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BE BOUNDLESS

BENGALURU CITY UNIVERSITY

**SYLLABUS FOR MASTER OF SCIENCE
(Environmental Science)**

(SEMESTER SCHEME)

2021-22 onwards

BENGALURU CITY UNIVERSITY
CENTRAL COLLEGE CAMPUS, BENGALURU 01
CHOICE BASED CREDIT SYSTEM (SEMESTER SCHEME)
SYLLABUS OF M.Sc. ENVIRONMENTAL SCIENCE
 Structure of the course

1 SEMESTER

Subject Code	Title of paper	Teaching hours per week	Examination duration (hrs)	Internal assessment Marks	Exam Marks	Total	Credits
Core Papers							
ENV101	Environmental Biology	04	03	30	70	100	4
ENV102	Environmental Chemistry	04	03	30	70	100	4
ENV103	Environmental Geology	04	03	30	70	100	4
ENV104	Meteorological Sciences and climate change	04	03	30	70	100	4
Softcore (No practical's)							
ENV105	Environmental Sampling & Application of Statistics	03	03	30	70	100	2
Practicals							
ENV106	Part A: Environmental Biology & Part B: Environmental Chemistry	08	03	30	70	100	4
ENV107	Part A: Environmental Geology & Part B: Meteorological Sciences and Climate change	08	03	30	70	100	4
Total credit of semester							26

Note: Field work for sampling



Related to practical's P

project and Seminar

II SEMESTER

Subject Code	Title of paper	Teaching hours per week	Examination duration (hrs)	Internal assessment marks	Exam Marks	Total	credits
Core Papers							
ENV201	Environmental Toxicology	04	03	30	70	100	4
ENV202	Environmental Engineering	04	03	30	70	100	4
ENV203	Environmental Microbiology	04	03	30	70	100	4
ENV204	Environmental Pollution Monitoring and Control	04	03	30	70	100	4
Softcore (No practicals)							
ENV205	Occupational Health Hazards	03	03	30	70	100	2
Practicals							
ENV206	Part A: Environmental Toxicology & Part B: Environmental Engineering	08	03	30	70	100	4
ENV207	Part A: Environmental Microbiology & Part B: Environmental Pollution Monitoring and Control	08	03	30	70	100	4
Total credits of semester							26

Note: Fieldwork for sampling

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Related to practical's P

project and Seminar

II SEMESTER

Subject Code	Title of paper	Teaching hours per week	Examination duration (hrs)	Internal assessment Marks	Exam Marks	Total	credits
Core Papers							
ENV301	Solid and Hazardous Waste Management	04	03	30	70	100	4
ENV302	Natural Resource Management	04	03	30	70	100	4
ENV303	Remote Sensing and GIS Application	04	03	30	70	100	4
Open Elective- Any one paper for the sister Departments							
ENV304	<ul style="list-style-type: none"> • Climate Change and Current Issues • Natural Resources Management 	04	03	30	70	100	4
Practicals							
ENV305	Part A: Solid and Hazardous Waste Management & Part B: Natural Resource Management	08	03	30	70	100	4
ENV306	Part A: Remote Sensing applications & Part B: GIS Application	08	03	30	70	100	4
Total credit of semester							24

Note: Field work for sampling

project and Seminar

} Related to practical's P

II SEMESTER

Subject Code	Title of paper	Teaching hours per week	Examination duration (hrs)	Internal assessment Marks	Exam Marks	Total	credits
Core Papers							
ENV401	Environmental Economics and Sustainable Development	04	03	30	70	100	4
ENV402	Environmental Impact Assessment and Environmental Law	04	03	30	70	100	4
ENV403	Disaster Management	04	03	30	70	100	4
ENV404	Ecofriendly Technologies and Environmental Modeling	04	03	30	70	100	4
ENV405	Dissertation/Project	12	-	-	-	150	6
ENV406	Vivavoce	4	-	-	-	50	2
Total credits of semester							24
Elective- Dissertation in any one of the field / Vivavoce. Dissertation / Project in place of Practical's. Research topic to be decided in consultation with guide and students.							
TOTAL CREDITS OF FALL SEMESTER = 100							

Marks for internal assessments shall be awarded on the basis of seminars, fieldwork, tests, assignments etc.

Scheme of Internal Assessment for I-III Semester

Theory	30	Practical (Each Part= 15 Marks)	15x2=30
Test	10	Test	5
Assignment	05	Class record	5
Seminar	05	Attendance	5
Field visit	05	Total IA of Practical for each paper	30
Attendance	05	-	-

Scheme of Internal Assessment for IV Semester & Dissertation

Theory	30	Dissertation/Project	Total
Test	10	Dissertation/project	150
Assignment	05	Vivavoce	50
Seminar	05	-	-
Field visit	05	-	-
Attendance	05	-	-

THEORY SYLLABUS

ISEMESTER.M.Sc ENVIRONMENTAL SCIENCE

ENV101: ENVIRONMENTAL BIOLOGY (CORE)

4 Credits, 4hrs/Week, 52hrs/semester

Unit 1: Definition, principle and scope of Environmental Science and Ecology, inter relation with other fields. Interaction between Man and Environment; Factors affecting the environmental systems - biotic and abiotic factors. **08hrs**

Unit 2: Ecosystems: Fundamental concepts and principles; Structure and function, Food chain disruption and consequences, modern concept of ecosystem, habitat and niche concept. Classification: aquatic and terrestrial ecology. Major biomes - Temperate forests, Tropical rain forests, Tropical savanna and Deserts. Population ecology - Fundamental concepts, characteristics, growth and regulation. Community ecology - species diversity, richness and dominance. **12hrs**

Unit 3: Primary and secondary productivity - Definition, measurement of biomass and productivity in terrestrial and aquatic communities. Productivity of terrestrial ecosystem; forest and grassland ecosystems. Ecosystem Pathways; basic laws of energy flow; Energy flow models, Energetic relations in Ecosystems. **10hrs**

Unit 4: Biodiversity: Definition, biodiversity hotspots of world & India and strategies for its conservation. CBD and Agenda 21, National parks and sanctuaries, biosphere reserves. Ecological indicators. Endemic and IUCN threatened species, Concept of keystone & flagship species. Biodiversity of agro-ecosystems and sacred grooves. **10hrs**

Unit 5: Forest Ecosystem: Forest influence on Climate regulation, flood & soil erosion control and wildlife habitat protection, maintaining hydrology and nutrient cycling. Green belt and its influence on urban environment. Carbon sequestration in forestry. Effect of fire on forest ecosystem - nutrient content, soil fauna and wildlife habitat. **12hrs**

Reference Books:

1. Ramesh Vijaya K. (2005). Environmental Microbiology. MG Publishers, Chennai.

2. Edward Alcamo I. (2001). *Fundamentals of Microbiology*, Jones and Bartlett Publishers, INC. VI Edition.
3. Kumar H. D. (1995). *General Ecology*, I Ed. Vikas Publishing House Pvt. Ltd., New Delhi
4. Pepper W. (1995). *Environmental Microbiology*. A.P. Publishers.
5. William C. Frazier and Dennis C. Westhoff. (1995). *Food Microbiology*, Tata McGraw-Hill Publishing Company limited, New Delhi, IVth Edition
6. Odum E. P. (1971). *Fundamental Ecology*, 5th Ed., Saunders.
7. Kormondy E. J. (1962). *Concepts of Ecology*, Prentice Hall.
8. Singh H. R. (1989). *Animal Ecology and Environmental Biology*. Nagin Chand & Co. Shoban Lal (1992). *Ecology*
9. Eisehart G. D. and Baumgardner K. D. (1981). *Population biology*, Van Nostrand Co., N.Y
10. Phillipson F. H. (1980). *Ecological Energetics*.
11. Michael J. Pelczar. (1986). *Microbiology*, 5th (Ed) McGraw-Hill Book Co.
12. Michael J. Pelczar. (1994). *Microbiology-Concepts and applications*, McGraw-Hill Inc.
13. Martin Alexander. (1983). *Introduction to Soil Microbiology*, 2nd Ed., Wiley Eastern Ltd.
14. Powar C. Band Dagainwala H. F. (1985). *General Microbiology*, Vol. I & II, 2nd Ed., Himalaya Publishing House.
15. Bhattacharya R. N. (1993). *Experiments with microorganisms*, Reprint, Emkay Publications, New Delhi.
16. Pepper W. (1995), *Environmental Microbiology*. A.P. Publishers.
17. Oliver S. Owen. (1980). *Natural Resources conservation- An Ecological approach*, 3rd Ed., Macmillan Publishing Co. Inc. New York.
18. Daniel D. Chiras. (1994). *Environmental Science*, 4th Ed., The Benjamin / Cummings Publishing Co., Inc.
19. Nandini N, Sunitha N. and Sucharita Tandon. (2007). *Environmental Studies*, Sapna Book House, Bangalore.

ISEMESTER.M.Sc ENVIRONMENTAL SCIENCE

ENV102: ENVIRONMENTAL CHEMISTRY (CORE)

4 Credits, 4 hrs/Week, 52 hrs/semester

Unit 1: Atmospheric Chemistry: Concept and scope of Environmental chemistry, Chemical composition and speciation in air, Chemistry of air pollutants, Thermochemical and photochemical reactions in the atmosphere, Atmospheric aerosol formation of inorganic and organic particulate matter, Ozone chemistry- Interaction of Chlorine and Bromine based compounds with Ozone, Toxicants and nutrient exchange between atmosphere and ecosystem. **08hrs**

Unit 2: Soil Chemistry: Soil profile- Physico-chemical properties of Soil, organic and inorganic components in soil, Major micro- and macronutrients of soil, Nutrient Pathways- Nitrogen, Phosphorus and Potassium pathways in the soil. Soil pollutants - Fate of chemical pollutants with soil types, soil pollutant stress on biosphere, correction of problematic soils - Saline, Acidic and Alkaline soils; Carbon speciation in soil. **10hrs**

Unit 3: Chemical pollution and fundamentals of chemical reactions: Acid-base reaction, oxidation, reduction, precipitation. Chemistry of organic pollutants: Phenols, Dioxins, Polyaromatic hydrocarbons, polychlorinated biphenyls and pesticides. Toxic chemicals in the environment: biochemical aspects of As, Cd, Pb, Hg, CO, O₃, PAN, pesticides, MIC and carcinogens in air. **10hrs**

Unit 4: Water chemistry: properties of water. Water pollutants: types and their sources- heavy metals, metalloids, organic, biological and radioactive substance. Types of reactions in various water bodies including marine environment. Chemistry of oil based and water based paints, physico-chemical basis of redox processes. Electrochemical theory of corrosion. **12hrs**

Unit 5: Instrumentation and Analytical Techniques: Theoretical principles of Analytical Techniques - Role and importance 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 - Flame and Graphite furnace. Nephelometry, Flame photometry, Fluorimetry; Chromatographic techniques: Paper, Thin Layer, GC and Gas - Liquid Chromatography, HPLC, X-ray fluorescence, X-ray diffraction, Electrophoresis. **12hrs**

Reference Books:

1. Sharma B. K. and Kaur H. (1995). Environmental Chemistry, I Ed., Goel Publishing House.

2. DeA.K(1989).EnvironmentalChemistry,IIEd.,WileyEasternLimited.3.SawyerC.N,Mc Carty P.LandPerkingG.F.(1994).Chemistry for EnvironmentalEngineering,IIEd,McGraw-Hill.
3. EnvironmentalEngineering,IIEd,McGraw-Hill.
4. Bailey,R.A.(1978).ChemistryoftheEnvironment,AcademicPress.
5. Tyagi O.D. andMehraM. (1990). Text Bookof EnvironmentalChemistry, IEd.,AnmolPublications.
6. CharlesR.GoldmanandAlexanderJ.Horene.(1983).Limnology,McGraw-Hill.
7. RoyL.Donahue,RaymondW.MillerandJohnC.Shickluna.(1987).Soils – AnIntroductiontosoilsandplantgrowthV.Ed.,Prentice-HallofIndia.
8. BiswasT.DandMukherjeeS.K.(1987).TextbookofSoilScienceIVEd.,McGraw-Hill.
9. Vogel’sTextbookofQuantitativeInorganicAnalysis.(1978).IVEd.,LongmanGroup Ltd.
10. Jacobs.(1969).AnalyticalChemistryofIndustrialpoisons.Hazardsandsolvents,M.B.InterScience.NewYork.
11. SawyerC.N,McMartyP.L.andPerkinG.F.(1994).ChemistryforEnvironmentalEngineering (II ed),McGrawHill.
12. TyagiO.D.andMehraM.(1990).EnvironmentalChemistry,AnmolPublications.
13. ManahanS.E.(2000).EnvironmentalChemistry(7thEd),LewisPublications,Florida,U.S.A.

