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**REVISED COURSES AND SYLLABI
OF
M.Sc. ENVIRONMENTAL SCIENCE
Faculty of Life Science
BASED ON CHOICE BASED CREDIT SYSTEM (CBCS)
Department of Environmental Studies,
Dr. Bhimrao Ambedkar University, Agra
UNDER NEP-2020**

Courses	M. Sc. Environmental Science I semester		Marks		Total 100	Credit
	Course Title	CIE	End Semester Examination			
EnvSc-C101	Ecology and Sustainable Development	25	75		100	4
EnvSc-C102	Environmental Pollution	25	75		100	4
EnvSc-C103	Energy and Environmental Policy	25	75		100	4
EnvSc-C104	Biodiversity and Conservation	25	75		100	4
EnvSc -C105	Practical			100	100	4
	Industrial training/Survey/Research Project					
	Total				500	20
Courses	M. Sc. Environmental Science II semester		Marks		Total	Credit
	Course Title	CIE	End Semester Examination			
EnvSc-C201	Environmental Chemistry	25	75		100	4
EnvSc-C202	Earth Processes and Soil Sciences	25	75		100	4
EnvSc-C203	Environmental Techniques	25	75		100	4
EnvSc-C204	Environmental Engineering	25	75		100	4
EnvSc-C205	Practical			100	100	4
EnvSc-C206	Industrial training/Survey/Research Project				200	8
	Minor (Other Faculty)	25	75		100	4
	Total				800	32
Courses	M. Sc. Environmental Science III semester		Marks		Total	Credit
	Course Title	CIE	End Semester Examination			
EnvSc-C301	Water resources and Marine Environment	25	75		100	4
EnvSc-C302	Solid and Hazardous Waste Management	25	75		100	4
EnvSc-C303	Environmental Bio-statistics and Modelling	25	75		100	4
EnvSc -E304	Meteorology: Tools And Techniques	25	75		100	4
EnvSc -E305	Atmosphere And Global Climate Change			100	100	4
EnvSc-C306	Practical					
	Industrial training/Survey/Research Project				100	4
	Total				500	20
Courses	M. Sc. Environmental Science IV semester		Marks		Total	Credit
	Course Title	CIE	End Semester Examination			
EnvSc-C401	Environmental Impact and Risk Assessment	25	75		100	4
EnvSc-C402	Environmental Biotechnology and Toxicology	25	75		100	4
EnvSc -E403	Environmental Biotechnology	25	75		100	4
EnvSc -E404	Environmental Instrumentation					
EnvSc -E405	Ecotoxicology And Environmental Health	25	75		100	4
EnvSc -E406	Environmental Hazards					
EnvSc-C407	Practical			100	100	4
EnvSc-C408	Industrial training/Survey/Research Project				200	8
	Total				700	28
	Total Marks and Credits				2500	100

Note; The I and II semesters of the First year of the M.Sc. Environmental Science (in Faculty of Life Science) Programme will be known as VII and VIII semesters of the B.Sc. Research (in Faculty of Life Science).

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FIRST SEMESTER
Core Course
Code-EnvSc-C101

ECOLOGY AND SUSTAINABLE DEVELOPMENT

Topics	Teaching Hours
<u>UNIT-I</u>	
1) Definition, principles and scope of ecology, Human ecology and settlement. 2) Population, Community, biome, limiting factor. 3) Characters of community and concept of habitat. 4) Functional role of ecology and niche, keystone species, ecotone and edge effect.	15
<u>UNIT-II</u>	
1) Population dynamics, model for single and interacting population. 2) Stable points, cycles, chaos competition. 3) Ecological succession, Climax community and their models. 4) Parasitism and prey-predation	15
<u>UNIT-III</u>	
1) Concept of ecosystem: abiotic and biotic concept. 2) Concept of energy, food chain, food web and ecological pyramids. 3) Pattern of primary and secondary production in major ecosystems of world, feedback and control. 4) Ten percent law, Gross and net production.	15
<u>UNIT-IV</u>	
1) The concept of sustainable development, temporal and spatial dimensions. 2) Public participation, education and environmental decision making. 3) Concept of reuse, reduce and recycle (3R) of different type of wastes, Environmental degradation and conservation issues. 4) Ecosystem as social process in Rehabilitation of degraded rural landscape, unbalanced soils and habitats e.g. water bodies and mangroves. Rehabilitation of mined area.	15

Suggested Readings: Clapham Jr., W.B., 1983, Natural Ecosystem: Chapters I, II, III and IV. Macmillan Publishers, London

Gadgil Madhav, 2004, Ecological Journeys. The Science and Politics of conservation in India, Permanent black, Delhi. Heywood, V.H. (Executive Editor), 1995, Global Biodiversity Assessment: Chapters 5 and 6. UNEP, University Press, Cambridge

Jennifer, A., Burch. W.R., Conover, B. and Field, D., 1998. Ecosystem Management: Adaptive strategies for Natural Resources organizations in the 21 st Century. Taylor and Francis, London. Reid, W.V. et al (Ed.), 2005, Ecosystems and Human well-being: Synthesis. p.1-37. Millennium Ecosystem Assessment, World Resource Institute, Island Press, Washington DC.

