Science		
Course Code: B150702T	**Course Title: Environmental Chemistry**	

Course Objectives:

The objective is to study about the concept of environmental chemistry, pollution and its effect on different environment matrices *viz.* air/water/soil/noise. To apprise students about various control measures of pollution problems. Gain knowledge about sustainable management of different wastes.

Course outcomes:

After completion of this course, a student will be able to:

CO1: Learn about the different aspects of environmental chemistry along with radioactive and, thermal pollution.

CO2: Understand the basic concept of pollution and its effect on environment. Develop understanding about history, sources, types and effect of air pollution. Gain skills on various control measures of pollution problems.

CO3: Develop understanding about history, sources, types and effect of water pollution, water quality standards, sewage and waste water treatment and recycling. To apprise students about marine pollution and control.

CO4: Understand the history, sources, types and effect of soil and noise pollution. Learn about the solid waste characterization and gain knowledge about sustainable management of different wastes.

CO5: Develop understanding of Bio-chemical toxicology (teratogenicity, carcinogenicity and mutagenicity), toxic chemicals in the environment. Also learn about xenobiotic its uptake, distribution, metabolism, accumulation and biotransformation.

Credits: 5	Core
Max. Marks: 25+75	Min. Passing Marks: 40
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-1-0	

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Unit	Topics	No. of Lectures
I	Fundamentals of environmental chemistry: stoichiometry, Gibbs energy, chemical potential, chemical equilibria, acid-base reactions, solubility product, solubility of gases in water, radioactive and, thermal pollution.	12
II	**Air:** Air chemicals speciation, particles ions and radicals in the atmosphere. Natural and anthropogenic source of pollution. Primary and Secondary pollutants, transport and diffusion of pollutants, gas laws governing the behavior of pollutants in the atmosphere. Oxygen and ozone chemistry, chemistry of air pollutants. Photochemical smog, methods of monitoring and control of air-pollution SO_2, NOx, CO, SPM. Effects of pollutants and human being, plants, animals, materials and on climate. Acid rain, greenhouse effect, air quality standards.	12
III	**Water:** chemistry of water, types, sources and consequences of water pollution, physicochemical and bacteriological sampling and analysis of water quality. Sewage and waste water treatment and recycling. Water quality standards. Concept of DO, BOD, COD, sedimentation, coagulation, filtration, redox potential. **Marine:** Sources of marine pollution and control, criteria employed for disposal of pollutants in Marine system, coastal management.	12
IV	**Soil:** Soil chemistry: inorganic and organic components of soil, nitrogen pathways and NPK in soils, physicochemical and bacteriological sampling and analysis of soil quality. Soil pollution and control. **Noise:** sources of noise pollution, measurement of noise and indices, effect of meteorological parameter on noise propagation, noise exposure level and standards, noise control and abatement measures, impact of noise on human health. **Solid Waste:** Sources and generation of solid waste, characterization, chemical composition, classification, different methods of disposal and management of solid waste (hospital and hazardous waste), recycling of waste materials, waste minimization technology.	12
V	**Bio-chemical toxicology:** Nature of toxicity, acute and chronic dose and time response relationship, teratogenicity, carcinogenicity and mutagenicity, toxic chemicals in the environment. Biotransformation of xenobiotics, uptake, distribution, metabolism, accumulation and excretion of xenobiotics.	8

Suggested Readings:

1. A text book of environmental chemistry and pollution control, Dara, S. S., S. Chand & Company Ltd, New Delhi.
2. Environmental Pollution, Khitoliya, R. K., S. Chand and Company, New Delhi.
3. Air Pollution, Rao. M. N. and Rao, H. V. N., Tata McGraw -Hill Publishing Company, New Delhi.
4. Environmental Pollution and Control, 4th edition, J. Jeffrey Peirce, Ruth E Weiner, E Aarne Vesilind, Boston Oxford Johannesburg Melbourne New Delhi Singapore.
5. Principles of Environmental Chemistry, 3rd edition, J. E. Girard, Jones & Bartlett Learning, Company, Burlington.

This course can be opted as an elective by the students of following subjects: M. Sc Microbiology, Biotechnology, Biochemistry, Geology, Chemistry, Botany, Zoology, Geography, Agriculture

Suggested Continuous Evaluation Methods:

Total Marks: 25
House Examination/Test: 10 Marks
Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 10 Marks
Class performance/Participation: 5 Marks

Course prerequisites: To study this course, a student must have had the Environmental Sciences/ Geography/ Agriculture/ Botany/ Zoology/ Chemistry/ Biochemistry/ Microbiology/ Biotechnology/Geology in B.Sc.

Suggested equivalent online courses:
swayam.gov.in; ugcmoocs.inflibnet.ac.in; epgp.inflibnet.ac.in

Further Suggestions: None

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Program/Class: Master in Environmental Sciences	Year: First	Semester: I
	Subject: Environmental Sciences	
Course Code: BI50703T	Course Title: Natural Resource Conservation and Management	

Course Objectives:

The objective is to study about natural resources (Mineral, Soil, Water, Energy, Forest), concept classification, conservation and management. To aware the necessity of natural and ecological resources and their management and conservation of ecological resources, recent initiatives of energy conservation. The basic knowledge of earth's resources and its optimum utilization for sustainable development.

Course Outcomes:

After completion of this course, a student will be able to:

CO1: Learn about the concept and classification of natural resources, importance and management of water resources, integrated water resources management, lake and river conservation program.

CO2: Learn about mineral resources and their reserves, resource cycle, ocean as new area for exploration, metallic and non-metallic deposits.

CO3: Learn about the soil management, role of organic matter and its maintenance, diagnosis of nutrient deficiencies, remedial measures and management techniques.

CO4: Learn about the classification of energy resources and fossil fuels, physico-chemical characteristics of non-renewable resources, principle of generation of renewable resources, bioenergy, energy use pattern in different parts of world, overview of current energy scenario and management.

CO5: Learn about the forest management, land use changes in India, captive plantation, community forest management, protected area management and conservation, integrated development program in forest area.

Credits: 5	Course: Core
Total Marks: 25+75	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-1-0

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Unit	Topics	No. of Lectures
I	**Natural resources:** concept and classification of natural resources, Management of water resources - concept and classification (Global water balance, Ice sheets and fluctuation of sea level, Human use of surface and groundwater, Groundwater pollution), Integrated water resources management, Watershed management: National Lake and river conservation program.	12
II	**Mineral resources and Environment:** Resources and Reserves. Resource cycle, Mineral and population, Ocean as new area of exploration of mineral resources. Ocean ore and recycling of resources mineral resources of Antarctica metallic and non-metallic default deposits.	12
III	**Soil management:** Soil loss and soil erosion. Conservation and management strategies. Role of organic matter and its maintenance, diagnosis of nutrient deficiencies. Remedial measures and management techniques	12
IV	**Energy Resources:** solar radiation and its spectral characteristics, Fossil fuels classification, composition, physic-chemical characteristics and energy content of coal, petroleum and natural gas. Principles of generation of hydroelectric power, tidal, ocean thermal energy conversion, wind, geothermal energy, solar collectors, photovoltaic, solar ponds, nuclear energy-fusion and fission: magneto hydrodynamic power, bioenergy- energy from biomass and biogas, anaerobic digestion, energy use pattern in different parts of worlds.	12
V	**Forest management:** Forest – land use changes in India – future demands of forest lands. Captive plantation, community forest management, forest rehabilitation, urban forestry, Protected area management and conservation. Integrated development program in forest area.	8

Suggested Readings:

1. Ecology Environmental Science and Conservation. J. S. Singh, S. P. Singh, S. R. Gupta. S. Chand Publication
2. Managing Natural Resources. Hrikesh N. Mishra, PHI Learning Publication.
3. Fundamentals of General Ecology, Life Safety and Environment Protection. Mark D Goldfein, Alexei V Ivanov and Nikolai V Kozhevnikov. Nova Science Publishers.
4. Essentials of Ecology and Environmental Sciences. S V S Rana, PHI Publication.
5. Environmental Science. Dr. Y. K. Singh. New Age International Publishers.
6. Fundamentals of Ecology and Environment. B. L. Chaudhary & Jitendra Pandey. Apex Publishing House.
7. Environmental Biology. Dr. P. S. Verma & V. K. Agarwal. S. Chand Publication
8. Natural Resources Conservation and Management. K. K. Singh. M. D. Publication Pvt Ltd.

This course can be opted as an elective by the students of following subjects: M. Sc Microbiology, Biotechnology, Biochemistry, Geology, Chemistry, Botany, Zoology, Geography, Agriculture

Suggested Continuous Evaluation Methods:

Total Marks: 25
House Examination/Test: 10 Marks
Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 10 Marks
Class performance/Participation: 5 Marks

Course prerequisites: To study this course, a student must have had the Environmental Sciences/ Geography/ Agriculture/ Botany/ Zoology/ Chemistry/ Biochemistry/ Microbiology/ Biotechnology/Geology in B.Sc.

