Course I (ECMP-501): Research Methodology in Ecology & Environmental Science-I

Unit-I (Basic Methods in Ecological Research)

1. Methods of acquiring knowledge: traditional, empirical, etc.
2. Role of assumption, construct, law, theory, hypothesis, etc.
3. Types of research: basic research, applied research, action research
4. Methods of research: theoretical, field-based, experimental and analytical

Unit-II (General Methodological Approaches)

1. Research problem selection, research objective and statement of the problem
2. Research proposal designing and formulation, review of literature, citing of references
3. Sampling strategy and methodology for socio-economic analysis
4. Preparation of report and scientific paper, plagiarism detection and control
5. Statistical techniques in ecological research

Unit-III: (Instrumentation in Ecology & Environmental Science)

1. Principles and applications of Spectrophotometry
2. Principles and applications of Chromatography, GC-MS
3. Principles and applications of atomic absorption spectrometry
4. Scanning and transmission electron microscopy: principles and sample preparation techniques

Unit-IV: (Techniques in Ecology & Environmental Science)

1. Wetland vegetation sampling, boundary delineation, mapping and conservation techniques
2. Meteorological tools in environmental science
3. Methods of studying physicochemical properties of water
4. Sampling techniques in pest management studies

Suggested readings:

1. Burns, R.B. (2000) *Introduction to Research methods*, New Delhi , Sage Publication.
2. Cochran, W.G and M.G. Cox (1946) *Experimental designs*. John Wiley & Sons, New York.
3. De, A.K (2010) *Environmental Chemistry* (7th Edition). New Age International Publishers Pvt. Ltd.
4. Fisher, R.A. (1935) *The design of experiments*. Oliver and Boyd, London.
5. Kothari C.K. (2014), *Research methodology- Methods and Techniques* (3rd Edition) (New Age International, New Delhi)
6. Montgomery, Douglas C. (2007), *Design and analysis of experiments* (5th Edition) Wiley India.
7. Tiner, R.W. (1999) *Wetland Indicators; A guide to wetland identification, delineation classification and mapping*. CRC Lewis Publisher.
8. Zar, J.H. (2010) *Biostatistical analysis* (5th Edition) Pearson Education.

Course II (ECMP-502): Research Methodology in Ecology & Environmental Science-II

Unit-I (Forest and Agricultural Ecosystem)

1. Methods of sampling terrestrial vegetation
2. Integrated pest management systems
3. Natural resource management using remote sensing and GIS
4. Methods of ethnobotanical study and drug discovery
5. Methods for studying phenology of trees

Unit-II (Soil Ecosystem)

1. Methods of studying soil physico-chemical properties
2. Extraction of soil fauna
3. Measurement of microbial diversity and culture techniques
4. Methods of studying physico-chemical properties of sediments

Unit-III (Aquatic ecosystem)

1. Methods for studying algal communities
2. Mass cultures of microalgae and sea weed
3. Algal immobilisation technique
4. Techniques in bioaccumulation and bioremediation studies
5. Rapid assessment approaches to biomonitoring of water using benthic macro-invertebrates
6. Methods for studying zooplankton communities

Unit-IV (Wildlife Conservation)

1. Herpetology: Methods of collection-tools and techniques, morphometric studies, studies of feeding behaviour
2. Census and monitoring technique for wildlife population, Ecological indices
3. Wildlife diseases
4. Tools for wildlife study
5. Techniques in behavioral studies

Suggested readings:

1. Alcock, J. (1989) *Animal Behavior: An Evolutionary Approach.* Fourth Edition. Sinauer Assocates, Inc. Sunderland, Massachusetts.
2. Allen, S.E (ed.) (1989) *Chemical analysis of Ecological Materials* (second edition) Blackwell Scientific Publications.
3. Anderson, J.M. and Ingram, J.S.I (1993) *Tropical Soil Biology and Fertility: A Handbook of Methods,* 2nd Edition. CAB International Wallingford, U.K.
4. Anonymous (1989) *Wildlife Management Techniques*. ed. R.N. Giles, The Wildlife Society, Washington DC.
5. Anonymous (1972) *Plant Pathologists Pocket Book.* Commonwealth Mycological institute, Kew, Surray, England.