Samson, B.F, and Knoff, F.L., 1996, Ecosystem Management. Springer-Verlag, New York.

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FIRST SEMESTER
Core Course
Code-EnvSc-C102
ENVIRONMENTAL POLLUTION

Topics	Teaching Hours
<u>UNIT-I</u>	
1) Chemistry of water-Types, sources and consequences of water pollution. 2) Types and characteristics of domestic, industrial and agricultural wastes and their effects on water bodies, animal and human beings. 3) Water quality parameters, Physiochemical and bacteriological sampling. 4) Water quality standards (Drinking Water).	15
<u>UNIT-II</u>	
1) Atmosphere and its fraction; gas laws governing the behavior of pollutants in atmosphere. 2) Natural and Anthropogenic sources of atmospheric pollutants, their effects on animal, human, vegetation and materials and their reaction in the atmosphere. 3) Transport and dispersal of pollutants, effects of meteorological and topographical factors. 4) Sampling of gaseous and particulate matter, their analysis and air quality standards.	15
<u>UNIT-III</u>	
1) Basic properties of sound waves plane and spherical waves, sound pressure and intensity levels, decibel, effects of meteorological parameters on sound propagation measurement and analysis of sound. 2) A weighted sound level, equivalent sound level (Leq.) Noise pollution level (NPL), Sound exposure level (SEL), Traffic sound index (TNI), Day night level. 3) Source of noise, noise control and abatement measures, sound absorption coefficient. 4) Hazards of noise pollution, effects on physiological, circulatory, respiratory, muscular, hearing loss and threshold shifts and noise standards.	15
<u>UNIT-IV</u>	
1) Physico-chemical and bacteriological sampling as analysis of soil quality. 2) Sources of soil pollution, Industrial waste effluents and heavy metals, their interactions with soil components. 3) Soil micro-organisms and their function, degradation of different insecticides/fungicides and weedicides in soil. 4) Different kind of synthetic fertilizers (NP & K) and their interactions with different components of soil.	15

Suggested Readings: Leslie Collier, Balows Albert and Sussman Max, Topley and Wilson's Microbiology and Microbial infections. Oxford University Press.

Murray J.F. and Nadel. J.A., 2000, Text book of respiratory medicine, 3rd Edn.,

W.B. Saunders & Co. Park. J.E. and Park. K., 1994, Text book of preventive and social medicine, Banarsi Das & Bhanot, Jabalpur.

A.C. Stern, Air Pollution vol. 1 - 7.

Anjaneyulu. Y, 2004, Introduction to Environmental Science. B. S. Publications.

D. Daniel Chiras, 2001, Environmental Science, 6th Ed., Jones and Bartlett Publishers.

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FIRST SEMESTER
Core Course
Code-EnvSc-C103
ENERGY AND ENVIRONMENTAL POLICY

Topics	Teaching Hours
<u>UNIT-I</u>	
1) Sun as source of energy: Earth and Sun relationship, nature and its radiation and heat budget of earth.	15
2) Conventional and non-conventional energy resources: Fossil fuel, coal, oil and natural gas, hydroelectric power, tidal, wind and geothermal energy.	
3) Biomass, solar collectors, photovoltaic and solar ponds.	
4) Natural energy resources: soil, water, land wood etc.	
<u>UNIT-II</u>	
1) Resources of energy and their impacts on environment.	15
2) Minerals Resources-Types, their characteristics and uses.	
3) Nature of nuclear energy, history of nuclear energy development, Nuclear Reactors	
4) Nuclear Fusion, Breeder Reactors, Nuclear Fission, Nuclear Fuel Cycle.	
<u>UNIT-III</u>	
1) Energy consumption criteria in different parts of world and conservation of energy.	15
2) Concept of environmental ethics.	
3) Energy and Sustainable development of environment,	
4) Strategic analysis of India-multi-dimensional energy crisis.	
<u>UNIT-IV</u>	
1) Agenda-21 and government policy for natural resources and environment.	15
2) Land use policy for India, urban planning for India.	
3) Environmental education and awareness: formal and non-formal education.	
4) Role of UNESCO and Non-governmental organizations in environmental conservation.	