ISEMESTER.ScENVIRONMENTALSCIENCE

ENV103:ENVIROMENTALGEOLOGY(CORE)

4Credits,4hrs/Week,52hrs/semester

Unit 1: Earth systems and its interaction: Origin of earth, Structure of Earth-Lithosphere, hydrosphere and biosphere. Earth's Materials – Minerals and their definition. Distribution and abundance of elements in the major units of earth, Geochemical features, Formation and classification of Rocks. Folds, faults, dykes and other geological formations and their environmental significance. **10hrs**

Unit 2: Mineral resources and Pedology: Resources and reserves, depletion trends of resources. Geological features of India and Karnataka. Land-use planning and Terrain evaluation. Soil characteristics, formation of soil, role of soil organisms in soil formation, soil erosion, types, soil conservation. Elemental Pathways-geochemical cycles. Biogeochemical factors in environmental health and effect of imbalance. **10hrs**

Unit 3: Water Resources and Environment: Classification of global water resources – Lotic and Lentic system. Global water balance, Ice sheets and fluctuations of sea levels. Origin and composition of seawater, Hydrological cycle, Human usage of surface and groundwater. Groundwater potential. Global water budget. **10Hrs**

Unit 4: Geochemical and geological process-exogenic and endogenic – Earthquakes volcanoes, cyclones, Tsunami - their impact on flora and fauna and human beings. River action, wind action and glaciers. Concept of major trace and REE classification and mobility of trace element Geochemical cycle, Human use, trace elements and health, Diseases induced by human use of land. **12hrs**

Unit 5: Geographical classification and zones of Environment. Energy budget of the earth. Earth's thermal environment and seasons. General relationship between landscapes, biomes and climate. Climate of India. Indian Monsoon, El Niño, droughts, Tropical cyclones and westerly disturbances. **10hrs**

Reference books:

1. Schwab S.O, Frevert R.K, Edimster T.W and Barns K.K.(1975). Soil and water conservation Engineering, John Wiley and Sons.

2. Loehr, R.C. Jesel, W.J. Novak, N.D., Clarkson, W.S. and Friedeman G.S. (1979). Land Application of Wastes (Vol-I and II). Van Nostrand Reinhold Co., New York.
3. Valdia K.S. (1987). Environmental Geology.
4. Menard H.W., W.H. Freeman and Company, San Francisco. (1969). The nature of oceanic life, The Ocean – A Scientific American Book.
5. Reed Wicander and James S. Monroe. Essentials of Geology, Wadsworth publishing
6. 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.
7. Biswas T. D. and Mukherjee S. K. (1987). Textbook of Soil Science IV Ed., McGraw-Hill.
8. Strahler and Strahler. (1970). Environmental Geology, Wiley & Sons, New York.
9. Valdiya K.S. (1985). Environmental Geology Allied Publishers New York.
10. Carla W. Montgomery. (1989). Environmental Geology, Wm C Brown Publishers. Dubuquo Iowa.
11. Peter T. Flawn. (1970). Environmental Geology, Harper and Row, New York.
12. Khurumi R.S. (1988). Engineering Geology, Dhanpet Rai & Sons, New Delhi.
13. Mahapatra G.B. (1989). A text book of Geology. CBS Publishers & Distributors New Delhi.
14. Mukherjee P.K. (1995). A text book of Geology. The World Press Private Ltd. Calcutta.
15. William D. Thornbury. (1984). Principles of Geomorphology. First Wiley Eastern print.
16. Berryl G, Mason Brian and R. V Dietrich. (1985). Mineralogy, CBS Publishers & Distributors.
17. Gribbis C.D. (1991). Rutley's Elements of Mineralogy, 27th Ed., Revised by CBS Publishers & Distributors.
18. Edward A Keller. (1981). Environmental Geology, 3rd Edition, Charles E. Merrill Pub. Co.
19. Earth Science and the Environment, Richard J. Ordway, D. Van Nostrand and Company, London.
20. Laporte. Encounter with the Earth, L.F. Oxford press, San Francisco.

ISEMESTER.ScENVIRONMENTALSCIENCE

ENV104:METEOROLOGICALSCIENCESANDCLIMATECHANGE(CORE)

4Credits,4hrs/Week,52hrs/semester

Unit 1: Fundamentals of Atmospheric Science: Definition and scope of atmosphere. Evolution of Earth's Atmosphere. Atmospheric structure and heating; Chemical Composition. Electromagnetic spectrum. Earth-Sun Geometry and seasonal variations. Global energy budget - Solar radiation and terrestrial radiation. Greenhouse effect - Definition, causes and facts. Components of weather and climate. Environmental lapse rate and Adiabatic lapse rate, temperature inversion and atmospheric stability and instability. **10hrs**

Unit 2: Meteorology: Definition, scope and objectives of Meteorology. Atmospheric motion and Circulation. Air Masses and Fronts. Weather patterns. Primary Meteorological Parameters and their Measurement - Temperature, Wind Speed and Direction. Secondary Meteorological Parameters and their Measurement - Humidity, Relative Humidity, Absolute Humidity, Pressure and Solar Radiation. Weather modifications - cloud seeding and its consequences. Wind patterns - Definition and facts; Collection and analysis of wind data, wind roses; air pollution and pollution roses. Effects of Meteorological Parameters on weather and climate. **10hrs**

Unit 3: Meteorological controls: Tropical cyclones, intense tropical cyclones, low-pressure areas, tropical waves, tropical disturbances and tropical depression. Atmospheric disturbances - Thunderstorms, dust storm, lightning, flood and drought. Global weather patterns - El-Nino and La-Nino. Implications of meteorological controls monitoring, assessment, research and prediction programs for Mitigation and adaptation strategies to changing climate. Weather forecasting **10hrs**

Unit 4: Climatology: Definition, scope and objectives of climatology, Latitudes, Longitudes and Latitudinal heat zones of the earth. Insolation - Factors affecting the distribution of insolation. Atmospheric Depletion of Solar Radiation. Process of Heat Energy Transfer - Radiation, Conduction and Convection. Clouds and their formation; Classification of clouds. weather forecasting and Hydrological cycle. Seasonal classification of India. Indian monsoon - Southwest monsoon, Northeast monsoon, Intra-seasonal monsoon. Monsoon depression. Role of Climatological Institutions - Indian Meteorological Department (IMD); World Meteorological Organisation (WMO); World weather watch and Global atmospheric research programme (GARP). **12hrs**

Unit 5: Global Climate Change: Introduction, scope and objectives of global

climate change. Earth's Greenhouse Gases – Definition, emissions and its impacts on earth's climate system. Ozone layer –

Definition, causes and facts. Ground level ozone, Stratospheric Ozone layer, Antarctic Ozone Hole, Mechanism of Ozone layer

depletion and its consequences. Ozone layer recovery. Advance research to protect the Stratospheric Ozone layer. Global dimming. Global climate change policies. Overview of Conference of Parties (CoP) - The Kyoto protocol; Montreal protocol; Paris agreement. **10hrs**

Reference Books:

1. General Meteorology: H.R. Byers, Tata McGraw Hill Publications, New Delhi.
2. Climatology: Fundamentals and Applications: Mater J.R.
3. Climatology: Selected Applications: Henry D. Foth.
4. Introduction to weather and climate: Trewartha.
5. The Atmosphere: An Introduction to Meteorology: Fedrik K. Lutgen, E.J. Tarbuck.
6. General Meteorology: H.R. Byers (Tata McGraw-Hill Publications, New Delhi).
7. Meteorology: Dr. S.R. Gadekar, Agromate Publishers, Nagpur 2000.
8. Environmental Analysis: M.M. Saxena, Agrobotanical Publisher, Bikaner 1994.
9. Climatology: D.S. Lal, Shraddha Pustak Bhavan Alahabad, 2001.
10. Atmosphere, Weather and Climate: K. Siddhartha, Kisalaya Publication Pvt. Ltd 2000.

ISEMESTER.M.Sc ENVIRONMENTAL SCIENCE

ENV105: ENVIRONMENTAL SAMPLING TECHNIQUES AND APPLICATIONS OF STATISTICS (SOFT CORE) 2 Credits, 3hrs/Week, 39hrs/semester

Unit 1: Air Sampling: Objective and Criteria of Air Sampling, Selection of Sampling Location, Sampling Methods (Sedimentation, Filtration, Centrifugal and Impingement Method), Instrumental Techniques used in Estimation of Atmospheric Air Pollutant, Dust Fall Jar, SPM and RSPM, SO₂, Oxides of nitrogen using Respirable Dust sample/High Volume Air Sampler. Flue gas sampling and monitoring in Industries and Stack. **08hrs**

Unit 2: Water and Waste Water Sampling: Necessity of Water Sampling, Objectives, Selection of Sampling Site, Sampling and characterization of water and wastewater by gravimetric, volumetric and colorimetric methods. Types of Water Samples, Collection, Transport, Handling and Preservation, Water samplers, sampling methods - Random/snap sample, Composite sampling, Stratified sampling. Classification of Water Quality Parameters - Inorganic, Organic and Nutrient; Field Parameters; Data Interpretation - Basic Concept, Significance and Measurement of DO, BOD, COD, in Water and Wastewater. **10hrs**

Unit 3: Soil and Solid Waste Sampling: Objectives of Soil and Solid Waste Sampling, Site Selection Criteria, Collection and Handling of Soil and Solid Waste Samples, Soil samplers: Shovel, Trial Pits, Hand/Machine Driven Auger, Continuous flight Auger, Spit-spoon sampler, Shelby Tube sampler, Piston samplers, Pitcher Barrel sampler. Preparation of Soil Samples for Analysis, Physico-Chemical Parameters and their Significance (Quality and Productivity). **09hrs**

Unit 4: Application of Statistics in Environmental Analysis: Introduction, Research Problem and Design, Data Collection, Data Representation, Measure of Central Tendency, Measure of Variation, Correlation and Regression; Testing of Hypothesis - Test based on Normal distribution; Analysis of variance - one-way and two-way classification. Sampling Distributions - t-test, chi-square and F distribution. Nature of Errors, Types of Errors and Importance of Error, Random Error, Estimation of Standard Deviation, Confidence Limit of Analytical Results, Combined Effects of Different Random Errors, Comparison of Two Means, Comparison of Two Standard Deviations, Laboratory Quality Control and Assessment, Correction, Limit of Detection, Bias, Precision, Accuracy, Interpretation and Report Writing. **12hrs**

References:

1. Freund, J.E. and Miller, I.R., Probability and Statistics for Engineers, Prentice-Hall of India, 5th Edition, New Delhi, 1994.

