Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Faculty of Science and Technology

Course: PG

M.Sc. Environmental Science

Programme Structure and Syllabus

Multiple Exit Option (NEP-2020)

ACADEMIC SESSION (w.e.f. 2023-2024)

DEPARTMENT OF ENVIRONMENTAL SCIENCE,
SCHOOL OF EARTH SCIENCES,
PUNYASHLOK AHILYADEVI HOLKAR
SOLAPUR UNIVERSITY, SOLAPUR

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
M.Sc. Environmental Science Choice Based Credit System (CBCS)
Course Structure (NEP-2020)
M.Sc. Part-I Environmental Science w.e.f. 2023-24

M.Sc. Part I Semester -I

Paper Code	Title of the Paper	Credits	Contact hours/week			Distribution of Marks for Examination				
			Th (L)	Pr (P)	Total	External		Internal		Total
						Th	Pr	Th	Pr	
DSC-1	Introduction to Environment and Ecology	4	4	---	4	80	---	20	---	100
DSC-2	Environmental Chemistry & Instrumentation techniques	4	4	---	4	80	---	20	---	100
DSE-1	1. Current Environmental Issues and Problems of India 2. Biodiversity and Conservation 3.Environmental Geo and Atmospheric science	4	4	---	4	80	---	20	---	100
RM	Research Methodology	4	4	---	4	80	---	20	---	100
DSC-1P	Practical-1	2	---	4	4	---	10	---	40	50
DSC-2P	Practical-2	2	---	4	4	---	10	---	40	50
DSE-1P	Practical-3	2	---	4	4	---	10	---	40	50
Total for Semester-I		**22**	**16**	**12**	**28**	**320**	**30**	**80**	**120**	**550**

M.Sc. Part I, Semester –II

Code	Title of the Paper	Credits	Contact hours / week			Distribution of Marks for Examination				
			Th (L)	Pr	Total	External		Internal		Total
						Th	Pr	Th	Pr	
DSC-3	Water and Wastewater Treatment Technology	4	4	---	4	80	---	20	---	100
DSC-4	Remote Sensing, GIS, GPS in Environmental Science	4	4	---	4	80	---	20	---	100
DSE-2	1. Climate Change and Sustainability 2. Environmental Pollution and Management 3. Environmental Law, Acts Ethics Policies	4	4	---	4	80	---	20	---	100
OJT/FP	OJT/FP/ In-house Project /Internship/Apprenticeship	4	---	4	4	---	80	---	20	100
DSC-3P	Practical-4	2	---	4	4	--	40	---	10	50
DSC-4P	Practical-5	2	---	4	4	---	40	---	10	50
DSE-2P	Practical-6	2	---	4	4	---	40	---	10	50
Total for Semester-II		**22**	**12**	**16**	**28**	**240**	**200**	**60**	**50**	**550**

M.Sc. Part I (Semester I & II)

Semester	Credits	Contact hours/week			Distribution of Marks for Examination				
		Th (L)	Pr	Total	External		Internal		Total
					Th	Pr	Th	Pr	
I	**22**	**16**	**12**	**28**	**320**	**30**	**80**	**120**	**550**
II	**22**	**12**	**16**	**28**	**240**	**200**	**60**	**50**	**550**
I + II	**44**	**28**	**28**	**56**	**560**	**230**	**140**	**170**	**1100**

Abbreviations: *DSC: Discipline Specific Course, DSE: Discipline Specific Elective, FP: Field projects OJT: On Job Training: Internship/ Apprenticeship, RM: Research Methodology, RP: Research Project, L: Lectures, P: Practical's, Th: Theory, Pr: Practical's.*

- ✓ **4 Credits of Theory = 4 Hours of Teaching per Week**
- ✓ **2 Credits of Practical = 4 Hours per week**

Choice Based Credit System with Multiple Entry and Multiple Exit Option (NEP-2023)
M.Sc. Environmental Science Programme
M.Sc. Part–I (Post Graduate Diploma in Environmental Science)
(Level-6.0)
Sem-I (Duration Six Months)

Paper Code / Course Code	Title of the Paper	Credits
DSC-1	Introduction to Environment and Ecology	4
DSC-2	Environmental Chemistry & Instrumentation techniques	4
DSE-1	1. Current Environmental Issues and Problems of India	4
	2. Biodiversity and Conservation	
	3.Environmental Geo and Atmospheric science	
RM	Research Methodology	4
DSC-1P	Practical-1	2
DSC-2P	Practical-2	2
DSE-1P	Practical-3	2
Total Credits for Semester-I		**22**

SYLLABUS

DSC-1	Introduction to Environment and Ecology	Total Contact Hrs. 60

Unit-1(15 Hrs.)

a) **Introduction of Environment & Environmental Science:** Definition, background, principles, scope and interdisciplinary nature of Environmental Science, objectives of environmental science; Environmental history, Timeline- incidents or events that brought about changes towards the perspective of environmental study, World Environment Day and Earth Day and their relevance; Environmental Science and environmental / sustainable technologies.

b) **Environmental Education and People's participation:**EnvironmentalEducation: history, concept,goals,objectivesandguidingprinciples,StrategiesforEEdevelopment,ModelsforfutureEE System,Awarenessandactionthroughenvironmentaleducation.Media and people, decision making and applications of Environmental Science.

Unit – 2(15 Hrs.)

a) **Environmental Segments and Consequences:**Concept of Environmental Segments or components, physical and biological environments; Hunting and gathering, Tribal and nature, agriculture societies, industrial societies, impact of cultural change on environment, population explosion, degradation of natural resources, environmental pollution.

b) **Environmentalmovements:**Concept and role of environmental movements, People'sparticipationandroleofNGOsinenvironmentalprotection,Involvementofsocial,organizations,womengroups,youths'nature**,**etc.inenvironmental protection action, Concept, Definition of sustainable development integrating economic andEcologicalprinciples,Sustainable developmentgoals and their importance.

Unit–3 (15 Hrs.)

a) **ConceptsofEcology:** Definition of ecology and sub divisions, Relation to other sciences, Relevance to civilization,levels of organization hierarchy, ecological models, Concept of ecosystem, structure and function, Energy inecologicalsystems,conceptofproductivity,foodchains,foodwebandtrophiclevels,ecologicalpyramids, Concept of habitat, niche and guild, concept of ecotone and edge effect, Carryingcapacity.

b) **Structureofecosystems:**Bio-geographical realms,Classificationof terrestrialbiomes– Tundra,Taiga,Grassland,Desert, Evergreenanddeciduousforests, Tropicalrainforests. ClassificationofAquaticHabitats:Freshwaterpond,Wetlands,Rivers–theircharacteristics,flora andfauna;Bio-geo-chemical Cycles:Gaseous andsedimentary cycles and their significance in environment and sustainable agriculture.

Unit–4 (15 Hrs.)

a) **Populationecology:**Basic concepts of population ecology, population dynamics, characteristics of population:natality,mortality,fecundity,density,agedistribution,relationshipsamongorganisms,populationexplosion,Communitytypesandcommunitycomposition.

b) **Communityecology:**Characteristicsofcommunity,Composition,structure,originanddevelopmentofcommunity,Charactersusedincommunitystructure,Communitydynamics,Succession:causes,typesandgeneralprocessofsuccession,DevelopmentofHydrosereorhydrarchandLithosereorXerosere.

Reference Books:

1) Chapman, J.L. and Reiss M.J. (2005) Ecology Principles and Applications, Cambridge University Press, London.
2) E. P. Odum (1996) Fundamentals of Ecology, Nataraj Publisher, Dehra Dun.
3) E.J. Kormondi (1999) Concepts of Ecology, Prentice Hall of India, New Delhi.
4) E.P. Odum and G. W. Barrett (2005) Fundamentals of Ecology, Thomson Asia Pvt. Ltd., Singapore.
5) Environment And Ecology-EAS105/EAS 205-R. Rajagopalan
6) K.M.M. Dakshini (1999) Principle and Practices in Plant Ecology, CRC, Boston.
7) M.C. Dash (1994) Fundamentals of Ecology, Tata McGraw Hill, New Delhi.
8) M.C. Molles Jr. (1999) Ecology- Concepts and Application, McGraw Hill, New Delhi.
9) S.V.S. Rana (2005) Essentials of Ecology and Environmental Sciences, Prentice Hall of India, New Delhi.
10) V. Ingegnoli (2002) Landscape Ecology: a widening foundation, Springer, Bonn.