Suggested Readings: Craig. J.R., Vaughan. D.J., Skinner. B.J., 1996, Resources of the Earth: origin, use, and environmental impact, 2 nd Ed. Prentice Hall, New Jersey. Klee. G.A, 1991, Conservation of natural resources.. Prentice Hall Publ. Co., New Jersey.

Owen. O.S, Chiras. D.D, Reganold. J.P, 1998, Natural resource conservation – management for sustainable future, 7 th Ed., Prentice Hall.

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FIRST SEMESTER
Core Course
Code-EnvSc-C104
BIODIVERSITY AND CONSERVATION

Topics	Teaching Hours
<u>UNIT-I</u>	
1) Concept: organic evolution through geological time scales. 2) Introduction to biodiversity and it's types. 3) Levels and gradients of biodiversity. 4) Ecosystem biodiversity – Biomes, Mangroves, coral reefs, wetlands.	15
<u>UNIT-II</u>	
1) Terrestrial diversity. 2) Threats to biodiversity: Disturbance and pollution, Introduction of exoctic species, Extinction of species. 3) Human interventions and biodiversity loss: Global environmental change, land and water use changes. 4) RED data book and related documentations.	15
<u>UNIT-III</u>	
1) Methods of biodiversity conservation – In situ conservation (Biosphere Reserve, National Parks, Wildlife Sanctuaries, Scared Groves). 2) Ex situ conservation (Botanical garden, Zoological garden, Gene Bank, pollen, seed and seedling banks tissue culture and DNA bank. 3) IUCN categorized – endangered, threatened, vulnerable species. 4) International organization realted to biodiversity conservation (Traffic, REED, REED +).	15
<u>UNIT-IV</u>	
1) Benefits of conservation. 2) Conservation projects. 3) History of conservation movements. 4) Biodiversity Hotspots and it's criteria.	15

Suggested Readings: Daily, G.C., Ed., 1997, Nature's Services: Societal Dependence on Natural Ecosystems. Island Press, Washington, D.C.

Dobson, A.P., 1996, Conservation and Biodiversity. Scientific American Library, New York, NY.

Gaston, K J. and J.I. Spicer, 1998, Biodiversity: An Introduction. Blackwell Science, London, UK.

Groom bridge, B., and M. Jenkins, 2000, Global Biodiversity: Earth's Living Resources in the 21 st Century. World Conservation Press, Cambridge, UK.

IUCN, 2004, Red list of threatened species. A global species assessment. IUCN, Gland, Switzerland

Loreau, M., and P. Inchausti, 2002, Biodiversity and Ecosystem functioning: Synthesis and Perspectives. Oxford University Press, Oxford, UK.

Primack, R.B., 2002, Essentials of Conservation Biology, 3 rd Edn., Sinauer Associates, Sunderland, Ma. USA

Wilson, Edward O., 1993, Diversity of Life. Harvard University Press, Cambridge, MA.

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SECOND SEMESTER
Core Course
Code-EnvSc-C201
ENVIRONMENTAL CHEMISTRY

Topics	Teaching Hours
UNIT-I	
1) Fundamentals of Environmental Chemistry. Stoichiometry, Gibb's energy, chemical potential, chemical equilibria. 2) Acid base reactions, solubility product, solubility of gases in water. 3) The carbonate system, unsaturated and saturated hydrocarbons, radionuclide's. 4) Energy fundamentals: First and Second law of Thermodynamics.	15
UNIT-II	
1) Chemical composition of air: Classification of elements, chemical speciation, particles, ions and radicals in the atmosphere. 2) Chemical processes for formation of inorganic and organic particulate matter, photochemical reactions in the atmosphere. 3) Oxygen and ozone chemistry: Ozone production, ozone destruction and its effects. 4) Photochemical smog, formation of peroxyacetyl nitrates (PAN) and its effects.	15
UNIT-III	
1) Water chemistry: Chemistry of water, concept of DO, BOD, COD, sedimentation, coagulation, filtration, redox potential. 2) Soil chemistry: Inorganic and organic components of soil, Nitrogen pathways and NPK in soils. 3) Elemental Cycles and their environmental significance (nitrogen cycle, Sulphur cycle, carbon cycle and oxygen cycle) 4) Acid rain: Formation of acid rain and its effects on artifacts, Toxic chemicals in the environment- (water) : Pesticides in water, biochemical aspects of arsenic, cadmium, lead, mercury,	15
UNIT-IV	
1) Toxic chemicals in the environment- (Air): carbon monoxide, ozone, pesticides, insecticides, MIC in the air. 2) Greenhouse gases and their effects, Global warming, Causes and Consequences of Global Climate Change. Role of ocean and forest as carbon sink. 3) Indoor air pollution: indoor/outdoor relationships, personal air pollution exposure, Indoor air quality problems, Prevention and control measures. 4) Vehicular Pollution: Automobile emissions, effects, prevention and control of Vehicular pollution, brief description of Euro I, Euro II, Euro III & Euro IV norms for automobiles and urban air quality.	15

