

**MANONMANIAM SUNDARANAR UNIVERSITY**  
**TIRUNELVELI 627 012**  
**Sri Paramakalyani Centre for Environmental Sciences**  
**Alwarkurichi-627 412**  
**M.Phil- Environmental Sciences**  
**Effective from the Academic year 2016 – 2017**

**Eligibility:**

A candidate shall be eligible for admission to Environmental Science (M.Phil) course if he/she has obtained Master's degree (M.Sc., Environmental Sciences, Environmental Biotechnology, Nanosciences, Environmental Biology, Environmental Management, Botany, Zoology, Biotechnology, Microbiology, Biochemistry, Chemistry, Geology, Biosciences, Bioinformatics, Agriculture, Horticulture, Forestry, Wildlife Biology and any other Biological Sciences) or equivalent degree recognized by our University with eligible marks stipulated by Manonmaniam Sundaranar University.

**Course Structure**

| S.No.        | Semester | Subject   | Credits   | Hours/week | Marks |      |            | Passing Minimum |      |
|--------------|----------|---|-----------|------------|-------|------|------------|-----------------|------|
|              |          |   |           |            | Int.  | Ext. | Tot.       | Ext.            | Tot. |
| 1            | I        | Core -I (Theory):<br>Research Methodology   | 8         | 8          | 25    | 75   | 100        | 38              | 50   |
| 2            | I        | Core – I (Theory)<br>Advancement and Recent<br>Development  | 8         | 8          | 25    | 75   | 100        | 38              | 50   |
| 3            | I        | <b>Elective –I (Theory):</b><br>1.Environmental Pollution<br>and Control<br>2 Plant Conservation<br>Biotechnology<br>3 Environmental<br>Nanosciences<br>4 Applied Entomology and<br>Biopesticide<br>5 Restoration Ecology<br>6. Aquatic Ecology | 8         | 8          | 25    | 75   | 100        | 38              | 50   |
| 4            | II       | <b>Project and Viva-voce</b>  | 16        | -          | 25    | 75   | 100        | 38              | 50   |
| <b>Total</b> |          |   | <b>40</b> | -          | -     | -    | <b>400</b> | -               | -    |

**MSU/2016-17/ Univ.Depts /M.Phil (Environmental Science)/Semester –I/Ppr.-1/Core-1  
Research Methodology**

**UNIT I**

Significance of Life Science Research – Types of Research – Formation of Research Problem – Formulation of Hypothesis – Sources of Data – Methods of Data Collection – Sampling design: Random and Non-random.

**UNIT II**

Meaning of Research - Objectives of Research - Types of Research - Research Approaches - Significance of Research - Research and Scientific Methods - Criteria of Good Research - Funding agencies-Choosing the Research Problem:

**UNIT-III**

Statistical analysis: Tests of Hypothesis- Parametric and Non-Parametric test: 't' and 'f' Test ANOVA – $\chi^2$  Test-statistical software including SAS, SPSS, sigma and origin

**UNIT-IV**

Basic Correlation: Definition, Meaning -Correlation types: Simple, Partial and Multiple Correlation - Regression: Meaning - Linear Regression- Difference between Correlation and Regression.

**UNIT-V**

Layout of the Research Report – Types – Precautions in writing Research Reports – Footnotes Bibliography- bibliographic software

**Reference**

1. Berg, B. L., Lune, H., 2004. Qualitative research methods for the social sciences, Pearson Boston.
2. Kothari, C.R., 2004. Research Methodology Methods and Techniques, New Age International
3. Merriam, S. B., 1998. Qualitative Research and Case Study Applications in Education. Revised and Expanded from " Case Study Research in Education.", Jossey-Bass Publishers, Sansome St, San Francisco, CA.
4. Bogdan, R.C., Biklen, S. K., 1998. Qualitative research in education. An introduction to theory and methods, Allyn & Bacon, A Viacom Company, MA 02194.
5. Davis, M., 1997. Scientific Papers and Presentations| San Diego: Academic Press.
6. Isaac, S., Michael, W., 1971. Handbook in research and evaluation, (2nd ed.), San Diego, USA.
7. McDonald, J. H., 2009. Handbook of biological statistics, Vol. 2, Baltimore, Sparky House Publishing. MD, USA.
8. Gomez, K.A., Gomez, A.A., 1984. Statistical procedures for agricultural research, John Wiley & Sons.
9. Townend, J., 2012. Practical statistics for environmental and biological scientists, John Wiley & Sons.