SYLLABUS

DSC-2	Environmental Chemistry & Instrumentation techniques	Total Contact Hrs. 60

Unit-1 (15 Hrs.)

Fundamentals of Environmental Chemistry: Concept and scope of environmental chemistry, Chemistry of environmental segments. Basics of Environmental Chemistry: elements, valency, molecular weight, equivalent weight, mole, normality, molarity, molality, molar solution, standardization or standard solution, titration, Nernst distribution law, Energy & forms of energy; laws of thermodynamics, Gibbs energy, stoichiometry, colloidal chemistry, emulsions, adsorption, absorption, chemical reactions, chemical potential, chemical equilibrium, acid-base reactions, solubility product; unsaturated and saturated hydrocarbons.

Unit-2 (15 Hrs.)

a) Atmospheric Chemistry: Chemical composition of air, Classification of elements, chemical speciation. Particles, ions and radicals in the atmosphere. Chemical processes for formation of inorganic and organic particulate matter. Thermo-chemical and photochemical reactions in the atmosphere. CFC's and Ozone chemistry, chemistry of air pollutants, photochemical smog.

b) Water Chemistry: Structure and properties of water, water pollutants, types, sources, heavy metals metalloids-organic, biological and radioactive- types of reactions in various water bodies including marine environment. Chemistry of oil based and water-based paints, physicochemical basis of redox processes.

c) Soil Chemistry: Soil profile, distribution of inorganic and organic components in soil, Chemical properties of Soil - Saline, Acidic and Alkaline soils. Major micro and macro nutrients of soil, Nutrient Pathways - Nitrogen, Phosphorus and Potassium pathways in the soil, adsorption of contaminants in soil, Effect of modern Agro-technology on quality of soil.

Unit-3 (15 Hrs.)

Toxic Chemicals in the Environment and monitoring methods: Organic and inorganic chemicals and their reactions in the environment, soaps, detergents, polymers, drugs, dyes, oil and grease, Inorganic chemicals in the environment, Inorganic gaseous pollutants, Particulate matter, trace leave toxic metals, Inorganic pesticides, Persistent organic pesticides and fertilizers. Sampling

of air and water pollutants, Monitoring techniques and methodology, pH, Dissolved Oxygen (DO), Chemical oxygen demand (COD), Biological Oxygen Demand (BOD), analysis of metals, monitoring and analysis of CO, NOx, CO_2, SOx and PM.

Unit-4 (15 Hrs.)

Instrumentation or Analytical Techniques for Environmental Monitoring: Theoretical principles of Analytical Techniques – Role and importance of analytical techniques in analysis of environmental samples. Titrimetry; types and applications of neutralization, precipitation, complexometric titrations; gravimetry, Conductometry, pH, Colorimetry, Spectrometry UV-Vis and IR Spectrophotometer and AAS. Nephelometry, Flame Spectrometry and fluorimetry; Chromatographic techniques: Paper, Thin Layer, GC and Gas – Liquid Chromatography, HPLC, X-ray florescence, X-ray diffraction, NMR, Elemental analyzer, HVS, Particulates & Gases Sampler and Electrophoresis.

Reference Books:

1. Bailey, R.A. (1978). Chemistry of the Environment, Academic Press.
2. Biswas T.D and Mukherjee S.K. (1987). Text book of Soil Science IV Ed., Mc Graw- Hill.
3. Charles R. Goldman and Alexander J. Horene. (1983). Limnology, McGraw- Hill.
4. De A.K (1989). Environmental Chemistry, II Ed., Wiley Eastern Limited.
5. Hobert H. Willard D.L. Merrit and J. R. J. A. Dean, Fundamentals of Analytical Chemistry, 1982.
6. Jacobs. (1969). Analytical Chemistry of Industrial poisons. Hazards and solvents, M.B. Inter Science. New York.
7. Manahan S.E. (2000). Environmental Chemistry (7th Ed), Lewis Publications, Florida, U.S.A. 13. Lave, L.B and Upton, A.C. Toxic Chemicals, health and the Environment, 1987. The Hopkins Press Ltd., London. 14. Chatwal and Anand, Instrumental Methods of analysis.
8. Roy L. Donahue, Raymond W. Miller and John C. Shickluna. (1987). Soils An Introduction to soils and plant growth V.Ed., Prentice-Hall of India.
9. Sharma B.K and Kaur H. (1995). Environmental Chemistry, I Ed., Goel Publishing House.
10. Tyagi O.D. and Mehra M. (1990). Environmental Chemistry, Anmol Publications.
11. Tyagi O.D. and Mehra M. (1990). Text Book of Environmental Chemistry, I Ed., Anmol Publications.
12. Vogel's Textbook of Quantitative Inorganic Analysis. (1978). IV Ed., Longman Group Ltd.

SYLLABUS

DSE-1	1. Current Environmental Issues and Problems of India	Total Contact Hrs. 60

Unit-1 (15 Hrs.)

a) **Global Environmental Issues and Solution:** Ozone Layer Depletion, Acid Rain and Its Spread, Desertification and Expansion, Greenhouse Effect and Global Warming, Climate Change and Current Issues, Energy Crisis and Issues, Genetically Modified Organisms, WTO and Environmental Issue, Species Loss and Human Impacts

b) **Global Environmental Issues:** E-Wastes and Global Generation, Food Crisis and Population, Biological Warfare and Future Threats, Eco-Terrorism and Issues, Issues Related to Shipping, Water Crisis and Future Conflicts, Population Explosion and Resource Crunch, Wastelands and Degradation.

Unit-2 (15 Hrs.)

a) **International Efforts:** Sustainable Development Goals and Solutions, Clean Development Mechanism, Carbon Emissions and Future Targets, Carbon Credits and Its Implementation, Carbon Sequestration and Programmes, Green Politics and Issues, Role of IUCN and UNEP, Important International Agreements.

b) **Environmental Issues in India:** Soil Erosion and Impacts on Production, Alkaline and Saline Soils, Industrial and Vehicular Air Pollution of Indian Cities, Water Quality Degradation of Indian Rivers, Groundwater Pollution and Its Consequences, Municipal Solid Wastes and Conflicts, Issues with Slums and Environmental Health, Droughts and Floods in India Eutrophication Issues of Major Aquatic Ecosystems, Dams and Displacement Issues

Unit-3 (15 Hrs.)

a) **National Efforts to Curb Issues:** Citizen Participation in Environmental Decisions, Environmental Information System Network, Right to Information and Environment Protection, Policies and Laws on Environmental Protection, Ganga Action Plan and Recent Programs, Interlinking of Rivers: Plan and Implementation, Strategies under Disaster Management Plan, Wasteland Development Programme, Fly Ash Utilization Policy, Rainwater Harvesting and Its Implementation.

b) **Environmental Issues and Genesis of Movements:**Genesis of Environmental Movements in India, Chipko Movement and Its Message to World, Narmada BachaoAndolan and Outcome, Developments in Save Silent Valley Movement, Tehri Dam Conflict and Current Situation, Indian Case Studies to Solve Issues, Environmental Movements in Developed Countries.

Unit-4 (15 Hrs.)

a) **Practices Followed in Environmental Conservation:** Environment as Core Part of Sustainability, Conservation for Economic and Social Upliftment, Vulnerability, Adaptation and Livelihoods Security, Conservation of Biodiversity and Forests for Survival, Water Conservation as Important Constituents of Ecosystems, Conservation in Smart Cities, Future Energy, Food, Agriculture Security and Conservation, Technical Skills Required for Environmental Conservation

b) **Current International Developments:**Need for Appropriate Technologies, International Environmental Governance, Polluter Pays Principle and Legal Liabilities MNCs/TNCs and Corporate Social Responsibility, Real Time Monitoring of the Issues, Ecological and Carbon Footprint Calculations, Life Cycle Assessment Studies for Organizations, Sustainability Measurement and Reporting Tools, Newer Approaches in Human Development Success stories of Mitigating Environmental Issues.