Suggested equivalent online courses:

swayam.gov.in; ugcmoocs.inflibnet.ac.in; epgp.inflibnet.ac.in

Further Suggestions: None

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Program/Class: Master in Environmental Science	Year: First	Semester: I
Subject: Environmental Science		
Course Code: B150704T	**Course Title: Elementary Math**	
Course Objectives:		
The objective of this course will deepen the understanding of students in the fundamental statistical techniques and quip them with necessary components of mathematics which will develop the critical thinking, analytical, technical and problem-solving approach. This will enable the students to implement the use of these techniques in research and disciplines.		
Course outcomes:		
After completion of this course, a student will be able to: CO1: Understand the basics of biostatics tools, handling of data, measures of central tendency like mean, median and mode, Measures of probability CO2: Learn about the data distribution, test of hypothesis, t and x2 test, correlation and regression analysis. CO3: Learn about the Types of reasoning, Number series, letter series, codes, and relationships and Mathematical aptitude. CO4: Understand the structure and forms of arguments, Evaluating and distinguishing deductive and inductive reasoning, Simple and multiple uses for establishing the validity of arguments CO5: Learn about the data interpretation, Graphical representation and mapping of data, data and governance.		
Credits: 5	**FIRST ELECTIVE**	
Max. Marks: 25+75	**Min. Passing Marks: 40**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-1-0		

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Unit	Topics	No. of Lectures
I	Basic elements and tools of statistical analysis, probability, sampling, management and distribution of attributes. Distribution- normal, Poisson, binomial, Arithmetic, geometric and harmonic mean	12
II	Test of hypothesis and significance, t-test and Chi-square test; Correlation and regression analysis, one-way ANOVA	12
III	Types of reasoning, Number series, letter series, codes, and relationships, Mathematical aptitude (fraction, time & distance, ratio, proportion and percentage, profit and loss, interest and discounting, averages, etc.)	12
IV	Understanding the structure of arguments: Argument forms, the structure of categorical propositions, mood and figure, formal and informal fallacies, uses of language, connotations, and denotations of terms, the classical square of opposition, Evaluating and distinguishing deductive and inductive reasoning, Analogies, Venn diagram: Simple and multiple uses for establishing the validity of arguments	12
V	Sources, acquisition, and classification of data, Quantitative and qualitative data, Graphical representation (bar-chart, histograms, pie-chart, table-chart, and line-chart) and mapping of data, Data interpretation, Data and governance	8

Suggested Readings:

1. Elements of Biostatistics, Prasad. S., Rastogi Publications, Meerut.
2. S. C. Gupta and V. K. 1986. Kapoor. Fundamentals of Mathematical Statistics. S.Chand & Co.
3. Aslam Mahmood. 1993. Statistical Methods in Geographical Studies. Rajesh Publications, New Delhi.
4. Gupta, S. P. 2000. Statistical Methods. Sultan Chand & Sons, New Delhi.
5. Mathematics Text Book for Class XI, National Council of Educational Research and Training.2020
6. Verma, R.S. & Sukla, K.S. Text Book on Trigonometry, Pothishala Pvt. Ltd, Allahabad.1999
7. Gupta, S.C. & Kapoor, V.K. Fundamentals of Mathematical Statistics, S. Chand & Sons.2002
8. Ivo Duntsch and Gunther Gediga, Set, Relations, Functions, Methodos Publishers.2000

Suggestive digital platforms web links

This course can be opted as an elective by the students of following subjects: M. Sc Microbiology, Biotechnology, Biochemistry, Geology, Chemistry, Botany, Zoology, Geography, Agriculture

Suggested Continuous Evaluation Methods:

Total Marks: 25
House Examination/Test: 10 Marks
Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 10 Marks
Class performance/Participation: 5 Marks

Course prerequisites: To study this course, a student must have had the Environmental Sciences/ Geography/ Agriculture/ Botany/ Zoology/ Chemistry/ Biochemistry/ Microbiology/ Biotechnology/Geology in B.Sc.

Suggested equivalent online courses:

swayam.gov.in; ugcmoocs.inflibnet.ac.in; epgp.inflibnet.ac.in

Further Suggestions: None

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Program/Class: Master in Environmental Science	Year: First	Semester: I
Subject: Environmental Science		
Course Code: B150705T	**Course Title: Elementary Biology**	

Course Objectives:

The objective of this course introduces the students to the overview of the diversity of life and levels of organization and related functions in plants. The course shall make the students aware about the relationships between plants and their environment. At the end of the course, the students will get an insight about the foundation of plant biology which will help them in future research aspects in terms of environmental science.

Course outcomes:

After completion of this course, a student will be able to:

CO1: Understand the characteristics of living world and binomial nomenclature and kingdom of life.

CO2: Understand the concept of plant tissues, morphology, anatomy and functions and about the concept of physiology.

CO3: Learn about the plants and mineral nutrition and about the process of nitrogen cycle and ecological relationship.

CO4: Understand the concept of environmental stress and cellular response under various environmental conditions in plants.

CO5: Learn about the role and function of stress proteins and physiological response of plants to heavy metals.

Credits: 5	FIRST ELECTIVE
Max. Marks: 25+75	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-1-0

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Unit	Topics	No. of Lectures
I	Definition and characteristics of living organisms; Diversity in the living world; Binomial nomenclature; Five kingdom of life and basis of classification; Salient features of Monera, Protista, Fungi, Animalia and Plantae, Virus	12
II	Tissues in plants, Morphology, anatomy and functions of different parts of plants; Plant Physiology (Concepts of diffusion, osmosis, imbibitions, Movement of water, food, nutrients and gases)	12
III	Plants and mineral nutrition (Essential mineral, macro and micronutrients; Nitrogen cycle, biological nitrogen fixation), ecological relationship, conservation methods.	12
IV	Concept of environmental stresses; cellular responses under salinity, drought stress, high temperature, freezing stress and nutritional stress (N, P, Ca and Fe deficiencies) in plants.	12
V	Role of some common and specific stress proteins; Physiological response of plants to heavy metals (Ni, Co, Mn, Cu, Pb, Mg) toxicity; Role of metallothiones, phytochelatins and Antioxidant in plants.	8

Suggested Readings:

Suggestive digital platforms web links

This course can be opted as an elective by the students of following subjects: M. Sc Microbiology, Biotechnology, Biochemistry, Geology, Chemistry, Botany, Zoology, Geography, Agriculture

Suggested Continuous Evaluation Methods:

Total Marks: 25

House Examination/Test: 10 Marks

Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 10 Marks

Class performance/Participation: 5 Marks

Course prerequisites: To study this course, a student must have had the Environmental Sciences/ Geography/ Agriculture/ Botany/ Zoology/ Chemistry/ Biochemistry/ Microbiology/ Biotechnology/Geology in B.Sc.

Suggested equivalent online courses:

swayam.gov.in; ugcmoocs.inflibnet.ac.in; epgp.inflibnet.ac.in

Further Suggestions: None

23/12/22

Program/Class: Master in Environmental Science	Year: First	Semester: I
Subject: Environmental Science		
Course Code: B150706P	Course Title: Lab Course -I	

COURSE OBJECTIVES:

It Provides basics practical knowledge of Environmental Sciences & ecology. It covers basic ecological experiments.

Credits:5	Second Elective
Max. Marks: 50+50	Min. Passing Marks:40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 5

A. To determine the following parameters of grassland vegetation.

1. Minimum size and number of quadrates
2. Frequency of plant species and its comparison with Raunkiaer's standard diagram.
3. Density of plant species
4. Important Value Index (IVI)
5. Abundance in light and shaded area.

B. To analyze the following water quality parameters of given water sample

1. Dissolved oxygen (D.O.)
2. Biological oxygen demand (B.O.D.)
3. Chemical oxygen demand (C.O.D.)
4. Total Dissolved solid (T.D.S.) /Hardness / Alkalinity /Transparency / Turbidity
5. Heavy metals by rapid field test.

C. Miscellaneous:

1. To calculate the λ_{max} of the given compound by spectrophotometer
2. To calculate the λ_{max} of the given compound by colorimeter.
3. To determine the following productivity by chlorophyll content method.
4. To determine the primary productivity by light and dark bottle method.
5. To study the morphological and anatomical adaptation of the given hydrophytes/ xerophytes/ mesophyte.

D. Comments on following-

1. Autecology & Synecology
2. SMOG
3. Ecological Niche
4. Probability
5. Hypsometric/ hypsographic curve of ocean
6. Algal bloom
7. Ecological efficiency
8. Biome
9. Estuaries
10. Diagnosis of nutrient deficiencies in plants
11. Eucalyptus dilemma
12. Gene Pool
13. Sacred Grooves
14. Coral reefs
15. Fly ash utilization
16. Minamata Disease
17. Super Bug
18. Edge effect
19. Ecological Efficiency
20. Standing crop

E. Viva-Voce

F. Practical record/ Chart/ Model

23/12/22

Program/Class: Master in Environmental Science	Year: First	Semester: II
Subject: Environmental Science		
Course Code: B150801T	Course Title: Environmental Meteorology and Remote Sensing	

Course Objectives:

This course aims to provide students with a scientific grasp of the physical characteristics of the Earth's climate system as well as the processes and the factors that influence climate. The students will be able to demonstrate a thorough understanding of the atmosphere and climate as important components of the physical environment. The students will gain knowledge and concept about Remote Sensing and Geographic Information System (GIS). They will also acquire skill about the techniques, methodologies and various applications of Remote Sensing and GIS which is a powerful tool for geospatial analysis.

