

M. J. P. ROHILKHAND UNIVERSITY, BAREILLY

SYLLABUS

OF

M.Sc. Environmental Science

CHOICE BASED CREDIT SYSTEM (CBCS)

(To be effective from session 2022-23)



महात्मा ज्योतिबा फुले
रुहेलखण्ड विश्वविद्यालय, बरेली

APPROVED BY:
THE BOARD OF STUDIES IN ENVIRONMENTAL SCIENCE
M. J. P. ROHILKHAND UNIVERSITY
BAREILLY, UTTAR PRADESH, INDIA

<https://mjpru.ac.in/>



S. NO.	PARTICULARS	PAGE NO.
1.	Course Structure	i - v
2.	First Semester – Theory/Practical	01 - 07
3.	Second Semester – Theory/Practical	08 - 14
4.	Third Semester – Theory/Practical	15 - 21
5.	Fourth Semester – Theory/Practical	22 - 25
6.	Minor Open Elective Theory (Students of Other Departments)	26 - 29

COURSE STRUCTURE & SYLLABUS
M.Sc. ENVIRONMENTAL SCIENCE (2 YEAR PROGRAMME) COURSE
Choice Based Credit System (CBCS)

FIRST YEAR (SEMESTER – I)

Core/ Elective Paper	Paper Code	Paper Title	L	T	P	Credits	Distribution of Marks			Page No
							Ext.	Int.	Total	
Core Paper Theory	MENVCT 101	Concept of Environment and Ecosystem Dynamics	3	1	0	3	70	30	100	1-2
	MENVCT 102	Instrumentation	3	0	0	3	70	30	100	3
	MENVCT 103	Water Pollution	3	1	0	3	70	30	100	4
	MENVCT 104	Environmental Chemistry	3	0	0	3	70	30	100	5
Practical	MENVP 105	Lab Work/Analysis & Practical Record	3	0	1	3	70	30	100	6
Industrial Training/ Research Project/ Internship	MENVR 106	Report on Industrial waste water Treatment Plant	0	1	0	3	0	100	100	7
Total Credit – 24			15	03	01	18	350	250	600	

FIRST YEAR (SEMESTER – II)

Core/ Elective Paper	Paper Code	Paper Title	L	T	P	Credits	Distribution of Marks			Page No
							Ext.	Int.	Total	
Core Paper Theory	MENVCT 201	Natural Resource and its Management	3	1	0	3	70	30	100	8
	MENVCT 202	Atmospheric and Noise Pollution	3	0	0	3	70	30	100	9
	MENVCT 203	Soil Pollution and Management	3	0	0	3	70	30	100	10
	MENVCT 204	Environmental Microbiology and Biotechnology	3	1	0	3	70	30	100	11-12
Practical	MENVP 205	Lab Work / Analysis & Practical Record	3	0	1	3	70	30	100	13
Industrial Training/ Research Project /Survey and Tour	MENVR 206	Report on Visit of Solid Waste Management Plant	0	1	0	2	0	50	50	14
		Survey & Tour with report	0	1	0	1	0	50	50	-
Total Credit – 24			15	4	01	18	350	250	600	

SECOND YEAR (SEMESTER – III)

Core/ Elective Paper	Paper Code	Paper Title	L	T	P	Credits	Distribution of Marks			Page No
							Ext.	Int.	Total	
Core Paper Theory	MENVCT 301	Biostatistics, Bioinformatics and Intellectual Property Rights	3	1	0	3	70	30	100	15
	MENVCT 302	Environmental Impact Assessment and legislation	3	0	0	3	70	30	100	16
	MENVCT 303	Environmental Toxicology	3	0	0	3	70	30	100	17
Elective Paper Theory (Choose any one Paper)	MENVET 304	Biodiversity and Wild life Management	3	1	0	3	70	30	100	18
	MENVET 305	Remote Sensing, geographic information system and Modeling	3	0	0	3	70	30	100	19
Practical	MENVP 306	Lab Work / Analysis	3	0	1	3	70	30	100	20
Industrial Training/Research Project/Survey	MENVR 307	Report on Visit of Sewage Treatment Plant	0	1	0	0	0	100	100	21
Total Credit – 24			15	03	01	18	420	180	600	

SECOND YEAR (SEMESTER – IV)

Core/ Elective Paper	Paper Code	Paper Title	L	T	P	Credits	Distribution of Marks			Page No
							Ext.	Int.	Total	
Core Paper Theory	MENVCT 401	Scientific Writings and Ethics	3	1	0	3	70	30	100	22
	MENVCT 402	Environmental Geosciences and Climatology	3	1	0	3	70	30	100	23
Research Work	MENVD 403	DISSERTATION :-								24-25
		Internal Evaluation								
		a) Synopsis	1	1	0	1			50	
		b) Midterm Presentation	1	1	0	1			50	
		External Evaluation								
		c) Dissertation Report	2	1	0	6			200	
		d) Presentation/Viva-Voce	0	1	0	2			50	
Survey & Tour with report		1	0	2		50	50			
Total Credit – 24			10	07	0	18		600		

Abbreviation -

L – Lecture; T - Tutorial; P – Practical, Ext. – External, Int. - Internal

Internal Evaluation:

Test/Quiz/Assignment/Seminar
Class Attendance min.75%

- 25 Marks
- 05 Marks

SUMMARY

Semester	Credits			Total Credit	Total Marks
	Core / Elective Theory	Practical	Survey & Tour/ Training/ Dissertation		
I	12	3	3	18	600
II	12	3	3	18	600
III	12	3	3	18	600
IV	06	0	12	18	600
Total	42	09	21	72	2400

THE DEPARTMENT OF ENVIRONMENTAL SCIENCES OFFERS THE FOLLOWING OPEN ELECTIVE COURSES FOR THE STUDENTS OF OTHER DEPARTMENTS:

MINOR OPEN ELECTIVE THEORY (STUDENTS OF OTHER DEPARTMENTS)