Reference Books:

1. Environmental Science by Santra S. C., New Central Book Agency (P) Limited (2001).
2. Environmental Chemistry by Sharma B. K., Goel Publishing House, Meerut (1997).
3. Environmental Chemistry by De A. K, New Age International (P) Limited (2017).
4. Environmental Issues in India: A Reader by Rangarajan, Pearson Education India (2006).
5. Climate Change and Environmental Issues by Singh N. and Thakur A. K., The Energy Resources Institute (TERI) (2016).
6. Global Environmental Issues by Frances Harris, Wiley-Blackwell, (2012).
7. An Introduction to Global Environmental Issues by Pickering K., Routledge (1994).
8. Environmental Science by Daniel D. Chiras, Jones and Bartlett Publishers (2001).
9. Environmental Science by Y.K. Singh, New Age International Private Limited; First edition (2006).

10. Development, Ecology and Climate Change: Issues and Challenges: Volume 1 by Mohinder Kumar SlariyaCreatespace Independent Publication; (2015).
11. Environmental Studies and Ethics by Gouri Suresh, U. S. Hampannavar I K International Publishing House Pvt. Ltd; (2009).
12. Environmental Conservation and Life (Hindi) by Nisha Maharana, Agrawal Publications; (2017).
13. Environmental Issues in India: A Reader, by Rangarajan, Pearson Education India; (2006).
14. The Climate Fix: What Scientists and Politicians Won't Tell You about Global Warming by Roger Pielke Basic Books; (2010).
15. Climate Change and Environmental Science by S. C. Bhatia Agrotech Press; (2012).
16. Environmental Management by Ajith Sankar Oxford University Press; (2015).
17. Principles of Environmental Science: Inquiry and Applications (SIE) by William Cunningham and Mary Cunningham McGraw Hill Education; (2017).
18. Principles of Environmental Science and Engineering by Rao P. Venugopala, Prentice Hall India Learning Private Limited; (2006).
19. Various Case Studies from Leading Journals of World.

SYLLABUS

DSE-1	2. Biodiversity and Conservation	Total Contact Hrs. 60

Unit-1 (15 Hrs.)

Introduction to Biodiversity: Level of biological organization, the global perspective, Global Environmental changes, Bio-geographical regions of India, Biodiversity concepts and patterns, Microbial diversity, Plant diversity, Agro-biodiversity, Soil biodiversity. Types: Species diversity, Genetic diversity, Pattern diversity, Alpha, Beta and Gama diversity, Gradients of Biodiversity, Ecosystem diversity, measuring of species diversity, richness and evenness, factors related to tropical species diversity.

Unit-2 (15 Hrs.)

Factors governing biodiversity: Biodiversity hot-spots, diversity distribution, factors affecting diversity, Mega diversity regions of India, Diversity trends of different ecosystem, Major Forest types and distribution of wild life in India. Impact of exotic species, disturbance on diversity, dispersal, diversity-stability relationship, keystone species.

Unit-3 (15 Hrs.)

Conservation of Biodiversity: Threats to biodiversity, Human interference and habitat destruction, Human & Wildlife Conflicts, biological invasion. Importance of biodiversity conservation, direct and indirect benefits, Bioprospecting, Biopiracy, REDD. Strategies for biodiversity conservation. In-situ and ex-situ conservation, wildlife habitats and their conservation. Protected Area network, Biosphere Reserves, National Parks, sanctuaries, sacred groves; ex-situ conservation, gene pools, germ plasm banks.

Unit-4 (15 Hrs.)

Biodiversity Action Plan: International conventions on biodiversity, IUCN Criteria, endemic, extinct, endangered, vulnerable and rare species, Red Data Book. National Policy and Action Plan, Role of Forest Department in Conservation, Biodiversity Legislation in India. Integrated Protected Area System, RAMSAR sites. Existing conservation projects: Tiger, Rhino, Elephant, Turtles, Crocodiles, coral reefs and Mangroves.

Reference Books:

1. Simpson, G.G. (1949). The meaning of evolution, A Study of the History of Life and of Its Significance for Man. Oxford University Press.
2. Magguran, A.E. (1996). Ecological diversity and its measurements. Princeton University.
3. Gadgil, M. () A methodology manual for scientific inventorying, monitoring and conservation of Biodiversity.
4. Sutherland, W. (2006). Ecological census technique: A Handbook, 2nd Edn. Cambridge University Press.
5. Gadgil, M. et. al. A Methodology Manual for Documenting People's Priorities for Biodiversity and Conservation. Shrustiygyaan.
6. Malhotra, K.C. et. al. (2001). Cultural and Ecological Dimensions of Sacred Grovesin India. INSA, New Delhi.
7. Gadgil, Madhav and Rao, P.R.S. Nurturing Biodiversity: An Indian Agenda. Centre for Environment Education, Ahmadabad, India. 1999.
8. Dobson, A.P., 1996, Conservation and Biodiversity. Scientific American Library, New York, NY.
9. Gaston, K J. and J.I. Spicer, 1998, Biodiversity: An Introduction. Blackwell Science, London, UK.
10. Loreau, M., and P. Inchausti, 2002, Biodiversity and Ecosystem functioning: Synthesis and Perspectives. Oxford University Press, Oxford, UK.
11. Primack, R.B., 2002, Essentials of Conservation Biology, 3rd Edn., Sinauer Associates, Sunderland, Ma. USA.
12. Hunter, Malcolm L., Jr., and Gibbs, James P. Fundamentals of Conservation Biology. 3rd ed. Wiley-Blackwell. 2006

SYLLABUS

DSE-1	3. Environmental Geo and Atmospheric Science	Total Contact Hrs. 60

Unit-1 (15 Hrs.)

Introduction to Environmental Geo-science: Fundamental concepts, Primary differentiation and formation of core, mantle, crust, magma generation, eruptions and volcanoes. Formation and classification of rocks: plate tectonics – sea floor spreading, mountain formation, rock deformation and evolution of continents, weathering and soil formation, Rock Cycle.

Unit-2 (15 Hrs.)

Environmental Geochemistry: Concept of major, minor and trace elements. Mobility of elements, geochemical cycles, sedimentary cycle, deforestation and erosion, Geo- indicators, geological consequences of industrialization, groundwater pollution and management-case studies related to fluoride, pesticide, fertilizers and arsenic contaminations in India, Mineral resources in relation to plate tectonics and geology, geology of mineral resources, mineral sources and reserves, distribution of mineral resources in India. Environmental impact of exploitation, processing and smelting of minerals.

Unit-3 (15 Hrs.)

Atmospheric Science: Concept of Radiation, conduction and convention, forms of condensation-dew, frost, fog, mist, smog and cloud, Atmospheric stability, adiabatic character, dry and wet adiabatic lapse rate, Turbulence and diffusion, Different layers and their characteristics, meteorological aspects- inversions, mixing height, wind-rose, electromagnetic radiations, solar radiation and terrestrial radiation, heat budget, Temperature measurements and controls, Environmental lapse rate, humidity, mixing ratio.

Unit-3 (15 Hrs.)

Environmental Climatology: Elements of Weather and Climate, classification, energy balance in atmosphere, greenhouse effect, Geo-strophic wind and gradient wind, cyclones, Forms of cloud condensation; Precipitation, Thunderstorms, floods and droughts, Acid rain, Effects of acid rain on environmental components, drinking water standard, introduction to weather forecasting models.