Course outcomes:

After completion of this course, a student will be able to:

CO1: Learn about the interaction between the earth and the atmosphere system. They will conceptualize the basics of the atmospheric elements and their function within the climate systems and also understand the general circulation of the earth.

CO2: Learn about the adiabatic processes and stability of the atmosphere. They will also understand about the wind system and formation and classification of the clouds.

CO3: Learn the components of climate system, its dynamics and the factors that influence the climate. They will understand the oceanic and continental influences and also learn about the impacts of climate change on various sectors of the environment.

CO4: Acquire knowledge about the basics of remote sensing and its physics. They will learn about different types of sensors and their characteristics. They will also learn about the electromagnetic spectrum and its interaction with earth and atmosphere.

CO5: Learn about types of sensing, interpretation of the data and its applications in environmental monitoring and assessment. They will also be able to understand about the principles of GPS and GIS.

Credits: 5	Core
Max. Marks: 25+75	Min. Passing Marks: 40
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-1-0	

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Unit	Topics	No. of Lectures
I	Earth as a planet: Motion of the earth, Earth's thermal environment and seasons, climate in India, Indian Monsoon and western disturbances, solar constant, Albedo, General Circulation.	12
II	Dry adiabatic and saturated adiabatic lapse rates, Stability of the atmosphere, Inversions, Local winds, Clouds- Their formation and classification, Artificial modification of Clouds.	12
III	Climatology-Climatic control, Elements and factors of climate and their interaction. Oceanic and Continental influence, Influence on environment, Climatic Change.	12
IV	Basic concepts of Remote Sensing, Physics of Remote Sensing, electromagnetic spectrum, terminologies. Principles of Radiation: Radiation Transfer, interaction of EMR with earth surface and atmosphere, Spectral reflectance of vegetation, soil and water, Interpretation principles and techniques.	12
V	Thermal and microwave sensing: basic concepts, Profiles: SAR, SLAR-operation, Characteristics of RADAR signals, earth surface characteristics influencing RADAR returns, Interpretation of microwave data, Application of remote sensing, G.P.S. and G.I.S	8

Suggested Readings:

1. Lutgens, Frederick K., Edward J. Tarbuck, and Dennis Tusa. The Atmosphere. Vol. 462. Englewood Cliffs, NJ, USA: Prentice-Hall, 2000.
2. Lal, D.S. 2021. Climatology, Sharda Pustak Bhawan, Prayagraj, ISBN-13: 978-9387028241
3. Ahrens, Donald C., 2009, Meteorology Today: An Introduction to Weather, Climate, and the Environment.
4. Burrough, P.A., McDonnell, R.A. and Lloyd, C.D. 2015. Principles of Geographical Information Systems. Oxford University Press.
5. Campbell, J.B. (2nd Ed), 1996. Introduction to Remote Sensing. Taylor and Francis.
6. Emery W. and Camps A., (2017) Introduction to Satellite Remote Sensing 1st Edition Atmosphere, Ocean, Land and Cryosphere Applications, Elsevier Publications
7. Solimini, D., (2016) Understanding Earth Observation: The Electromagnetic Foundation of Remote Sensing (Remote Sensing and Digital Image Processing) 1st Edition, Springer;

Suggestive digital platforms web links

This course can be opted as an elective by the students of following subjects: M. Sc Microbiology, Biotechnology, Biochemistry, Geology, Chemistry, Botany, Zoology, Geography, Agriculture

Suggested Continuous Evaluation Methods:

Total Marks: 25
House Examination/Test: 10 Marks
Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 10 Marks
Class performance/Participation: 5 Marks

Course prerequisites: To study this course, a student must have had the Environmental Sciences/ Geography/ Agriculture/ Botany/ Zoology/ Chemistry/ Biochemistry/ Microbiology/ Biotechnology/Geology in B.Sc.

Suggested equivalent online courses:
swayam.gov.in; ugcmoocs.inflibnet.ac.in; epgp.inflibnet.ac.in

Further Suggestions: None

23/12/22

Program/Class: Master in Environmental Sciences	Year: Second	Semester: II
Subject: Environmental Sciences		
Course Code: B150802T	**Course Title:** Environmental Microbiology and Biotechnology	

Course Objectives:

The objective of this course is to study about microbial diversity, algal blooms, microbiology of air, water and soil, alternative source of energy like hydrogen, principles of immunology, biodegradation of xenobiotics, use of bacteria, recombinant DNA technology, biopesticides, biofertilizer, industrial use of bacteria, food microbiology, microbiology of milk and milk products.

Course outcomes:

After completion of this course, a student will be able to:

CO1: Learn about the Microbial diversity, Microbial colonization, effect of environmental detriments, Algal blooms, biological interactions of microbes with plants and animals.

CO2: Learn about the Microbiology of air, water and soil. Alternative sources of energy like hydrogen. Utilization of treated effluent water.

CO3: Learn about the Principles of immunology, Inflammation and complement systems. Hypersensitivity (Allergy). AIDS and cancer. Bioremediation, biodegradation of xenobiotics and pollutants, Biosorption: Use of bacteria, fungi and algae in biosorption, Biomineralization and biolcaching.

CO4: Learn about the Recombinant DNA technology. Biopesticides, biodegradation of pesticides, hydrocarbon, plastic etc. Role of genetically engineered microbes in the environment. Microbial management of Hazardous waste and wastelands. Biofertilizer technology: Rhizome culture, Blue-green algae culture, Azolla culture and Mycorrhizae culture.

CO5: Learn about the concept Industrial use of bacteria, lactic acid, vinegar and amino acid production, alcoholic fermentation, penicillin production, vitamins and enzymes. Food microbiology, Microbiology of milk, milk products – sources and types of microorganisms, pasteurization.

Credits: 5	Core
Max. Marks: 25+75	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-1-0

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Unit	Topics	No. of Lectures
I	**Microbial diversity,** General classification, Microbial colonization, effect of environmental detriments (Temperature, radiation, salinity etc.), Algal blooms, biological interactions of microbes with plants and animals.	12
II	**Microbiology of air, water and soil.** Alternative sources of energy like hydrogen. Utilization of treated effluent water.	12
III	**Principles of immunology** – resistance, antigen immunity, antigen, antibody, binding and reaction mechanism. Immunological response to infectious disease. Inflammation and complement systems. Hypersensitivity (Allergy). AIDS and cancer. Bioremediation: Bioreactors for Bioremediation, Types of bioremediations (Natural, solid phase, slurry phase and bioventing), application of bioremediation, biodegradation of xenobiotics and pollutants, Biosorption: Use of bacteria, fungi and algae in biosorption, Biomineralization and bioleaching.	12
IV	**Recombinant DNA technology and its application.** Biopesticides, biodegradation of pesticides, hydrocarbon, plastic etc. role of genetically engineered microbes in the environment, guideline and ethics of their release. Microbial management of Hazardous waste and wastelands. Biotechnological approaches and steps involved in conventional and advance treatment technology. Biofertilizer technology: Rhizome culture, Blue-green algae culture, Azolla culture and Mycorrhizae culture. Benefits and significance of biofertilizers in agriculture.	12
V	**Industrial use of bacteria,** lactic acid, vinegar and amino acid production, alcoholic fermentation, penicillin production, vitamins and enzymes. Food microbiology – contamination and spoilage of fresh food, Preservation of food. Fermented food, food poisoning, Microbiology of milk, milk products – sources and types of microorganisms, pasteurization.	8

Suggested Readings:

1. Environmental Biotechnology, Bimal C. Bhattacharya &Rintu Banerjee, Oxford university press Publication
2. Environmental Biotechnology, S. V. S. Rana, Rastogi Publications. and Society. Valdiya K. S., University Press.
3. Microbiology, P. D. Sharma, Rastogi Publications.
4. Microbial Environment and Bioremediation. Dr. Alka Chauhan and Dr. Ashok Rathore. Discovery Publishing House Pvt Ltd.
5. An Introduction to Industrail Microbiology, Dr. P. K. SivaKumar, Dr. M. M. Joe, Dr. K. Sukesh, S. Chand Publication

Environmental Microbiology and Biotechnology, O. P. Singh and S. K. Dwivedi, New Age International Publishers.

This course can be opted as an elective by the students of following subjects: M. Sc Microbiology, Biotechnology, Biochemistry, Geology, Chemistry, Botany, Zoology, Geography, Agriculture

Suggested Continuous Evaluation Methods:

Total Marks: 25
House Examination/Test: 10 Marks
Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 10 Marks
Class performance/Participation: 5 Marks

Course prerequisites: To study this course, a student must have had the Environmental Sciences/ Geography/ Agriculture/ Botany/ Zoology/ Chemistry/ Biochemistry/ Microbiology/ Biotechnology/Geology in B.Sc.