Suggested Readings: Manahan. Stanely E, 2000, 7 th Edn., Environmental Chemistry, Lewis Publishers.
 Stumm, W.; Morgan, J. J., 1996, Aquatic Chemistry: Chemical Equilibria and Rates in Natural Waters; Wiley Interscience: New York.
 Wayne, R. P., 2000, Chemistry of Atmospheres: An Introduction to the Chemistry of the Atmospheres of Earth, the Planets, and their Satellites (3rd Ed.), Oxford University Press
 Williams Ian, 2001, Environmental Chemistry -a modular approach, Willey John & Sons
 Williams. R.J.P and Frausto da. J.J.R, 1996, The Natural Selection of the Chemical Elements, Oxford University Press, Oxford, UK /New York, NY
 Willard & Others, 1988, Instrumental Methods of Analysis, Wadsworth.

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SECOND SEMESTER
Core Course
Code-EnvSc-C202
EARTH PROCESSES AND SOIL SCIENCES

Topics	Teaching Hours
<u>UNIT-I</u>	
1) Primary formation of core, mantle and crust. 2) Magma generation, Formation of igneous rock and sedimentary rock. 3) Glaciers and glaciations: Types of glaciers, surface profile of glaciers, Glaciers and glaciations: Types of glaciers, surface profile of glaciers. 4) Weathering of rocks, Erosion, transportation and deposition of earth's materials by running water, wind and glaciers	15
<u>UNIT-II</u>	
1) Concept of Geological hazards. 2) Study of Floods, landslides, earthquake, volcanism, drought and cyclones. 3) Prediction and perception of hazards and disaster management. 4) Sea floor spreading and mountain building, rock deformation, evolution of continents.	15
<u>UNIT-III</u>	
1) Soil genesis: formation and soil profile development. 2) Classification of soil, chemical and mineralogical composition of soil. 3) Soil organic matter and their sources, composition, microbial decomposition of organic matter. 4) Humus formation: nature and properties of humus, clay-humus complex and significance.	15
<u>UNIT-IV</u>	
1) Soil colloidal system, soil acidity and alkalinity salinity, nature, formation and control. 2) Major soil nutrients and elements, hygroscopic nature of soil, capillary and gravitational forms of soil water. 3) Soil air composition and gaseous exchange between atmosphere and soil air. 4) Soil temperature and loss of heat and thermal conductivity.	15

Suggested Readings: Keller, Edward A, 1996, Introduction to Environmental Geology, Prentice Hall, Upper Saddle River, New Jersey

Kesler, S. F. 1994, Mineral resources, economics and the environment. Upper Saddle River, NJ: Prentice Hall.

Owen., Oliver S, Chiras. Daniel D, Reganold. John P., 2002, Natural Resource Conservation, 7th Ed., Prentice Hall, Upper Saddle River, New Jersey

Skinner, Brian J., Porter, Stephen C., 1995, The Dynamic Earth: An Introduction to Physical Geology, Casebook, 3rd Edition (Paperback), John Wiley, New York

Skinner, B. J., and Porter, S. C., 1995, The Blue Planet, An Introduction to Earth System Science, John Wiley & Sons, Inc.

Slaymake, Olav, (Editor), 2000, Geomorphology, Human Activity and Global Environmental Change. John Wiley, New York.



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SECOND SEMESTER
Core Course
Code-EnvSc-C203
ENVIRONMENTAL TECHNIQUES

Topics	Teaching Hours
<u>UNIT-I</u>	
Air Quality Monitoring and Sampling Methods 1) Sulphur di Oxide 2) Oxide of Nitrogen 3) Suspended Particulate Matter 4) RSPM - PM10 and PM2.5	15
<u>UNIT-II</u>	
Water Quality Sampling and Analysis Methods 1) Turbidity, Total Solids 2) DO, BOD, COD 3) Sodium, Potassium, 4) Arsenic, Cadmium, 5) Zinc, Chromium, 6) Copper, Iron. 7) Biological Analysis : Qualitative and quantitative methods for planktons, MPN incoliforms.	15
<u>UNIT-III</u>	
Biochemical Methods 1) Serum Total Protein, Serum Albumin, 2) Serum Globulin, Albumin-Globulin Ratio, 3) Cholesterol, HDL-Cholesterol, 4) Alkaline Phosphatase, 5) Acid Phosphatase, 6) SGPT, SGOT.	15
<u>UNIT-IV</u>	
Methods of Exposure of Toxicants 1) Dose-Response and Dose-Effect Relationship; 2) Statistical Concept of LC50 and LD50; 3) Bioassays.	15