Reference Books:

1. A.N. Strahler and A.H. Strahler (1973), Environmental Geo-science-Hamilton Publication
2. Basu S.K. (2003), Handbook of Oceanography, Global Vision, Delhi.
3. Bell F. G., (1998), Environmental geology: Principles and practice. Blackwell Sc. Oxford.
4. Bennett, M. R. and Doyle, P. (1997), Environmental geology - Geology and the Human Environment. John Wiley and Sons.
5. Botkin, Daniel B. and Keller, Edward A (2007), Environmental Science: Earth as a Living Planet. 6th ed. John Wiley & Sons, USA.
6. Bouwer, H. (1978), Groundwater Hydrology. McGraw-Hill, New York.
7. Butz, S.D. (2004), Science of Earth Systems. 2nd ed. Thomson Delmar Learning, USA
8. Chamley, H. and Chamley, H. (2003), Geosciences, Environment and Man Elsevier Science & Technology pub.
9. Chiras,D.D (1989), Environmental Science-A frame work for decision maling-Addison-Wesley publishing company- New York

SYLLABUS

RM	Research Methodology	Total Contact Hrs. 60

Unit-1 (15 Hrs.)

Introduction to Research in Environment Sciences: Principles of scientific research experimentation in natural sciences. Purpose, Characteristics and Types of Research - Process of Research -Formulation of objectives - Formulation of Hypotheses - Types of Hypotheses - Methods of testing Hypotheses - Research plan and its components - Methods of Research (Survey, Observation, case study, experimental, historical and comparative methods) - Difficulties in environmental research. Identification and formation of research problem (Hypothesis). Elements in research methodology: Research design (CRD, RBD, LSD). Scientific database- Science Direct and PubMed.

Unit-2 (15 Hrs.)

Research Methodology: Selection of Methodology of study various tools and their scope and limitation in application, Selection of research topic, Library consultation, compilation of working, bibliography preparation. Principles and application of advanced instrumentation techniques in environmental research (spectrophotometry, chromatography, microscopy, XRD, XRF, photometry).

Unit-3 (15 Hrs.)

Scientific writing: Technique and knowledge of preparation of abstracts, Manuscripts, Dissertation thesis and report writing, Research Proposal and Research Paper. Meaning and types - Stages in preparation - Characteristics - Structure - Documentation: Footnotes and Bibliography - Editing the final draft-Evaluating the final draft- Checklist for a good proposal/report/research paper. Basic knowledge of organizing conferences, symposia, workshop, exhibition etc.

Unit-4 (15 Hrs.)

Preparation of research articles for scientific journal: typing/printing-manuscripts, margins, spacing, heading and title page numbers, tables and illustrations, corrections and insertion, preparation of contents. Preparation of list of work cited: General guidelines, placement, arrangement, citation of books, and other references, citation technique in report writing, information storage and retrieval sample entries, maintenance of field notebook.Abbreviations and reference words, standard abbreviations, scientific connotations, Units, geographical names, common scholarly abbreviations and reference/ keyworks, publishers names, symbols and abbreviations used in printing technology and proofreading. Ethics in research – plagiarism Intellectual Property Rights Copyright, Trademark, geographical indicators, design, Patent, Role of patent in R & D, Criteria for patentability, Indian patent act, Provisional and final patent filing, writing claims, procedure for patent granting

Reference Books:

1. Research Methodology- G.R. Basotia and K.K. Sharma.
2. Research Methodology- C.H. Chaudhary, RBSA Publication
3. Principles of Biophysical chemistry - Upadhayay and Nath.
4. Research Methods for Environmental Studies - A Social Science Approach. 2nd Edition-Mark Kanazawa
5. Research methodology and Project work by Prakash Herekar, PhadakePrakashan
6. Research methodology: Tools and Techniques by Prabhat Pandy and M.M.Pandy,bridge conter,2015 Romania,Europian union.
7. Research Methodology by R.Rajasekar, P.Philominathan and V.Chimathambi,2013
8. Handbook of Research Methodology; by S.B.Mishra and A compendium for Scholars and Researchers Shashi alok. 2011 Education Publishing, New Delhi.
9. The Essence of Research methodlogy: A concise Guide for master and Ph.D Students in Management Science by Jan Jonker and Bartjan Pennink, 2010 Springer, New York.
10. Essentials of Research Design and methodology by G. Marcyk David Dematttes and David festinger, Essential of behavioral Science,2005, John wiley and sons New jersey
11. Fundaments of Research methodology and data collection by chineloIgwenagy, Enugu state Writessity of Science and technology, 2016 Research Gate Publications.
12. Geogrophic Information Systems; concepts methodologies tools and Applications, vol-I Editor in Chief Meh Khosrow-pour, Contemporary research in Information science and technology –Book series 2013, USA.
13. Measurements and instrumentation: Theory and application B.AlanS.Morris and Reza Hangar IInd edition 2016 elservier London UK
14. Research methodology: A Step by step guide for beginners by Ranjit Kumar 2011 Sage Publication, London UK.
15. Research Method handbook by Stuart Macdonald and MicolaHadlam, CLES 1986, Manchster UK.

SYLLABUS

DSC-1P	Practical - 1	Total Contact Hrs. 60

Practical's:

1) Determination of diversity indices in plant communities.
2) To construct ecological pyramids of population sizes in ecosystem.
3) Determination of Importance value index of species in a plant community and to compare two plant communities
4) Quantitative measurement of plankton in fresh and marine water samples.
5) Sampling technique of phytoplankton and Sampling technique of zooplankton
6) Quantitative estimation of phytoplankton – Sedgwick-Rafter method and estimation of zooplankton – Sedgwick-Rafter method
7) Determination of organic pollution – Palmer's Algal Pollution index
8) Estimation of primary productivity of a pond – Light and Dark bottle method
9) Estimation of primary productivity of terrestrial vegetation – Chlorophyll method and determination of Harvest method.
10) Estimation of primary productivity of grasses – Harvest method
11) Study of plant community – Individual count method/Quadrat method
12) Study of animal community – Line transect method
13) Determination of species diversity indices –Simpson and Shannon's Wiener Index
14) Estimation of carbon capture and storage of trees
15) Identification of ecological indicators.

Practical References:

1) Michael, P. (1986). Ecological Methods for Field and Laboratory Investigations. Tata Mc Graw-Hill Publishing Co. Ltd.
2) Rolan, R. G. (1973). Laboratory and Field Investigations in General Ecology. Macmillan Co.
3) Standard Method for Examination of Water and Wastewater. (2017). APHA–WEF.
4) Subrahmanyam, N. S. and Sambamurty, A. V. S. S. (2000). Ecology. Narosa Publishing House.
5) Trivedi, P. K. and Goel, P. K. (1984). Chemical and Biological Methods of Water Pollution Studies. Environmental Publications.

SYLLABUS

DSC-2P	Practical - 2	Total Contact Hrs. 60

Practical's:

1) Sampling technique of water
2) Determination of pH – pH metric method and Determination of Electrical Conductance – Conductivity meter method
3) Estimation of Turbidity – Nephelometric method
4) TS, TSS & TDS – Gravimetric and Filtration method
5) Estimation of Acidity – Alkalimetric method / CO2 – NaOH titration method and Estimation of Alkalinity – Acidimetric method
6) Estimation of Hardness – EDTA Complexometric method
7) Estimation of Chlorides – Argentometric method
8) Estimation of Dissolved Oxygen – Modified Winkler's method
9) Estimation of Biochemical Oxygen Demand (BOD)
10) Estimation of Chemical Oxygen Demand (COD)
11) Estimation of Nitrates – Phenoldisulfonic Acid method
12) Estimation of Fluorides – Fluoride meter method/SPADNS Reagent method
13) Estimation of Sulphates – Barium chloride method
14) Principal, Working, demonstration and applications of flame photometer, Turbidity meter, Colorimeter and HVS / AFD ambient sampler
15) Visit to Instrumentation Centre for XRD, XRF, NMR, AAS, GC-MS and UV spectrophotometer.