Suggested equivalent online courses:
swayam.gov.in; ugcmoocs.inflibnet.ac.in; epgp.inflibnet.ac.in

Further Suggestions: None

23/12/22

Program/Class: Master in Environmental Sciences	Year: Second	Semester: II
Subject: Environmental Sciences		
Course Code: B150803T	Course Title: Environmental Geosciences	

Course Objectives:

The objective is to study about fundamental concept of geosciences, conservation of matter, earth's processes and geological hazard's introduction of oceanography, land use planning, environmental geochemistry, knowledge about most common method used to mitigate each type of hazardous natural process, techniques to utilize earth's resources and ways to mitigating its hazards

Course outcomes:

After completion of this course, a student will be able to:

CO1: Learn about the fundamental concept of environmental geosciences, conservation of matter in various geosphere, mean heat balance of the earth atmosphere system, general relationship between landscape, biome, and climate.

CO2: Learn about the earth's processes, concept of residence, catastrophic geological hazards, different natural disasters, prediction and perception of the hazards.

CO3: Learn about the composition of ocean water, horizontal and vertical distribution of temperature in ocean, sources of organic salinity in oceans sources, types, classification and distribution of marine deposits.

CO4: Learn about the land use planning, soil surveys in relation to land use planning, methods of site.

CO5: Learn about the concept of earth elements, classification and mobility of race elements, possible effects of imbalance of some trace elements, disease induces by human use of land.

Credits:5	Core
Max. Marks: 25+75	Min. Passing Marks:40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-1-0

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Unit	Topics	No. of Lectures
I	**Environmental Geosciences:** Fundamental concepts, Conservation of matter in various geospheres, lithosphere, hydrosphere, atmosphere. Mean heat balance of the earth atmosphere system. General relationship between landscape, biome and climate, El Nino, Droughts, tropical cyclones.	12
II	**Earth's processes and geological hazards:** earth processes: Concept of residence, times and rates of natural cycles. Catastrophic geological hazards. Study of floods, landslides, earthquakes. Volcanism and Avalanche. Prediction and perception of the hazards and adjustment to hazardous activities.	12
III	**Introduction: Composition of ocean water.** Horizontal and vertical distribution of temperature in ocean, source of organic salinity in oceans and its controlling factors. Sources and types of marine deposits, their classification and distribution.	12
IV	**Land use planning:** The land plan. Soil surveys in relation to land use planning. Methods of site selection and evolution.	12
V	**Environmental Geochemistry:** Concepts of Major, Trace and rare earth elements (REE). Classification of trace elements, mobility of trace elements. Trace elements and health. Possible effects of imbalance of some trace elements. Diseases induced by human use of land.	8

Suggested Readings:

1. Environmental Science. Botkin and Keller. Willey Publication.
2. Geology, Environment and Society. Valdiya K. S., University Press.
3. Introduction to Environmental Geology. Edward A Keller. Pearson Publication.
4. Fundamentals of Geology. A. B. Roy. Narosa Publication
5. Geochemistry and Environmental Geology. Umesh Kumar. Amiya Press Inc Publication
6. Environmental Geography. Savindra Singh. Pravalika Publication.
7. Economic Geology, Principles and Practices. Walter L Pohl. Willey Blackwell Publication
8. Environmental Geology. K. Knoddel, G. Lange and H. J. Voigta. Springer Publication

This course can be opted as an elective by the students of following subjects: M. Sc Microbiology, Biotechnology, Biochemistry, Geology, Chemistry, Botany, Zoology, Geography, Agriculture

Suggested Continuous Evaluation Methods:

Total Marks: 25
House Examination/Test: 10 Marks
Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 10 Marks
Class performance/Participation: 5 Marks

Course prerequisites: To study this course, a student must have had the Environmental Sciences/ Geography/ Agriculture/ Botany/ Zoology/ Chemistry/ Biochemistry/ Microbiology/ Biotechnology/Geology in B.Sc.

Suggested equivalent online courses:

swayam.gov.in; ugcmoocs.inflibnet.ac.in; epgp.inflibnet.ac.in

Further Suggestions: None

23/12/22

Program/Class: Master in Environmental Sciences	Year: First	Semester: II
Subject: Environmental Sciences		
Course Code: B150804T	Course Title: General Environmental Aspects	

Course Objectives:

The objective is to study about evolution, origin of life and speciation, environmental education and awareness and management, convention, different environmental issues in India, epidemiological issues, environmental priorities in India, fly ash, resettlement and rehabilitation process, wetlands conservation, desertification.

Course Outcomes:

After completion of this course, a student will be able to:

CO1: Learn about the evolution, origin of life and speciation human ecology, environmental education and awareness, environmental management.

CO2: Learn about convention on conservation of Antarctic marine living resources, treaty on principles governing the activities of state in the exploration and use of outer space, the citizens convention on biodiversity, intervention of oil pollution causalities.

CO3: Learn about the different environmental issues in India, formation and reclamation of wastelands, epidemiological issues.

CO4: Learn about the different environmental priorities in India, Sustainable development, urban and rural planning, power generation fly ash, resettlement and rehabilitation process.

CO5: Learn about the wetland conservation, water crisis and rainwater harvesting, water conservation, coastal management, desertification, coral reef conservation.

Credits: 5	Course: Third Elective
Total Marks: 25+75	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-1-0

23/12/22

Unit	Topics	No. of Lectures
I	Evolution, Origin of life and Speciation, Human ecology and human settlement, Environmental education and Awareness, Environmental management: meaning and need.	12
II	Convention on conservation of Antarctic Marine living resources (1980), Treaty on principles governing the activities of state in the exploration and use of outer space (1967). The citizens convention on biodiversity (1992), International convention on the high seas, fishing and living resources (1958), Intervention of oil pollution casualties (1969).	12
III	Environmental issues in India viz. Narmada Dam, Tehri Dam, Chipko movement, Beez Bachao Aandolan, Green revolution, Silent Valley movement, Urja gram, CNG implementation in Delhi, Formation and Reclamation of Waste lands: User, Alkaline and Saline soil. Epidemiological issues: Goiter, Fluorosis and Arsenic poisoning.	12
IV	Environmental priorities in India, Sustainable Development: Concept, Objectives and Principles, Challenges for sustainable development: Social, Political and Economic considerations, Role of individual and community in sustainable development. Urban and rural planning, power generation, fly ash: utilization of fly ash, disposal and recycling, resettlement and rehabilitation process.	12
V	Wetland conservation, Water crisis and rainwater harvesting, Water conservation, Coastal management: concept, scopes, uses and strategies, desertification and its control, Coral reef conservation.	8

Suggested Readings:

1. Concept of Environmental Sciences, Sugandha Mishra and Dhirendra Kumar, Rajesh Publication.
2. Environmental Management. Ajith Sonkar, Oxford Publication.
3. Environmental Ecology, Biodiversity, Climate Change and Disaster Management. Ravi P Agrahari. Mc Graw Hill Publication.
4. Environment. Manjunath Thamminidi. PMF IAS Publication.
5. Fundamentals of Environmental Science and Ecology. Zigma Publication.
6. Basics of Environmental Sciences. Michael Allaby. Atlantic Publishers and distributors.

This course can be opted as an elective by the students of following subjects: M. Sc Microbiology, Biotechnology, Biochemistry, Geology, Chemistry, Botany, Zoology, Geography, Agriculture

Suggested Continuous Evaluation Methods:

Total Marks: 25
House Examination/Test: 10 Marks
Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 10 Marks
Class performance/Participation: 5 Marks

Course prerequisites: To study this course, a student must have had the Environmental Sciences/ Geography/ Agriculture/ Botany/ Zoology/ Chemistry/ Biochemistry/ Microbiology/ Biotechnology/Geology in B.Sc.

Suggested equivalent online courses:

swayam.gov.in; ugcmoocs.inflibnet.ac.in; epgp.inflibnet.ac.in

Further Suggestions: None

23/12/22

Program/Class: Master in Environmental Sciences	Year: First	Semester: II
Subject: Environmental Sciences		
Course Code: B150805T	Course Title: Community Health and Safety	

Course Objectives:

This course will enable students to

- Know the outburst of diseases in rural and urban areas.
- Understand the behaviour of pathogens and Transmission of Diseases.
- To know about the prevention of Communicable diseases and Risk Approach.

Course Outcomes:

During this course, students will be trained:

- To understand the role and importance of transmission of various diseases in Urban and Rural Community.
- To understand the Dynamics of Disease Transmission.
- Control and remedial measures to maintain good Sanitation.
- Knowledge about water, wastewater and Solid waste management and
- Environmental administration.