2. Gupta, S.C. and Kapur, V.K., *Fundamentals of Mathematical Statistics*, Sultan Chand and Sons, New Delhi, 1999.
3. Taha, H.A., *Operations Research: An Introduction*, Prentice-Hall of India, 6th Edition, New Delhi, 1997.
4. Kapoor, V.K., *Problems and Solutions in Operations Research*, Sultan Chand and Sons, New Delhi, 1997.
5. *Biostatistics*: P.N. Arora, P.K. Malhan, Himalaya Publishing House, Delhi, 2008.
6. *Basic concepts of Biostatistics*: N. Arumugam, Saras Publications, Kanyakumari, 2003.
7. *Biostatistics in theory and Practice*: T.K. Saha, Emkay Publications, Delhi, 1992.
8. *Biostatistics*: P. Ramakrishnan, Saras Publications, Kanyakumari, 1995.
9. *Statistical Methods*: S.C. Gupta, S. Chand & Sons Publishers, New Delhi, 1997.
10. *Evolution Biostatistics AND Computer Applications*: A. Gopi, A. Meena, N. Arumugam, Saras Publications, Kanyakumari, 2003.
11. *Fundamentals of Computer*: V. Rajaraman, Prentice Hall of India, New Delhi, 2008.
12. *Computer Fundamentals*: Pradeep K. Sinha, Preeti Sinha, BPB Publications, New Delhi, 2007.
13. *Field Book for Describing and Sampling Soils, Version 2.0*, National Soil Survey Center, USDA, Nebraska

II SEMESTER. Sc ENVIRONMENTAL SCIENCE

ENV 201: ENVIRONMENTAL TOXICOLOGY (CORE)

4 Credits, 4 hrs/Week, 52 hrs/semester

Unit 1: Introduction to toxicology, scope, goals and branches of toxicology; Toxicants and Toxicity-influencing factors, drug toxicity, biochemical basis of toxicity – mechanism of toxicity and receptor mediated events, acute and chronic toxicity. Selective toxicity. Concentration and dose, Toxicity of chemical mixtures – synergism and antagonism. **10hrs**

Unit 2: Dose – Response relationships – Graded response, quantal response, Time action curves. Statistical concept of toxicity. Threshold Limit Value (TLV); LC50; Margin of safety; Toxicity curves; Cumulative toxicity and LD50 & CTF. Toxicity testing; Toxicity curves. Bioassay – Definition, purpose, criteria for selection of test organism, methodology, estimation of LC50, Limitation and importance of Bioassay, Acute Toxicity (single); Subacute Toxicity. **10hrs**

Unit 3: Heavy metals toxicology: Bio-chemical cycles of toxic metals, Metabolism, toxicity monitoring and exposure standards for heavy metals such as Cadmium, Lead, Nickel, Mercury, Arsenic in humans - Chronic Toxicity; Teratogenicity, carcinogenicity and mutagenicity. Immunotoxicity, histotoxicity, cell toxicity, neurotoxicity, nanotoxicity; Biomonitoring of Toxic Chemicals - Objectives, programs & parameters, concepts of bioindicators - groups with examples **10hrs**

Unit 4: Toxicants as Public health hazards; Toxicology of major pesticides - Environmental impact of pesticides - Persistence, Bioaccumulation and Bio-magnification in food chain. Food additives – types, functions and related health hazards; Radiation hazards and pollution related diseases; Environmental forensics; Chemical and safety evaluation. **10hrs**

Unit 5: Bio-transformation of Xenobiotics (Selective Toxicity); Principles, Receptor sites, absorption and storage of xenobiotics; types of Bio transformations; microsomal oxidations, mixed function oxygenases, conjugation, biotransformation of organo-chlorine and organo-phosphorous pesticides, Absorption, translocation and excretion of xenobiotics. Antidotal procedures in Toxicology. Biomonitoring of toxic chemicals and parameters, Concept of bioindicators and Environmental monitoring. **12hrs**

Reference Books:

1. Jerome O. Niragu and Lakshminarayana J. S. S. (1989). Aquatic Toxicology and Water Quality Management, John Wiley & Sons. 23
2. Sharma P. D. (1994). Environmental Biology and Toxicology, Rastogi and Company.

3. Meera Asthana and Asthana D.K. (1990). Environmental Pollution and Toxicology, A
lka Printers.
4. Mettelev V.V, Kanaev A.I and Dzasokhova N.G. (1971). Water Toxicology, Amerin
d Publishing Co. Pvt. Ltd.
5. Standard Methods for the Examination of water and Wastewater, 17th Ed., (1989). A
PHA-AWWA-WPCF.
6. Guithinier Perry. (1980). Introduction to Environmental Toxicology, Elsevier.
7. Waldron H.A. (1980). Metals in Environment. Academic Press, Toronto.
8. Butter G.C. (1988). Principles of Ecotoxicology. John Wiley and Sons.
9. Moriarty F. (1983). Ecotoxicology. Academic Press, New York.
10. Oehme W.F. (1989). Toxicity of Heavy Metals in Environment Marcel Dakkar Inc., Ne
w York.

I I SEMESTER M.Sc ENVIRONMENTAL SCIENCE

ENV202-Environmental Engineering (CORE) 4

Credits, 4hrs/Week, 52hrs/semester

Unit 1: Environmental Engineering: Introduction and Scope of Environmental Engineering, Water and Wastewater standards for specific applications. Water Demand: Manmade and environmental factors, Population forecasting methods, design period, Quality of water supply. Water distribution systems: pipe networks, Methods, Design, analysis and optimization – appurtenances – corrosion prevention – minimization of water losses – leak detection Storage reservoirs. Water transmission and distribution: Need for Transport of water and Wastewater-Planning of Water System – Selection of pipe materials. Water transmission main design- gravity and pumping main; Selection of Pumps- characteristics- economics; Specials, Jointing, laying and maintenance. **10hrs**

Unit 2: Water Treatment Methods: Preliminary, Primary, Secondary and Tertiary. Theory, Mechanism and Significance of Aeration, Coagulation, Flocculation, Sedimentation, Filtration and Disinfection. Chlorination- forms and methods of chlorination; Ozonation; Water softening; Hardness treatment- Desalination, Membrane Techniques Removal of Taste and Odour; Miscellaneous Treatment Methods, (Lime, Soda Process, Zeolite Process, Demineralization Process) and their Chemical reactions; Occurrence of Fluoride in water- Chemical Treatment of Defluoridation and Mechanism, significance and methods of removal; Role of Ozone and UV as Disinfectant. **10hrs**

Unit 3: Wastewater Sources: Domestic and Industrial wastes, Measurement of wastewater, frictional head loss in free and pressure flow, minor head losses, Carrying Capacity – Flow measurement. Storm water drainage: Necessity- combined and separate system; Estimation of storm water runoff; Formulation of rainfall intensity, duration and frequency relationships- Rational methods. Wastewater Collection systems; sewerage and drainage system, Principle of design for a sewerage system. Storm water and sewage characteristics and quantities estimation method. **10hrs**

Unit 4: Objective of wastewater treatment, Principles of wastewater treatment, Unit Operation and Unit Processes, Different wastewater treatment flow sheets, Physico-chemical and Bacteriological Parameters and their role in waste water treatment. Physico-chemical and Biological characteristics of sewage, Sewage management; Disposal on land, sewage sickness; disposal by dilution method, self-purification and natural treatment of streams – Deoxygenation and Reoxygenation process, variation of DO, BOD and COD and their importance. **10hrs**

Unit 5: Wastewater treatment methods: Principles of Physical Treatment; Screening, Mixing, Equalization, Sedimentation, Filtration. Primary, Secondary and Tertiary

levels. Principle of Chemical Treatment- Unit Operations involved in Chemical Treatment. Methods of Treatment, Chemical Coagulation, Flocculation, Sedimentation, Clarifiers, Efficiency of Chemical Precipitation, Disinfection of treated sewage, Septic tank design and effluent disposal methods; Design Aspects- Design of biological treatment units. Oxidation ponds, Lagoons; Sludge characteristics- treatment, conventional and high rate digesters, sludge thickening, sludge digestion, sludge dewatering- mechanical and gravity, disposal of sludge, gas utilization.

12hrs

Reference Books

1. Qasim, S.R., Motley, E.M. and Zhu, G. Waterworks Engineering – Planning, Design and Operation, Prentice Hall, New Delhi, 2002.
2. Lee, C.C. and Shundar Lin, Handbook of Environmental Engineering Calculations, McGraw Hill, New York, 1999.
3. Hendricks, D. 'Water Treatment Unit Processes – Physical and Chemical' CRC Press, New York 2006
4. Arceivala, S.J., Wastewater Treatment for Pollution Control, TMH, New Delhi, Second Edition, 2000.
5. Manual on Sewerage and Sewage Treatment CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 1999.
6. Metcalf and Eddy, INC, 'Wastewater Engineering – Treatment and Reuse, Fourth Edition, Tata Mc Graw-Hill Publishing Company Limited, New Delhi, 2003.
7. Qasim, S.R. Wastewater Treatment Plant, Planning, Design & Operation, Technomic Publications, New York, 1994.
8. Bajwa, G.S. Practical Handbook on Public Health Engineering, Deep Publishers, Simla, 2003.
9. Manual on water supply and Treatment, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 1999.

IISEMESTER.M.ScENVIRONMENTALSCIENCE

ENV203:ENVIRONMENTALMICROBIOLOGY(CORE)

4Credits,4hrs/Week,52hrs/semester

Unit1:Introduction,conceptsandscopeofenvironmentalmicroorganismsascomponents of ecosystem, classification and characteristics of microorganisms; Role of microorganism in Biogeochemical cycles - nitrogen, sulphur, and phosphorous. Detrimental effects of diverted biogeochemical cycles. Biological nitrogen fixation: asymbiotic, symbiotic and associative nitrogen fixation structure, function and genetic regulation of nitrogenase. **08hrs**

Unit 2: Microbial diversity of environment- Microbes in air, water, waste water and soil; biological pollution of water. Microbial interactions and associations - inhibition, parasitism, symbiosis, etc.; plant-microbe's interaction - mycorrhizae, plant growth promoting rhizobacteria. Introduction, distribution, sampling and measurement techniques and identification. Microbes of extreme environment. Mechanisms of adaptation by microorganisms to environmental extremes. **10hrs**

Unit 3: Study of air-borne allergens and air-borne diseases. Microbiological aspects in drinking water and their distribution. Indicator microorganisms and their quantification - MPN and MF technique. Bio-fouling- definition, sources and causes - bio-film and Bio-corrosion. Major antibiotic resistant bacteria in drinking water and their implications. **10hrs**

Unit4:Microbes in the degradation of wastes. Bioremediation- Its role in Environmental management advantages and disadvantages. Control of pests and diseases by microorganisms, Treatment of solid and liquid industrial wastes, role of microorganism in biodeterioration of wood and metals, mechanism and its control. Microbial degradation of pesticides. Microbes in metal extraction, mineral leaching and mining, microbes in petroleum product formation. Ecological implication of genetically modified microorganisms and Environment. Nano-technology and its applications. Biosensors and its applications. **12hrs**

Unit 5: Food and Medical Microbiology - Introduction to Fermentation Technology; Microbial production of amino acids, glutamic acid, lysine: industrial alcohol, beer and wine, vitamin B12, B2; Types of microorganisms in vegetables, meat, poultry, seafood and dairy products. Spoilage of food - factors influencing spoilage - methods of detection - physical, chemical and bioassay methods. Food poisoning - types of food poisoning prevention and control, indicators of health. Human viral infections: nature and the source of interferons, classification, Induction of interferon, anti-viral agents (chemical and biological) their mode of actions, Nosocomial infections - Microbial contamination in hospital environment, salient features and control strategies. **12hrs**

Reference Books:

1. Ramesh Vijaya K. (2005). Environmental Microbiology. MG Publishers, Chennai.
2. Edward Alcamo I. (2001). Fundamentals of Microbiology VIth Edition., Jones and Bartlett Publishers, INC.
3. Pepper W. (1995). Environmental Microbiology. A.P. Publishers.
4. William C. Frazier and Dennis C. Westhoff. (1995). Food Microbiology IVth Edition, Tata McGraw-Hill Publishing Company limited, New Delhi.
5. Michael J. Pelczar. (1986). Microbiology 5th (Ed), McGraw-Hill Book Co.
6. Michael J. Pelczar. (1994). Microbiology- Concepts and applications, McGraw-Hill Inc.
7. Martin Alexander. (1983). Introduction to Soil Microbiology 2nd Ed., Wiley Eastern Ltd.
8. Powar C. and Daginwala H. F. (1985). General Microbiology, Vol. I & II, 2nd Ed., Himalaya Publishing House.
9. Bhattacharya R. N. (1993). Experiments with microorganisms, Reprint, Emkay Publications, New Delhi.
10. Pepper W. (1995). Environmental Microbiology. A.P. Publishers.