SEMESTER	Paper Code	Paper Title	L	T	P	Credits	Distribution of Marks			Page No
							Ext.	Int.	Total	
SEMESTER - I	MENVOE 501	Minor Elective Theory (Open Elective)	3	0	0	3	70	30	100	27
SEMESTER - II	MENVOE 502	Minor Elective Theory (Open Elective)	3	0	0	3	70	30	100	28
SEMESTER - III	MENVOE 503	Minor Elective Theory (Open Elective)	3	0	0	3	70	30	100	29



SEMESTER – I

**M.Sc.
ENVIRONMENTAL SCIENCE**

**M.Sc. Environmental Science
1st Year Semester – I
Core Paper 1 (MENVCT 101)**

CONCEPT OF ENVIRONMENT AND ECOSYSTEM DYNAMICS

Max Marks 70+30 Credit : 03

- Unit 1** Principles and concept of Environmental Science, Objectives of Environmental studies, Structure and composition of Biosphere, Hydrosphere, Atmosphere and lithosphere, Kinds of rocks, Origin and formation of soil, Physicochemical and Biological Properties of Soil.
- Unit 2** Ecosystem : Definition and component, functional aspect of an ecosystem. Major ecosystem of the globe viz. Terrestrial, Aquatic and other man made ecosystem, Types of Biomes, Concept of productivity, Food chain and food webs in various ecosystem, Ecological pyramids, Energy and its flow in ecosystem: Energy flow model, Ecological energetics and energy budgeting in ecosystem. Concept of ecotone and edge effect.
- Unit 3** Biogeochemical cycle in ecosystem : water, nitrogen, carbon and phosphorus cycle, Concept of hybrid cycle and its discrepancies over gaseous cycle, Sulphur and iodine cycle. Concept of system ecology, modelling of ecosystem and their regulation, science of cybernetics, Aging of ecosystem their vulnerability and fragility, ecosystem management.
- Unit 4** Study of population dynamics, Characteristics of population, Concept of carrying capacity, Biointeractions: mutualism, protocooperation, symbiosis, parasitism, allelopathy and Kairopathy. Ecological succession, hydrarch and xerarch, heterotrophic succession, ecosystem development, Seral and climax concept in succession.
- Unit 5** Environmental factors : light, temperature, precipitation, humidity of air, atmospheric pressure, wind, fire and soil- their fluctuation, build up and role in biosphere formation, Leibig's law of minimum, Shelford's law of tolerance.

Suggested Readings

1. Ecology, William by D. B., Sally, D. H.
2. Fundamentals of Ecology, by Eugene P. Odum and Gary W. Barrett.

3. Biodiversity: Concepts, Conservation and Biofuturem by Fatik B. Mandal and Nepal C. Nandi
4. Encyclopedia of Ecology by Jorgensen, Sven Erik
5. Biodiversity and Environmental Management. Joshi, B.D., Tripathi, C.P.M and Joshi, P.C
6. Biodiversity and conservation by Joshi, P.C. and Joshi, N.
7. Invasive Plants and Forest Ecosystems. Kohli, R. K., Jose, S., Singh, H. P. and Batish, D. R.
8. Essentials of Ecology and Environmental Science Rana, S.V.S

e-Resources

1. http://envis.nic.in/ENVIS_html/ENVISSubject/subject.html
2. <https://www.iucn.org/> (& <https://www.cbd.int/>)
3. <https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14>

**M.Sc. Environmental Science
1st Year Semester - I
Core Paper 2 (MENVCT102)**

INSTRUMENTATION

Max Marks 70+30 Credit : 03

- Unit 1** Types and application of different microscopes, Design and function of Phase contrast, scanning and transmission electron microscope.
- Unit 2** Water and air samplers and their applications, Principle, design and application of centrifuges and electrophoresis, SDS- Page and Agarose Gel Electrophoreses.
- Unit 3** Principle of Spectrophotometer (UV-Vis. AAS, ICP-AES, ICP-MS), Beer Lambert's law, design and application of spectrophotometer in Environmental research.
- Unit 4** Principle, Design and application of Flame photometer and Fourier Transmission Infrared (FTIR) in elemental analysis of environmental samples.
- Unit 5** Principle of Analytical Methods, Titrimetry, Gravimetry, Chromatography, Types of chromatography and their applications (Paper, TLC, GC, HPLC).

Suggested Readings

1. Practical Biochemistry by Willson & John Walker
2. Instrumental Methods of Chemical Analysis by Sharma, B.K.
3. Instrumental methods of analysis by Malathi, S., Patil, P. M., Kumar, S
4. Standard Methodology of Biochemical Analysis by SK Thimmayiah,
5. Environmental Instrumentation and Analysis Handbook by Randy D. Down and Jay H. Lehr
6. Environmental Analysis and Instrumentation by N. Rajvaidya and D. K. Markandey
7. Instrumentation and Measurement for Environmental Sciences by Bailey W. Mitchell.
8. Environmental sampling and analysis: a practical guide. Routledge by Keith, L. H.

e-Resources

1. <https://cpcb.nic.in/displaypdf.php?id=c291cmNIYXBwb3J0aW9ubWVudHN0dWRpZXMucGRm>
2. <https://cpcb.nic.in/manual-monitoring>

**M.Sc. Environmental Science
1st Year Semester - I
Core Paper 3 (MENVCT 103)**

WATER POLLUTION

Max Marks 70+30 Credit: 03

- Unit 1.** Sources of water pollution, Effects of water pollution on aquatic and terrestrial ecosystem, Eutrophication and Biomagnification, Water Quality Standards.
- Unit 2.** Biological monitoring of water, Concept of C-BOD, N-BOD, COD, TDS, TSS, DO, Oxygen sag curve, Coliform test.
- Unit 3.** Effect of thermal, Industrial and municipal water pollution in the environment, Water Borne human diseases and causative agents, Acid mine drainage
- Unit 4.** Marine pollution: Source, Control and disposal of pollutants in marine system
- Unit 5.** Types of waste water and their characteristics, Primary, Secondary and Tertiary treatment of waste water, Treatment of drinking water: sedimentation, coagulation and flocculation, filtration, disinfection, reverse osmosis process.