6. Darley, W.H. (1982) *Algal Biology: A Physiological Approach.* Blackwell Scientific Publication Oxford.
7. De, A.K (2010) Environmental Chemistry (7th Edn). New Age International Publishers Pvt. Ltd.
8. Dent, M.K. (1997) *Methods in Ecological and Agricultural Entomology,* CAB International Wallingford, U.K.
9. Dhingra, O.D. and J.B. Sinclair, (1995) *Basic Plant Pathology Methods.* CRC Lewis Publishers.
10. Duellman, W.E. and L. Trueb (1994) *Biology of Amphibia.* The John Hopkins Univ. Press.
11. http://ifs.nic.in/rt/main/course/wildlife-census.pdf.
12. Hudson,I.L. and Keatley, M.R. (2010) *Phenological Research:Methods for Environmental and Climate Change Analysis*. Springer.
13. Hynes, H.B.N (1974) *The Biology of Polluted Waters.* Liverpool University Press.
14. Jain S.K. (1987) *A Manual of Ethnobotany*. Scientific Publishers. Jodhpur.
15. Marr, I.L. and M.S. Cressor. (1983) *Environmental Chemical Analysis*. International Textbook Co. Glasgow.
16. Martin, P. and B.Patrick (1988) *Measuring Behaviour: An Introductory Guide.* Cambridge University Press. Cambridge.
17. Mueller Dombois & H. Ellenberg (1974) *Aims & Methods of Vegetation Ecology* John,Wiley & Sons.
18. Negi S.S. (1991) *Handbook of National Parks, Sanctuaries and B.R. in India.* Indus Publishing Co. New Delhi
19. Pedigo, L. (1996) *Entomology and Pest Management.* Prentice Hall.
20. Price, P.W. (1975) *Insect Ecology.* Jon Wiley and Sons.
21. Ramesh, R. and Anbu, M. (1996) *Chemical Methods for Environmental Analysis – water and sediment.* Macmillan India Limited.
22. Resh V. H. and D. M. Rosenberg. (1984) *Ecology of Aquatic Insects* Praeger
23. Rosenberg D. M. and Resh V. H. (1993) *Freshwater biomonitoring and benthic macroinvertebrates.* Chapman and Hall, Inc.
24. Round, F.E. (1981) *The Ecology of Algae*. Cambridge University Press.
25. Schwartz M.D. (2003) *Phenology: An Integrative Environmental Science*. Springer
26. Singh S.K. (2005) *Text Book of Wildlife Management*. International Book Distributing Co. New Delhi
27. Subba Rao N.S. (1986) *Soil Microorganisms and Plant Growth*, Oxford and IBH Publishing Co. Ltd.
28. Wiersma, G.B (Ed.)(2004) *Environmental Monitoring*. CRC Press.

Course III (ECMP-503): Advances in Natural Resource Management and Climate Change Studies

UNIT-I (**Management of water and soil)**
1. Surface and ground water resource management
2. Conservation and eco-restoration of wetlands for climate change mitigation and adaptation
3. Plant functional traits, soil organic matter and soil carbon sequestration
4. Role of soil inhabiting micro-arthropods in nutrient management

UNIT-II (**Management of forest, agriculture and agroforestry systems)**
1. Recent advances in climate change mitigation and adaptation studies in forest, agriculture and agroforestry systems
2. Role of fertilizer trees in agroforestry systems
3. Carbon management for carbon market
4. Modern concept and practices of IPM for sustainable agriculture

UNIT-III (**Waste management and Environmental Ethics)**
1. Phytoremediation and constructed wetlands for wastewater management
2. Solid waste management Rules, 2016
3. Biomedical Waste management Rules, 2016
4. Hazardous and other Wastes (Management and Trans boundary Movement) Rules, 2016
5. Environmental Ethics

UNIT-IV: (**International negotiations/Conference of parties (COP) on biodiversity and climate change**)
1. Strategic plan for Biodiversity 2011-2020 and the Aichi targets; Paris Agreement and Marrakech Action Proclamation
2. The "4 per 1000" initiative-Soils for Food Security and Climate Change Mitigation
3. Ethnobiology in biodiversity management
4. Intellectual Property Rights

Suggested readings:

1. CIFOR (2005) *Carbon Forestry: Who will benefit?*. Centre for International Forestry Research, Indonesia.
2. FAO (2012) *Forest Management and Climate Change*. Food and Agricultural Organization of the United Nations, Rome.
3. FSI (2015) India State Forest Report. Forest Survey of India, Dehradun.
4. Lal, R. and Stewart, B.A. (2015) Soil-Specific Farming: Precision Agriculture, Taylor and Francis, Boca Raton, FL, 431 pp
5. Pedigo, L. (1996) *Entomology and Pest Management*. Prentice Hall.

6. Price, P.W. (1975) *Insect Ecology.* Jon Wiley and Sons.

7. Satarkar, S.P. (2003). Intellectual Property Rights and Copyright. Ess Ess Publications, New Delhi.

Course IV (ECMP-504): Term Paper

Term paper is to be assigned in the beginning of the semester to each PhD student for its submission to the department. The paper may be preparation of protocol, review of literature, methodology on the assigned research topic.