II SEMESTER M.Sc ENVIRONMENTAL SCIENCE

ENV204: ENVIRONMENTAL POLLUTION MONITORING AND CONTROL (CORE)

4 Credits, 4hrs/Week, 52hrs/semester

Unit 1: Air pollution: Definition, Sources and Classification of air pollutants. Transport and diffusion of pollutants. Gas laws governing the behavior of pollutants in the atmosphere. Meteorological parameters, scale of meteorology, Effect of temperature, precipitation, humidity, pressure, radiation and wind. Heat transferring processes, atmospheric stability, inversions and mixing heights, Plume behavior and Stack dispersion theories & models of monitoring & control of exhaust emissions.

10hrs

Unit 2: Automobile pollution in Indian cities: Monitoring and control of exhaust emissions. Effects of air pollution on human, animal, plants, inanimate objects and climate. Source types and control of indoor air pollutants sick building syndrome and building related illness, Categorization of industries based on pollution. Air Pollutant Concentrations Inventory; Comparison with Air Quality Standards Ambient air quality standards and air pollution indices. **Noise Pollution:** Definition, Sources and Terminology; types of noise; Measurement of noise; Noise indices; Effect of meteorological parameter on noise propagation. Noise exposure level and Standard Impact on biota and inanimate objects. Noise control and abatement measures.

14hrs

Unit 3: Aquatic Pollution: Definition; Sources and classification of aquatic pollutants. Point and Non point sources of pollution, Causes and consequences of pollution on surface, subsurface (groundwater) and marine water sources. Coastal water intrusion. Oil leakage and industrial effluents. Water pollution control criteria, Thermal pollution: Sources, causes and effects. Preventive and control measures. Water quality indices.

10hrs

Unit 4: Soil Pollution: Definition, sources and classification of soil pollutants and their impacts on physico-chemical and biological properties of soil, plants, animals and man. Industrial waste effluents and heavy metals, their interactions with soil components, Soil microorganisms and their function, degradation of insecticides, fungicides and weedicides in soil. Interaction of fertilizer (NPK) with different components of soil. Soil pollution control Measures.

10hrs

Unit 5: Radioactive Pollution: Definition, Radioactivity, Radionuclide, Radiation emissions, sources, Radioactive decay and buildup. Biological effects of radiation. Radiation exposure Standards. Radioactive pollution impacts on ecosystem. Pollution control measures. Biological dosimetry.

08hrs

Reference Books:

1. Nandini N, Sunitha Nand Sucharita Tandon. (2007). Environmental Studies, Sapna Book House, Bangalore
2. Stern A.C. (1986). Air Pollution Vol. I-VIII, Academic Press. Henry C. Perkins. (1974). Air Pollution, McGraw Hill.
3. William L. Donn. (1975). Meteorology 4th Ed., McGraw Hill.
4. Furry R, Baddel. Rand Haurker L. (1985). Air Pollution and Lichens.
5. Mansfiels M.R. (1989). Effects of air pollutants on plants.
6. Lodge. (1994). Methods of air sampling and analysis.
7. Trivedy R. Kand Goel P.K. (1995). An Introduction to air Pollution, Techno Science Publications Jaipur.
8. Science Publications Jaipur.
9. Kudesia V.P. (1993). Air Pollution, Pragati Prakashan, New Delhi.
10. Mishra P.C. (1989). Soil Pollution and Soil Organisms.
11. Goel P.K. (1997) Water Pollution - Causes, Effects & Control. Techno Science Pub., Jaipur.
12. Pratap Mowle Pand Venkatasubbayya N. (1990). Air pollution and Control. Divyajyothi Prakashan, Jodhpur.

II SEMESTER M.Sc ENVIRONMENTAL SCIENCE

ENV205: OCCUPATIONAL HEALTH HAZARDS (SOFT CORE)

2 Credit, 3 hrs/Week, 39 hrs/semester

Unit 1: Occupational Environment: Occupational hazards - Physical, mechanical, chemical, Electrical, Biological, radiation and, their Permissible exposure limits. Occupational diseases - Pneumoconiosis, silicosis, Anthracosis, Byssinosis, Bagassosis, Farmers lung, Lead poisoning, Occupational cancer and Occupational Dermatitis. **08hrs**

Unit 2: Occupational hazards of agricultural and industrial workers: Human factors contributing to accidents - causes for unsafe acts. somatic diseases, accidents, toxic hazards, physical hazards, respiratory diseases, sickness, absenteeism. Measures for health protection of workers - personal protective equipment's, medical measures, engineering measures; prevention of occupational diseases. Human health problems due to pollution, public health programs. **12hrs**

Unit 3: Occupational health hazards: Evaluation and control of occupational health hazards, occupational health surveillance, Storage & handling of compressed gases - Acetylene, LPG and Hydrogen. Epidemiology and Public health - Principles of Epidemiology, Epidemiology and control of diseases caused by import and microbe in water, air, milk and soil. Status of communicable diseases in India. Administration of public health in India. **10hrs**

Unit 4: Public health Legislation - The Factories Act, 1948. Industrial safety standards and regulations. Accidents - definitions - prevention and control. Safety management system - concepts of safety management systems as per EMS **ISO 18000 and ISO 22000 series**. OSHA, NIOH, WHO - Law & Regulations. Public Liability Insurance Act, Mining Act. **09hrs**

Reference Books:

1. Benjamin O. Fundamental principles of occupational health and safety.
2. Louis J. Diberardinis. All Handbook of Occupational Safety and Health.
3. Keith Smith and David N. Petley. Environmental Hazards: Assessing Risk and Reducing Disaster.
4. Peter H. Wald, Gregg M. Stave Prqctor and Hughes. Physical and

Biological Hazards of the workplace.

5. Gloria J. Hathaway, Nick H. Proctor, James P. Hughes. Chemical Hazards of the Workplace.
6. G.K. Kulakarni. Implementation of occupational health legislation at workplace, issues and concerns.

III SEMESTER.Sc.ENVIRONMENTALSCIENCE

ENV301:SOLIDANDHAZARDOUSWASTEMANAGEMENT(CORE)

4Credits,4hrs/Week,52hrs/semester

Unit 1: Solid Waste: Introduction, Classification - Source based and Type based; Evolution of SWM and influencing Factors - Municipal Solid waste (MandH) rules, 2000, SW rules 2016; Waste stream Assessment: Rationale for analysis, Waste Generation, Composition and Characteristics (Physical, Chemical and Biological Characterization); Health and Environmental Effects. Significance of Solid waste management System, Environmentally Sound Solid Waste Management (ESSWM) and Environmentally Sound Technologies (EST). **10 hours**

Unit 2: Solid Waste Generation and Collection Rates: Collection, Handling, transfer station and Implementation methods - Storage: Containers, storage bins; Transportation: collection operations, movement of Collection Crew, Collection Vehicle routing; Transfer Station: Type, Capacity and Viability, Waste collection System Design, Control Inventory, Monitoring and record maintenance. **08 hours**

Unit 3: Waste Disposal: Disposal Options and Selection Criteria - Sanitary Landfill: Principle and process; Landfill Gas Emission - Composition, Properties, Hazards, Migration and Control; Leachate Formation - Composition, Leachate migration, control and Treatment; Environmental Effects of Landfill; Landfill Operation Issues; Waste Processing Techniques: Purpose of Processing, Volume reduction and compaction, Size reduction and Shredding, Component Separation - Air separation, Magnetic Separation, Screening, Other Separation Techniques, Drying and Dewatering. Remedial Actions at Inactive Waste Disposal Sites. **10 hours**

Unit 4: Source Reduction: Raw materials, product recovery and recycling; Basics, Purpose, Implementation, Monitoring, Evaluation, Significance of Recycling, Planning of Recycling Programme its elements including - Source Separation, Drop-off and buy-back, Curbside programme, Storage and Collection of recyclables, Collection vehicle for recycling, Material recovery facilities, Full stream processing; Commonly Recycled Materials and Processes; Compost and Biogas: Composting - Benefits, Processes, Stages, Technologies; Biogasification - Anaerobic Processing, Types of Digester; Composting and Bio gasification - Environmental Effects. Waste to energy recovery. **12 hours**

Unit 5: Hazardous Waste Management: Identification and Classification, Generation, Storage and Collection, Transfer and transport, processing, Disposal; Hazardous Waste treatment: Physical, Chemical, Thermal and Biological treatment; Pollution prevention and Waste Minimisation, Hazardous Waste Management in India, Rules and Policies; Product Safety Management System (PSMS). Safety, Handling, storage and management of Hazardous Materials; Integrated Waste Management: Characteristics, Planning, Implementation, Benefits of IWM for Developing

economics; Waste Management Model; Life Cycle Assessment (Benefits, stages), Public Education and Involvement. Meeting Federal and State Mandated Diversion Goals, Legislative Trends and Impacts; Biomedical waste and E-wastes management

- Biomedical waste (Management & Handling) rules, 2016 and 2020; Hazardous Wastes (Management and Handling) Rules, 2016; E-waste (Management & Handling) Rules, 2016. Battery waste management rules, 2020. **12 hours**

Reference Books:

1. Integrated Solid Waste Management - Engineering principles and Management Issues: George Tchobanoglous, Hilary Theisen, Samuel A. Vigil. (2014)
2. Tchobanoglous, H., Theisen H., and Samuel A. Vigil, 1993. *Integrated Solid Waste Management*, McGraw-Hill, Inc., New Delhi
3. Hazardous Waste Management: Michael D. LaGrega, Phillip L. Buckingham, Jeffrey C. Evans and Environmental Resource Management.
4. Ali, M., Cotton, A., and Westlake, K. 1999. *Solid Waste Disposal for Low-Income Countries*. Loughborough University, London.
5. Flintoff, R. 1984. *Management of Solid Wastes in Developing countries*, WHO Regional Publications, Southeast Asia Series 1
6. Ramachandra T. V. and Saira Varghese K. 2004. Environmentally sound options for e-wastes management, ENVIS Journal of Human Settlements (ISSN 0971-9091), March 2004
7. US Environmental Protection Agency. 1989. *The Solid Waste Dilemma: An Agenda for Action*, Washington.
8. Aradhana Salpekar. Solid waste pollution, Jnanada Prakashan, New Delhi.
9. Lie D. H. and Liptak B. G. (2000). *Hazardous Wastes and Solid Wastes*- Lewis publishers, New York.
10. Solid Waste management in Developing countries - Indian National Scientific.
11. Miliary Theiren and Samuel A. Solid waste management - George Tchobanoglous -
12. WHO Manual on solid waste management.
13. CPHEEO Manual on solid waste management.
14. LaGrega M. D., Buckingham P. L. and Evans. Hazardous Waste Management, IIEd,
15. Baker K. M. and Herson, B. S. (1994). *Bioremediation* Mc. Grqw-Hill Inc.
16. Eweis, J. B., Ergas S. J., Change D. P. Y. and Schroeder E. D. *Bioremediation - Principles*, Mc. Grqw Hill Inc.
17. Charles A. Wentz. (1996). *Hazardous waste Management*. McGraw-Hill International Edition.