Suggested Readings

1. Wastewater Engineering: Treatment, disposal, Reuse by Metcalf & Eddy
2. Environmental Science by S.C. Santra.
3. Living in the Environment –T.J.Miller.
4. Water Pollution by V.P. Kudesia & Emmanuel Pullman.
5. Textbook of Environmental Science and Technology, BS Publications by Reddy, MA

e-Resources

1. <https://archive.ipcc.ch/ipccreports/tar/wg2/index.php?idp=356>
2. <https://wcedportal.co.za/eresource/71131>
3. <http://osou.ac.in/eresources/Air%20pollution.pdf>

M.Sc. Environmental Science
1st Year Semester - I
Core Paper 4 (MENVCT 104)

ENVIRONMENTAL CHEMISTRY

Max Marks 70+30 Credit: 03

- Unit 1** Thermodynamic states of the system, First law of thermodynamics, adiabatic transformation, Second law of thermodynamics, Metal corrosion and its types.
- Unit 2** Chemical potential and chemical equilibrium, Acid-base reactions, Solubility and solubility product. Carbonate equilibria (system) and Stoichiometry, Gibbs energy.
- Unit 3** Structure and physicochemical properties of water, acidity and alkalinity. Chemistry of important components of paint, Chemistry of petroleum and its product.
- Unit 4** Structure and physicochemical property of atmosphere, Thermo-chemical and photochemical reaction in atmosphere, Chemistry of particulate and gaseous pollutants, Photochemical smog formation, Acid-base reaction in the atmosphere (acid rain), Ozone formation and depletion process.
- Unit 5** Concept of Green Technology, Principles of Green Chemistry, Techniques and researches to reduction of Green House Gas (GHG), Emissions carbon capture and storage (CCS) technologies, Green chemistry for bioremediation, Green technology for energy generation.

Suggested Readings

1. Fundamentals of Environmental Chemistry by Manahan, S. E.
2. Press, USA. Application of Environmental Aquatic Chemistry: A practical guide by Weiner E. R.
3. Environmental Chemistry by Baird, C. and Cann, M.
4. Environmental Chemistry by Baird, C., Cann, M.

e-Resources:

1. https://chem.libretexts.org/Bookshelves/Environmental_Chemistry
2. <https://www.uvm.edu/~gpetrucc/courses/chem196/Textbooks/>
3. https://geo.libretexts.org/Bookshelves/Soil_Science

**M.Sc. Environmental Science
1st Year Semester - I
(MENVP 105)**

PRACTICAL ON WATER POLLUTION

Credit: 03

- 1) Learning methods of collection, storage and analysis of polluted water samples.
- 2) Analysis of water
 - (i) pH
 - (ii) Alkalinity
 - (iii) free CO₂
 - (iv) Total Hardness
 - (v) Phosphate
 - (vi) Nitrate
 - (vii) TDS
 - (viii) BOD
 - (ix) DO
 - (x) COD
 - (xi) Iron
 - (xii) Chloride
- 5) **Instrumentation Climatology**
 - (i) Lux meter
 - (ii) Anemometer
 - (iii) pH meter
 - (iv) Rain gauge
 - (v) Maximum Minimum thermometer
 - (vi) Hygrothermometer
 - (vii) Secchi disc
- 6) Instrumentation: basic principle and handling of spectrophotometer,
- 7) Field study of ecosystem grassland and pond
- 8) Determine the minimum size of quadrat by species area curve method
- 9) To study the community by determining frequency, density and abundance of different species present at sample area by quadrat method

Suggested Readings

1. Environmental Analysis water, Soil and Air By MM Saxena
2. Adventures in Earth and Environmental Science Practical Manual: by Dr Peter T Scott and Andrew J Scott

e-Resources

1. <https://cpcb.nic.in/displaypdf.php?id=c291cmNIYXBwb3J0aW9ubWVudHN0dWRpZXMucGRm>
2. <https://cpcb.nic.in/manual-monitoring/>

**M.Sc. Environmental Science
1st Year Semester – I
(MENVR 106)**

Industrial Training/ Research Project/ Internship

Max. Marks – 100 Credit: 03

Report on Industrial Waste Water Treatment Plant

Every enrolled student of M.Sc. (Environmental Sciences) programme shall have to undergo training for the period of (4-6 weeks) in any governmental /nongovernmental /industrial organizations working on various aspects of environment and will submit a report (hard copy and soft copy) along with training certificate issued by the organization. After completing training programme he/she will also prepare and deliver a power point presentation of the training attended in the department .The power point presentation will be of 10-15 minutes duration during which question will be raised by the committee comprising of faculty of the department. Every student shall be required to submit the topic of his/her training to the chairperson so that the same may be displayed on the notice board for the presentation schedule



SEMESTER – II

**M.Sc.
ENVIRONMENTAL SCIENCE**

**M.Sc. Environmental Science
1st Year Semester - II
Core Paper 1 (MENVCT 201)**

NATURAL RESOURCES AND ITS MANAGEMENT

Max Marks 70+30 Credit : 03

- Unit 1** Natural resources: Definition, Classification, need for resource Conservation, Strategies for sustainable development
- Unit 2** Energy resources: Types and their management, Fossil fuel, Solar, Hydroelectric power, Tidal, Wind, Geothermal, Nuclear energy, nuclear reactors in India.
- Unit 3** Concept of Biofuels, biomass energy, Mechanism of Biogas production, factors affecting biogas production, Carbon sequestration. Carbon Credit, Carbon footprint, Mineral resource and environmental impact of mineral exploitation
- Unit 4** Water resource: Global water balance, Degeneration of water resource, Conservation of ground and surface water resource, Rainwater harvesting.
- Unit 5** Wildlife and forest resources and its Management.