Credits: 5	Course: Third Elective
Total Marks: 25+75	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-1-0

23/12/22

Unit	Topics	No. of Lectures
I	**Introduction:** Concept of Health, Communicable Diseases; Terminology,classification, Methods of communication, general methods and control. **Community Health and Sanitation:** Importance of Community Health, Environmental Sanitation, Rural and urban sanitation, Classification of Health- WHO, Physical, Mental, Social Health Science. Responsibility for Health.	12
II	**Concept of Diseases and Prevention:** Spectrum of Disease, Concept of prevention and Levels. preventive and Social medicine. Community medicine. Risk Approach. **Principles of Epidemiology:** Epidemiology and Aims of Epidemiology, Basic measurements, Common Sources of Epidemics and Control measures, Uses of Epidemiology.	12
III	**Dynamics of Disease Transmission:** Sources and Reservoirs: Human, Animal and non-Living things Routes of Transmission, Classification of Immunity Agents.	12
IV	**Disease Prevention and Control:** Source of Infection, Routes of Transmission, Immunization Cholera, Typhoid, Yellow Fever, Disinfection and Types.Environmental factors. **Insect Control:** House fly and Mosquito – Life cycle disease Transmission and control measures.	12
V	**Food and Milk Sanitation and Environmental Administration:** Food Poisoning, Types, Prevention and Control. Essentials and Test for milk quality, Pasteurization, Cattle Born Diseases. Health Care System at National level and Principles.	8

Suggested Readings:

1. Joseph. A. Salvato, by Environmental Sanitation.
2. E.W. Steel, Water Supply and Sanitary Engineering.
3. Environmental Sanitation and Eradication of Scavenging in India By Bindeshwar Pathak · 2015,Motilal Banarsidass Publishers Private Limited.
4. Environmental Sanitation By Baljeet S. Kapoor · 2001, S. Chand Limited.
5. Environmental Sanitation Health and Panchayati Raj By Bakshi Dayanath Sinha, P. S. K. Menon 2000, Institute of Social Sciences.
6. Environmental Sanitation and Community Water Supply Country Situation Analysis By K. J. Nath · 2000, the University of Michigan.

This course can be opted as an elective by the students of following subjects: M. Sc Microbiology, Biotechnology, Biochemistry, Geology, Chemistry, Botany, Zoology, Geography, Agriculture

Suggested Continuous Evaluation Methods:

Total Marks: 25
House Examination/Test: 10 Marks
Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 10 Marks
Class performance/Participation: 5 Marks

Course prerequisites: To study this course, a student must have had the Environmental Sciences/ Geography/ Agriculture/ Botany/ Zoology/ Chemistry/ Biochemistry/ Microbiology/ Biotechnology/Geology in B.Sc.

Suggested equivalent online courses:

swayam.gov.in; ugcmoocs.inflibnet.ac.in; epgp.inflibnet.ac.in

Further Suggestions: None

23/12/22

Program/Class: Master in Environmental Science	Year: First	Semester: II
Subject: Environmental Science		
Course Code: B150806P	Course Title: Lab Course -II	

COURSE OBJECTIVES:

It Provides basics practical knowledge of Environmental Sciences & ecology. It covers basic ecological experiments.

Credits:5	Fourth Elective
Max. Marks: 50+50	Min. Passing Marks:40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-3

A. Air quality

1. To determine the stack height on the basis of particulate matter concentration.
2. To determine the stack height on the basis of SO_2 concentration.
3. To determine the following air pollutants.
   a. NO_x
   b. SO_x
   c. SPM
   d. RSPM

B. To analyse soil for the following parameters.

1. Soil texture, temperature, pH analysis.
2. Organic matter analysis.
3. Water holding capacity.
4. Bulk density
5. heavy metals by rapid field test.

C. Microbiological experiments:

1. Isolation of bacteria from air, water and soil
2. Culture of Bacteria by pouring, streaking and spreading
3. Preservation of isolated bacterial colony
4. Morphological characterization of bacterial colony
5. Biophysical characterization of bacterial colony

D. Comments on following-

1. Biofertilizers
2. Metallic and non-Metallic minerals
3. Redox Potential
4. Hazardous waste
5. LC50 and LD50
6. Albedo
7. Atmospheric stability
8. Wind rose
9. GPS
10. Tropical cyclone
11. Heat balance
12. Hydrogen Energy
13. Hyper Sensitivity
14. Bioleaching
15. Biopesticides
16. Pasteurization
17. Fermentation
18. Bioremediation
19. Biosorption
20. Trace elements

E. Viva-Voce

F. Practical record/ Chart/ Model

23/12/22

Program/Class: Master in Environmental Sciences	Year: Second	Semester: III
Subject: Environmental Sciences		
Course Code: B150901T	Course Title: Environmental Impact Assessment	

Course Objectives:

The objectives of the course are to learn, understand and identify the environmental issues/ problems. The course will provide formal knowledge on prevention, control, mitigation of problems. Along with these, suggested alternate ways are helpful to maintain Environmental balance. This course will provide student capacity to identify the possible impact of any developmental activity in society through the EIA. The risk assessment and Economics of the Environment are very well described for student to execute the developmental projects. Overall, this course is fruit full knowledge to students willing to serve in Industries/ NGO's and other sectors.

Course outcomes:

After completion of this course, a student will be able to:

CO1: Acquired basic knowledges of Environmental management with Ecological significance.

CO2: Get the theoretical knowledge of various aspects of EIA and their practical applications.

CO3 Enhance understudying about Environmental Economics and Social Ethics.

CO4: Provide knowledge on different EIA Projects and Role of Public in Environmental protection and decision making.

CO5: Prepare EIA report and will be able for auditing of any developmental projects.

Credits:5	Core
Max. Marks: 25+75	Min. Passing Marks:40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-1-0

23/12/22

Unit	Topics	No. of Lectures
I	**Environmental management:** Concept, Aspect and Approaches of the Environmental Management. Ecological basis of the Environmental Management. Agroclimatic Regional Planning. **Risk Assessment:** Basic component of Hazard Control System, Technique of risk assessment. Emergency Control and disaster planning	12
II	**Environmental Impact Assessment**: Introduction, Concept, aim, Impact statement, methods and process. Prediction and assessment of impacts on Air, water and noise. Environmental Protection and EIA Notifications 2006 and 2020 of Govt. of India	12
III	**Environmental Economics:** Economic Environmental Management, Economics of pollution control, Cost Benefit Analysis. Environment Economic Growth, GNP and quality of life. Discount factors and Sustainable earth Economy. **Environmental Ethics:** Ethics and Moral, Society ethics, Sustainable earth Society ethics. Ethical Guidelines	12
IV	Public participation in Environmental decision making. Prediction and assessment of impact on the biological, cultural and socioeconomic environment. **EIA of Major Projects**: industries, mining, thermal power plants, atomic power station, transport (Rail, Road highway), tourism (hotels, beaches and resorts) and River valley project.	12
V	EIA report preparation, EIA of different Xenobiotics (Chemical, Fertilizers and heavy Metals). **Environmental audit:** Introduction, concept and steps involved	8

Suggested Readings:

1. Concept of Environmental Management for Sustainable Development by M.C. Dash, Wiley publisher
2. Trends in Environmental Management by A. G. Devi Prasad, Astral Publication
3. Environmental Impact Assessment by Peter Wathern, Brunner-Routledge, ISBN-13 9780415078849.
4. Environmental Impact Assessment by Gorge Alex, Blue Rose Publishers, ISBN- 9789389763812
5. A Hand Book of Environmental Audit by Hemant Pathak, Kindle Edition, ASIN- B0132D5PAG
6. Suggestive digital platforms web links

This course can be opted as an elective by the students of following subjects: M. Sc Microbiology, Biotechnology, Biochemistry, Geology, Chemistry, Botany, Zoology, Geography, Agriculture

Suggested Continuous Evaluation Methods:

Total Marks: 25
House Examination/Test: 10 Marks
Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 10 Marks
Class performance/Participation: 5 Marks

Course prerequisites: To study this course, a student must have had the Environmental Sciences/ Geography/ Agriculture/ Botany/ Zoology/ Chemistry/ Biochemistry/ Microbiology/ Biotechnology/Geology in B.Sc.

Suggested equivalent online courses:

swayam.gov.in; ugcmoocs.inflibnet.ac.in; epgp.inflibnet.ac.in

Further Suggestions: None

23/12/22

Program/Class: Master in Environmental Sciences	Year: Second	Semester: III
Subject: Environmental Sciences		
Course Code: B150902T	Course Title: Environmental Policies and Laws	

Course Objectives:

The objectives of the course are to learn and understand the fundamentals knowledge of Environmental Policy and Law. This course provide jurisdiction with natural resources as applied strictly in society regarding prevention and control of Pollution. Beside the Scientific and Engineering approaches for pollution control, this course provides administrative approach to balance the Environmental resource and their sustainable utilization. This course offers to students for critical thinking for past present and future situation and encourage for development of policy and laws including amendment needed.

Course outcomes:

After completion of this course, a student will be able to:

CO1: Learn about Indian Policies and laws in reference to mitigate Environmental problems.

CO2: Provide knowledge and understanding of Water Act (1974), Air Act (1981) and Environmental Protection Act (1986).

CO3: Understand about Regulation for Management of Hazardous substances.

CO4: Understand detailed information on PIA, PLIA, Tribunal Act, and the organizations directly involved in protection of Environment.

CO5: Learn about Movements and cases filed in India for protection of Environment and life.