### **Advancement and Recent Development**

**Unit - I:** Environmental pollution, Air, Water, Soil and noise pollution, control - Sources, effect on environmental quality and health; Environmental issues of the 21st century; Important environmental accidents. Legislation and regulation for pollution control; Impact of geological hazards on Environment

**Unit – II:** Eutrophication. Management of polluted rivers Techniques of rain water harvesting. Energy conservation- role of bio-energy in energy management. Land use Policy and Planning Land and Soil conservation Sand, granite and ore mining issues. Biosphere reserves of India - role in conservation, Environmental health-air, water, food & soil borne diseases; prevention & control.

**Unit-III:** Principles and mechanism of toxicity; Biotransformation, bioactivation, biodegradation, biomagnifications of toxicants. Effect of Environmental pollutants zone; Physiology of animals and plants. Bio monitoring of water, air and soil pollution. Fermentation technology. Pathological problems peculiar to ecotoxicology.

**Unit - IV:** Institutional framework of disaster management in India; Disaster management in industries – emergency planning, preparedness, response; Eco friendly technologies, Green chemistry. Role of Ecotourism and Eco clubs in environmental preservation Environmental Laws and Legislations. Environmental Ethics. Impact of GMOs and LMOs in natural ecosystems. Urban Planning in India.

**Unit –V:** Natural disasters, concept of earthquake, tsunami, landslide, land subsidence and forest fire, hazard reduction, mitigation and control; Disaster preparedness for natural hazards; Safety Audit;; Accident management, rescue, relief and rehabilitation; community organization and their role; ISO series.

## References

1. Grebner DL, Bettinger P and Siry A (2013) Introduction to Forestry and Natural Resources, Academic Press, UK.
2. Kreipe M (2010) Genetically Modified Food - Trade Regulation in view of Environmental Policy Objectives, Diplomica Verlag, GmbH, Germany.
3. Brenner S, The genetics of *Caenorhabditis elegans*. Genetics, 1974; 77: 71 -94.
4. Botkin DB and Keller EA (2012) Environmental Science, 8th edition, Wiley India Pvt. Ltd., New Delhi.
5. Canter LW (1996) Environmental Impact Assessment. Mc Graw Hill, New York.
6. Dannreuther R and Ostrowski W (2013) Global Resources Conflict and Cooperation, Palgrave Macmillan, USA.
7. Steinberg P (2013) High-Throughput Screening Methods in Toxicity Testing, John Wiley & Sons Inc., USA.
8. Venkateswar Rao G (2012) Intellectual Property Rights: Patent Laws in India, SSDN Publishers & Distributors, New Delhi.
9. Ostrom LT and Wilhelmsen CA (2012) Risk Assessment – Tools, Techniques and their Applications, John Wiley & Sons Inc., NJ, USA.

1. Environmental Pollution and Control

UNIT I:

Characteristics of major industrial effluents — primary — secondary and tertiary treatment of effluents - Ion exchange — reverse osmosis — electro dialysis — colour removal from 'industrial effluents — Sludge treatment and disposal — Modelling of activated sludge process

UNIT II:

Working principles of the following reactors - Rotating Biological Contactors, Fluidized Bed Reactor, Expanded Bed Reactor, Contact Digesters, Packed Column Reactors, UASB Reactor — Microbial removal of nitrogen and phosphorus — Nutrient removal through biomass production - Hazardous waste management — Hospital waste management—Air pollution control in industries

UNIT III:

Metal microbes interactions — Microbial immobilization and transformation of metals — Genetic aspects of heavy metal resistance— Pesticide biodegradation —Biotechnological applications for pesticide waste disposal — Oil degradation by microbes — Aquatic macrophytes for waste water treatment — Biotechnology in soil pollution abatement