Suggested Readings

1. Renewable Energy: Environment and Development by M. Dayal.
2. Alternative Energy by S. Vandana.
3. Nuclear Energy: Principles Practice and Prospects. by S. K. Agarwal
4. Bio-Energy Resources. by P. Chaturvedi.
5. National Energy: policy, crisis and growth by V S. Mahajan

e-Resources

1. http://envis.nic.in/ENVIS_html/ENVISSubject/subject.html
2. <https://www.iucn.org/>
3. <https://www.cbd.int/>
4. <https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14>
5. <http://moef.gov.in/en/#>

**M.Sc. Environmental Science
1st Year Semester - II
Core Paper 2 (MENVCT 202)**

ATMOSPHERIC AND NOISE POLLUTION

Max Marks 70+30 Credit: 03

- Unit 1.** Structure and physicochemical properties of atmosphere. Thermochemical and photochemical reactions in atmosphere. Chemistry of particulate and gaseous pollutants. Photochemical smog formation, Acid-base reaction in the atmosphere (acid rain). Ozone formation and depletion process.
- Unit 2.** Types and sources of air pollutants (primary and secondary pollutants). Methods of collection of air pollutants. Effect of pollution on living and nonliving, Covid 19, Bio-indicator of atmospheric pollution, Global Warming.
- Unit 3.** Air Quality Standard and criteria, Management of air pollutants (SO_x , NO_x , O_3 , Hydrocarbons, Polynuclear Aromatic Hydrocarbon, Suspended Particulate Matter).
- Unit 4.** Source of noise pollution; Measurement of noise and indices, Effect of meteorological parameter on noise propagation, Noise exposure level and standards.
- Unit 5.** Decibel scale of loudness, addition of loudness, percentile level and equivalent sound pressure levels (L_{eq}). Noise pollution by supersonic transmission, sonic boom. Infra and Ultra sound sources and hazards. Effects of noise on man, Noise control measures.

Suggested Reading

1. Industrial noise control: Fundamentals and applications. by Bell, L.H. and Bell, D.H.
2. Handbook of air pollution prevention and control. Cheremisinoff, N.P.
3. Industrial air pollution monitoring. by Clarke, A.G.
4. Air pollution: measurement, modelling and mitigation by Tiwary, A. and Williams, I
5. Fundamentals of air pollution. by Vallero, D.A.

e-Resources

1. <https://swayam.gov.in/> & <https://nptel.ac.in/courses/>
2. <https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14>

**M.Sc. Environmental Science
1st Year Semester - II
Core Paper 3 (MENVCT 203)**

SOIL POLLUTION AND MANAGEMENT

Max Marks 70+30 Credit: 03

- Unit 1.** Soil formation and weathering, Primary and secondary minerals, Physical, Chemical and Biological Properties of Soil, soil profile, Soil organic matter, C/N ratio
- Unit 2.** Sources of soil pollution, Types of soil pollutants, Inorganic contaminant in soil: Metal and radionuclides, Pesticides in soil, fate of pesticides, Different kinds of synthetic fertilizer and their interaction with biotic and abiotic component of soil, Soil Management: Reclamation of acid/alkaline/saline/ sodic soil.
- Unit 3.** Source, generation and classification of waste, Impact of solid waste on environment, Human and plant health. Solid Waste Management: Different techniques used in collection, storage, transportation and disposal of solid waste, 5 R Concept-reduce, reuse, recycle, remove and reform of solid waste management.
- Unit 4.** Hospital waste management, Characteristics of hazardous waste and its management methods viz neutralization, oxidation, reduction, solidification, stabilization, incineration and final disposal.
- Unit 5.** Radioactive Pollution: Sources, Control and disposal of Radioactive pollutants. E-waste: sources, types and management.

Suggested Reading

1. Environmental Science: Earth as a Living Planet. by Botkin, Daniel B. and Keller, Edward A.
2. Introduction to Soil Physics by Hillel, D.
3. Environment by Raven, Peter H., Berg, Linda R. and Hassenzahl, David M.

e-Resources

1. https://onlinecourses.nptel.ac.in/noc20_ar05/preview
2. <https://nptel.ac.in/noc/courses/noc20/SEM2/noc20-ar05/>
3. <https://nptel.ac.in/courses/126/105/126105016/>
4. <https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14>
5. <https://www.icar.org.in/>

**M.Sc. Environmental Science
1st Year Semester - II
Core Paper 4 (MENVCT 204)**

ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY

Max Marks 70+30 Credit: 03

- Unit 1** Introduction of microbiology, Process of biological nitrogen fixation, free living and symbiotic nitrogen fixing microbes; root nodulation of leguminous crops by Rhizobium, regulation of Nif genes, Concept of Biofertilizer, Role of plant growth promoting rhizobium (PGPR), Classification and function of Vesicular Arbuscular Mycorrhizae (VAM), Mobilization of phosphate and other nutrients by (VAM).
- Unit 2** Microbial interaction and concept of antibiosis, Production of secondary metabolites/toxins by microbes, Concept of biopesticides and its role in crop productivity, role of genetic engineering in biopesticides technology with example of BT cotton, biodetrioration (usefulness physical and chemical value change) of Industrial and food products such as cotton, jute, leather and paint.
- Unit 3** Microbial enzymes and mechanism of hemicellulose degradation, accessory enzymes in hemicellulose degradation, multiplicity of hemicellulose in recovery of commercial product and utilization of waste, Factors regulating lignin biodegradation uses of ligninolytic enzymes in biopulping, bioleaching and waste removal and biocomposting.
- Unit 4** Concept of Environmental Biotechnology and Application, Concept of Bioremediation, hydrocarbons, xenobiotic compounds (pesticides and other organic compounds), Superbug, role of genetic engineering in bioremediation, biotransformation of toxicants, Phytoremediation of heavy metals, phytochelatins.
- Unit 5** Microorganism in mining industry, bioleaching; basic chemistry and recovery of sulphide, copper, gold and uranium, Government of India action plan for waste management and its difference with Western countries.

Suggested Reading

1. Environmental biotechnology by Bhattacharyya, B. C., & Banerjee, R.
2. Microbial Environment and Bioremediation by Chauhan, A., Rathore. A.