Credits:5	Core
Max. Marks: 25+75	Min. Passing Marks:40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-1-0

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Unit	Topics	No. of Lectures
I	Environmental Protection: Current Environmental issues and problems. National and international Efforts for Environmental Protection. Environmental policies in India. PSAP, 1992 and NCSPED 1992. Provision of Constitution of India and amendments (Article 48, Article 51A (g), Article 253.	12
II	The water (Prevention and Control of Pollution) Act 1974; The water rule, 1975; The Air (Prevention and Control of Pollution) Act 1981; The Air rule, 1982; Environmental protection Act, 1986; Forest Conservation Act, 1980; Wildlife protection Act, 1972 and amendment; Noise Pollution (Control and Regulation) Rule, 2000; Motor Vehicle Act, 1988.	12
III	Regulations for management of Hazardous Substances: Hazardous waste (management and handling) Rule, 1989. Manufacturer, Use, Export, Import, and storage of Hazardous Microorganisms and Genetically engineered Cell Rule, 1989.Hazardous chemical (manufacture, storage and Import) Rules 1998. Biomedical waste Rule, 1998.	12
IV	Public Liability insurance Act, 1991; National Environmental tribunal Act, 1995; Public Interest Litigation (cases filed and movements) in India, National Organization dealing with Environmental issues, Famous Environmental Conventions.	12
V	Case studies to be taken up: M.C. Mehta Vs Union of India: Ganga pollution case of tanneries; AIR-1988 SC 1037 (1987); M.C. Mehta Vs Union of India: Ganga pollution (Municipalities); AIR-1988 SC 1115 (1988); R.L. and E Kendra Dehradun Vs State of U.P. (Dehradun quarrying case, AIR 1985 SC 652 and Banwasi sewa Ashram Vs. State of U.P. AIR, 1987, SC 374.	12

Suggested Readings:

1. Environmental Law by Gurdip Singh, Eastern Book Company
2. Environmental Law and Policy by Aruna Venkat, Eastern Economy Edition, ISBN No. 978-81-203-4436-5.
3. Environment and Pollution Laws by S.K. Mohanty, Universal Law Publishing Co. Pvt. Ltd. ISBN: 81-7534-3680
4. Environmental Regulation: Law, Science, and Policy by Robert V. Percival, Christopher H. Schroeder, Alan S. Miller, James P. Leape, Aspen Publishing, ISBN:9781454897729, 1454897724

5. Suggestive digital platforms web links Suggestive digital platforms web links

This course can be opted as an elective by the students of following subjects: M. Sc Microbiology, Biotechnology, Biochemistry, Geology, Chemistry, Botany, Zoology, Geography, Agriculture

Suggested Continuous Evaluation Methods:

Total Marks: 25
House Examination/Test: 10 Marks
Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 10 Marks
Class performance/Participation: 5 Marks

Course prerequisites: To study this course, a student must have had the Environmental Sciences/ Geography/ Agriculture/ Botany/ Zoology/ Chemistry/ Biochemistry/ Microbiology/ Biotechnology/Geology in B.Sc.

Suggested equivalent online courses:

swayam.gov.in; ugcmoocs.inflibnet.ac.in; epgp.inflibnet.ac.in.

Further Suggestions: None

23/12/22

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Program/Class: Master in Environmental Science	Year: Second	Semester: III
Subject: Environmental Science		
Course Code: B150903T	**Course Title: Modern Analytical Techniques**	

Course Objectives:

COURSE OBJECTIVES:

Bio analytical techniques are used to understand the theoretical principles involved in bioinstrumentation which may further utilized for the determination of different environmental matrices (water, air, soil etc.) major ions and trace elements together with the analytical techniques. This will enable the students to implement the use of these techniques in research and in developing new products/methods for a sustainable growth.

Course outcomes:

After completion of this course, a student will be able to:

CO1: Acquaint with basic instrumentation, principle and procedure of various sophisticated instruments.

CO2: Get the theoretical knowledge of various models and their practical applications.

CO3 Learn about Chromatography & Electrophoresis. They will also learn different types of samplers and sample preservation.

CO4: Implement the use of instruments like microscopy, pH meter, refractometer, nephelometer, biochips, and smoke meter. CO5: To apprise students about computer basics, communication technology, MS Windows, MS office and application of computer in environmental modelling and forecasting.

Credits:5	Core
Max. Marks: 25+75	Min. Passing Marks:40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-1-0

23/12/22

Unit	Topics	No. of Lectures
I	Principal of analytical methods: titrimetry, gravimetry, colorimetry, spectrophotometry (atomic absorption spectrophotometry, X-ray fluorescence, X-ray diffraction, flame photometry, NMR ESR spectroscopy)	12
II	Models of population growth and interaction- Lotka-Volterra model, Leslie's Matrix model, point source stream pollution model, box model, Gaussian plume model.	12
III	Chromatography, gas chromatography, GLC, HPLC, Electrophoresis, filtration. Samplers- types, methods of sample preservation.	12
IV	Biosensors: Radioactive techniques and scintillation counter, microscopy (Compound, Phase contrast, fluorescent, electron microscopy), pH meter, refractometer, nephelometer, biochips, smoke meter.	12
V	Introduction and history of computer, computer basics, communication technology and information superhighway, IT tools, MS Windows MS office (MS word, MS PowerPoint, MS excel). Application of computer in environmental modelling and forecasting.	8

Suggested Readings:

9. Elements of Biostatistics, Prasad. S., Rastogi Publications, Meerut.
10. Vogel's Text Book of Quantitative Inorganic Analysis, Barnes, J.D. J., Denney, R.C., Jeffery, G.H. and Mendham, J., 6th Edition, Pearson Education Ltd., U.K.
11. Instrumental Methods of Chemical Analysis, Sharma, B.K. (2005), Goel Publishing House, Meerut, India.
12. Instrumental methods of analysis, Malathi, S., Patil, P. M., Kumar, S. (2020). Thakur publications (pvt.) Ltd, Lucknow, India.

Suggestive digital platforms web links

This course can be opted as an elective by the students of following subjects: M. Sc Microbiology, Biotechnology, Biochemistry, Geology, Chemistry, Botany, Zoology, Geography, Agriculture

Suggested Continuous Evaluation Methods:

Total Marks: 25

House Examination/Test: 10 Marks

Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 10 Marks

Class performance/Participation: 5 Marks

Course prerequisites: To study this course, a student must have had the Environmental Sciences/ Geography/ Agriculture/ Botany/ Zoology/ Chemistry/ Biochemistry/ Microbiology/ Biotechnology/Geology in B.Sc.

Suggested equivalent online courses:

swayam.gov.in; ugcmoocs.inflibnet.ac.in; epgp.inflibnet.ac.in

Further Suggestions: None

23/12/22

Program/Class: Master in Environmental Science	Year: Second	Semester: III
Subject: Environmental Science		
Course Code: B150904T	Course Title: Waste Treatment Design	
Course Objectives:		
COURSE OBJECTIVES: This course focuses on the application of theory and engineering experience to the design of unit operations for the treatment of wastewater and sewage. It covers characteristics of wastewater; wastewater regulations; primary, secondary & tertiary treatment processes; selected topics on advanced treatment and resource recovery; sludge disposal; and design of water, wastewater and sewage treatment plants. At the end of the course, the students will have a working knowledge of the wastewater industry and have the skills to perform a preliminary design of a treatment plant.		
Course outcomes:		
After completion of this course, a student will be able to: • Describe different methods for wastewater treatment and environmental effects of wastewater • Apply methods from mathematical modelling to describe different waste water treatment processes • Apply simulation tools for waste water treatment, and to interpret and evaluate the results • Grasp the microbiological processes in the activated sludge process • Apply the knowledge of preliminary design of a treatment plant.		
Credits:5	Fifth Elective	
Max. Marks: 25+75	Min. Passing Marks:40	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-1-0		

23/12/22

Unit	Topics	No. of Lectures
I	Introduction: Pollutants in water and wastewater - characteristics, Standards for performance - Significance and need for physico-chemical treatment; Industrial activity and Environment, Uses of Water by industry, Sources and types of industrial wastewater, Industrial wastewater and environmental impacts.	12
II	Wastewater treatment – aerobic, anaerobic, suspended and attached growth systems. Microbial Treatment - Degradation of high concentrated toxic pollutants, hydrocarbons metals. Rural wastewater systems – Septic tanks, two-pit latrines, Eco-toilet, soak pits.	12
III	Design of conventional water treatment units, - Aeration, chemical dosing tanks, Flash mixers, Flocculators, Sedimentation tanks, Clariflocculators, filter beds, disinfection units - hydraulic profile and layout of conventional treatment units - upgrading of existing plants - Residue management.	12
IV	Design of sewage treatment plant units - screen chamber, Grit chamber with proportional flow weir, sedimentation tank - Trickling filters, Rotating Biological contactor, activated sludge process & variations, aerated lagoons, waste stabilization ponds - reclamation and reuse - Flow charts, layout, hydraulic profile.	12
V	Management of treatment plants: Individual and Common Effluent Treatment Plants, zero effluent discharge systems, Quality requirements for Wastewater reuse, Industrial reuse - Disposal on water and land, Quantification and characteristics of Sludge - Thickening, digestion, conditioning, dewatering and disposal of sludge - Management of RO rejects.	8

Suggested Readings:

1. Davis, Mackenzie L., Water and Wastewater Engineering: Design Principles and Practice, 2nd Edition, McGraw-Hill, New York, 2010.
2. Metcalf and Eddy, Wastewater Engineering: Treatment and Resource Recovery, Fifth Edition, Metcalf & Eddy, Inc., McGraw-Hill Publishers, New York, 2013.
3. Tchobanoglous, G., et al., Wastewater Engineering: Treatment, Disposal, and Reuse, Fifth Edition, Metcalf & Eddy, Inc., McGraw-Hill Publishers, New York, 2013.
4. Crittenden, J.C., et al., Water Treatment Principles and Design, 2nd Ed., Montgomery, Inc., John Wiley and Sons, New York, 2005.
5. Reynolds, T.D., Richards, P.A., Unit Operations and Processes in Environmental Engineering, PWS Publishing Company, Boston, 1996.
6. Waste water Engineering Treatment and Reuse: Mc Graw Hill, G. Tchobanoglous, FI Biston, 2002.

