MANONMANIAM SUNDARANAR UNIVERSITY, TIRUNELVELI

P.G. COURSES – AFFILIATED COLLEGES

M.Sc. Environmental Science

(Choice Based Credit System)

(with effect from the academic year 2020-2021 nwards)

Duration: 2 Years

M.Sc. Environment Science or Master of Science in Environment Science is a postgraduate Environmental Science course. Environmental Science is an interdisciplinary academic field that integrates chemistry and biological sciences, (including but not limited to Ecology, Chemistry, Biology, and Geology) to the study of the environment, and the solution of environmental problems. Environmental science provides an integrated, quantitative, and interdisciplinary approach to the study of environmental systems. The duration of M.Sc. in Environment Science is mostly of two academic years. The syllabus for the course is divided into four semesters.

M.Sc. Environment Science Eligibility

- Aspiring students should have passed Bachelor's Degree from any recognised University or its equivalent examination with any of the following subjects like Environmental Sciences, Chemistry, Botany, Zoology, Microbiology, Biotechnology, Geology, Life Sciences, Home Science Relevant courses in B.E. and B. Tech- Environmental Engineering, Agriculture, Biotechnology, secured minimum 55% marks (45% in case of SC/ST candidates) in the above mentioned examination.
- Candidates who have appeared or who are likely to appear for the qualifying examination i.e. B.Sc. or equivalent but whose results have not been as yet declared can also appear for this entrance test provided, they have offered the mentioned subjects at the said examination.

Scheme of Examination

Theory Paper

Assessment Components (External : Internal – 75 : 25

Internal Marks --25

Test	- 15 marks
Assignment	- 5 marks
Seminar	-- 5 marks
Total	25 marks

External Marks - 75 marks

Section A	: 10X 1marks	= 10 marks
Section B	: 5X 5 marks	= 25 marks
Section C	: 5X 8 marks	= 40 marks
Total		75 marks

Practical Paper

Assessment Components (External : Internal – 50 : 50)

Course Structure

Sem. (1)	Sub. No. (2)	Subject Status (3)	Subject Title (4)	Contact Hrs./ Week (5)	Credits (6)
I	1	Core - 1	Fundamentals of Ecology and Ecosystem*	6	4
	2	Core - 2	Biodiversity Types, Concept and Conservation*	6	4
	3	Core - 3	Environmental Biology*	5	4
	4	Core - 4	Statistical and Research Methods *	5	4
	5	Core - 5 Practical - 1	Ecology & Biodiversity*	4	2
	6	Core - 6 Practical – 2	Environmental Biology	4	2
			Subtotal	**30**	**20**
II	7	Core - 7	Environmental microbiology*	5	4
	8	Core - 8	Environmental chemistry*	5	4
	9	Core - 9	Solid Waste and Management	4	4
	10	Core - 10	Environmental Toxicology	4	4
	11	Core - 11	Field Work	4+	3
	12	Core - 12 Practical - 3	Environmental microbiology & toxicology	4	2
	13	Core - 13 Practical - 4	Environmental chemistry & solid waste management	4	2
			Subtotal	**30**	**23**

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Fundamentals of Ecology and Ecosystem

Unit I: Introduction to Ecology -Definition, subdivision and scope, Basic concepts in ecology, Autecology and Synecology, Level of organization in Ecology, Environmental heterogenicity, Applied ecology, Environmental complexes, Interaction of ecological factors.

Unit II: Ecological factors-Light, temperature, precipitation (rainfall), humidity. Atmosphere: gases and wind, atmospheric gases, wind factor and fire factor, topographic and edaphic factors. Different environmental laws andlimiting factors (Liebig's law of minimum, Shelford's law of Tolerance, Combined concept oflimiting Factors). Biotic community, Interdependence in a community and community metabolism, Community ecology: structure, composition and development of community, species diversity in communities, Ecotones, Concept of edge effect, Ecological niche, Gause's Principle.

Unit III: Ecosystem-Introduction, kinds of ecosystem, structure and functions, abiotic and biotic component, Ecological energetics, Energy flow models, Food chain and Food web, Concepts of productivity and standing crops, Ecological Pyramids-types, Ecological succession, Ecological indicators, Ecological efficiencies, Biogeochemical cycles in ecosystems.

Unit IV: Population ecology-Population characteristics; density, natality, mortality, biotic potential, survivorship curves, age distribution, growth curves and models, r &k selection. Population interaction, Prey-Predator Relationship, Ecological Model.