18. Tandon.(1995).Recyclingofcrop,AbnimalandHumanwasteinAgriculture.Mc-GrawHillPublishingCo.
19. ArneVesilind,WilliamWorrelandReinhartDebra,2002.SolidwasteEngineering, ThomsonBrooks/Cole,Singapore
20. Areivala,S.J. 1971. *SolidWastesDisposalinIndia*, Central/Public Health EngineeringInstitute.Nagpur

III SEMESTER M.Sc. ENVIRONMENTAL SCIENCE

ENV302: NATURAL RESOURCE MANAGEMENT (CORE)

4 Credits, 4 hrs/Week, 52 hrs/semester

Unit 1: Natural Resources: Definition, Classification, concepts and distribution of natural resource in India and global level. Importance and applications of natural resources. Conservation and Management- Definition, Broad Classification - Renewable and Non-Renewable resources. Ecological, economic and social dimensions of resource management. Renewable: Solar Energy, Wind Energy, Geothermal Energy, Tidal Energy, Ocean Energy, Wave energy and Magneto-hydrodynamic Power (MHD), Impact on Environment and their applications, Non Renewable: Thermal Power, Hydro Energy, Atomic Energy, Nuclear Energy (Fission and Fusion) and Fossil fuels (Coal, Petroleum and natural Gas). Global Energy Production and Consumption. Energy use pattern in India and its impact on environment.

12 hrs

Unit 2: Power generation from waste, residue, plantations: Biogas plants - principles of generation and designs. Biofuels: Ethanol, Biodiesel. Dendrothermal energy. Hydrogen. Gasification. Pyrolysis. Conservation of Energy - Importance, Methods of Conservation, Barrier to Energy Conservation, Measures for promoting energy conservation - Global and National scenario.

10 hrs

Unit 3: Mineral Resource management: resources, reserves and classification. Metals and Non-Metals, Formation of Mineral Deposits, consequences of over-exploitation. Conservation and management of mineral resources in India. Oceans as new areas for exploration of mineral resources. Oceans ore and recycling of resources.

08 hrs

Unit 4: Water Resources Management - Concept and classification. Water resources scenario in India and Karnataka. Integrated water resource management; Participatory watershed development; National Lake and River Conservation Programmes. Wetland management. Coastal zone management - concept, scope, issues and strategies. Implications of National River linking programme on environment. Water Conservation Strategies in India - Rain Water Harvesting.

10 hrs

Unit 5: Land and Forest Resources: Agricultural Practices in India. Exploitation of Agricultural Land. Range Land Management. Wasteland development concept, scope, issues and strategies. Forest resource Management: Importance of Forestry, forest products, Forest based medicinal

& Pharmaceutical Industries. Forest management practices and programmes – scenario in India. Protected forest area management – Eco-development committees and Eco-tourism. Gene pool management. Forest Fire and its Control. Wild life habitat management- In-situ and Ex-situ conservation of Biodiversity in India. Conservation of key wildlife species – project tiger, project elephant, crocodile project, sea turtle project. Role of NGOs in wildlife and forest conservation. **12hrs**

Reference Books:

1. V.P. Agrawal. (1968). Forests in India: Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.
2. Sitaram Rao. Introduction to Social Forestry, Oxford and IBH Pub. Co. Pvt. Ltd.
3. Anand S. Bal. (2005). An Introduction to Environmental Management, Himalaya Publishing House.
4. Prabhakar V. K. Energy Resources and Environment, Anmol Publisher
5. Biomass Energy and Environment: H. R. Ravindranath, Oxford University Press, New York. 1995.
6. Rai G. D. Non-Conventional Energy Sources, Khanna Publication, New Delhi.
7. Kothari D. Band Singal K. C. (2011). Renewable Energy Sources and Emerging Technologies: PHI Learning Pvt. Ltd. New Delhi.
8. Satyanaraya, Sitre S. R., Zade S. B., Meshram P. U. A Textbook of Environmental Studies: Allied Publisher.
9. Oliver S. Owen. (1980). Natural resources conservation – An Ecological approach, 3rd edition, Macmillan publishing Co. Inc. New York.
10. Daniel D. Chiras. (1994). Environmental Science. 4th edition.
11. Sapru R. K. (1987). Environment Management in India. Vol. I & II. Ashish Pub. House.
12. The state of India's Environment, The second citizen's report (1984-85). Center for science and environment. New Delhi.
13. Agarwal and Rana S. V. S. (1985). Environment & Natural resources, society of Biosciences.
14. Sharma V. K. (1985). Water resources planning and management, Himalaya Pub. House.
15. Maheshwar Dayal. (1992). Renewable energy. Konark publishers Pvt. Ltd.
16. Shrikander P. and Varade S. R. (1991). Ecology of water and land management vol 1 & 2, Chugh publishers.
17. Kittredge J. (1978). Forest influences. Dover publishers Inc. New York.

18. Srivastava M.B. (1977). Introduction to forestry. Vikas publishers, New Delhi.
20. Agarwal V.G. (1985). Forests in India. Oxford and IBH, New Delhi.
21. Negi S.S. (1986). Handbook of social forestry. IBH, New Delhi.
22. Singh B. (1992). Social forestry for rural development. Anmol publication, New Delhi.
19. Wenger K.E. (1984). Forestry Handbook. John Wiley and Sons. New York.
20. Berthkur S. and Ghosh A.K. (1987). Biological pest control. In: I.J. Simons, I.J. eds. 1986. The ecology of natural resources.
21. Shafi R. (1992). Forest ecosystem of the World.
22. Nalini K.S. (1993). Environmental resources and management. Anmol publishers.
23. Aradhana P.S. (1991). Environmental management. Rajat publishers.
24. Singh G. (1996). Manual of soil and water conservation practices.
25. Coppel H.C. and Mertins J.W. (1997). Biological insect pest suppression. Springer-Verlag, Heidelberg, New York.
26. Haue R and Freed V.H. (1975). Environmental dynamics of pesticides. Menumpress, London.
27. Raymond F. Dasmann. (1984). Environmental conservation, 5th eds. John Wiley & Sons.
28. Shrikande R.P and Varade S.R. (1991). Ecology of water and land management vol 1 & 11, Chugh publishers.
29. Newson M.M. (1993). Managing the human impact on the natural environment: patterns and processes. International book distributor, Dehradun.
30. Rajagopalan R. (2005). Environmental Studies, Oxford University Press, New Delhi.

III SEMESTER M.Sc. ENVIRONMENTAL SCIENCE

ENV303: REMOTE SENSING AND GIS APPLICATION (CORE)

4 Credits, 4 hrs/Week, 52 hrs/semester

Unit 1: Introduction to remote sensing: Definition, basic concepts and history; characteristics of Electromagnetic Radiation – Interactions between matter and electro-magnetic radiation - Interaction of EMR with atmosphere, earth's surface and ground objects, spectral reflectance curves; Fundamentals of aerial photography – concepts and principles, types of aerial photographs and aerial cameras, ground coverage, interpretation and applications. Remote sensing satellites – types and their characteristics – Low earth orbit, sun-synchronous, geosynchronous and geostationary satellites; earth resources, meteorological, navigation and communication, etc.; GPS – Principles, orbital geometry, measurements and accuracy; Indian Space programmes. **10hrs**

Unit 2: Sensors and Scanners-

Types of remote sensing sensors (with respect to wavelength regions) - Active and Passive; Imaging and non-imaging sensors; sensor characteristics - whisk broom and push broom scanning; Basic concepts, principles and interpretation of optical, thermal, microwave - SAR, SLAR, RADAR, LiDAR and hyperspectral sensing; Concept of sensor resolutions - spectral, spatial, radiometric and temporal - panchromatic, multispectral and hyperspectral data; stereo images; Platforms - evolution, types and their characteristics - ground based, airborne and space-borne.

10hrs

Unit 3: Digital image processing: Principles and types; Techniques of visual interpretation and interpretation keys; Pre-processing of image - Image registration, image rectification and restoration - line dropouts, line stripping, noise, data errors and geometric distortions; image enhancement - resolution merging, band rationing, edge enhancement, spatial filtering, contrast stretching, scale effects; Classification and Information extraction - supervised and unsupervised classification; classifiers and data mining classification methods

- minimum distance to mean, parallelepiped, maximum likelihood; Image transformation; Post classification smoothing and classification accuracy enhancement - error matrix and kappa coefficient. **10hrs**

Unit 4: GIS - Definitions, History, development and components; GIS data: spatial and non-spatial data - sources and quality; linking of spatial and non-spatial data - geo-referencing and Map scale; Data processing - Spatial and attributed data acquisition; verification, storage, RDBMS concepts, database operations and formats, data stream, output. Spatial and non-

spatial data editing functions: Retrieval, classification, measurement, neighbourhood, topographic, interpolation, overlay, buffering, spatial join and query, connectivity, network functions. spatial data model - raster, vector, hierarchical, network, relational and object-oriented data models, Topology

and topological models - TIN and DEM; Current issues and future GIS – WebGIS, 3D-GIS. **12hrs**

Unit5: Application of Remote Sensing, GPS and GIS for Environmental Planning and Management: land use/land cover mapping, land transformation studies, Urban and rural planning and management. Vegetation - Agriculture and forest management. Water resource management - Surface water, groundwater, watershed, marine resources, Coastal zones, glacio-geomorphic features. Wildlife management. Mineral resource management - mining and Quarrying; Disaster management - earthquake, flood, fire, landslides, drought; monitoring and mapping; GPS applications - navigation, tracking, mapping and timing. **10hrs**

Reference Books:

1. Anji Reddy M. (2000). Remote Sensing and Geographical Information Systems: An Introduction. Book Syndicate.
2. Robert G. Reeves (Ed). (1983), Manual of Remote Sensing, John Wiley and Sons, New York.
3. Morris M. Thomson (Ed). (1988). Manual of Photography. Tata McGraw-Hill Publishing Co.
4. Berry S. Siegal and Allen R. Gillispie. (1987). Remote Sensing in Geology, Tata McGraw-Hill Publishing Co.
5. Miller J. C. (1986). Photography, John Wiley and Sons, New York.
7. Smith J. T. (1991). Manual of colour Photography. John Wiley and Sons, New York.
8. Leuderr D. R. (1993). Aerial Photography interpretation - Principles and Applications, McGraw-Hill.
9. Lillesand and Kiefer. (1993). Principles of Remote Sensing
10. Nag P. and Kudrat M. (1998). Digital Remote Sensing. Concept Publishing Co., New Delhi.
11. Chouhan and Joshi K. N. (1996). Applied Remote Sensing and Photo interpretation.
12. Rajan M. S. (1991). Remote Sensing and GIS for Natural Resources.
13. Narayana L. R. A. (1999). Remote Sensing and its application University Press (India).
14. Lillesand T. M. (1987). Remote Sensing and Image interpretation. John Wiley, Hamburg.

15. Sabins F. F. and Floyd F. J. R. (1978). Remote Sensing- Principles and Interpretations.
16. Burrough P. A. and McDonnell R. A. (1988). Principles of Geographical Information System. Oxford Univ. Press.
17. Jorgensen S. E. (1996).
Applications of Ecological Modeling in Environmental Management. Elsevier Sci. Co., London.
18. Muralikrishna I. V. (2001). Spatial Information Technology- RS and GIS.
Vol. I and II BSP Publications, Hyderabad.
19. Burrough P. A. (1986). Principles of GIS for Land Resource Assessment. Oxford University Press.
20. Elachi C. (1978). Introduction to Physics and Techniques of Remote Sensing. John Wiley Publication New York.