Suggestive digital platforms web links

This course can be opted as an elective by the students of following subjects: M. Sc Microbiology, Biotechnology, Biochemistry, Geology, Chemistry, Botany, Zoology, Geography, Agriculture

Suggested Continuous Evaluation Methods:

Total Marks: 25
House Examination/Test: 10 Marks
Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 10 Marks
Class performance/Participation: 5 Marks

Course prerequisites: To study this course, a student must have had the Environmental Sciences/ Geography/ Agriculture/ Botany/ Zoology/ Chemistry/ Biochemistry/ Microbiology/ Biotechnology/Geology in B.Sc.

Suggested equivalent online courses:
swayam.gov.in; ugcmoocs.inflibnet.ac.in; epgp.inflibnet.ac.in

Further Suggestions: None

23/12/22

Program/Class: Master in Environmental Science	Year: Second	Semester: III
Subject: Environmental Science		
Course Code: B150905T	**Course Title: Solid and Hazardous Waste Management**	
Course Objectives:		
COURSE OBJECTIVES: Understanding of problems of municipal waste, biomedical waste, hazardous waste, e-waste, industrial waste, etc. Knowledge of legal, institutional and financial aspects of management of solid wastes. Become aware of environment and health impacts and solid waste mismanagement. Understanding engineering, financial and technical options for waste management.		
Course outcomes:		
CO1: Identify the different sources of solid wastes, Hazardous and e- wastes, Physico-chemical and biological characteristics of theses wastes. CO2: Execute the relevant method of collection and transportation of solid waste. CO3: Implement the relevant method for disposal of bio-medical and radioactive waste. CO4: Implement the relevant method for disposal of industrial waste and e-waste. CO5: Implement the relevant laws and role of public related to solid waste management.		
Credits:5	**Fifth Elective**	
Max. Marks: 25+75	**Min. Passing Marks:40**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-1-0		

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Unit	Topics	No. of Lectures
I	Introduction to solid wastes (Municipal, Agricultural, Industrial), Hazardous wastes (biomedical and radioactive wastes) and e- wastes, Physico-chemical and biological characteristics of these wastes, Effects of these wastes on environment	12
II	Solid waste: sources, types (Municipal, Agricultural, Industrial) storage, collection and transportation. Management of solid wastes.	12
III	Hazardous waste: Biomedical and radioactive wastes, sources, storage collection and transportation. Management of biomedical and radioactive wastes.	12
IV	E-wastes: sources, storage, collection and transportation. Management of e- wastes	12
V	Integrated waste management, Role of public in waste management Current scenario of solid and hazardous wastes problems at National and International level.	8

Suggested Readings: Batstone R., Smith J. E. and Wilson D. (1989). The safe disposal of hazardous wastes, the special needs and problems of developing Countries, The world bank technical Paper No 93Vol. I, II and III, Washington DC, The world bank.

Gupta, O. P. Elements of Solid Waste Management, Khanna Book Publishing Co. Delhi Ed. 2018.

Hosetti, B. B., Prospect and Perspectives of Solid Waste Management, New Age International Publisher.

Suggestive digital platforms web links

This course can be opted as an elective by the students of following subjects: M. Sc Microbiology, Biotechnology, Biochemistry, Geology, Chemistry, Botany, Zoology, Geography, Agriculture

Suggested Continuous Evaluation Methods:

Total Marks: 25

House Examination/Test: 10 Marks

Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 10 Marks

Class performance/Participation: 5 Marks

Course prerequisites: To study this course, a student must have had the Environmental Sciences/ Geography/ Agriculture/ Botany/ Zoology/ Chemistry/ Biochemistry/ Microbiology/ Biotechnology/Geology in B.Sc.

Suggested equivalent online courses:

swayam.gov.in; ugcmoocs.inflibnet.ac.in; epgp.inflibnet.ac.in

Further Suggestions: None

23/12/22

Program/Class: Master in Environmental Science	Year: Second	Semester: III
Subject: Environmental Science		
Course Code: B150906P	Course Title: Lab Course -III	

COURSE OBJECTIVES:
It Provides basics practical knowledge of Environmental Sciences & ecology. It covers basic ecological experiments.

Credits:5	Sixth Elective
Max. Marks: 50+50	Min. Passing Marks:40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-6

A. Analysis of the following Soil parameter

1. Qualitative analysis of Carbonate a Nitrate in soil.
2. Estimation of total Nitrogen in given soil sample.
3. Estimation of Phosphorus in given soil sample.
4. Estimation of Potassium in given soil sample.

B. Noise level and solid waste analysis in urban area

1. To determine the noise levels of residential institutional and industrial area
2. To determine the noise exposure index by sound level meter.
3. To determine the noise level different distance from the source by calculation method.
4. To analyse the composition of solid waste
5. To analyse moisture content of given solid waste
6. To determine compostable organic matter in given solid waste

C. Miscellaneous:

1. To determine the flow of liquid by laminar flow bench.
2. To determine and compare humus contents of polluted & unpolluted soils.
3. Determination of oxygen absorbed in four hours by the organic matter of sewage water sample.
4. Rf. Value of the given sample by thin layer chromatography.
5. Rf. Value of the given sample by paper chromatography.

D. Comments on following-

1. PIL
2. IPR
3. Eco-mark
4. Electrophoresis
5. GEM
6. Scintillation counter
7. Smoke meter
8. OTEC Point count method
9. Silent Valley movement
10. Slash and burn cultivation
11. JFM
12. Mass balance of water
13. Scoping
14. Delphi Approach
15. Box Model
16. Checklist method
17. Gaussian Plume Model
18. Trickling filter
19. Oxidation pond
20. Hazardous substances

E. Viva-Voce

F. Practical record/ Chart/ Model

23/12/22

Program/Class: Master in Environmental Sciences	Year: Second	Semester: IV
Subject: Environmental Sciences		
Course Code: B151001T	Course Title: Environmental Engineering	

Course Objectives:

The objective is to study about general principles and application of chemical engineering, basic knowledge on mathematical model construction and analyse environmental problems mathematically, heat and mass transfer, the packed column, various types of packing, chemical process industries, elements of Hydraulics – principles of fluids.

Course Outcomes:

CO1: Learn about the general principles and application of chemical engineering. Heat transfer: different methods, Heat exchangers – evaporators. Basic principles of radiation. Handling of toxic and Hazardous materials.

CO2: Learn about the Mass transfer: Ideal mixtures, Rault and Henery's laws, X – Y diagrams – the distillation columns, reflux ratio, ideal plate, and estimation of the number of ideal plates by Mc cabeThiels method.

CO3: Learn about the packed column, various types of packing, Requisite properties of packing, Channelling and flooding – Introduction of liquid – liquid extraction. Solid – liquid separation: filtration, Filtration equipments (details) Centrifuges, Sedimentation continuous thickener, solid – gas separation, Cyclone, electrostatic precipitators, bag filters and scrubbers.

CO4: Learn about the chemical process industries, Concepts of Unit operations and unit processes, the flow chart, Simplified flow chart with description for the following, Sulphuric acid, caustic soda, metal refining, Insecticides, petroleum refining, paper and pulp organics with emphasis on local plants and sources of pollutants.

CO5: Learn about the elements of Hydraulics – principles of fluids – basic equation for flow through pipes and open channel – Discharge and velocity equation. Water purification process in natural and engineered systems. Water supply design and layout of water distribution systems. Process analysis, design and layout of industrial and municipal waste water systems.

Credits: 4	Course: Core
Total Marks: 25+75	Min. Passing Marks: 40
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-1-0	

23/12/22

Unit	Topics	No. of Lectures
I	**Basics raw water engineering and Unit Operations** Importance and necessity of water supply engineering, Sources of water, Suitability of water, Types of demand, Population forecast, Fluctuation in demand, Factors affecting demand, Impurities in water, Physical, Chemical and Biological Tests, Standards of quality of water; Equalization Sedimentation: Filtration: Adsorption: Membranes: Desalination	12
II	**Basics of Unit Processes:** Chemical Equilibrium, Leaching, Coagulation: Disinfection; and Ion Exchange	12
III	**Basics of Environmental Hydraulics:** Concepts of fluid mechanics; Properties of fluids; Types of flow; Pressure measurement; Hydrostatic force on surfaces; Buoyancy and flotation	12
IV	**Basics of wastewater engineering:** Water distribution and storage, Point and non-point sources of wastewater; Design of sewer and storm water sewers; Preliminary, primary, secondary and tertiary sewage treatment; Sludge generation, processing and disposal methods; Sewage farming.	12
V	**Basics of Industrial pollution, heat mass and reactors:** Sources and characteristics of industrial effluents; Concept of Common Effluent Treatment Plants (CETP); wastewater recycling and zero liquid discharge. Kinetics and reactor design: Mass and energy balance.	8

Suggested Readings:

7. Concept of Environmental Management for Sustainable Development by M.C. Dash, Wiley publisher
8. Trends in Environmental Management by A. G. Devi Prasad, Astral Publication
9. Environmental Impact Assessment by Peter Wathern, Brunner-Routledge, ISBN-13 9780415078849.
10. Environmental Impact Assessment by Gorge Alex, Blue Rose Publishers, ISBN- 9789389763812
11. A Hand Book of Environmental Audit by Hemant Pathak, Kindle Edition, ASIN- B0132D5PAG
12. Suggestive digital platforms web links

This course can be opted as an elective by the students of following subjects: M. Sc Microbiology, Biotechnology, Biochemistry, Geology, Chemistry, Botany, Zoology, Geography, Agriculture

Suggested Continuous Evaluation Methods:

Total Marks: 25

House Examination/Test: 10 Marks

Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 10 Marks

Class performance/Participation: 5 Marks

Course prerequisites: To study this course, a student must have had the Environmental Sciences/ Geography/ Agriculture/ Botany/ Zoology/ Chemistry/ Biochemistry/ Microbiology/ Biotechnology/Geology in B.Sc.