3. An Introduction to Industrial Microbiology by Kumar, P. K. S., M. M. Joe, K. Sukesh, S.
4. Environmental Microbiology and Biotechnology by D. P. Singh and S. K. Dwivedi
5. Microbiology by Michael P. J.

e-Resources

1. <https://www2.hcmuaf.edu.vn/data/quoctuan/Environmental%20Biotechnology%20-%20Theory%20and%20Application,%20G%20M%20Evans%20&%20J%20C%20Furlong.pdf>

M.Sc. Environmental Science
1st Year Semester - II
(MENVP 205)

PRACTICAL ON SOIL ANALYSIS

Max Marks 70+30 Credit: 03

1. Washing and sterilization of labware.
2. Media preparation for growing bacteria and fungi.
3. Study the solid waste degradation by microbes.
4. Culturing of microorganism
 - a) Slant Preparation
 - b) Suspension Culture
 - c) Streaking
 - d) Plating
5. Report on metrological department/pollution control board.
6. Preparation of disaster management plan for any one disaster Earthquake/flood/ cyclone/ fire/Tsunami outbreak.
7. Staining of gram positive and gram negative bacteria.
8. Study the biochemical test for the identification of microorganism.
9. Isolation of nitrogen fixing bacteria through selective media preparation.
10. Study of soil sampling techniques.
11. Soil Analysis
 - a) Soil texture
 - b) Bulk density
 - c) Particle density
 - d) Porosity
 - e) Water holding capacity
 - f) Moisture content
 - g) pH
 - h) Alkalinity
 - i) Chloride
 - j) Sulphate
 - k) Available phosphorus
 - l) Total soil nitrogen
 - m) Available Iron
12. Report on the visit of Water treatment/ waste water treatment/Sewage treatment plant
13. To study principle and designs of Air samplers.

Suggested Reading

1. Adventures in Earth and Environmental Science, Practical Manual: by Dr Peter T Scott and Andrew J Scott.
2. MEVL 011 Environmental Science Lab Course-I by Zigmakart.
3. MEVL-12 Environmental Science Lab Practical by Zigma Panel of Experts.

M.Sc. Environmental Science
1st Year Semester – II
(MENVR 206)

**Industrial Training/ Research Project/ Internship/
Survey and Tour**

Max. Marks. 100 Credit: 03

S. NO	REPORT AND TOUR	MARKS	CREDIT
1.	Report on Visit of Solid Waste Management Plant etc.	50	02
2.	Tour	50	01
	Total Credit	100	03

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SEMESTER – III

**M.Sc.
ENVIRONMENTAL SCIENCE**

M.Sc. Environmental Science
2nd Year Semester – III
Core Paper 1 (MENVCT - 301)

BIostatistics, Bioinformatics and Intellectual Property Rights (IPR)

Max. Marks 70+30 Credit: 03

- Unit 1** Scope of statistics in Environmental data analysis, Tabulation and diagrammatic presentation of data, Measures of Central tendency (mean, mode, median), dispersion (mean deviation and standard deviation).
- Unit 2** Simple measure of Skewness and Kurtosis, Test of significance, Z- test, t-test, chi-square test, Correlation and regression and analysis of variance (ANOVA), Lotka Voltera Model, Leslie's Matrix Model.
- Unit 3** Introduction, Classification and Generation of computer, Components of a computer system, input and output device.
- Unit 4** Introduction and scope of bioinformatics, Biological database, Basic concept of primary, secondary and composite database.
- Unit 5** Intellectual property right (IPR), Bio-safety, International trade and environment: Trade Related Intellectual Properties (TRIPs). Intellectual Properties Right (IPRs). Corporate Environmental Ethics. Role of environmental agencies (NGT). Scheme of labelling environment friendly products (Ecomark).

Suggested Reading

1. Elements of Biostatistics, by Prasad. S, Rastogi.
1. Vogel's Text Book of Quantitative Inorganic Analysis, by Barnes, J.D. J., Denney, R.C., Jeffery.
2. Fundamentals of applied statistics by SC Gupta & DK Kapoor.
3. Biostatistics by P.N. Arora & D.K. Malhan.
4. Basic of Biostatistics for Public health by B. Burt Gerstman.
5. Statistics by David Freed man Rabert Pisani.
6. Fundamental of Bioinformatics by Harisha S.

**M.Sc. Environmental Science
2nd Year Semester - III
Core Paper 2 (MENVCT 302)**

ENVIRONMENTAL IMPACT ASSESSMENT AND LEGISLATION

Max. Marks 70+30 Credit: 03

- Unit 1** Environmental management waste minimizing technology and clean development mechanism (CDM).
- Unit 2** Impact assessment methodologies guidelines for environmental audit environmental planning.
- Unit 3** Introduction of Environment Impact Analysis, National Environmental Policy and statutory requirement of EIA: objectives of EIA, Methodology of EIA, Scoping, categorization and evaluation criteria: prediction and assessment of impact.
- Unit 4** Environmental appraisal, Environmental Impact Statement (EIS), Environmental Management Plan, Environmental audit, Concept of Sustainable development.
- Unit 5** Provision of constitution of India regarding environment (48A and 51A), Wildlife Protection Act 1972. Forest Conservation Act 1980 and its amendments, Air Act 1981. Motor Vehicle Act 1988, Water (prevention and control of pollution) act 1974. The Environment (protection) act 1986, ISO 14000 and its series, Public liability insurance act 1981 and rules 1991, Solid Waste Management and Handling Rule 2016.

Suggested Reading

1. Fundamentals of General Ecology, Life Safety and Environment Protection by Mark D Goldfein.
2. Concept of Environmental Management for Sustainable Development by M.C. Dash (2019) Wiley publisher.
3. Trends in Environmental Management by A. G. Devi Prasad.
4. Environmental Impact Assessment by Peter Wathern.
5. Environmental Impact Assessment by Gorge Alex.

e-Resources

1. <https://www.iisd.org/learning/eia/wp-content/uploads/2016/06/EIA-Manual.pdf>

**M.Sc. Environmental Science
2nd Year Semester - III
Core Paper 3 (MENVCT 303)**

ENVIRONMENTAL TOXICOLOGY

Max. Marks 70+30 Credit: 03

- Unit 1** Principles of toxicology, Classification of important toxicants, Dose-response relationship, lethal dose and lethal concentration, Exposure of toxicants, route and sites of exposure.
- Unit 2** Translocation of toxicants, Biotransformation and bioactivation of toxicants, Mechanism of action of organ specific toxicity, Teratogenicity, Carcinogenicity, Immunotoxicity Hepatotoxicity, Nephrotoxicity.
- Unit 3** Potency vs toxicity, Margin of safety, Toxicity test, Target and non-target organ toxicity, Occupational factor and health hazards, Metal toxicity viz. Hg, Cd, Pb, Cr, Co, Ni, As, Sn and copper toxicity in living organisms.
- Unit 4** Concept of Environmental stress, Oxygen- an agent of oxidative stress, Chemistry of free radicals and their effect on living system.
- Unit 5** Food additive; Classification and their impact on human health, Classification of pesticides based on functional group such as Organohalide, Carbamates and Organonitrogen.