UNIT IV:

Bioremediation approaches — Advantages and disadvantages of bioremediation — Types of bioremediation — Factors affecting bioremediation — Role of microbes in bioremediation — Bioremediation techniques - Bioremediation monitoring and case studies - Effluent irrigation in agriculture — Microalgal species for aquaculture — Mass cultivation techniques — Closed and Semi Outdoor Culture Systems —Harvesting and Drying of Algal Biomass — Bioaugmentation for commercial production of algae

UNIT V:

Genetic concept in pollution management — Transgenic microbes for treating toxic chemicals — Environmental effects of biotechnology — Gene transfer in the environment— GEMS and biosafety — Ethics of microbial biotechnology

## References

1. Pradipta Kumar Mohapatra (2007), Text book of Environmental Biotechnology, I.K. International Publishing House Pvt. Ltd
2. Jogdand. S.N. (2003) Environmental Biotechnology, Himalaya Publishing House
3. Chatterji, (2003), Introduction to Environmental Biotechnology, Prentice Hall of India Pvt. Ltd
4. A.G.Murugesan and C.Rajakumari, Environmental Science and Biotechnology —Theory and Techniques, MJP Publishers
5. P. Rajendran • and G. Gunasekaran, 2006. Microbial bioremediation. MJP Publishers, Chennai. ISBN — 81-8094-022-5. ,
6. J.C. Fry et al, 1992. Microbial Control of Pollution, Cambridge University Press
7. C.S.Rao, (1997), Environmental Pollution Control Engineering, New Age International Pvt. Ltd, India .
8. Dara.S.S. (2000), Environmental Chemistry and Pollution Control, S. Chand & Co., Pvt. Ltd
9. William C. Blackman, Jr, (1996), Basic Hazardous waste management (Ed.) CRC Press Inc
10. Sharon Mc Eldovmey et al, (1993), Pollution Ecology Biotreatment Longman Scientific & technical, Harlow, England
11. Herber F. Lund — Industrial Pollution control handbook
12. Mahajan, S.P. Pollution control processing In industries
13. Trivedy, R.K. (1995). Encyclopedia of environmental pollution and control, Vol.2. Enviromedia
14. Jenkins, D & B.H. Olson, Waste water microbiology, Pergamon Press
15. Kaul, Nandy & Trivedy, (1989). Pollution "control in Distilleries Enviromedia, India

## 2. Plant Conservation Biotechnology

### Unit —I

Introduction - Plant conservation Biotechnology — Integration of biotechnology into conservation practices. Molecular approaches to assessing plant diversity. Biotechnology in plant germplasm acquisition. Methods of Plant conservation, and sustainable utilization of plant genetic resources.

### Unit —II

Tissue culture techniques in In vitro Plant Conservation: Culture room and lab facilities. Media composition and preparation — plant growth regulators, adjuvants; sterilization. Brief history of plant tissue culture, Totipotency, Morphogenetic patterns. Callus culture - Subculture, differentiation, and regeneration. Organogenesis Embryoids, Caulogenesis, Rhizogenesis, Cell Line, Somaclone, Gametoclone.

### Unit— III

Micro propagation — Preparative stage: Germplasm acquisition and selection of explants. Establishment stage: Axenic and viable cultures. Multiplication stage. Plantlet production: induction of roots and acclimatization of plantlets to green house condition. Somatic embryogenesis. Synthetic seed technology. Suspension culture, in vitro production of secondary metabolites, cell immobilization.

Unit— IV Protoplast isolation and culture, Somatic hybridization. Production of transgenic plants through Genetic Engineering: Insect resistant plant, drought tolerant plant, and saline tolerant plant. Application of biotechnology in plant diversity conservation. Recalcitrant seed biotechnology to rain forest conservation:

### Unit — V

Cryopreservation and germplasm storage: Slow or retarded growth. Principles, Cryoprotection, Freezing and long term cryogenic storage, protocols and recovery of germplasm. Conservation of Rare, endemic, threatened and economically important plants of India, current status and Active research stations in India. Stability assessments of conserved plant germplasm.