Suggested equivalent online courses:

swayam.gov.in; ugcmoocs.inflibnet.ac.in; epgp.inflibnet.ac.in

Further Suggestions: None

23/12/22

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Program/Class: Master in Environmental Sciences	Year: Second	Semester: IV
Subject: Environmental Sciences		
Course Code: B151002T	Course Title: Forest and Wildlife Ecology	

Course Objectives:

The objective of this course is to study about forest type, organization and productivity, objective, scope and necessity, people's participation, silviculture practices, forest management, values of wild life, Indian wildlife, IUCN categories, reasons for wildlife depletion, eco-tourism management, measurement of wild life conservation, international trade of wild life.

Course Outcomes:

After completion of this course, a student will be able to:

CO1: Learn about the Forest type, organization and productivity, social forestry: objective, scope and necessity, agroforestry, Extension forestry, Eucalyptus dilemma, People's participation, Role of NGO's.

CO2: Learn about the Silviculture practices: impact of deforestation and shifting cultivation on forest ecosystems. Forest management: Objectives and principles.

CO3: Learn about the Values of wild life, Wild life census methods Component of wildlife habitat, Common flora and fauna of India.

CO4: Learn about the Indian wildlife, IUCN categories, National Parks, Wildlife Sanctuaries, Biosphere Reserves and Zoos in India, Gene pool, Habit, Habitat and breeding biology of few mammals and birds. Wildlife protection, management of forest fire, Agenda 21.

CO5: Learn about the Reasons for wildlife depletion. Eco-tourism management, Measurement of wild life conservation, Special projects for endangered species, international trade of wild life, Animal cruelty, causes and prevention.

Credits: 5	Course: Core
Total Marks: 25+75	Min. Passing Marks: 40
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-1-0	

23/12/22

Unit	Topics	No. of Lectures
I	**Forest type, organization and productivity:** Major types and composition of forests of India, structural organization of forest ecosystem, Primary production in different ecosystems and methods of measurement of primary production, social forestry: objective, scope and necessity, agroforestry, Extension forestry, Eucalyptus dilemma, People's participation, Role of NGO's.	12
II	**Silviculture practices:** Silvicultural principles. Different silvicultural practices, impact of deforestation and shifting cultivation on forest ecosystems. Forest management: Objectives and principles, techniques, sustainable yield relation, biodiversity and forest.	12
III	**Values of wild life.** Wild life census methods (waterhole survey, point count and line transect methods, pug marks count method, King's census method), Component of wildlife habitat (Cover, Food, Water and Space), Common flora and fauna of India.	12
IV	**Indian wildlife** (Introduction, distribution of wildlife in ecological subdivision of India), IUCN categories, National Parks, Wildlife Sanctuaries, Biosphere Reserves and Zoos in India, Gene pool, Habit, Habitat and breeding biology of few mammals (viz. Elephant, Tiger) and birds (viz. Weaver bird, Oriental Magpie Robin). Wildlife protection: wildlife and range management, management of forest fire, Agenda 21.	12
V	**Reasons for wildlife depletion** (Habitat destruction, wildlife exploitation, Overgrazing, etc.). Eco-tourism management, Measurement of wild life conservation (Ecological basis, Policies and programs of wildlife conservation and management), Special projects for endangered species (Project tiger, Gir lion Sanctuary Project, Sea turtle, Crocodile breeding project, Project hangul), International trade of wild life, Animal cruelty, causes and prevention.	8

Suggested Readings:

1. Forest Wildlife Ecology and Habitat Management. David R. Patton, CRC Press Publication.
2. Wildlife Ecology, Conservation, and Management, John M. Fryxell, Anthony R. E. Sinclair and Graeme Caughley, Wiley Blackwell Publication.
3. Wildlife Biology: An Indian Perspective, Goutam Kumar Saha and subhendu Mazumdar. PHI Publication.
4. Textbook of Wildlife Management. S. K. Singh., CBS Publication & Distributors.
5. India's Forests, Forestry and Wildlife. S. S. Negi., Indus Publishing Company.

This course can be opted as an elective by the students of following subjects: M. Sc Microbiology, Biotechnology, Biochemistry, Geology, Chemistry, Botany, Zoology, Geography, Agriculture

Suggested Continuous Evaluation Methods:

Total Marks: 25
House Examination/Test: 10 Marks
Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 10 Marks
Class performance/Participation: 5 Marks

Course prerequisites: To study this course, a student must have had the Environmental Sciences/ Geography/ Agriculture/ Botany/ Zoology/ Chemistry/ Biochemistry/ Microbiology/ Biotechnology/Geology in B.Sc.

Suggested equivalent online courses:
swayam.gov.in; ugcmoocs.inflibnet.ac.in; epgp.inflibnet.ac.in

Further Suggestions: None

23/12/22

Program/Class: Master in Environmental Sciences	Year: Second	Semester: IV
Subject: Environmental Science		
Course Code: B15003P	**Course Title:** Lab Course –IV (Environmental Engineering)	
COURSE OBJECTIVES: The objective is to study basic knowledge on mathematical model construction and analyse environmental problems mathematically, heat and mass transfer, the packed column, various types of packing, chemical process industries.		
Credits:5	**Seventh Elective**	
Max. Marks: 50+50	**Min. Passing Marks:40**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-3		

1. Calibration of V notch and rectangular notch; Venturi meter, Orifice meter,
2. Verification of Bernoulli's theorem,
3. Determination of friction factor of given pipe system for laminar flow & turbulent flow for single and multiple pipes,
4. Reynolds experiment: Establishment of laminar, transition & turbulent flows,
5. Characteristics of free and forced Vortex, measurement of velocity, Hydraulic jump.
6. Determination of volatile and fixed solids of sewage sample.
7. Determination of optimum dose of coagulants of water samples.
8. To measure the residual chlorine concentration of water samples.
9. Determination of water quality Index (WQI) of surface and groundwater sources.
10. Treatment Plant Design.
11. Oil and Grease in water/wastewater sample

Comments on following-

1. Sedimentation
2. Desalination
3. Force of Buoyancy
4. Leaching
5. Coagulation
6. Population forecast
7. Sewage farming
8. Sludge generation
9. Mass and energy balance
10. Electrostatic precipitators
11. Natural Water treatment
12. Water Quality Index
13. Bernoulli's theorem
14. Activated sludge Process
15. Trickling Filter
16. Hydrostatic force on surfaces
17. Point sources of wastewater
18. Oil Pollution
19. Ion Exchange
20. Bag filters

Viva-Voce

Practical record/ Chart/ Model

23/12/22

Program/Class: Master in Environmental Sciences	Year: Second	Semester: IV
Subject: Environmental Science		
Course Code: B15004P	Course Title: Lab Course –V (Geo-informatics)	

COURSE OBJECTIVES:

Learning the tools will help in building the systemic process and will widen the knowledge and use of broad range of data sources useful for research

Credits:5	Seventh Elective
Max. Marks: 50+50	Min. Passing Marks:40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-3

1. To georeference the given toposheet using Ground Control Point (GCP) in ArcGIS.
2. To prepare a geodatabase with three different feature classes consisting of Point, Polygon and Polyline.
3. To prepare a layout map for the given toposheet.
4. To generate an Area of Interest (AOI) of satellite imagery with a given shapefile.
5. To perform supervised classification consisting of at least three feature classes (buildup area, water bodies, cropland, etc.) of a given satellite imagery.
6. To prepare Land Use Land Cover (LULC) layout map for objective 5.

Comments on following-

1. Discharge and Velocity
2. Unit operation and Unit process
3. Electrostatic precipitator
4. Rault and Henry's Law
5. Heat Transfer
6. Primary productivity
7. IUCN
8. EMR
9. Digitization
10. Spectral reflection of vegetation
11. Scattering
12. RADAR
13. GPS
14. GIS
15. Interaction of EMR with earth surface
16. Interaction of EMR with Atmosphere
17. Manual Image Interpretation
18. Thermal Remote Sensing
19. Application of remote sensing
20. 20. Principle of RADAR

Viva-Voce

Practical record/ Chart/ Model

23/12/22