Suggested Reading

1. Environmental Toxicology : Biological and Health Effects of Pollutants by Ming Ho Yu.
2. Principles of Environmental Toxicology by I. Shaw, J. Chadwick
3. Environmental Chemistry by A.K. De.
4. Fundamental of Toxicology by Cassette & Doulls.
5. Fundamental of Toxicology by Shukla, Pandey & Trivedi.
6. Environmental Chemistry by James E. Girrard.
7. Environmental Chemistry by Stanley. E. Manchen.

e-Resources

1. <https://litfl.com/tox-library/resources/>
2. <https://wwwn.cdc.gov/TSp/substances/SubstanceResources.aspx>
3. <https://www.webpages.uidaho.edu/etox/lectures.htm>

**M.Sc. Environmental Science
2nd Year Semester - III
Elective Paper (MENVET 304)**

BIODIVERSITY & WILD LIFE MANAGEMENT

Max. Marks 70+30 Credit: 03

- Unit 1** Concept and types of biodiversity, Importance of biodiversity, Threats to biodiversity, Extinction and vulnerability of species, Threatened and endangered species. Red Data Book.
- Unit 2** Principles of biodiversity conservation: Ex-Situ and In-Situ conservation, Protected areas Botanical garden, National park and Sanctuaries, Gene Pool, Hotspot, Sacred grooves, Key stone species Role of public and NGOs in biodiversity conservation, Eco restoration and Eco development.
- Unit 3** Understanding of wildlife, Role of stakeholders in managing wildlife. Journey of mankind from Predator to conservator Wildlife management, conservation and policies regarding protected area in 21st century: positive values provided by wildlife conservation (Monetary, Recreational, Scientific and Ecological Benefits)
- Unit 4** Analysis of threatened species as per guideline of IUCN and developed possible conservation strategy. Analysis of wildlife management problems, Species conservation project in India (Tiger, Elephant, Rhino, Lion).
- Unit 5** Development of conservation site (National park and Sanctuaries, Biospheres reserve scientifically and legislatively).

Suggested Reading

1. Environmental Communication lab to land by Mishra and Upadhyay.
2. Wildlife Ecology, Conservation, and Management by John M. Fryxell, Anthony R.E. Sinclair, Graeme Caughley.
3. Wildlife Biology: An Indian Perspective by Goutam Kumar Saha, Subhendu Mazumdar.
4. Forest Wildlife Ecology and Habitat Management by David R. Patton

**M.Sc. Environmental Science
2nd Year Semester - III
Elective Paper (MENVET 305)**

REMOTE SENSING, GEOGRAPHIC INFORMATION SYSTEM AND MODELING

Max. Marks 70+30 Credit: 03

- Unit 1** Definitions and principles: Electromagnetic (EME) spectrum, Interaction of EMR with earth's surface, spectral signature; satellite and sensor, aerial photographs and image interpretation
- Unit 2** Definition and components: spatial and non-spatial data, raster and vector data Database generation.
- Unit 3** Database management system, land use and land cover mapping, overview of GIS
- Unit 4** Software packages: GPS survey, data import, processing and mapping.
- Unit 5** Application and case studies of remote sensing and GIS in geosciences for Water resources management, Land use planning, Forest resource, Agriculture, Marine and Atmospheric studies.

Suggested Reading

1. Remote Sensing for the Beginner by Guha P.K.
2. Remote Sensing of the Environment: An Earth Resource perspective Pearson by Jenson J.R.
3. Remote Sensing and Image Interpretation by Lillesand T.M and Kiefer R.W.
4. Remote Sensing – Principles and Interpretation by Sabin, F.F. J.
5. Introduction to Geographic Information Systems by Chang, K.
6. Global Positioning System: Principles and Applications by Gopi, S..

e-Resources

1. <https://cpcb.nic.in/displaypdf.php?id=c291cmNIYXBwb3J0aW9ubWVudHN0dWRpZX MucGRm>
2. <https://cpcb.nic.in/manual-monitoring/>

**M.Sc. Environmental Science
2nd Year Semester - III
(MENVP 306)**

PRACTICAL ON REMOTE SENSING & AIR POLLUTION

Max. Marks 70+30 Credit: 03

1. Analysis of air pollution -
 - a) Determination of Settled Particulate Matter (SPM) in the Air.
 - b) Determination of ambient concentration of suspended particulate matter with the help of high volume sampler.
 - c) Monitoring of NO_x and SO_x.
2. Arc GIS online study for mapping.
3. Q GIS online study for mapping.
4. Analysis of mapper and imaging,
5. Analysis of Carbon emission for industry and road side,
6. Green technology for energy generation.
7. Reduction method for Green House Gases.
8. Emission Carbon Capture and Storage (CCS) Technology.
9. Submit a report on Green Energy Development (Biofuels, Wind Energy, Solar Energy, Geothermal Energy, Tidal Energy, Ocean Energy, and Nuclear Energy) in Indian context.
10. One case study on environmental issues.
11. Estimation of chlorophyll content of different plant leaves under stress.
12. Estimation of Lethal potency (LC and LD)
13. Stress determination on plant fungi and bacteria
14. Computational analysis of biological data by Mean, Median, Mode, SD, Correlation, Regression analysis, Chi -square test, Student t-test, ANOVA.