Suggested Readings: American Public Health Association (APHA), 1998 Standard Methods for the Examination of water and waste water 20th edition

Thimmaiah, S.K., 1999 Standard Methods of Biochemical Analysis, Kalyani Publisher

Abbasi S.A. 1998 Water Quality Sampling and Analysis, Discovery Publishing House, New Delhi




SECOND SEMESTER
Core Course
Code-EnvSc-C204
ENVIRONMENTAL ENGINEERING

Topics	Teaching Hours
<u>UNIT-I</u>	
1) Elimination and minimization of air pollution emission. 2) Selection criteria of a control system. 3) Air pollution Control Equipments: Cyclone Collector, Filtration and Electrostatic Precipitators. 4) Air pollution Control Equipments: Scrubbing, Adsorption.	15
<u>UNIT-II</u>	
1) Waste water treatment by aeration, coagulation and flocculation, sedimentation and filtration. 2) Aerobic and anaerobic process of waste water treatment. 3) Waste water treatment process – Primary, Secondary and Tertiary treatment. 4) Sludge treatment and disposal.	15
<u>UNIT-III</u>	
1) Solid waste collection and transportation. 2) Solid waste processing and recovery. 3) Disposal Technique – Landfilling method, it's basic aspect and types and Incineration. 4) Energy recovery methods of solid waste disposal: Gasification, Pyrolysis, Plasma pyrolysis.	15
<u>UNIT-IV</u>	
1) Hazardous waste treatment strategies. 2) Treatment of biomedical waste by incineration, Microwave, Autoclave, Hydroclave. 3) Disposal of plastic waste and treatment and disposal of metal sharps. 4) Nuclear waste disposal technique.	15

Suggested Readings: Henry Gya, J. and Heinke, 2004, Gary W. Environmental Science and Engineering. Pearson low priced edition.

Kiely, G., 1998, Environmental Engineering, Irwin McGraw Hill, Boston.

Masters, M.G., 1998, 2nd Edition, Introduction to Environmental Engineering and Science, Prentice Hall, London.

Peavy, H.S., Rowe, D.R. and George, T., 1987, Environmental Engineering, McGraw Hill, New York.

Vesilind, P.A., 1997, Introduction to Environmental Engineering. PWS publishing, Boston.

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THIRD SEMESTER

Core Course

Code-EnvSc-C301

WATER RESOURCES AND MARINE ENVIRONMENT

Topics	Teaching Hours
<u>UNIT-I</u>	
1) Ground Water: Origin, types, importance, occurrence, reservoirs, basins and movement. Hydrologic cycle and its balance. Hydrologic properties of rocks: porosity, permeability, specific yield, specific retention, hydraulic conductivity, transmissivity, storage coefficient. 2) Darcy's law and experiment. 3) Well hydraulics: Confined, semi-confined and unconfined aquifer. Time variations of levels, fluctuations due to evapotranspiration, urbanization, Meteorological phenomena and land subsidence. 4) Ground water quality, measurement of water quality, Ground water contamination and pollutants: Problem of arsenic and fluoride.	15
<u>UNIT-II</u>	
1) Surface water, Atmospheric aspects of the hydrologic cycle: weather and climate, evaporation, evaporation and transpiration, Evapotranspiration. 2) Precipitation and run off: Conditions for precipitation occurrence, forms of precipitation, average basin precipitation, rainfall and run off. 3) Stream flow: Measurement of stream flow, Interaction of surface water and ground water. 4) Rainwater harvesting, eutrophication restoration of Indian lakes and wetland conservation, National Water policy	15
<u>UNIT-III</u>	
1) Origin and composition of sea water. 2) Physical properties of marine water: temperature, density, optics, currents, wave generation, thermo-haline turbidity currents (gravity), gyres. 3) Chemical properties of marine water: Salinity and its determination and distribution, causes of salinity variations. 4) Dissolved gases and carbonate chemistry of ocean water, residence time, biochemical reactions and their distributions.	15
<u>UNIT-IV</u>	
1) Biological Oceanography: Division of the marine environment benthic, pelagic, bathyal, littoral, ocean water as biological environment. 2) Ocean pollution by toxic wastes and its effect. 3) Geological and Geophysical Oceanography: History of ocean basin, geophysical and geological processes, ocean basin rocks and sediments. 4) Beach and beach processes, littoral sediment transport, coastal erosion- causes and protection, resources of ocean, renewable and non-renewable.	15

Suggested Readings: Aggarwal, A., 1991, Floods, Floodplains and Environmental Myths. Centre for Science and Environment, New Delhi.