REFERENCES

1. Begon, M., Townsend, C.R. and Herper, J.L. (2005). Ecology: From Individuals to Ecosystems, 4thEdition, John Wiley & Sons.
2. Botkin, D. and Edward, K. (1997). Environmental Sciences, John wiley& Sons, New York.
3. Chapman, J. L. and Reiss, M. J. (1998). Ecology: Principles and Applications.Cambridge University Press, UK.
4. Cunningham, W. P. and Cunningham, M. A. (2004). Principles of Environment Science. Enquiry andApplications. 2nd Edition. Tata McGraw Hill, New Delhi.
5. Dash, M.C. and Dash, S.P. (2009). Fundamentals of Ecology. McGraw Hill Education.
6. Odum, E.P. (2005). Fundamentals of Ecology, 5thEdition, Cengage Learning Publication.
7. Raven, P. H., Berg, L.R. and Hassenzahl, D.M. (2008). Environment. 6th Edition. John Wiley & Sons., USA.
8. Sharma, P.D. (2000). Ecology & Environment, 7thEdition, Rastogi Publications, Meerut.
9. Singh, J.S., Singh, S.P. and Gupta, S.R. Ecology, Environment and Resource Conservation. Anamaya Publishers, New Delhi, India. 2006.
10. Smith, T.M. and Smith, R.L. (2015). Elements of Ecology. 9thEdition, Pearson Benjamin Cummings, USA.

Biodiversity Types, Concept and Conservation

Unit I : Biodiversity concept, Biodiversity-components, Biodiversity-Types, Biodiversity-importance, ecological importance, economical importance, key stone umbrella and flagship species, Economic value of biodiversity, ecotone and niche.

Unit II: Biodiversity- values, Biodiversity status: National status and Global status, hotspot; threatened species, IUCN Red list, endangered species, vulnerable species, rare species, extinct species and endemic species. Climate change, induced losses. Common flora and fauna in India- Aquatic: phytoplankton, Zooplankton and macrophyes. Terrestrial: Forests; Endangered and threatened species.

Unit III: Concepts, distribution and importance of megadiversity zones, Biodiversity hotspots, National and global red data lists, Categories of species and their management, Restoration of biodiversity, Acceleration of ecological succession, Reintroduction of biota.
Unit IV: IPRs, national and international programs for biodiversity conservation. Wildlife values and eco-tourism, wildlife distribution in India, problem in wildlife protection, role of WWF, WCU, CITES, TRAFFIC, Wildlife Protection Act 1972.

Unit V: Importance of Biodiversity conservation, Different approaches for Biodiversity conservation-In-situ conservation: sanctuaries, biospheres reserves, national parks, nature reserves, preservation plots. Ex-situ conservation: botanical gardens, zoos, aquaria, homestead garden; herbarium; In-vitro Conservation: germplasm and gene Bank; tissue culture: pollen and spore bank, DNA bank.

1. Sustaining Life: How Human Health Depends on Biodiversity Eric Chivian Aaron Bernstein
2. (2008)
3. Shahid Naeem, Daniel E. Bunker, Andy Hector and Michel Loreau (2009)Biodiversity, ecosystem
4. fuctioning and human well being: An ecological and economic perspective
5. S.K. Agarwal et al (1996) Biodiversity and Environment, APH, Dehra Dun.
6. S.S. Negi (1993) Biodiversity and its Conservation in India, Indus Publications, New Delhi.
7. W.W. Collins and C.O. Qualset (1998) Biodiversity in Agro-ecosystem, CRC, Boston.
8. V.K. Krishnamurthy (2003) Text Book of Biodiversity, Science Publisher, Chennai.
9. P.S. Ramakrishnan (2000) Mountain Biodiversity, Land Use Dynamics and Traditional Ecological
10. Knowledge, Oxford and IBH, New Delhi
11. Global Biodiversity strategy: WRI, IUCN & UNEP
12. Ecotourism and Sustainable Development: Singh; Abhijeet Pub

Environmental Biology

Unit I: Fundamentals of Ecology, Definition, Subdivisions. Ecosystems: concept of ecosystems, energy flow in ecosystems, Nutritional Flux. Development and evolution of the ecosystems. Biogeochemical cycles, Food-chains, ecotone, edge effects, ecological niche, and ecosystem stability.

Unit II: Environmental Microbiology: Microbes – classification and their applications in the environmental sciences. Cultivation and growth of microorganisms. Microorganisms and their association with man, animals and plants. Microbes as anti-microbial agents, Extremophilic microorganisms, Microbial metabolism.