Practical References:

1) Nandini, N. (2009). Handbook on water quality monitoring and Assessment. Sapna Book House, Bengaluru.
2) Sawyer, C. N. and Mc Carty, P. L. (1978). Chemistry for Environmental Engineering. Mc Graw – Hill International.
3) Saxena M M. (1990). Environmental Analysis: Water, Soil and Air. Edition, 2. Publisher, Agro Botanical Pub.
4) Standard Methods for Examination of Water and Wastewater. (2017). APHA – WEF.
5) Trivedi, P. K. and Goel, P. K. (1984). Chemical and Biological Methods of Water Pollution Studies. Environmental Publication.
6) Zhang, C. (2007). Fundamentals of environmental sampling and analysis. John Wiley & Son.

SYLLABUS

DSE-1P	Practical - 3	Total Contact Hrs. 60

Practical's:

1) Prepare a map of India, showing bio-geographical zones and expanse of territorial waters.
2) Identification and description of plant species.
3) To plot biosphere reserve on a map of India.
4) Prepare a document of endemic and exotic species of plants and animals for a selected PAN.
5) Indicate distribution range of a plant and animal species identified as endangered on an Indian map.
6) Prepare a map of. Maharashtra showing Protected Area Network (PAN) in it.
7) To study qualitative and quantitative characters of a plant community by quadrate method.
8) To study a plant community by using line transect method, using line, belt and profile transects.
9) Measurement of photo density flux by Luxmeter.
10) Determination of CO_2 in the atmosphere by volumetric method.
11) To prepare the station-based wind rose for an area.
12) Climatic data: Interpretation of Indian daily weather report 8. Wind Rose diagram, Line Graph, Dispersion diagram
13) Calculation of similarity & dissimilarity index between two adjoining communities and Calculations of Niche overlap between two species.
14) Visit to plateaus, grasslands, forests to understand diversity.
15) Discuss and write environmental case studies (Local, National and Global)

Practical References:

1) A comprehensive laboratory manual for Environmental Sciences and Engineering by P.R. Sree Mahadevan Pillai. New Age International Publishers.
2) Chemical and biological methods for water pollution studies By R.K. Trivedi
3) Handbook of water and waste water analysis By S.K. Maiti.
4) Soil and air analysis by S.K. Maiti.
5) Standard methods for examination of water and waste water, American Public Health Association.

M.Sc. Part I, Semester –II		
Code	**Title of the Paper**	**Credits**
DSC-3	Water and Wastewater Treatment Technology	4
DSC-4	Remote Sensing, GIS, GPS in Environmental Science	4
DSE-2	1. Climate Change and Sustainability	4
	2. Environmental Pollution and Management	
	3. Environmental Law, Acts Ethics Policies	
OJT/FP	OJT/FP/ In-house Project/Internship/Apprenticeship	4
DSC-3P	Practical-4	2
DSC-4P	Practical-5	2
DSE-2P	Practical-6	2
Total for Semester-II		**22**

SYLLABUS

DSC-3	Water and Wastewater Treatment Technology	Total Contact Hrs. 60

Unit-1 (15 Hrs.)

Water and Methods of treatment Water requirement or consumption: Domestic, institution, firefighting, commercial, industrial and cultural places, consumption. Population forecasting for water & wastewater - demographic, arithmetical progression, geometrical progression and logistic method. Water Quality Standards for drinking and package drinking water- BIS, WHO. Methods and Concept of water treatment plant (WTP), Sewage treatment plant (STP), Effluent treatment plant (ETP), Common Effluent treatment plant (CETP) design aspects of major units in treatment plants and their functions.

Unit-2 (15 Hrs.)

Physical Treatment (Physico-Chemical) Physical Unit operations and Chemical processes: Principles, applications and designing aspects of - Bar screen, grit chamber, barmunitors, skimming tanks Chemical Unit operations and processes: Principles, applications and designing aspects of Coagulation and Sedimentation, flocculation, disinfection, clarifier.

Unit-3 (15 Hrs.)

Biological Treatment Aerobic treatment: Principles, applications and designing aspects of - Activated Sludge Process, Aerobic ponds, Oxidation ponds, Stabilization ponds. Anaerobic treatment- Principles, applications and designing aspects of - Trickling filter, Rotatory Biological Contactors (RBC's), Continuous Stirring Tank Reactor, UASB, septic tank, Imhoff tank, constructed wetlands, Root Zone Bed Technology for waste water treatment.

Unit-3 (15 Hrs.)

Advanced treatment & Sludge Management Advance or Tertiary Treatment: Activated carbon filtration unit, PACT, disinfection of water -UV radiation, Ozonation, Chlorination, Water softening. Filtration- Micro-filtration, Ultra-filtration, Nano-filtration, Reverse Osmosis, Wet Air Oxidation, ion exchange, Membrane bioreactor. Discharge or management of treated wastewater:

On land, on river and on ocean. Sludge Treatment - Bioremediation or green technologies used for sludge management: Composting, land filling, thickening, alkaline stabilization, Conditioning, incineration, Dewatering.

Reference Books:

1. Wastewater Engineering: B.C.Punmia and Ashok Jain. Laxmi Publication N.Delhi
2. Water and Wastewater Engineering:G.S.Birdie and G.S.Birdie
3. Water and Wastewater EngineeringVol.I: Garg and Garg
4. Water and Wastewater Engineering: Metcalf and Eddy
5. Environmental Engineering: R.S.Gidde
6. Water and Wastewater Engineering: Arcivala
7. Water and Wastewater Engineering: Mackenzie L Devis WEF Publication
8. Principles of Foundation Engineering:BrajaM.Das
9. Standard Handbook of Environmental Engineering 2nd Edi. Robert A.Corbitt

SYLLABUS

DSC-4	Remote Sensing, GIS, GPS & UAV in Environmental Science	Total Contact Hrs. 60

Unit-1 (15 Hrs.)

Fundamentals of Remote sensing:History & development, definition, concept and principles. Energy Resources, radiation principles, Electromagnetic radiation, interaction between matter and Electromagnetic radiation, Sensors: Types of sensors, concept of resolution – Spatial, Spectral, Temporal and Radiometric, Spectral Signatures. Basic concept and principles of thermal, microwave and hyperspectral sensing, spectral reflectance and their characteristics of Earth surface features.

Unit-2 (15 Hrs.)

Platforms and Photogrammetry Products used in Remote sensing: Images, scale, mosaics, time and seasons of orbital cycles. Aerial photographs, photographic systems, Satellite data products. Photogrammetry - Basic principles, types, steps and elements of image interpretation, visual interpretation, and interpretation equipment's - digital image processing - image rectification, enhancement, classification, data merging and biophysical modeling - image processing software. Satellites and their characteristics – Geostationary and sun-synchronous, Indian Space programs.

Unit-3 (15 Hrs.)

Geographical Information System (GIS): Definition, History, Objectives of GIS, components of GIS, Applications of GIS software's. Types of Geographical Data: Raster Data Model, Vector Data Model, GIS Tasks: Digitization, Input, Manipulation, Management, Query, Analysis and Visualization. Layer, Geographic Reference, Level of measurement: Nominal, Ordinal, Interval, Ratio. Concept of Topology, Arc, Node and Vertices, Connectivity, Containment, Contiguity. Remote Sensing Data Products and their procurement, GIS and spatial distribution of environmental data. GIS software's, Remote sensing and GIS applications - Management and monitoring of Environment, conservation of resources, natural resources, coastal zone management.

Unit-4 (15 Hrs.)

Concepts of GPS & UAS Spherical trigonometry, History, Types, Navigation Systems and Applications, Introduction to IRNSS. Concept of Unmanned Aircraft Systems (UAS), UAS are finding expanding commercial and public application across many industries including construction, agriculture, environmental monitoring, security, delivery, and more.