Andrew D. Ward and Stanley Trimble, 2004, 2 nd Ed., Environmental Hydrology, Lewis Publishers.

Karant, K.R.C., 1988, Ground Water: Exploration, Assessment and Development. Tata-Mcgraw Hill, New Delhi.

Mahajan, G., 1989, Evaluation and Development of Groundwater. Ashish Publishing House, New Delhi.

Rao, K.L., 1982, India's water wealth. Orient Longman, Delhi.

Subramaniam V., 2002, Text Book of Environmental Science, Narosa Publishing House, Delhi.

Timothy, Davie, 2003, Fundamentals of Hydrology. Rowledge, Taylor and Francis Group, U.K.

Todd, D.K., 2004, Groundwater Hydrology, John Wiley & Sons Inc.

Vijay P. Singh, 1995, Environmental Hydrology. Kluwer Academic Publications, The Netherlands.

Wright. R.T and Nebel. B.J., 2002, Environmental Science: toward a sustainable future, Prentice Hall India Ltd, 8 th Edition.

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THIRD SEMESTER
Core Course
Code-EnvSc-C302
SOLID AND HAZARDOUS WASTE MANAGEMENT

Topics	Teaching Hours
<u>UNIT-I</u>	
1) Definition and Classification Hazardous waste, ignitability, corrosivity, reactivity, toxicity, radioactivity. 2) Hazardous waste : Sources, effects, storage and handling. 3) Management of Hazardous wastes: Pollution, prevention, waste minimization, recycling of wastes, land disposal. 4) Risk assessment: Carcinogens, dose response assessment, risk exposure assessment.	15
<u>UNIT-II</u>	
1) Radioactive pollution, biological effects of ionizing radiation. 2) Radiation exposure, radiation protection, radioactive waste. 3) E- waste & it's effect and Plastic waste and It's effect. 4) Fly ash and its utilization.	15
<u>UNIT-III</u>	
1) Solid Waste : Definition, Source and types 2) Generation and Effects of soild waste. 3) Physical and chemical composition of solid waste. 4) General characterization and classification of solid waste	15
<u>UNIT-IV</u>	
1) Different methods of solid waste management. 2) Recycling of solid waste material. 3) Environmental concern of landfilling of municipal soild waste. 4) Biomedical Waste: Definition, Sources of generation, categories, colour coding system for segregation, transportation specifications.	15

Suggested Readings:

Henry Glya, J. and Heinke, 2004, Gary W. Environmental Science and Engineering. Pearson low priced edition.
 Kiely, G., 1998, Environmental Engineering, Irwin McGraw Hill, Boston.

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THIRD SEMESTER
Core Course
Code-EnvSc-C303
ENVIRONMENTAL BIOSTATISTICS AND MODELLING

Topics	Teaching Hours
<u>UNIT-I</u>	
1) Sampling techniques and data representation 2) Measures of central tendency 3) Measures of dispersion. 4) Distribution.	15
<u>UNIT-II</u>	
1) Probability and Chi-square test. 2) Correlation and linear regression. 3) Tests of significance. 4) Experimental design and analysis of variance.	15
<u>UNIT-III</u>	
1) Computer fundamentals and operating system-function/need of operating system 2) Permanent storage of data, number systems, decimal to binary and vice-versa, binary coded decimal numbers. 3) Low and high level languages. 4) Basic concept of algorithms and flow charting.	15
<u>UNIT-IV</u>	
1) Programming in 'C' and C++ : Introductory concepts. 2) Word Processing: MS- word, Excel and their application. 3) Internet : History, Application, Service provider, computer and ethics-hacking, viruses, abuses. 4) Application of computers in Environmental Science.	15

Suggested Readings: Gallager R., 1996, Discrete Stochastic Processes, Kluwer Academic Publishers. Grant, W.E., Pederson, E.K. and Sendra, L.M., 1997, Ecology and Natural Resource Management: Systems Analysis and Simulation, John Wiley, New York.
 Jorgensen, S.E. Miller, F., (Ed.), 2000, Hand Book of Ecosystem Theories and Management, Section-I and 11.4 of Section II. CRC press, Florida.
 Recknagal, F., (Ed.), 2003, Ecological Informatics, chapters I, II, III and IV. Springer, Germany.
 Wainwright, John (Editor), Mulligan, Mark (Editor), 2004, Environmental Modelling: Finding Simplicity in Complexity. John Wiley, New York
 Zannetti, P., 1990, Air pollution modeling, theories computational methods and available softwares. Van Nostrand Rheinhold, New York.