Suggested Reading

1. Analyses of Hazardous Substances in Air: Volume 1 - The MAK–Collection for Occupational Health and Safety. Part III: Air Monitoring Methods (DFG)) by Antonius Kettrup.
2. Handbook of Air Pollution Analysis by Roy M. Harrison.

**M.Sc. Environmental Science
2st Year Semester - III
(MENVR 307)**

INDUSTRIAL TRAINING/RESEARCH PROJECT/SURVEY

Max. Marks - 100 Credit: 03

Report on Visit of Sewage treatment Plant

Every enrolled student of M.Sc. (Environmental Sciences) programme shall have to undergo training/Visit for the period of (4-6 weeks) in any governmental /nongovernmental /industrial organizations working on various aspects of Agro Industry and will submit a report (hard copy and soft copy) along with training/ Visit certificate/ issued by the organization. After completing training programme he/she will also prepare and deliver a power point presentation of the training attended in the department .The power point presentation will be of 10-15 minutes duration during which question will be raised by the committee comprising of faculty of the department. Every student shall be required to submit the topic of his/her training to the chairperson so that the same may be displayed on the notice board for the presentation schedule.



SEMESTER – IV

**M.Sc.
ENVIRONMENTAL SCIENCE**

**M.Sc. Environmental Science
2nd Year Semester - IV
Core Paper 1 (MENVCT 401)**

SCIENTIFIC WRITINGS AND ETHICS

Max Marks 30+70 Credit: 03

- Unit 1.** Overview of Moral and Ethical questions in Scientific writing. Overall outline and structure of the article/manuscript.
- Unit 2.** Description, value, and development of points/outlines before writing. Screening of Material for inclusion within the structure of the manuscript.
- Unit 3.** Importance of Authors and their sequence, importance of clear title, abstract or summary. Introduction, Methods, Results, and Discussion.
- Unit 4.** Numbers and statistics, Tables and Figures, Discussion. Writing Style: Active or passive, Punctuation, use of commas, apostrophe, semicolon and colon. Avoiding duplication and repetition. Importance of revisions and references.
- Unit 5.** Plagiarism, paraphrasing and copyright violation. Consequences of plagiarism. Why not to fudge, tinker, fabricate or falsify data.

Suggested Readings

1. Research Methodology: The Aims, Practices and Ethics of Science by Peter Pruzan
2. Research Methodology, A step-by-step guide for beginners by Kumar, Ranjit
3. Methodology and Research Design by Stacy Ann Brett

**M.Sc. Environmental Science
2nd Year Semester - IV
Core Paper 2 (MENVCT 402)**

ENVIRONMENTAL GEOSCIENCES, CLIMATOLOGY AND METROLOGY

Max Marks 30+70 Credit: 03

- Unit 1** Earth processes and geological hazards, Cyclones, Tsunamis, El-nino, La-nino, Nature and effect of flood, flood mitigation method, Earthquake: causes, intensity, magnitude, effect and mitigation measures, Types, effects and mitigation measures of volcanoes.
- Unit 2** Introduction to climatology ; atmospheric air, temperature, pressure, winds, moisture and precipitation, Wind Rose, cloud formation. Weather forecasting, General atmospheric circulation pattern of atmosphere and blocking action.
- Unit 3** Pollution climatology: Greenhouse gases, Global warming, Sea level rise and climate change.
- Unit 4** Atmospheric stability, Environmental lapse rate, inversion, plume rise and plume behavior models, Transportation and diffusion of pollutants.
- Unit 5** Gas laws governing the behavior of pollutants in the atmosphere, heat Islands.

Suggested Readings

1. Meteorology Today: an Introduction to Weather, Climate, and the Environment by Ahrens, Donald C.
2. Physical Geography- A Landscape Appreciation by McKnight, T.L.
3. Climate and Man by Pearce, F.
4. Fundamentals of the Physical Environment. by Smithson, P.; Addison, K. and Atkinson, K.
5. Dryland Climatology by Nicholson, S.E

e-Resources

1. <https://www.unccd.int/>

M.Sc. Environmental Science
2nd Year Semester – IV
Research Work (MENVD - 403)

DISSERTATION

Max. Marks. 400 Credit : 12

Internal Evaluation		Credit	Marks
a.	Synopsis	01	50
b.	Midterm Presentation	01	50
External Evaluation			
a.	Dissertation Report	06	200
b.	Viva-Voce/ Presentation	02	50
c.	Tour	02	50
Total		12	400

COURSE OBJECTIVES

1. Identify/define environmental problems existing in the area of interest and generate research questions and/or relevant hypotheses
2. Identify and apply appropriate research methods to deal with the research questions and hypothesis also conduct research responsibly and ethically using good laboratory practices.
3. Evaluate, interpret, and analyze a body of empirical data and evidence to generate an empirical model for better understanding and discuss findings and prepare report in the broader context of the field.
4. Learn to prepare the scientific report.

BY THE END OF THE COURSE, THE STUDENT WILL BE ABLE TO

- Identify real existing problem and searching solutions.
- Prepare and generate the scientific report with clear findings.
- Conversion of publishable results to help in a decision support system.

COURSE OBJECTIVES

1. Identify/define environmental problems existing in the area of interest and generate research questions and/or relevant hypotheses
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4. Learn to prepare the scientific report.

BY THE END OF THE COURSE, THE STUDENT WILL BE ABLE TO

- Identify real existing problem and searching solutions.
- Prepare and generate the scientific report with clear findings.
- Conversion of publishable results to help in a decision support system.
- Engage in systematic research and critical review of relevant information sources.
- Disseminate the output of the work for public welfare and scientific community.
- Carryout independent and sustained critical investigation and evaluation of selected research findings.

COURSE CONTENT

Each student will work for M. Sc. Project under the supervision of formally assigned supervisor in the department. Student shall complete the process of academic interaction to obtain teachers consent to supervise his/her project work. The work on research project will start under the supervision of assigned faculty member and will be completed by end of semester with submission of dissertation thesis in prescribed format. Dissertation will be evaluated by internal and external expert members based on the presentation and viva- voce.