Unit III: Biomes and Habitat Diversity: Classification of biomes, major biotic elements of each biome and their characteristics. Biological diversity of India: Definition and nature, India's biogeographically history, physiography, climate and its impact on biodiversity. Indian forest and vegetation types and diversity of flora and fauna. Population and Community Ecology.

Unit IV: Wetlands Forests and Semi-arid Habitats of India: Definition and types of wetlands, important wetlands of India and their conservation issues. Forests and semi-arid habitats of India: their distribution in India, ecological status of forests and arid lands, and their conservation.

Unit V: Endangered, Endemic and Extinct Species of India: Threatened species categories of IUCN, threatened species of plants and animals in India and their reasons, Red data books. Environmental biotechnology. Role of biotechnology in conservation of species, *insitu* and *ex-situ* conservation.

References :

1. Microbes, Man and Animals : The Natural History of Microbial Interactions : Linton, A. H. and Burns, R.G. (1982) john Wiley and Sons.
2. Elements of Microbiology : Pelczar, M.J. and Chan ECS, 1981 McGraw Hill.
3. General Microbiology : Stainer, R.Y.., Adelberg, E.A. and Ingraham, J.L. 1977. Macmillan Press.
4. Microbial Methods for Environmental Biotechnology : Grainer, J.M. and Lynch, J.M. 1984. Academic Press.
5. Microbiological Methods for Environmental Scientists and Enginners : Gaudy, A.F. and Guady, E.T. 1980, McGraw Hill.

Statistical and Research Methods

Unit I: Sampling, Data collection and recording. Central tendency – concept; arithmetic mean, mode, median for ungrouped and grouped data.

Unit II: Measures of dispersion: absolute and relative measures; range, standard deviation (grouped and ungrouped data), variance, quartile deviation, coefficient of variability. Skewness, Kurtosis. Probability - normal, poisson and binomial.

Unit III: Statistical Methods: Hypothesis testing, significance and correlation. Correlation. Linear models and regressions. Pearson and other correlation coefficients. Multiple regressions. Distribution- Normal, t and chi square test.

Unit IV: Difference among means: F-test: 1 way ANOVA; F-test: 2 ways ANOVA. Computer applications in environmental modeling. Computer-based modeling: Linear, regression, validation and forecasting. Computer-based modeling for population and population studies.

Unit V: Matrices, simultaneous linear equations; tests of hypothesis and significance. Time series analysis - moving averages (3 and 5 unit cycles). Current development in the subject

References :

1. Zar, Jerrold H. (1998). Biostatistical Analysis. Prentice Hall, N.J.
2. Sokal, Robert and James Rohlf (1997). Biometry, Freeman Press, N.Y.
3. Walpole, R. and R. Myers (1993). Statistics for Engineers and Scientists, 5th edn. MacMillan, N.Y.
4. Wayne, R. Ott (1995). Environmental Statistics and Data Analysis, CRC Press.
5. Manly (2001) Statistics for environmental science and management, Chapman and Hall / CRC.
6. Ramsay and Schafer (1997). The Statistical Sleuth, Duxbury Press.

Practical-1

Ecology & Biodiversity

1. Determination of Importance value index of species in a plant community.
2. To compare two plant communities
3. Quantitative measurement of plankton in fresh and marine water samples.
4. Determination of primary productivity by light and dark bottle method.
5. Indicate distribution range of a plant and animal species identified as endangered on an Indian map.
6. Identification and description of plant species.
7. To plot biosphere reserve on a map of India.
8. Prepare a document of endemic and exotic species of plants and animals for a selected PAN.

Practical- 2
Environmental Biology

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

ENVIRONMENTAL MICROBIOLOGY

Unit-I: General and Aquatic Microbiology: **C**lassification, characteristics, occurrence and distribution of microorganisms. Microbial cultivation and growth. Microbial mats, Bio-films, Role of Microorganisms in Wastewater and Water Treatment; Bioassay tests for toxicity evaluation, Pathogens and Indicator microorganisms; Eutrophication of water bodies.

Unit-II: Soil microbiology: General characteristics and activities of microorganisms in surface soil, Mineralization and Immobilization of soil nutrients, Microbial degradation of cellulose, hemicelluloses and lignin. Microbes in Agriculture- Biological nitrogen fixation, bio-fertilizers, Mycorrhiza and their environmental significance. Microbe mediated C, N and S transformations.

Unit-III: Food microbiology**:** Food borne infections: bacterial (Clostridium, Salmonella, Shigella, Staphylococcus), Mycotoxins in food with reference to Aspergillus species. Genetically modified foods. Microbes in food production. Applications of microbial enzymes in food industry.