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THIRD SEMESTER

Elective Course

Code-EnvSc-E304

METEOROLOGY: TOOLS AND TECHNIQUES

Topics	Teaching Hours
UNIT-I	
1) Meteorological Parameters: Pressure, Atmospheric Pressure belts, temperature, wind and wind roses humidity, precipitation and radiation. Atmospheric stability, inversions, mixing heights. 2) Scales of Meteorology. 3) Dew, Fog, Frost, Haze, Clouds: Cloud development and classification of Clouds. Cloud Bursting and its consequences 4) Air masses and Fronts.	15
UNIT-II	
1) World Climates: Elements of climate, Climatic controls, Classification of climate, Preliminary concept of climate change. 2) Indian climate, seasons in India. Spatial and temporal patterns of climatic parameters in India, Weather Forecasting. 3) Elements of Agro climatology. and EL Nino, Southern Oscillations. 4) Human and animal bio-climatology.	15
UNIT-III	
1) Basic Principle, instrumentation and application of spectroscopy, colorimetry and Flame photometer. 2) Spectroscopy: Basic principle, instrumentation and applications of atomic absorption and emission spectroscopy. 3) Chromatography: Principle, types and application of Gas Chromatography, Gas-liquid chromatography and HPLC. 4) Centrifugation: Basic Principle, Types and instrumentation and application.	15
UNIT-IV	
1) Nephelometer: Principles and Applications. 2) High Volume Sampler, Respirable Dust Sampler, Fine Particulate Sampler: Principle, instrumentation and applications. 3) Titrimetry and Gravimetry. 4) X-ray diffraction.	15

Suggested Readings: Barry, R. G., 2003. Atmosphere, weather and climate. Routledge Press, UK
 Critchfield, Howard J., 1998, General climatology, Prentice Hall India Pvt. Ltd., New Delhi,
 C. Donald Ahrens, Meteorology Toady Seventh edition .

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THIRD SEMESTER
Elective Course
Code-EnvSc-E305
ATMOSPHERE AND GLOBAL CLIMATE CHANGE

Topics	Teaching Hours
<u>UNIT-I</u>	
1) Earth systems: Atmosphere, hydrosphere, lithosphere, biosphere and their linkage. 2) Earth's geological history and development and evolution of atmosphere. 3) Fractions of atmosphere. 4) Atmospheric composition.	15
<u>UNIT-II</u>	
1) Ocean: general circulation pattern, air- sea interaction. 2) Wind, Stability and turbulence. 3) EL Nino, Southern Oscillations. 4) Energy Balance of atmosphere.	15
<u>UNIT-III</u>	
1) Natural Climate Change: Records of climate change (Glacial cycle, Ocean sediments, corals, tree rings). 2) Causes and Consequences of Global Climate Change. 3) Role of ocean and forest as carbon sink. 4) Ozone depletion - Stratospheric ozone shield.	15
<u>UNIT-IV</u>	
1) Impact of climate change on human, ecosystem, species distribution, spread of diseases. 2) Extinction risk of temperate- sensitive species. 3) UV effects on human, animal and plants. 4) Policy for climate change: Kyoto, carbon trading, carbon sequestration, carbon footprint, carbon credit and clean development mechanism.	15

Suggested Readings: Barry, R. G., 2003. Atmosphere, weather and climate. Routledge Press, UK
 Critchfield, Howard J., 1998, General climatology, Prentice Hall India Pvt. Ltd., New Delhi.
 Firor, J., and J. E. Jacobsen, 2002. The crowded greenhouse: population, climate change and creating a sustainable world. Yale University Press.
 Glantz, M. H., 2003. Climate Affairs: a primer. Island Press.
 Harvey D., 2000, Climate and Global Climate Change, Prentice Hall.
 Kump, L. R., Kasting, J.F., and Carne, R. G., 2004. The Earth System. 3 rd Ed. Prentice-Hall

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FOURTH SEMESTER
Core Course
Code-EnvSc-C401
ENVIRONMENTAL IMPACT AND RISK ASSESSMENT