## References

1. Dodds.I.H, and Roberts.L,W, 1995, Experiments In plant tissue culture. Cambridge University press, London.
2. Erica E.Benson. 1999, Plant conservation Biotechnology. Taylor and Francis Ltd., UK.
3. Dixon.R.A, 1994, Plant cell culture, A Practical approach.IRL press.Oxford, L ondon.
4. Freifelder.D.1990.Molecular Biology.Narosa publishing house, New Delhi.
5. Murray Moo — Young. Plant biotechnology, comprehensive biotechnology series, pergamon press, Netherlands.
6. Narayanasamy.S, 1994, Plant cell and tissue culture. Tata McGraw — Hill Publishing co., Delhi.
7. Yeomen, 1987, Plant cell culture technology. Narosa Publication. New Delhi.
8. Lindsay, 1992, Plant Tissue Culture manual, Kluver Academic Publishers. Netherland.
9. George. E. F, 1994, Plant Propagation by Tissue culture. Exegectics Ltd., England.
10. Vasil.I.L, and Vasil.V.K, 1992, Plant Biotechnology and tissue culture. Kluver Academic Publishers, Netherlands.
11. Raven, Johnson, Losos, hilason and Singer 2008. BIOLOGY. 8m edition. McGraw Hill. New York, New Delhi.
12. Russell, Wolfe, Hertz and Starr 2008. Biology—THE DYNAMIC SCIENCE. Thomson Brooks/Cole, Australia, United States.



### 3.Environmental Nanosciences

#### Unit I

Generic Methodologies for Nanotechnology: Introduction and classification - What is nanotechnology? - Classification of nanostructures - Nanoscale architecture; Summary of the electronic properties of atoms and solids - Current Status of Nanobiotechnology — Future Perspectives of Nanobiology; Nanosensors - Introduction - INhat is a Sensor? — Nanosensors- Nanobiosensors- Nanomedicines.

#### Unit II

Biological Methods of Synthesis: Use of bacteria, fungi, Actinomycetes for nanoparticle synthesis, Magnetotactic bacteria for natural synthesis of magnetic nanoparticles; Mechanism of formation; Viruses as components for the formation of nanostructured materials; Synthesis process and application; Role of plants in nanoparticle synthesis, Microorganisms for synthesis of nanomaterials and for toxicity detection Natural and artificial synthesis of nanoparticles In microorganisms; Use of microorganisms for nanostructure formation, Testing of environmental toxic effect of nanoparticles using microorganisms;

#### Unit III

Characterization Techniques: X-ray diffraction, Scanning Probe Microscopy, SEM, TEM, Optical microscope and their description, operational principle and application for analysis of nanomaterials, UV-VIS-IR Spectrophotometers.

#### Unit IV

Nanobio Systems: Nanoparticle-biomaterial hybrid systems for bioelectronic devices, Bioelectronic systems based on nanoparticle-enzyme hybrids; nanoparticle based bioelectronic biorecognition events. Biomaterial based metallic nanowires, networks and circuitry. DNA as functional template for nanocircuitry; Protein based nanocircuitry; Neurons for network formation. DNA nanostructures for mechanics and computing and DNA based computation; DNA based nanomechanical devices. Biosensor and Biochips.

#### Unit V

Drug Delivery, Therapeutic action of nanoparticles and nanodevices: Targeted, non-targeted delivery; controlled drug release; exploiting novel delivery routes using nanoparticles; gene therapy using nanoparticles; Nanostructures for use as antibiotics; Diseased tissue destruction using nanoparticles;