Unit-IV: Bio-indicators: Plankton community as indicators of water pollution; use of diversity index in evaluation of water quality. Determination of microbiological quality of recreational and potable waters, indicator organisms, coliforms and E.coli, fecal streptococci, clostridia, and heterotrophic plate counts etc. lichens as air pollution indictors.
Biosensor Components, advantages and limitations, biocatalyst based, ion-affinity based and microorganism based biosensors; Applications of biosensors in environmental monitoring.

Unit V: Applied Environmental Microbiology: Bioremediation: principle and mechanisms, types and environmental applications. Specific Processes: Biodegradation of pesticides and hydrocarbons, Bio-hydrometallurgy, Microbial Enhanced Oil Recovery, Biodegradable Plastics, Biosurfactants. Release of genetically engineered microbes and environmental risk.

REFERENCES

1. Gaudy, A.F. & E.T. (1980). Microbiological Methods for Environmental Scientists and Engineers, McGraw Hill.
2. Grainer, J.M. & Lynch, J.M. (1984). Microbial Methods for Environmental Biotechnology: Academic Press.
3. Madigan, M.T. &Martinko,J.M. (2006). Brock Biology of Microorganisms. Pearson Prentice Hall.
4. Maier, R.M., Pepper, I.L. &Gerba, C.P. (2000). Environmental Microbiology, Academic Press.
5. Parihar, P. &Parihar, L. (2008). Advances in Applied Microbiology. 1stEd., Agrobios (India).
6. Pelezar, M.J. Jr., Chan, E.C.S and Kreig, N.R (1993). Microbiology, Tata McGraw Hill, Delhi.
7. Purohit, S.S. (2010). Microbiology Fundamentals and Applications, 6th Ed., Agrobios.
8. Stainer, R.Y., Adelberg, E.A. & Ingraham, J.L. (1977). General Microbiology, Macmillan Press.
9. Environmental Microbiology - Alan H. Varnam and Malcolm G. Evans.
10. Environmental Microbiology - Annette Bolger.
11. Environmental Microbiology - Purnima Sethi and V.S. Kulkarni

ENVIRONMENTAL CHEMISTRY

Unit I: Chemistry of water and aquatic system -Stiochiometry, Gibb's energy, chemical potential, chemical equilibria, acid base reactions, solubility product, solubility of gases in water. The carbonate system; Chemistry of water, Properties of water and their significance, types, sources and consequences of water pollution, Physico chemical and bacteriological sampling and analysis of water quality. Water quality standards. Concept of DO, BOD, COD, sedimentation, coagulation, filtration, Redox potential, alkalinity, acidity, calcium and other metals in water, organic pollutants in sewage, soaps, oil and detergents, radionuclide in water.

Unit II: Atmospheric chemistry-Particles, ions and radicals in the atmosphere. Natural and anthropogenic sources of pollution. Primary and Secondary pollutants. Transport and diffusion of pollutants. Oxygen and ozone chemistry. Chemistry of air pollutants, Photochemical smog. Methods of monitoring and control of air pollution- SO2, NOx, CO, SPM. Effects of pollutants on human beings, plants, animals and materials. Air quality Standards

Unit III: Soil and sediment geochemistry-Inorganic and organic components of soil, Weathering of rocks, rock forming minerals, Soil properties, acid-base and ion-exchange reaction in soil, Macro and micronutrients in soil, Nitrogen pathways and NPK in soils, Interior of the earth- minerals and rocks- earth processes- plate tectonics- sea floor spreading, mountain building, rock deformation.

UNIT IV: Toxic chemicals in the environment- Organic compounds: Hydrocarbons, Chemistry of hydrocarbons, phenols, chlorofluorocarbons, pesticides, chemical fertilizers, environmental effects, effects on macro and microorganisms. Gasoline lubricants and greases, Pesticides**:** Classification, degradation, analysis, pollution due to pesticides and heavy metals

REFERENCES

1. De, A.K. (2001).Environmental Chemistry. Wiley Eastern Ltd, New Delhi
2. Field, F.W. & Haines, P.J. (2000). Environmental Analytical Chemistry, Blackwell Science Ltd. USA.
3. Karikalan, V.L. (2002). Environmental Engineering. DhanpatiRai& Co. (P) Ltd., Delhi.
4. Manahan, S.E. (1991). Environmental Chemistry. Lewis Publishers, Chelsea, Michigan.
5. O' Neill, P. (1993). Environmental Chemistry. Chapman and Hall, London.
6. Rao, C.S. (1991). Environmental Pollution Control Engineering. Wiley Eastern, New Delhi.
7. Sharma, B.K. and Kaur H. (1998). Environmental Chemistry. Goel Publishing House, Meerut.
8. Sodhi, G.S. (2002). Fundamental concepts of Environmental Chemistry, Narosa Publishing House, New Delhi.