Suggested Reading

1. Planning Research: A Concise Guide for the Environmental and Natural Resource Sciences by John C. Gordon
2. Research Methodology by C.R. Kothari and Gaurav Garg
3. Research Methodology & Biostatistics by Sharma Suresh
4. Research Methodology: Concepts And Cases by Deepak Chawla and Neena Sondhi
5. Research Methodology in Environmental Science by Dr. Satish Patil

**THE DEPARTMENT OF ENVIRONMENTAL SCIENCES OFFERS THE
FOLLOWING OPEN ELECTIVE COURSES FOR THE STUDENTS OF OTHER
DEPARTMENTS:**

**MINOR OPEN ELECTIVE THEORY
(STUDENTS OF OTHER DEPARTMENTS)**

SEMESTER	Paper Code	Paper Title	L	T	P	Credits	Distribution of Marks			Page No
							Ext.	Int.	Total	
SEMESTER - I	MENVOE 501	Minor Elective Theory (Open Elective)	3	0	0	3	70	30	100	26
SEMESTER - II	MENVOE 502	Minor Elective Theory (Open Elective)	3	0	0	3	70	30	100	27
SEMESTER - III	MENVOE 503	Minor Elective Theory (Open Elective)	3	0	0	3	70	30	100	28

M.Sc. Environmental Science
1st Year Semester - I
Minor Elective (MENVOE 501)

BIODIVERSITY AND WILDLIFE CONSERVATION

Max Marks 30+70 Credit: 03

- Unit 1** Concept of biodiversity, Genetic, Species and Ecosystem biodiversity, Values of biodiversity for example productive, consumptive, social and ecological etc.
- Unit 2** Biodiversity and its conservation: importance of biodiversity and threats to biodiversity. Biodiversity 'Hotspots'.
- Unit 3** National Parks, Sanctuaries, Biosphere Reserves, Protected areas in India. Conventions and protocols related to biodiversity and wildlife conservation.
- Unit 4** Major environmental movements- Extinct, Rare, Endangered and Threatened flora and fauna of India, National and Global Red Data Book.
- Unit 5** Important Wildlife conservation projects, Global Environmental Issues. Biodiversity loss, International efforts for Biodiversity Conservation.

Suggested Readings

1. Wildlife Ecology, Conservation, and Management by John M. Fryxell, Anthony R.E Sinclair, Graeme Caughley
2. Wildlife Biology: An Indian Perspective by Goutam K. Saha, Subhendu Mazumdar
3. Forest Wildlife Ecology and Habitat Management by David R. Patton
4. Biodiversity: An Introduction by Gaston K. J., Spicer, J. I
5. Environmental Science by S. C. Santra,
6. Conservation Biology Foundations, Concepts, Applications by Dyke, F.V.
7. Essentials of Conservation Biology by Primack, R.
8. Principles of conservation biology by Groom, M. J., Meffe, G. R. & Carroll, C. R.
9. The world's Protected Areas: Status, Values and prospects in 21st century by Stuart, C., Spalding, M. & Jenkins, M.

e-Resources

1. <https://www.nwf.org/Educational-Resources/Wildlife-Guide/Understanding-Conservation/Biodiversity>

M.Sc. Environmental Science
1st Year Semester - II
Minor Elective (MENVOE 502)

FUNDAMENTALS OF ECOLOGY & ENVIRONMENT

Max Marks 70+30 Credit: 03

- Unit 1** Ecosystem Structure and functions: Structures - Biotic and Abiotic components, Functions - Energy flow in ecosystems, food chains and food webs, inter and intra species interaction in ecosystem. Types of ecosystem.
- Unit 2** Biogeochemical cycles viz. Nitrogen, Phosphorus, Carbon, Water cycle, Current Environment Issues & Challenges.
- Unit 3** Population ecology: Characteristics of population, concept of carrying capacity, population growth and regulations. Keystone species. Community ecology: Definition, community concept.
- Unit 4** Basics of Air, Water, and Noise Pollution, Eutrophication, Solid Waste Management, Global Warming and Climate Change.
- Unit 5** Structure of earth, types of rocks, origin and formation of soil, soil profile, physicochemical and biological properties of soil.

Suggested Reading

1. Fundamentals of Environment and Ecology by Dr. Debasish De.
2. Ecology and Environment by P. D. Sharma.
3. Fundamentals of Ecology by E.P. Odum
4. Essentials of Ecology by John L. Harper and Michael Begon.
5. Environmental Sciences by Robert M Shaoh.
6. Environmental Science by Andrew RW & Julie M Jackson.
7. Ecology and the Environment by Russell K, Manson Silent Spring.

e-Resources

1. <https://environment.wsu.edu/undergraduate-studies/forest-ecology-and-management/>

M.Sc. Environmental Science
2st Year Semester - III
Minor Elective (MENVOE 503)

DISASTER AND ITS MANAGEMENT

Max. Marks 70+30 Credit: 03

- Unit 1** Introduction to Hazards, Hazard classification: Natural and Man-made disasters, Risk and Vulnerability in Disasters.
- Unit 2** Introduction to plate tectonics, sea floor spreading, mountain building and evolution of continents.
- Unit 3** Earthquake; causes, intensity and magnitude, geographical distribution of earthquake zone, effects and mitigation. Volcanism: Causes, effects and mitigation method.
- Unit 4** Coastal hazards: Cyclones and Tsunamis, El-nino, river flooding causes, nature and extent of flood hazard. Urbanization and flood, effect and mitigation method.
- Unit 5** Mitigation and Management techniques of Disaster, Basic principles of disasters management, Disaster Management cycle, Disaster management policy, National and State Bodies for Disaster Management, Early Warning Systems, Building design and construction in highly seismic zones.

Suggested Reading

1. Introduction to Disaster & Its Management by Ravi Kumar Kanda.
2. Warning Alert for Disaster & Its Management by Shruti Gupta and Manoj Kumar
3. Disaster Management and Its Implications for Development by Kambere Eriah
4. Disaster Management: Concepts and Approaches by Debarata Mondal and Debarata Basu.