Reference Books:

1. Ahmed, E. L. Rabbany(2002): Introduction to Global Positioning Systems, Artech House, Boston.
2. Anji Reddy, M. (2008): Textbook of Remote Sensing and Geographic Information System, B.S. Publication, Hyderabad
3. Burrough, P. A. and McDonnell, R.A. (2000): Principles of Geographical Information Systems, Oxford University Press, New York
4. Campbell, J. (2002): Introduction to Remote Sensing, Taylor & Francis, London
5. Chang, K. T. (2008): Introduction to Geographic Information Systems, Avenue of the Americas, McGrawHill, New York
6. Demers, M. N.(2000):Fundamentals of Geographic Information Systems, John Wiley and Sons, New Delhi
7. Heywood, I., Cornelisus, S., Carver, S. (2011):An Introduction to Geographical Information Systems, Pearson Education, New Delhi.
8. Jensen, J. R. (2005): Introductory Digital Image Processing, Prentice Hall, New Jersey
9. Joseph, G. (2004): Fundamentals of Remote Sensing, Universities Press, Hyderabad, India
10. Korte, G. B.(2001):The GIS Book, Onward Press, Bangalore
11. Lillesand, T. M., Kiefer, R. W. and Chipman, J. W.(2008): Remote Sensing and Image Interpretation, John Wiley & Sons, New Delhi
12. Lo, C. P.,Yeung, A. W.(2002): Concepts Techniques of Geographical Information Systems, PrenticeHall of India, New Delhi
13. Longley, P. A., Goodchild, M. F., Maguire, D. J.,Rhind, D. W. (2002):Geographical Information Systems and Science, John Wiley & Sons, Chichester.

SYLLABUS

DSE-2	1. Climate Change and Sustainability	Total Contact Hrs. 60

Unit-1 (15 Hrs.)

a) **Climatic Systems and Variations:** Global Climate System, Causes for Modern Climate Change, Internal Variability: Ocean-Atmosphere Variability, Ocean Currents, External Climate Forces: Greenhouse Gases, Orbital Variations, Solar Fluctuations, Volcanism, Plate Tectonics, Evidence and Measurement of Climate changes.

b) **Consequences and Challenges**: Impacts on Life, Vegetation, Fauna, Glaciers and Ice Sheets Melting, Sea Level Changes, Economics of Climate Change, Climate Change and Water Scarcity, Coastal Ecosystem and Vulnerability, Threats to Forest and Biodiversity, Agriculture and Food Security, Energy Generation and Climate Change Mitigation.

Unit-2 (15 Hrs.)

a) **Confronting Climate Change:** Policies and Efforts, India: National Action Plan on Climate Change (NAPCC), State Action Plan on Climate Change (SAPCC), National Adaptation Fund on Climate Change (NAFCC), India's Post-2020 Climate Goals. Climate Change Action Programme (CCAP), National Carbonaceous Aerosols Programme (NCAP), Long Term Ecological Observatories (LTEO) Programme Clean Development Mechanism (CDM), Extreme Events and Disasters, International Efforts, UNFCCC and Conference of the Parties, Special Reports by IPCC, Kyoto Protocol and Agreements, Copenhagen Conference, Paris Agreement, Findings and Efforts by NASA and ISRO.

b) **Mitigation Approaches in Climate Change**: Climate and Weather Statistics, Climate Change Modelling, Carbon Emissions Reduction Technologies, Climate Change Research, Climatology Journals and Top Institutions, Governance for Climate Change, Clean Development Mechanism, Technology Options Fuel Switching and Carbon Sequestration, The Economics of Carbon Mitigation: Integrated Assessment Models (IAM), Regional, National and International Experiences.

Unit-3 (15 Hrs.)

a) **Concepts in Sustainable Development**: Origins of Sustainable Development: Definition, Evolution and Principles, Brundtland Report, Strategies for Sustainable Development, Sustainability and Human Development, Green Politics and Sustainable Development, Cultural Elements in Sustainable Development Frameworks, Human Cantered Designs in Sustainability, The 2030 Agenda for Sustainable Development

b) **Sustainable Development Goals and Issues**: UN Sustainable Development Knowledge Platform, Tools for Sustainable Development, Sustainable Development Goals, Communicating the Sustainable Development Goals, Criticisms in Sustainability, Insubstantial Stretching of the Term, Cross-Cutting Issues, Women and Gender Equality, Education and Sustainable Development, Implementation, Support and Tracking Progress, Public Engagement in Sustainable Development.

Unit-4 (15 Hrs.)

a) **Environmental Conservation and Sustainability:** Technical Skills in Environment and Sustainability, Vulnerability, Adaptation and Livelihoods, Preservation of Biological Diversity, Sustainable Forest Management, Environmental Governance and Sustainability, Environmental Economics and Sustainability, Water Conservation and Sustainable Development, Urbanization and Sustainable Cities, Challenges in Energy, Food and Agriculture.

b) **New Developments in Sustainability:** Appropriate Technology and Sustainability Science, Consumption and Production Patterns, Sustainable Transport, Corporate Sustainability, Sustainability Metrics and Indices, Ecological and Carbon Footprint for Sustainability Measurement, Sustainability Measurement and Reporting Tools, Success Stories of Strategies in Sustainability, Sustainability in Policy Design.

Reference Books:

1. The Climate Fix: What Scientists and Politicians Won't Tell You About Global Warming by Roger Pielke, Basic Books (2010).
2. The Climate Solution: India's Climate Change Crisis and What We Can Do About It by Mridula Ramesh, Hachette India (2018).
3. This Changes Everything: Capitalism vs. the Climate by Naomi Klein, Penguin (2015).
4. What Is Climate Change? (What Was?) by Gail Herman (Author), Illustrated by John

Hinderliter, Penguin Workshop (2018).
5. Climate Change Biodiversity and Green Economy by H.S. Sharma S. Padmaja and Ganesh Sharma, Concept Publishing Company Pvt. Ltd. (2013).
6. Climate Change by Joseph Romm, OUP US (2018). Environment and Sustainable Development by M.H. Fulekar, Bhawana Pathak, R K Kale, Springer Nature (2013).
7. Sustainable Development in Digital Era by Dr. Aparna Mishra, Dr. Vikas Dahiya, Dr. Kamini Tandon, JSR Publishing House LLP; (2019).
8. The Age of Sustainable Development by Jeffrey D. Sachs and Ban Ki–moon, Columbia University Press (2015).
9. Target 3 Billion: Innovative Solutions Towards Sustainable Development by APJ Abdul Kalam, Srijan Pal Singh, Penguin India (2011).

SYLLABUS

DSE-2	2. Environmental Pollution and Management	Total Contact Hrs. 60

Unit-1 (15 Hrs.)

a) **Air pollution:** Types and sources of air pollutant and air pollution, Major air pollutants SO2, NO2, O3, HF, photochemical smog and particulates. Impacts on environment, plants and human health. Types of aeroallergens and allergies. Ozone layer depletion: Causes and consequences. Air quality criteria and standards, air pollution indices; National Environment policy; National air monitoring programme. Control of inorganic emissions, clean coal technology, coal conversion, industrial clean-up technology. Air pollution control equipment's: settlers, cyclone collectors, air filters, scrubbers and electrostatic precipitators.

b) **Noise pollution:** Definition of Noise, Concept of sound pressure level (SPL), decibel scale. Measurement and analysis of sound. Types, sources (Industrial Noise and Traffic Noise and household), effects of noise pollution on human health. Standards, permissible limit, abatement and control for noise pollution.

Unit-2 (15 Hrs.)

a) **Water Pollution:** Classification of water bodies; physicochemical and biological properties of fresh water; water quality standard. Types and sources of water; Effects on water quality, plants and human health; water pollution control- Bioremediation, Bioaugmentation and Bio stimulation. Oil pollution and marine pollution, ecology, factors effecting fate of oil after spillage movement, spreading, evaporation, emulsification, dispersion, Water management strategies, rain water harvesting, recharging of ground water, use of domestic waste water, recycling of waste water, recycling of industrial effluent after treatment.

b) **Thermal pollution:** Definition and sources, Chemical and biological effects of thermal pollution, Effect on marine life, bacteria, water quality and other aquatic biota; Thermal pollution from power plants and their control.