III SEMESTER M.Sc ENVIRONMENTAL SCIENCE

ENV304: CLIMATE CHANGE AND CURRENT ISSUES (Open Elective)

4 credits, 4 hrs/week, 52 hrs/semester

Unit 1: Climate Change: Definition, scope and facts of climate change. Origin and evolution of the earth's atmosphere. Atmospheric structure and heating; Chemical composition. Overview of key concepts – weather and climate; Climatic classification – Koppen's-Geiger climatic classification; Climatic variability - temperature, rainfall, wind speed and direction. Effect of various anthropogenic activities on earth's atmosphere. **12hrs**

Unit 2: Global warming and greenhouse effect – Major greenhouse gases, sources and sinks of greenhouse gases; Urban Heat Islands effect; Ozone layer – Ground level ozone and air pollution; Stratospheric Ozone layer, Antarctic Ozone Hole, Mechanism of Ozone layer depletion and its consequences. Ozone layer recovery. Advances in research to protect the Stratospheric Ozone layer. Sea level rise and its impact; Global wind patterns - El-Niño, La Niño and their impacts. Global dimming. Implications of climate change on Environment. **14hrs**

Unit 3: Climate change and policy frameworks – History of international climate change policies. United Nations Framework Convention on Climate Change – Key provisions, structure and different party groups under the convention – Annex I, Annex II and Non-Annex I countries. Agenda 21, The Kyoto Protocol, Paris Agreement. Overview of Conference of Parties (CoP). Climate change negotiations evolved over the past years. Future relevant climate change regime. **12hrs**

Unit 4: Climate change adaptation and mitigation: Definition, scope, Objectives and linkage between climate change mitigation, adaptation and development. National and International mitigation and adaptation initiatives and programs. Overview of greenhouse gas emissions levels and mitigation targets per country. Integrated development planning through low-emission development strategies – Clean Development Mechanisms; Green Climate Fund, The Adaptation Fund. International mechanisms supported to assist countries in planning and implementing mitigation actions. United Nations Sustainable Development Goals and role of individual in achieving SDG's. **14hrs**

Reference Books:

1. Abhishek Tiwary and Jerem Colls, 2010. Air Pollution: Measurement, Modelling and Mitigation. III Edition, Routledge Publication.
2. Dey. A.K. 2005. Environmental Chemistry, V Ed., New Age International Publishers.
3. Donald Ahrens. C. 2008. Essentials of Meteorology: An Invitation to the

Atmosphere. Cengage Learning publication.

4. Frederick K. Lutgens, Edward J. Tarbuck. 1995. The atmosphere: an introduction to meteorology. Prentice Hall publication.
5. IPCC. 2006. Guidelines for National Greenhouse gas Inventories. Published by the Institute for Global Environmental Strategies (IGES), Hayama, Japan on behalf of the IPCC.
6. John E. Oliver, John J. Hidore. 2002. Climatology: An Atmospheric Science, Second Edition. Prentice Hall publication.
7. John T. Hardy. 2003. Climate Change: Causes, Effects and Solution. John Wiley & Sons publications.
8. Jonathan I. Lunine, Cynthia J. Lunin. 1999. Earth: Evolution of a Habitable World. Cambridge University Press. Great Britain.
9. Nicholas Stern. 2008. The Economics of Climate Change: The Stern Review. Cambridge University Press. Great Britain.
10. Pal Arya. S. 1998. Air Pollution Meteorology and Dispersion. Oxford University Press.
11. Agarwal K.M, Sikdar P.K. and Deb S.C. 2002. A text book of Environment – MacMiller India Ltd., Calcutta
12. Tyler Miller Jr. Living in the Environment – Principles, Connections and Solutions.
13. Botkin D.B. 1989. Changing the Global Environment, Academic Press, San Diego.
14. Howard J. Critchfield. (1983). General Climatology (Fourth Edition), Phi Learning Pvt Ltd.
15. Mark Maslin. 2013. Climate – a very short introduction, Oxford University Press.
16. Roger G. Barry and Richard J. Chorley. 2007. Atmosphere, weather and Climate, 8th Edition, Routledge Publishers.
17. Oliver. 2002. Climatology: An Atmospheric Science, 1st Edition, Pearson Publishers.
18. Mark Maslin. 2008. Global Warming, 2nd Edition, Oxford University Press Publishers – New Delhi.
19. Manoj Singh. 2012. Climatology: Sonali Publications Publisher.

III SEMESTER M.Sc. ENVIRONMENTAL SCIENCE

ENV304: NATURAL RESOURCES MANAGEMENT (Open Elective)

4 Credits, 4 hrs/Week, 52 hrs/semester

Unit 1: Natural Resources: Definition, classification and concepts. Distribution - Indian and global scenario. Importance, application, conservation and management of natural resources. Conventional and Non-Conventional sources of energy. Mineral Resources - Formation of mineral reserves and deposits, Consequences of over exploitation and conservation of mineral resources. Oceans as new areas for exploration of mineral resources. Oceans and recycling of resources. **12hrs**

Unit 2: Water Resources Management - Concept and classification. Distribution - Indian and global scenario. Integrated water resource management; Participatory watershed development; rainwater harvesting. National Lake and River Conservation Programmes. Wetland management. Coastal zone management - concept, scope, issues and strategies. Implications of National River linking programme on environment. Water Conservation strategies in India. **14hrs**

Unit 3: Land Resources Management: Agricultural Practices in India - Exploitation of Agricultural Land. Range Land Management - Wasteland development - concept, scope, issues and strategies. Minerals - Mining, Quarrying and their Impacts. Exploration of Oil and Natural Gas. Soil Fertility and Soil Degradation. Types of Soil Erosion, Detrimental Effects, Control Measures, Soil Conservation Practices. **12hrs**

Unit 4: Biodiversity: Biodiversity hot spots of world & India. Strategies for Biodiversity conservation. CBD and Agenda 21. Forest resource Management: Afforestation and Joint Forest Management - Social Forestry, Agro-Forestry. Urban forestry. Eco-development committees and Eco-tourism. Wildlife habitat management project tiger, project elephant, crocodile project and sea turtle project. **14hrs**

Reference Books:

1. Forests in India: V.P. Agrawal, Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi. (1968).
2. Introduction to Social Forestry: Sitaram Rao, Oxford and IBH Pub. Co. Pvt. Ltd
3. An Introduction to Environmental Management: Dr. Anand S. Bal, Himalaya Publishing House (2005).
4. Energy Resources and Environment: V.K. Prabhakar, Anmol Publisher

5. Biomass Energy and Environment: H.R. Ravindranath, Oxford University Press, New York. 1995.
6. Renewable Energy Sources and Emerging Technologies: D.B. Kothari and K.C. Singal, PHI Learning Pvt. Ltd. New Delhi, 2011.
7. A Textbook of Environmental Studies: Dr. Satyanaraya, Dr. S.R. Sitre, Dr. S.B. Zade, Dr. P.U. Meshram, Allied Publisher.
8. Oliver S. Owen. 1980. Natural resources conservation – An Ecological approach, 3rd edition. Macmillan publishing Co. Inc. New York.
9. Daniel D. Chiras. 1994. Environmental Science. 4th edition
10. Sapru R.K. 1987. Environment Management in India. Vol. I & II. Ashish Pub. House.
11. The state of India's Environment, The second citizen's report (1984-85). Center for science and environment. New Delhi.
12. Agarwal & Rana S.V.S. 1985. Environment & Natural resources, society of Biosciences .
13. Sharma V.K. 1985. Water resources planning and management, Himalaya Pub. House.
14. Maheshwardayal 1992. Renewable energy. Konark publishers Pvt. Ltd.
15. Shrikande R.P. and Varade S.R. 1991. Ecology of water and land management vol 1 & 2, Chugh publishers.
16. Kittredge, J. 1978. Forest influences. Dover publishers Inc. New York.
17. Srivastava, M.B. 1977. Introduction to forestry. Vikas publishers, New Delhi.
18. Singh, B. 1992. Social forestry for rural development Anmol publication, New Delhi
19. Wenger, K.E. 1984. Forestry Handbook. John Wiley and sons. New York.
20. Berthkur, S. and Ghosh, A.K. 1987. Biological pest control. Simons, I.J. eds. 1986. The ecology of natural resources.
21. Shafi, R. 1992. Forest ecosystem of the world.
22. Nalini, K.S. 1993. Environmental resources and management. Anmol publishers.
23. Aradhana, P.S. 1991. Environmental management. Rajat publishers.
24. Singh, G. 1996. Manual of soil and water conservation practices.
25. Coppel, H.C. and Mertins, J.W. 1997. Biological insect pest suppression. Springer – Verlag, Heidelberg, New York.
26. Haue, R. & Freed, V.H. 1975. Environmental dynamics of pesticides. Menumpress, London.

27. Raymond F. Dasmann. 1984. Environmental conservation, 5th ed. John Wiley & Sons.
28. Shrikant R. Pand Varade S. R. 1991. Ecology of water and land management vol 1 & 2, Chugh publishers.
29. Newson, M. M. 1993. Managing the human impact on the natural environment: patterns and processes. International book distributor, Dehradun.
30. R. Rajagopalan. (2005). Environmental Studies, Oxford University Press, New Delhi.

IV SEMESTER M.Sc ENVIRONMENTAL SCIENCE

ENV401: ENVIRONMENTAL ECONOMICS AND SUSTAINABLE DEVELOPMENT (CORE)

4 credits, 4 hrs/week, 52 hrs/semester

Unit 1: Environmental Economics: Definition, Relation between Economics and environment, environmental quality, resource taxonomy – resource scarcity, problem of social costs, economics of exhaustible resources.
08 hrs

Unit 2: Economics Valuation, concept of economic value – objectives, standard based valuation, indirect and direct method of valuation, cost-benefit analysis. Negative international externalities and global concerns. Methods of site selection and evaluation.
10 hrs

Unit 3: Sustainable Development: Scope & definition, goals, principles of sustainability. Population stabilization, integrated land use planning, development of non-polluting renewable energy systems. Ecologically compatible human settlement and slum improvement, environmental education and awareness. REDD+.
12 hrs

Unit 4: Planning: definition and concept, land use policy for India. Urban and rural planning for India. Land use and land cover planning. Environmental priorities in India. Sustainable development in theory and practice: sustainable urban and industrial development. Consumerism and lifestyle.
10 hrs

Unit 5: Sustainability in agriculture: crop rotations, organic farming. Environmental degradation due to pesticides and chemical fertilizers. Environmental movements and role of NGO's in sustainability. Global policy for sustainable development – world summits. Urbanization and its impact on Environment.
10 hrs

Reference Books:

1. Berck Peter and Helfand Gloria. (2011). The Economics of The Environment. Prentice-Hall Publishers.
2. Jhingan M.L. (2009). Environmental Economics - Theory, Management & Policy, 2nd Edition. Vrinda Publications Pvt. Delhi Publishers.
3. Anne Bayley and Tracey Strange. (2010). Sustainable Development: Linking Economy, Society, Environment, Academic Foundation Publishers.

4. SundarI. (2006).Environment and SustainableDevelopment, 1stEdition,APHPublishingCorporationsPublishers.
6. Bhattacharya Rabindranath (Ed). (2002). Environmental Economics: AnIndianPerspective,1stEdition,OxfordUniversityPressPublishers.
7. Karpagam.(1986).EnvironmentalEconomics.
8. AnilShishodia.(2007).EnvironmentalEconomics:TheoryandApplications,SagePublicationsIndiaPvt.Ltd.Publishers.
9. MaruthiS.(1998).Economicgrowthandenvironment.RSBApublishers.
10. DavidC.(1988).EnvironmentalEconomics.EarthScan,UK.
11. Eco-Efficiency:TheBusinesslinktoSustainableDevelopmentbyLivioDesimone.PlanningSustainabilitybyMichaelKenny.
12. EnvironmentallySustainableEconomicDevelopmentbyAsayehgnDesta.
13. Sakarama Somayaji. (2011). Environmental Concerns and SustainableDevelopment:SomeperspectivesfromIndia.TERIPress.