## References:

1. Bio-Inspired Nanomaterials and Nanotechnology. Edited by Yong Zhou, Nova Publishers.
2. Bionanotechnology : Lessons frOm Nature, David S. Goodsell, Wiley-Liss, 2004.
3. Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology, Hari Singh Nalwa, American Scintific Publishers, 2005.
4. Introduction to Nanotechnology, Charles P. Poole Jr and Frank J. Owens, Wley Interscience, 2003.
5. Nano:The Essentials: Understanding Nanoscience and Nanotecnology, T.Pradeep, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2008.
6. NanoBiotechnology Protocols, Sandra J. Rosenthal, David W.Wright; Humana Press, New Jersey, 2005. '
7. Nanobiotechnology,.C.M.Nierneyer, C.A. Mirkin, Wiley VCH, 2004.
8. Nanoscale Science and Technology, Robert W. Kelsall, Ian W. Hamley and Mark Geoghegan, John Wiley & Sons, Ltd.,.UK, 2005.
9. Nanoscience : Nanobiotechnology and Nanobiology, P. Boisseau, P. Houdy and M. Lehman', Springer, 2007.
10. Protein Nanotechnology, Protocols, Instrumentation and Applications, Tuan Vo-Dinh, Humana Press, New Jersey, 2005.

4. Applied Entomology and Biopesticide

Unit I

General classification of insects- General anatomy of insects: Digestive system, Respiratory system, Circulator/ system, Reproductive systems of male and female, Excretory system, Nervous system, Endocrine system.

Unit II

Insect Behavior and Reproduction:Mechanoreception-Thermoreception-Chemoreception-Sem ht reception-Reproduction.

Unit III

Economic important insects: Sericulture-Apiculture-Lac insect [Including rearing technique and natural enemies].

Unit IV

Classification of biopesticides — Advantages and disadvantages of biopesticides target and nontarget problems in biopesticides — impact on environment.

- Unit V

Botanical insecticides — Bacterial insecticides-Insecticides from fungi and virus — Entomopathogenic nematodes [Including classification and mode of action]

References :

1. Richards, OW, Davies,R. G., 1977. Imms' general textbook of entomology. • Volume 2: classification and biology, Springer, pp. 388.
2. Whitten, M.J., 1992. Pest management in 2000: what we might learn from the twentieth century In: Kadir, A.A.S.A. (Ed.), Pest Management and the Environment in 2000. CA.B.I., Wallingford, pp. 9-44.
3. Hall, F. R., Menn, J. J., 1998. Biopesticides: Use and Delivery (Methods in Biotechnology), Humana Press, 1st Edition, pp 640.
4. Pedigo, L. P., Rice, M. E, 2008. Entomology and Pest Management, 5th edn. Upper Saddle River, Ni, USA.
5. Harris, J., Dent, D., 2001.Priorities in Biopesticide Research and Development in Developing Countries (Biopesticides), CABI Publ.
6. Burgess, N.D., 1981. 'Microbial control of pest and diseases, Academic press, New York.
7. Hunter-Fujita, F. R., Entwistle, P. F., Evans, H. F., Crook, N.E., 1998. Insect Viruses and Pest Management, John VViley, New York, pp. 620. •
8. Ramakrishna Ayyar,T.,1940 Handbook of economic Entomology for South India, Government Press, Madras Phennall, pp. 528.

## 5. Restoration Ecology

### Unit I

Restoration Ecology - Definition, principles, concepts and strategies.(long term vs. short term); physical, chemical and biological restoration; role of ecological principles in restoration, role of pioneer species in restoration and holistic approach in restoration.

### Unit II

Restoration of natural resources; restoration of river corridor, water resources and mine spoils. Approaches to Flood Plain Management, Concepts and Programs related to Restoration and Management of Lakes, Rivers and streams, Riverine = Riparian ecosystem and Wetlands, Fluvial restoration.

### Unit III

Planning and evaluating aquatic ecosystem restoration — Project planning, Purpose of evaluation, Selecting assessment criteria and synthesizing data. Introduction to watershed, concept and significance. Physical and hydrological characteristics of watershed. Drain — line treatment; Area treatment — Goals, features and watershed as unit of sustainable development.

### Unit IV

Integrated Aquatic Ecosystem Restoration- Introduction, Institutional barriers to Integrated Aquatic Restoration, Importance of Integrated restoration to wildlife, Appropriate scale for restoration, Use of Historical records in reconstructing watersheds.

Unit V National restoration goals, Policy and Program. redesigning for restoration. Role of public participation, government agencies and NGOs in conservation and restoration; environmental education and its role in conservation and restoration.