SOLID WASTE AND MANAGEMENT

UNIT I: Sources, generation, classfication & composition of solid wastes. Solid waste management methods - Sanitary land filling, Recycling, Composting, Vermi composting, Incineration, energy recovery from organic waste.

UNIT II: Solid Waste Management Plan, Waste minimization technologies, Hazardous Waste Management, Sources & Classification, physicochemical properties, Hazardous Waste Control & Treatment.

Unit III: Methods of disposal – Dumping, Sanitary Landfill, Incineration, Pyrolysis, Composting, Ocean Dumping. Leachate Management for MSW landfills

UNIT IV: Applied Uses of Solid Waste: Biogas production, Composting and Vermicomposting. International cooperation in municipal solid waste management.

Unit V: Integrated Waste Management. Municipal Solid Waste Management & Handling Rules,2000

References:

1. Solid Waste Management CPCB. New Delhi.
2. Ecotechnology for pollution control & environmental manage
3. ment - By R.K. Trivedi & Arvind Kr.
4. Basic Environmental Technology - J.A. Nathanson
5. AareneVesilind .P, Worrell.W&Reinhart.D(2002),Solid Waste Engineering, Cengage Learning India Pvt. Ltd .
6. Cunningham, W. P. (2001): Environmental Science- Global Science. McGraw Hill, London.
7. Liu.H.F and Liptak.G.B.(2000),Environmental Engineer’s Handbook, Second Edition, Lewis Publishers , New York
8. Peper, I. L., Gerba, C. P. &Brusseau, M. L.(1996): Pollution Science. Academic Press, San Diego.
9. Ramachandra.T.V (2006),Management of Municipal Solid Waste, Capital Publishing Company
10. Tchobanoglous G and Kreith. F(2002), Handbook of Solid Waste Management, Second Edition, McGraw- Hill Companies.
11. Tchobanoglous G, Rowe.R.D and Peavy. S.H (1985), Environmental Engineering, International Edition, McGraw –Hill Book Co. Singapore

ENVIRONMENTAL TOXICOLOGY

UNIT I: Toxic chemicals in the environment - air, water & their effects, Pesticides in water, Biochemicals aspects of arsenic, cadmium, lead mercury, carbon monoxide, ozone and PAN pesticide.

Unit II: Toxic agents: Pesticides, metals, solvents and vapours, radiation and radioactive materials, chemical carcinogens, food additives and contaminants, air, water and soil pollutants.

UNIT III: Mode of entry of toxic substance, biotransformation of xenobiotics detoxification, Carcinogens in air, chemical carcinogenicity, mechanism of carcinogenicity, Environmental carcinogenicity testing.

Unit IV: Insecticides, MIC effects. Concept of major, trace and Rare Earth Element (REE)-possible effects of imbalance of some trace elements.

Unit V: Biogeochemical factors in environmental health,. Epidemiological issues goiter, fluorosis, arsenic poisoning

References

1. Environmental chemistry - Sodhi
2. Principals of Environmental chemistry - Manhan
3. Environmental hazards & human health R.B. PhilipMehta, C.S. (1991)
4. Environmental Protection & the Law. Ashish Pub., Delhi.
5. Environmental hazards & human health R.B. Philip
6. Toxicology - principles & applications - Niesink & Jon devries
7. Parasitology - Chatterjee
8. Preventive & Social medicines – Perk

Field Work

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Environmental Microbiology & Toxicology

1. Laboratory safety.
2. Basic microbial techniques
3. Isolation of microorganisms from air, water and soil.
4. Microbial staining, observation and micrometry; presence of pathogen in waste water.
5. Isolation of microorganisms of environmental interest.
6. Analysis of soil microflora by dilution plate method, study of rhizospheric and rhizoplane microbes.
7. Study of anatomical changes in plants to detect effect of pollution.
8. Determination of chloroplasts per unit area, estimation of chlorophyll content and stomatal conductance.

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Environmental chemistry & solid waste management

1. Sampling methods of soil and solid waste
2. Physico-chemical characterization water and waste water,
3. Physico-chemical characterization soil and sediment.
4. Air quality assessment
5. Solid waste characteristics.
6. Analysis of Moisture content
7. Analysis of Organic Matter
8. Analysis of Organic Carbon
9. Preparation of Compost
10. Biological analysis of Municipal Solid waste