Unit-3 (15 Hrs.)

a) **Soil Pollution:** Inorganic and Organic-Definition of pollution and contamination, sources of soil pollution, Effects of chemical residues on soil, (pesticides, fertilizers, heavy metals etc., Soil salinity and alkalinity, Soil pollution from nitrogen, phosphorus, sulfur,

micronutrients or trace elements and radionuclide, land degradation, soil erosion. Soil pollution and climate change: Greenhouse gases emission, mitigation, carbon sequestration, soil quality.

b) E-waste & Hazardous waste: Definition, sources, composition, recycling and disposal methods. Hazardous waste: Definition, sources, classification, effects and disposal methods

Unit-4 (15 Hrs.)

a) Solid Waste Pollution: Concept and types of solid waste, Major sources of solid waste, effects of solid waste classification of waste. Domestic, Industrial, Municipal, Hospital, Nuclear, E-waste and Agriculture waste. Transfer and transport, waste minimization technologies -recycle, reuse, recovery, conversion of solid waste to energy / manure, sea disposal, incineration, compost and land disposal.

b) Radiation Pollution: Types, sources- natural and manmade, Measurement and detection of radiation intensity, consequences of radiation life, coefficient units for measurement of radiation, control of radiation pollution., Nuclear reactor safety, case studies.

Reference Books:

1. Bhatia H. S. (2003). A Textbook on Environmental Pollution and Control. Galgotia Publications Private Limited, Delhi.
2. Mark L. Brusseau, Ian L. Pepper and Charles P. Gerba. (2019). Environmental and Pollution. Academic Press.
3. Marquita K. Hill. (2012). Understanding Environmental Pollution. Cambridge University Press.
4. Nandini, N. (2019). A text book on Environmental Studies (AECC). Sapna Book House, Bengaluru.
5. Peirce, J. J., Vesilind, P. A., & Weiner, R. (1998). Environmental pollution and control. Butterworth-Heinemann.
6. Rachel Carson. (2002). Silent spring. Houghton Mifflin Harcourt.
7. Rajit Sengupta and Kiran Pandey. (2021). State of India's Environment 2021: In Figures. Centre Science and Environment.
8. Trivedi P. R. (2004). Environmental Pollution and Control. Ashish Publishing House - APH Publishing Corporation.
9. Yogendra N Srivastava. (2009). Environmental Pollution. Ashish Publishing House - APH Publishing Corporation.

SYLLABUS

DSE-2	3. Environmental Law, Acts, Ethics Policies	Total Contact Hrs. 60

Unit-1 (15 Hrs.)

Environmental Law and Policy: Introduction to Law, Policy: Meaning, Basic difference and Importance. Indian Constitution and Environment, Role of Constitution in Environment Protection,Fundamental Rights and Duties, Article 48A, 51A (g) and 58A, Precautionary and Polluter pays principles; Absolute and Strict liability Principles and Frameworks, Stockholm declaration, Nairobi Declaration, Rio Conference, Kyoto Protocol, World Summit on Sustainable Development (Rio + 10), Paris Agreement, CoP,

International Conventions: Convention on Biological Diversity, Convention on Climate Change, Ramsar Convention, Vienna Convention, Basal convention, Role of UN authorities in protection of Global Environment, G20, C40 cities, Net zero mission, carbon neutrality.

Unit-2 (15 Hrs.)

Environmental Laws in India: Anti-Pollution Acts, The Water (Prevention and Control of Pollution) Act,1974, The Air (Prevention and Control of Pollution) Act,1981, The Environment (Protection) Act,1986, The Public liability Insurance Act, 1991, The National Environmental Tribunal Act, 1995 Environmental Laws in India: Conservation Acts, Indian Forests Act (Revised),1982, The Indian Wildlife (Protection) Act,1972 amended 1991, The Biological Diversity Act, 2002, National Green Tribunal Act,2010, Public Interest Litigation (PIL).

Unit-3 (15 Hrs.)

Rules and Regulations: Hazardous waste management and handling rules, Solid waste management and handling rules, Biomedical waste regulations, Plastic waste management regulations, Noise Pollution Rules, E-Waste management rules Consent applications and forms, Introduction to consent applications and categories; Process for new application and amendments, Environment statement form, Water cess form, MSW applications, Hazardous waste applications, Bio-medical waste applications, Plastic regulation application, E-waste application.

Unit-4 (15 Hrs.)

Policies: National Environmental Policy, National Forest Policy, National Water Policy, Policies on Renewable and Non-renewable energy resources, Environmental Status report, Environmental Ethics, Introduction and concept of Environmental Ethics, Ethical theories applied to the Environment, The ethical dilemma: Environmental ethics and population, ethics and pollution, Human life and its Environment: art of ethics and an ethical dilemma, Challenges of World Environmental ethics.

Reference Books:

1. Alexander Gillespie: International Environmental Law, Policy and Ethics. Oxford University Press, 2014.
2. Divan Shyam and Armin Rosencranz: Environmental Law and Policy in India, Oxford University Press, 2002.
3. Joseph R. Des Jardins, Environmental Ethics: An Introduction to Environmental Philosophy, Wadsworth Publishing, 2005.
4. P. B. Sahasra Aman: Handbook of Environmental Laws, Oxford University Press, 2012. Nancy K. Kubasek and Gary S. Silverman: Environmental Law, Pearson, 1999.
5. P. Leela Krishnan: Environmental Law in India, LexisNexis, 2010.
6. Paul Pojman and Louis Pojman: Environmental Ethics, Wadsworth Publishing, 2011.
7. Environmental Laws of India - An Introduction: CPR Environmental Education Centre, Chennai (2001).
8. Environmental Law and Policy in India: Divan S and RosencrazA,Oxford University Press, New Delhi. (2001)
9. Labour and Industrial Law: Sing, A, K. and Agrawal R. K., Pioneer Printers, Agra (2000).
10. Environmental Policies: Sinha P. C., Anmol Publications Pvt. Ltd, New Delhi (1998).
11. Environmental Guidelines and Standards in India:Goel P. K and Sharma K. P, Techno Science Publications, Jaipur (1996).

SYLLABUS

OJT/FP	OJT/FP/In-house Project/Internship/ Apprenticeship	Total Contact Hrs. 60

OJT/FP (On Job Training, Internship/Apprenticeship/Field Project):

A) Industrial training: Students are encouraged to undergo summer/winter in plant training in a suitable industry, consultancy, research laboratory, institute etc. so as to get firsthand experience of corporate environmental management.

B) Field Project Report (FP): Project Work Instructions for Students
(Total marks: 100. Project work: 80 marks, internal: 20 marks)

Candidates will write a field project report on issues related to Environmental Science under the guidance of their respective guides. Each student will work independently on the topic. The field project must consist of review of literature and produce a deep insight of the subject on the basis of personal research. Field project work will be initiated at the start of M.Sc. I year (IInd semester). The students will undertake field work in terms of collection of data and surveys. The field project will have to be submitted for appraisal and acceptance by the University. The students should submit their field project report in the following format.

Chapter I: Introduction with Aims and Objectives: A background with historical information and a review of existing material or data on the subject along with the aims and objectives of the study.
Chapter II: Methodology with Material and Methods: Description of the issue, methodology adopted for the study.
Chapter III: Experimental: Presentation of data collected and detailed analysis of results.
Chapter IV: Result and Discussion: Discussion on the data and results obtained and Presentation of method suggested to solve the problem.
Chapter V: Summary and Conclusions: A summary of the dissertation and important conclusions drawn at the end of the investigation.
Bibliography or References: A list of references of cited in the text.

The Field Project Report should be typed on A4 size bond paper with 1.5 line spacing. Illustrations and photographs should be of high quality. The report should be flawless without any spelling mistakes or grammatical errors. Students will have to submit their field project report one month Before the practical examination at the end of M.Sc. I year (IIndsemester). The field work report will carry 100 marks (Internal marks 20 and External marks 80). Assessment of the report will be done at the end of the year. Students have to present a Power Point Presentation. Assessment of the field work shall be done by the external examiner appointed by the PAH Solapur University.