III SEMESTER. Sc ENVIRONMENTAL SCIENCE

ENV402: ENVIRONMENTAL IMPACT ASSESSMENT AND ENVIRONMENTAL LAW (CORE)

4 credits, 4 hrs/week, 52 hrs/semester

Unit 1: Environmental Impact Assessment: Definition, Basic Concepts and Principles of EIA, Scope and Elements of EIA, Nature of Impacts- Primary, Secondary, Tertiary, Short Term, Long Term, Reversible and Irreversible Impacts. Overview of Impacts - Direct and Indirect; Measurable Impacts of Air, Noise, Water, Land, Biological and Socio-Economic Elements. **10hrs**

Unit 2: EIA Procedure: Salient features of EIA guidelines of India by MOEF & CC – 1994, 2006, 2021 (draft); Screening, Scoping and Methodologies of EIA - Checklist, Matrices, Overlays, Cost Benefit Analysis, Modelling; Strategies for Environmental Management Plan and Green Belt Development. Environmental Appraisal of Project with Reference to Industry, Mining and River Valley projects. Critical Issues and Formulation of Strategies for EMP and ESMP; Cumulative assessment and Carrying Capacity based EIA; Role of Statutory Agencies in Environmental Clearance. Strategic Environment Assessment. **12hrs**

Unit 3: Environmental Audit and EMS: Definition, Concept, Types and Benefits, Scope and Objectives; Procedural Requirements of Conducting EA, Pre-Audit, on-Site Audit and Post Audit Activities; Water Audit, Raw Materials Audit and Energy Audit, Health and Safety Audit- Reuse and Conservation of Water and Energy, Waste Minimization, Environmental and Economic Benefits of An Environmental Audit, ECO and Green Auditing and its Importance in Environmental Management. Concept of ISO 9000 and ISO 14000 series in Environmental System Management. Life cycle assessment. **10hrs**

Unit 4: Environmental protection: issues and problems. **International and national efforts** for environmental protection. Environmental Policies: Need for policies; different policies. Environmental policy resolution. Public policy- strategies in pollution control. **06hrs**

Unit 5: Environmental Legislation: Legal Control of Environmental Pollution with Reference to: The Indian Forest Act, 1927; The Indian Wildlife (Protection) Act, 1972; The Water (Prevention and control of pollution) Act, 1974, amended 1988; CESS Act 1977, amended in 1991; The Forest (Conservation) Act, 1980, amended in 1988; The Forest (Conservation) Act, 1980; The Forest (Conservation) Rules, 1981; The Air (Prevention and Control of Pollution) Act, 1981, amended in 1990; The Environment

(Protection) Act, 1986; The Wildlife (Protection) Rules, 1995; Biodiversity Act, 2002. Salient Features of Coastal Zone Regulations (CZR) Notification. Eco-sensitive zones
12hrs

Reference Books

1. Environmental Impact Assessment: Principles and Procedures, John Wiley and Sons, New York.
2. Environmental Impact Assessment: A.K. Shrivastav, APH Publishing Corporation, New Delhi.
3. Environmental Impact Assessment: S.A. Abbasi, D.S. Arya, Discovery Publishing House, New Delhi.
4. Environmental Pollution Control: Neelima Rajvidya and Dilip Kumar Markandey, APH Publishing Corporation, New Delhi. (2005).
5. Environment Problems and Solutions: D.K. Asthana and Meera Asthana, S. Chand & Co. Ltd. New Delhi.
6. An Introduction to Environmental Management: Dr. Anand S. Bal.
7. John G. Rau and David C. Wooten 1980, Environmental Impact Analysis Handbook. McGraw-Hill.
8. John Glasson, Riki Therival, Andrew Chdwick. Introduction to Environmental Impact Assessment, Research Press. (1994).
9. Canter L. (1996). Environmental Impact Assessment. McGraw Hill.
10. Allarachand. (1985). Environmental Challenges - A global survey, UDH, New Delhi.
11. Newson M.M. (1993). Managing the human impact on the natural environment.
12. Nanda. A.N. (1996). Environmental Education.
13. Ulter S.L. (1994). Environmental Risks and hazards, Prentice Hall of India, New Delhi.
14. Peter Calow. (1998). Handbook of Environmental Impact Assessment, McGraw Hills Inc., New Delhi.
15. Westman W.E. (1995). Ecology, Impact Assessment and Environmental planning, John Wiley and sons, New York.
16. Srivastava. AK (2018) Environmental Impact Assessment APH Publishing Corporation, New Delhi
17. Mitra SN (2017) Environmental Management and Development (Global Perspective) Astha Publishers and Distributors, New Delhi.

IV SEMESTER M.Sc ENVIRONMENTAL SCIENCE

ENV403: DISASTER MANAGEMENT (CORE)

4 credits, 4 hrs/week, 52 hrs/semester

Unit 1: Environmental Disasters: Types of Hazards- Natural and Manmade Hazards- Nature of Hazards, Environmental security and Hazard zoning. Strategies of hazard mitigation. Concept of residence time and rates of natural cycles. Catastrophic-geological Hazards. Earthquake and seismic Hazards- effects of earthquake, stability of structures and risk evaluation, seismic topography. Prediction of earthquake, Volcanic Hazards- Nature of volcanic hazards, volcanic belt, prediction and mitigation of volcanic Hazards. **10hrs**

Unit 2: Environmental security and hazard zoning and strategies for hazard mitigation. Landslides and Mud flows- Types of mass movement, strength of materials and instability of slopes, controlling the landslides. Floods and flood management- causes of floods, management of floods. Flood control methods. Avalanches- Types of avalanches monitoring of avalanches. Effects, Prediction, forecasting and mitigation of hazards. **12hrs**

Unit 3: Man-made Disasters and Hazards: Improper Irrigation, deforestation, Industrial hazards- safety and management of hazardous waste in industry (DMP). Management of dangerous materials in industry, Safety system in industry. Disaster and accident prevention evaluation of the common and major accidents. Safety versus production. **08hrs**

Unit 4: Hazard prediction, perception and alteration to hazards: Environmental risks- Developmental project activities. Preparation of on-site and off-site (DMP) activities. Pre disaster, Actual disaster and Post disaster management techniques. Relief Camp Organization; role of voluntary organization and armed forces. **12hrs**

Unit 5: Risk analysis and assessment: Vulnerability to natural hazards. Tools of risk assessment, hazard models, risk data, risk identification, risk minimization, risk communication and psychology of risks. Economic and evaluation of risks. Risk assessment in developing programmes. Experience of World Bank – risk communication. DM-2005 Act for Pandemics. Biological disasters – epidemics, pandemics. Diarrhoeal group of diseases including cholera; respiratory diseases like Tuberculosis, Influenza, Chickenpox, Meningitis; Mosquito-borne diseases – Malaria, Dengue, Filariasis, Chickenguniya **10hrs**

Reference Books:

1. Disaster Management – Shailendra, K Singh, Subash. C Kundu and Shobu Singh, Mittal Publications, New Delhi (1998).
2. Disaster Management – Induprakash, Rashtra Prahari Prakashan, Gaziabad (1994).
3. Industrial Hazards and Safety, Kind. R. W. and Magic J, Handbook, Butterworth (1982).
4. Disaster Preparedness in India – Narendrakumar Jain, Adhyatma Sadhan Kendra Mehrauli, New Delhi.
5. Peter Calow (Ed). (1998). Handbook of Environmental Risk Assessment and Management. Blackwell Sciences, London.
6. Management of Disasters and How to prevent them, Wharband O. P. and Stallworthy, E. A. (1986).
7. M. D. David Taylor and Rupert-Prudrare (Eds) (196) Environmental Impact of Chemicals Assessment and Control. The Royal Society of Chemistry, Cambridge.
8. Petal W. J. and Allison, A. A (1982), Natural Hazards Risk Assessment and Public Policy - Anticipating the unexpected, Springer Verlag, N. Y
9. Cuttler S. I (1994). Environmental Risk and Hazards, Prentice hall of India New Delhi.
10. Introduction of Safety Science, Khulman A, TUV Rheinland, (1986).
11. Explosion Hazards & Evaluation, Barkey, W. E. Elsevier, Amsterdam (1983).
12. Natural Disasters - A Guide for relief workers - JAC Adhyatma Sadhana Kendra Mehrauli, New Delhi - 30. 1980.
13. Harold D. Foster. (1980). Disaster Planning. The preservation of life and property. Springer-verlag, N. Y.
14. Shailendra K. Singh, Subash C, Kundu and Shobu Singh (1998) Disaster Management, Mittal Publications.
15. Parasuraman Sand Unikrishnan P. V. (2000). Indian Disasters report towards a policy initiative. Oxford University press.
16. Indu Prakash. (1994). Disaster Management. Rashtra Prahari Prakashan, & 50 Rajendra Nagar, Sector 2, Shababad.
17. Risk Earthquakes and people's Vulnerability, Sudhiren Sharma, Energy and Environment Group. P. O. Bag 4, New Delhi - 24.
18. Girish K. Mishra and G. C Mathur (eds). (1993). Natural Disaster reduction. Reliance Publishing House, 302/74, Ranjit Nagar, New Delhi.
19. Narendrakumar Jain, Disaster preparedness in India. Joint Assistance centre. Adhyatma sadhanakendra Mehrauli, New Delhi - 30.

IV SEMESTER M.Sc ENVIRONMENTAL SCIENCE

ENV 404: ECO-FRIENDLY TECHNOLOGIES AND ENVIRONMENTAL MODELING (CORE)

4 Credits, 4 hrs/Week, 52 hrs/semester

Unit 1: Eco-technology-

Ecological farming system, Integrated Intensive farming system, Organic farming, Advantages of Organic farming, maggot farming from organic waste. Integrated Plant Nutrient Management (IPNM). Soil Solarization, Genetic resource management and Eco-friendly detergents and Biodegradable plastics. Cleaner Environmentally friendly Technologies: Necessity, application in fertilizer & chemical industries, agro-based industries, distillery effluents. Green nanotechnology, its importance and application **10hrs**

Unit 2: Technologies to mitigate global warming: Advanced Techniques – new paradigm in business, green business – new marketing stance. Carbon sequestration. CO₂ and methane reduction potential through renewable energy. Energy and Environment- Technology and economic of electric power generation through renewable sources, hydropower and its constraints. Decentralized versus grid electricity for rural India. Decentralized energy planning from wastes for Industries. **10hrs**

Unit 3: Advanced technology for prevention and control of air pollution – Latest technologies with respect to fuel selection and utilization process design and equipment changes, site selection and zoning. Removal methods of Particulate Matter – Gravitational Settling, Impaction on Obstacles, Precipitation, Condensation, Particle filtration, Bag Filters, nanofabric filter, packed bed filters, Inertial Collectors, Scrubbers, Electrostatic precipitators (ESPs), Absorption, Adsorption, Exhaust Emission Control. **12hrs**

Unit 4: Environmental Modeling: Definition, concept, scope and components. Classes of Mathematical Models. Modeling procedures. Analysis of model properties; Approaches to the development of models. Use and limitations of Models, Modeling of Streams, Lakes, and groundwater and disposal sites. Modeling of Air, Water quality and Noise characteristics. **12hrs**

Unit 5: Population Models: Lotka-Volterra model, Leslie's matrix model. Exponential growth curve model; Exponential decay model; Fitting model emanations in experimental data. **08hrs**

Reference Books:

1. Keith J. Beven. Environmental Modelling: An Uncertain Future, 1st Edition, Routledge Publishers
2. Jo Smith Pete Smith. (2007). Introduction to Environmental Modelling, 1st Edition, Oxford University Press.
3. Bhatia S.C. (2002). Handbook of Industrial Pollution & Control CBS Publishers, New Delhi.
4. Steven L, Erickson and Brain J King, Fundamentals of Environmental Management, John Wiley & sons, New York, 1999.
5. Christopher Sheldon and Mark Yoxon. (1999). Installing Environmental Management Systems, Earthscan. London.
6. Sharma B. K. and Kaur H. (1995). Environmental Chemistry, I Ed., Goel Publishing House.
7. Chatterji A. K. (2005). Introduction to Environmental Biotechnology, Prentice-Hall of India Private Limited. New Delhi.
8. Jørgensen S. E. (1996). Applications of ecological modeling in environmental management. Elsevier Sci. Co., London.
9. Nasrollahzadeh, M., Sajadi, M. S., Atarod, M., Sajjadi, M., & Isaabadi, Z. (2019). An introduction to green nanotechnology. Academic Press
10. Surendra, K. C., Olivier, R., Tomberlin, J. K., Jha, R., & Khanal, S. K. (2016). Bioconversion of organic wastes into biodiesel and animal feed via insect farming. *Renewable energy*, 98, 197-202.
11. Carson, N., Davies, S., Shields, G., Jones, P., & Hillgarth, T. (2008). Decentralised energy: Business opportunity in resource efficiency and carbon management. The UK Government's Business Taskforce on Sustainable Consumption and Production.
12. Sharma, S. K. (Ed.). (2014). Heavy metals in water: presence, removal and safety. Royal Society of Chemistry

PRACTICAL SYLLABUS

ISEMESTER M.Sc. ENVIRONMENTAL SCIENCE

ENV106: ENVIRONMENTAL BIOLOGY & ENVIRONMENTAL CHEMISTRY

ENV106-Part A: Environmental Biology

1. Sampling techniques of phytoplankton/invertebrates.
2. Estimation of primary productivity of a pond/lake.
3. Estimation of standing crop (biomass) of phytoplankton in a aquatic system.
4. Numerical estimation of standing crop of phytoplankton.
5. Estimation of standing crop and productivity in grassland habitat.
6. Estimation of growth, productivity and characteristics of terrestrial plants.
7. Productivity and biomass estimation of litter fauna.
8. Estimation of standing crop in forest/plantation.
9. Estimation of chlorophyll in terrestrial plants and phytoplankton.
10. Study of Ecological adaptations – a) Hydrophytes and xerophytes
b) Rocky shore and sandy shore fauna

ENV106-Part B: Environmental Chemistry

1. Sampling techniques for water and air.
2. Determination of pH, Electrical Conductivity and Turbidity of water sample.
3. Determination of Total Dissolved Solids in water samples.
4. Determination of Total hardness, calcium hardness and magnesium hardness by EDTA complexometric method.
5. Determination of Chloride in water sample by AgNO_3 method.
6. Estimation of Phosphates in water by Ammonium Molybdate method.

7. Estimation of Sulphates in water sample.
8. Estimation of nitrates in water sample.
9. Estimation of fluorides in water sample.
10. Estimation of particulate matter, sulphur dioxide and oxides of nitrogen in ambient air.

ENVP107: ENVIRONMENTAL GEOLOGY AND METEOROLOGICAL SCIENCES & CLIMATE CHANGE

ENVP107-Part A: Environmental Geology

1. Study of terrain characteristics using topographic sheets.
2. Delineation and Morphometric analysis of watershed.
3. Study of geomorphological models – a) coastal plain b) Volcanoes c) Fault block mountains d) Folded mountains e) Glaciers f) Canyon g) Coastline
4. Mineralogy – Identification of common rock forming minerals.
5. Petrology – Identification of major rock types – Igneous, Metamorphic and Sedimentary.
6. Verification of Lambert-Beer's law.
7. Sampling techniques for soil.
8. Determination of pH and Electrical conductivity of soil sample.
9. Determination of water holding capacity, Bulk density and moisture content of soil.
10. Estimation of calcium and magnesium content of soil.
11. Estimation of organic matter in soil.
12. Estimation of available phosphates and total nitrogen in soil.

ENVP107-PartB: Meteorological Sciences and Climate Change

1. Study of meteorological instruments.
2. Determination of maximum and minimum temperature using psychrometer.
3. Determination of relative humidity in ambient atmosphere.
4. Determination of solar radiation and illuminations.
5. Study of precipitation, rainfall analysis and Indian monsoon patterns.
6. Determination of wind speed and direction by anemometers
7. Estimation of ambient carbon dioxide.
8. Study of clouds and their types.
9. Study of wind roses and pollution roses.
10. Quantification of greenhouse gas emissions from Energy sector; Industrial sector; Agriculture and forestry sector; and waste sector.
11. Community perception on climate change – Questionnaire method.

II SEMESTER M.Sc ENVIRONMENTAL SCIENCE

ENV206: ENVIRONMENTAL TOXICOLOGY & ENVIRONMENTAL ENGINEERING

ENV206-Part A: Environmental Toxicology

1. Study of the effects of heavy metals on fish species.
2. Study of the effect of heavy metal concentration on seed germination using HACH colorimeter (DR/890)
3. Cytological study of nanotoxins on onion root tips
4. Estimation of chlorophyll pigments in the plant species exposed to polluted environment.
5. Estimation of dust accumulated on plant parts – leaves and its effects on morphology and anatomy of plants.
6. Detection of some Organochlorine pesticides in vegetables and fruits.
7. Detection of some Organochlorine pesticides in vegetables and fruits using Gas Chromatography.
8. Estimation of protein content of biological samples.
9. Determination of total carbohydrates in biological system.
10. Estimation of Proline in biological samples.
11. Study of rate of uptake of metal toxins by different species of plants.
12. Determination of the mortality rate of fishes exposed to different effluents.
13. Estimation of lead, zinc, chromium, copper and mercury in biological samples by spectrophotometric method.
14. Observations on plant growth using wastewater (industrial and domestic).
15. Study of Chlorosis and Necrosis in plant species.

ENV206-Part B: Environmental Engineering

1. Determination of Turbidity in water/wastewater sample.
2. Determination of Alkalinity in water/wastewater sample.
3. Determination of Total, settleable, suspended and dissolved solids in wastewater sample.
4. Determination of Hardness in water/wastewater sample.
5. Determination of Fluoride in wastewater sample.
6. Determination of Chlorides, Sulphate and nitrates in water/wastewater

sample.

7. Determination of Dissolved Oxygen (DO) in water/wastewater sample.
8. Determination of Biochemical Oxygen Demand (BOD) in wastewater sample.
9. Determination of Chemical Oxygen Demand (COD) in wastewater sample.
10. Determination of Sludge Volume Index (SVI) in the sewage sample.
11. Determination of optimum dose of coagulants for water/wastewater sample.

ENV207: ENVIRONMENTAL MICROBIOLOGY AND ENVIRONMENTAL POLLUTION MONITORING & CONTROL

ENVP207-Part A: Environmental Microbiology

1. Preparation of culture media and study of colony characteristics.
2. Micrometry and Haemocytometer.
3. Isolation and Identification of fungal and Bacterial colonies from air and soil.
4. Bacterial examination of water –
Total and Faecal coliforms by MPN and MF techniques.
5. Determination of *E. coli* in water – MPN, Plate count and membrane filtration techniques
6. Isolation and Identification of Bacteria and Fungi from fruits & vegetables.
7. Isolation and Identification of Bacteria and Fungi from touch surface of working places.
8. Study of Phylloplane/ rhizosphere microflora.
9. Biochemical tests a) Indole test b) Methyl red c) Vogues proskauer test d) Citrate utilization test e) Citrate utilization test f) Catalase test
f) Oxidase test g) Urease test h) Sugar fermentation test (Glucose)
i) Gelatin hydrolysis j) Casein hydrolysis k) Amylase production starch hydrolysis l) Antibiotic sensitivity tests.
10. Study of Fermentation technology using Fermenter.

11. Biosynthesis of nano-particles.
12. Study of Bio-sensors.

ENVP207–PartB:EnvironmentalPollutionMonitoringandControl

1. Determination of pH and Electrical Conductivity in water sample.
2. Estimation of Dissolved Oxygen and Biochemical Oxygen Demand in water sample.
3. Estimation of Chemical Oxygen Demand in water sample.
4. Estimation of Fluoride content in water sample.
5. Estimation of Particulate Matter (PM) in air using RDS/HVS.
6. Determination of SO₂ and NO_x in ambient air using RDS/HVS.
7. Computation of Water Quality Index (WQI).
8. Modelling of Air Quality and Air Quality Indices (AQI).
9. Determination of Air Pollution Tolerance Index (APTI).
10. Air and Noise Pollution Survey – questionnaire method.
11. Determination of instantaneous noise levels and continuous noise monitoring in selected areas using sound level meter.

III SEMESTER M.Sc ENVIRONMENTAL SCIENCE

ENV 305 – Part A: SOLID AND HAZARDOUS WASTE MANAGEMENT & NATURAL RESOURCE MANAGEMENT (Practicals)

ENV305–PartA:SolidandHazardousWasteManagement

1. Sampling techniques for solid wastes
2. Characterization of wastes
3. Determination of crude and bulk density.
4. Study of percentage reduction of waste by traditional burning method.
5. Determination of moisture content of the MSW.
6. Collection and characterization of leachate.
7. Estimation of pH and EC of the leachate.
8. Estimation of nitrates, Sulphate, phosphates in leachate.
9. Composting methods a) Pit, b) Field, c) Vermicomposting d) urban compost bins
10. Biogas production from the organic waste in the laboratory.
11. Waste generation pattern by questionnaire method.

ENV305–PartB:NATURALRESOURCEMANAGEMENT

1. Agro-climatic zones of Karnataka.
2. Vegetation zones of India.
3. Soil types in India
4. Community studies using quadrates (diversity indices).
5. Study of selected national park and wildlife sanctuaries in India.
6. Key areas of conservation in India – Biosphere reserves, Elephant reserves, Tiger reserves, Natural World Heritage Sites.
7. Study of lakes and rivers in India
8. Study of selected key wildlife of India.
9. Study of selected exotic species of the Indian subcontinent: (a) Naturalized weeds (b) Exotic plantation species (c) Pests
10. Energy content in solid and liquid energy resources A) Petrol and diesel B) Husk, fodder, wood and tree species.
11. Energy and water consumption pattern in urban areas – Questionnaire method.

ENV306: REMOTE SENSING AND GIS APPLICATIONS

ENV306-Part A: REMOTE SENSING APPLICATIONS

1. Coordinates and formats – Degree-Minutes-Seconds (DMS), Decimal Degrees (DD) and Degree decimal minutes (DDM)
2. Calculation of latitude and longitude for Area of Interest
3. Calculation of area and perimeter for Area of Interest using planimeter and grid method.
4. Preparation of drainage map and morphometric analysis using Toposheet
5. Preparation of contour map and slope analysis using toposheet
6. Study of aerial photographs, photo interpretation for environmental studies and topographical maps.
7. Interpretation of Satellite data – Visual and Digital image processing
8. Composite Image creation using Landsat 8 Imagery - band combinations and sub-setting using boundary
9. Land-use and land-cover classification from satellite data & toposheets.
10. Preparation of NDVI map using Landsat 8 imagery.
11. Collection of Altitude data to create contour and DEM using QGIS (terrain analysis).
12. GPS Survey of Natural and Man-made features (Tree species, Buildings, etc) and their mapping using QGIS.

ENV306-Part B: GIS APPLICATIONS

1. GIS softwares (QGIS, ArcGIS, ERDAS)
2. Preparation of Data models using topomaps: (a) Vector models (b) Raster models
3. Rasterization and vectorization using Q-GIS and data generation.
4. Method of georeferencing of Topomaps/ancillary data
5. Preparation of thematic maps from Topomaps- (a) Basemap/administrative boundaries (b) drainage map (c) transportation network (d) settlement map (e) Wasteland maps (f) Contour map

6. Linking spatial and non-spatial data entry and its mapping using QGIS
7. Collection of Ground control points (GCPs) from Google Earth and ground truthing
8. Buffer creation and proximity analysis
9. Overlay analysis, clipping and data generation
10. Creating vector layers through Google Earth and mapping using QGIS and coordinated delineation
11. Creating vector layers from Google Earth and mapping using QGIS and area calculation
12. Introduction to Bhuvan web portal and its thematic services & archives.