### Unit IV

Impact of human activities on water resources, climate change threats to water quality, Shifts in freshwater ecosystems

### Unit V

Ecohydrology- Urbanization effect on Water resources. Integrated Water Resource Management (IWRM), artificial recharge methods, Ecological restoration. and Management of Aquatic Systems.

## References .

1. John Cairns Jr., 1992. Restoration of Aquatic Ecosystems - Science, Technology and Public Policy. National Academy Press. Washington D.C.
2. Adamus, P.R., Clairain, E. J., Smith R.D., Young R. E., 1987. Wetland Evaluation Technique (WET). Vol II. Methodology Operational Draft. U.S. Army Corps of Engineers waterways Experiment Station, Vicksburg, Miss.
3. Barker, LA and E. B. Swain, 1989. Review of lake management in Minnesota. Lake Reservoir Manage. 5:1-10. .
4. Young, T. P. 2000. Restoration ecology and conservation biology. Biological Conservation 92: 73-83.
5. Hobbs, R. J. and Harris, J. A 2001. Restoration ecology: repairing the Earth's ecosystems in the new millennium. Restoration Ecology 9: 239-246.
6. Van Diggelen et al. 2001. Ecological restoration: state of the art or state of the science? Restoration Ecology 9: 115-118.
7. Ehrenfeld, J. G. 2000. Defining the limits of restoration: the need for realistic goals. Restoration Ecology 8: 2-9.
8. McClanahan, T. R. and Wolfe, ft W. 1993. Accelerating forest succession in a fragmented landscape: the role of birds and perches. Conservation Biology 7: 279-288.
9. Palmer et al. 1997. Ecological theory and community restoration ecology. Restoration Ecology 5: 291-300.
10. Cairns, J.Jr., and T. V. Crawford, eds. 1991. Integrated Environmental Management. Lewis Publishers, Chelsea, Mich. 214 pp.

## 6. Aquatic Ecology

### Unit I

Introduction and Overview: Properties of Water, Physical Factors: Light, Heat, Circulation, Hydrologic Cycle - precipitation- evaporation and evapotranspiration : Oxygen and Gases; Nutrients and Biogeochemistry.

### Unit II

Classification of aquatic systems, Salient features of lentic, lotic and marine systems, Wetlands Lakes, ponds, rivers, mangroves, salt marsh and estuaries- Oceans: Stream Ecosystem; Wetlands: Origins, Hydrology, and Physical Structure

### Unit III

Primary producers and Production, Food Web Interactions in Fresh Water: Stream and river Ecology — Biota -Invertebrates: phytoplankton, Zooplankton and macrophytes, insects, fishes and other organisms, Rapid Bioassessment Protocols (RBP)

### References :

1. Adam, P. 1990. Saltmarsh Ecology. Cambridge: Cambridge University Press.
2. Allen J. D. 1995 Stream Ecology — Structure and function of running waters. Chapman and Hall, UK.
3. Azous, A.L., and R.R.Horner, eds. 2001. Wetlands and Urbanization: Implications for the future. Boca Raton, FL: Lewis Publishers.
4. Batzer D P. and R. Sharitz. 2014 Ecology of Fresh water and Estuarine Wetlands. University of California Press.
5. Begon, M., Townsend, C. R., and Harper, J. L.. 2005. Ecology from Individuals to Ecosystems. Wiley-Blackwell, USA.
6. Ramchandra, T.V., Kiran, and R.N. Ahalya. 2002 Status, Conservation and Management of Wetlands. Allied Publ. New Delhi.
7. Sharma VK (1985) Water Resources Planning and Management. Himalaya Pub. House.
8. Odum, E P. 1996. Fundamentals of Ecology. W.B Saunders College Publishing, Philadelphia.
9. Townsend C., Harper J, and Michael Begon. Essentials of Ecology, Blackwell Science. Univ. Press.

**MSU/2016-17/ Univ.Depts/M.Phil (Environmental Science)/Semester –II/Ppr.-9/Project**

(Related to Environmental Science)