C) Study visits: PAH Solapur University affiliated area and nearby places

i) PAH Solapur University Instrumentation Centre

ii) Udyyam Innovation & Incubation Centre, PAH Solapur University

iii) Solapur Science Centre, Solapur

iv) Forest Department Govt of Maharashtra DFO -Solapur

v) Soil Laboratory Dept of Agriculture Govt of Maharashtra, Solapur

vi) National Research Centre of Pomegranate (NRCP) Solapur

vii) Krushi Vidyan Kendra Solapur

viii) National Jawar Research Centre Solapur

ix) National Great Indian Bird Sanctuary Nannaj Solapur

x) Industrial visits – Chincholi MIDC, Akkalkot MIDC Solapur - Industries

xi) National Thermal Power Station (NTPC) Solapur

xii) Environmental Consultancy Services, NGO etc

xiii) Ground Survey Development Authority (GSDA) Solapur

xiv) Maharashtra Pollution Control Board, SRO - Solapur

xv) Stone Quarry Mining Solapur

xvi) Solapur Municipal Corporation, Solapur

xvii)Solapur Collector Office, Solapur

xviii) Solapur Jilha Parishad Solapuretc

D) Seminar: Student may select any environmental related topic of their choice (in consultation with the faculty) and make a power point presentation for 30 minutes. They shall be able to answer questions invited from the audience.

E) Field diary: The student shall prepare their field diary under the following heads

i) Issue on local/regional/national problem of environmental interest (Case Studies).

ii) About famous personalities in environmental movements.

iii) New Acts and Judgments of environmental interests.

F) Guest lecture series: In each year guest lectures will be given by the faculty and other invited speakers on current topics and environmental issues. The course would run as a guest lecture series with compulsory attendance.

SYLLABUS

DSC-3P	Practical -4	Total Contact Hrs. 60

Practical's:

1. Draw and demonstrate Flow Charts / Diagrams of ETP, STP, WTP and CETP with detailed explanation of unit processes and unit operations.
2. Calculations on Population forecasting for water & wastewater management.
3. Determine the color of the given wastewater sample
4. Determine the odor of the given water sample
5. Determine SVI, SDI, MLSS and MLVSS(suspended, settleable, volatile and fixed solids) of given wastewater sample
6. Determine oil and grease of given wastewater sample
7. Determination of Calcium in the given wastewater sample
8. Determination of residual chlorine and available chlorine in bleaching powder
9. Determination of Optimum Coagulant dosage in waste water sample
10. Study of Jar test for wastewater treatment
11. Determination of Ammonia Nitrogen in given wastewater sample.
12. Determination of acidity and alkalinity of given wastewater sample.
13. Determination of optimum lime soda dose for hardness removal
14. Determination of Sodium and Potassium for the given sample.
15. Visits to industries ETP, Water Treatment Plant (WTP), Sewage Treatment Plant (STP) and Common Effluent Treatment Plant (CETP).

Practical References:

1) Saxena M M. (1990). Environmental Analysis: Water, Soil and Air. Edition, 2. Publisher, Agro Botanical Pub.
2) Standard Methods for Examination of Water and Wastewater. (2017). APHA – WEF.
3) Trivedi, P. K. and Goel, P. K. (1984). Chemical and Biological Methods of Water Pollution Studies. Environmental Publication.
4) Punmia B.C. and Jain A.K. (2007). Water and Wastewater Engineering.

SYLLABUS

DSC-4P	Practical -5	Total Contact Hrs. 60

Practical's:

1. Field Work- Identification of Features in the Field Using Aerial Photographs and/or Satellite Images
2. Aerial Photo and Image Interpretation: Interpretation of Aerial Photos: Single, Vertical Stereo Pairs.
3. Measurements: Geometry of Aerial Photographs, Determination of Scale, Parallax and height measurement
4. Overview of Arc GIS: Arc map, Arc catalog and Arc tool Box
5. Attribute Data Input: Creation of Schema, Tables, Data Definition, Data Input, Data Updating, Queries on Tables, Simple-Complex Query with Two or More Tables Using SQL. Queries Using Union, Intersection, Join etc. Operations. Use of MS-Excel and MS Access
6. Spatial Data Input: Vector Data Formats with File Extensions. Scanning, On-Screen Digitization, Editing, Topology Creation, Line and Area Measurements, Data Attribution
7. Geodatabase in Arc catalog and Arc map: Feature Dataset, Feature Classes, Import of Data, Spatial Data Formats, Shape/Coverage Files and Layers, Data Frames, Maps, Managing TOC
8. Georeferencing Data: Coordinate Systems, Datum Conversions, Map Projections, Types, Storing- Viewing Projection Information
9. Working with Layers in Arc map: Building Templates, Classification, Displaying Qualitative and quantitative Values, Labeling Features and Map Creation.
10. Time-series data analysis in Arc GIS.
11. GPS: GPS Survey, Data Import, Processing and Mapping
12. Overview and mapping with Q-GIS software
13. Overview, tools, mapping and image processing with ERDAS software
14. Overview, tools, and mapping with Google Earth.
15. Overview and use of NRSC, BHUVAN, SRTM sources of satellite data procedure. Visit to Engineering colleges and demonstrate working and applications of UAS in Environmental Science

Practical References:

1. Arc GIS practical manual
2. ERDAS practical manual
3. QGIS practical manual
4. BHUVAN official website
5. NRSC official website

SYLLABUS

DSE-2P	Practical -6	Total Contact Hrs. 60

Practical's:

1. Measurements for the impact of environmental stress conditions on plants
2. Estimation of carbon sequestration by using different methods
3. Studies on plants facing pollutants from selected areas
4. Measuring the impact of climate change in a vulnerable population
5. Impacts of extreme events in selected areas: A case study
6. Use of RS and GIS technology in mapping climatic changes
7. Measurement of ozone concentration and analysis of the data
8. Studies on measurements of sustainable farming practices
9. Questionnaire survey based on online platforms and analysis
10. Measurement and analysis of the data by using online software about sustainability
11. Measurement of sustainability by using innovative approaches and designs
12. Measurement of carbon footprint and ecological footprints by using online software
13. Learning and understanding law specific case study
14. Study of major judgement given by courts on selected law
15. Study of case studies related to fundamental duty and rights
16. Preparation of drafts report on various Environment related policies in India
17. Study of issues and challenges associated with Environmental ethic
18. Study of industrial process for Environmental management
19. Writing Environmental policy for an organization, Monitoring a plan for Green city
20. Baseline survey on provisions under selected environmental laws
21. Study of major judgment given by courts on selected law
22. Preparation of drafts report on various Environment related policies in India
23. Learning: How to file case under Environmental laws and Learning: How to file case under NGT
24. Study of Air micro flora, PM 10 and PM 2.5 measurement by Find Air Dust Sampler
25. SOx and NOx measurement by Find Air Dust Sampler 4. Measurement of Noise-by-Noise Level Meter
26. Calculation of Noise levels from different locations
27. Estimation of WHC, Soil texture and soil profile

Practical References:

1. The Climate Solution: India's Climate Change Crisis and What We Can Do About It by Mridula Ramesh, Hachette India (2018).
2. Climate Change Biodiversity and Green Economy by H.S. Sharma S. Padmaja and Ganesh Sharma, Concept Publishing Company Pvt. Ltd. (2013)
3. Environment and Sustainable Development by M.H. Fulekar, Bhawana Pathak, R K Kale, Springer Nature (2013).
4. Environmental Science: S. C. Santra, New Central Book Agency, Kolkata, 2005
5. Environmental Law and Policy in India: Divan S and RosencrazA,Oxford University Press, New Delhi. (2001)
6. Labour and Industrial Law: Sing, A, K. and Agrawal R. K., Pioneer Printers, Agra (2000).
7. Environmental Policies: Sinha P. C., Anmol Publications Pvt. Ltd, New Delhi (1998).
8. Environmental Guidelines and Standards in India:Goel P. K and Sharma K. P, Techno Science Publications, Jaipur (1996)