Topics	Teaching Hours
UNIT-I	
1) Principles and procedures: Nature and purpose of environmental impact assessment (EIA), Worldwide spread of EIA. 2) Environmental impact assessment process, Screening, Scoping and Terms of References (TOR) 3) Impact assessment methodologies. 4) Baseline information, Generalized approaches to impact analysis and prediction	15
UNIT-II	
1) Identification of impacts, mitigation measures and comparison of alternatives. 2) Environmental impact assessment evaluation of proposed action 3) Environmental management plan and Environmental Impact statements 4) Procedure for reviewing, environmental impact analysis and statement.	15
UNIT-III	
1) Case study: River valley projects, thermal Power Plants, mining projects. 2) EIA guidelines 1994, notification of Government of India. 3) Guidelines of environmental monitoring audits. 4) Applications of geographic information system (G.I.S.) in environmental management.	15
UNIT-IV	
1) Risk assessment-Hazard analysis, hazards identification, vulnerability analysis, risk analysis. 2) Risk assessment and comparisons-risk and uncertainty, risks of new technologies, comparison of risks, contrasting risks. 3) Risk consequences : Impacts of serious accidents, uncertainty costs, signal incidents and risk probabilities : Human factors, organizational factors and external social factors. 4) Remote sensing : Principle and applications of remote sensing in environmental science.	15

Suggested Readings: Glasson J., Therivel R., Chadwick. A., 1994, Introduction to environmental impact assessment- Principles and procedures, process, Practice and prospects. Research Press, Delhi.
 Morris. P. & Therivel. R., 2001, Methods of environmental impact assessment, 2 nd Ed. Spon Press, New York, With a chapter on GIS and EIA by A.R. Bachiller & G. Wood, p. 381-401. Petts Judith, 1999, Handbook of environmental impact assessment. Vol. 1, Blackwell Science.



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FOURTH SEMESTER
Core Course
Code-EnvSc-C402
ENVIRONMENTAL MANAGEMENT AND LAWS

Topics	Teaching Hours
<u>UNIT-I</u>	
1) Environmental management: fundamentals and goals, standards, monitoring, Environmental auditing, types and general methodology of audit. 2) Modeling, And Environmental Management Systems, public participation for environmental management. 3) Environmental management and economics: greening of economics, evaluating the environment and natural resources, cost benefit analysis, green taxes, green funding, 4) Debt, structural adjustment and environment, trade and environmental management.	15
<u>UNIT-II</u>	
1) International Standardization Organization (ISO), EMS Certification, ISO 14000 Series, and ISO-14001 requirements, Difference Between ISO 14000 and ISO14001 Environmental Policy, and Relationship between ISO-9001 and ISO-14001. 2) Environmental protection: Issues and problems, national and international conventions: Stockholm conference 1972, Earth Summit 1992. Montreal Protocol 1987. 3) Policy for climate change: kyoto, carbon trading, carbon sequestration, carbon footprint, carbon credit and clean development mechanism. Provision of Constitution of India regarding environment [Article 48 A and 51-A(g)]. 4) Municipal Solid Wastes (Management and Handling) Rules, 2000. Hazardous waste management and handling rules, 1989. Biomedical Waste (Management And Handling) Rules, 1998 and amendment 2016.	15
<u>UNIT-III</u>	
1) The Environmental (Protection) Act, 1986 and rules 1986. 2) Air (Prevention and Control of Pollution) Act, 1981 as amended by 1987 and rule 1982. 3) The Water (Prevention and Control of Pollution) Act, 1974 as amended upto 1988 and rules 1975. 4) The Wildlife Protection Act 1972, amendment bill 1991.	15
<u>UNIT-IV</u>	
1) The Indian Forest Act, 1927 and Forest conservation Act, 1980. 2) The Public Liability Insurance Act, 1991 and rules 1991. 3) Scheme of labelling of environmental friendly products (Ecomark). 4) Motor Vehicle Act, 1988 and Vehicular exhaust emission standards, 1990.	15

Suggested Readings: Bell Stuart & Mc Gillvray Donal, 2001, Environmental Law, Universal Law Publishing Co., Diwan Shyam and Rosencranz Armin, 2002, Environmental Law and Policy. Hughes David, 1992, Environmental Law, Butterworths.

Jariwala C.M., 2004, Environmental Justice, APII Publishing Corporation, N. Delhi Leelakrishnan. P. 2004, Environmental Law Case Book, Lexis Nexis, Butterworths Mohanty. S. K., 2004, Environment and Pollution Law, Universal Law Publishing Co. Pvt. Ltd.

Singh Gurdip, 2004, Environmental Law in India, Mcmillan & Co.

Singh Gurdip, 2003, International Environmental Law, Macmillan

Shastri. S. C., 2005, Environmental Law, Eastern Book Company.


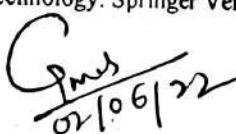
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FOURTH SEMESTER
Elective Course
Code-EnvSc-E403
ENVIRONMENTAL BIOTECHNOLOGY

Topics	Teaching Hours
UNIT-I	
1) Natural environmental of microorganisms, The terrestrial environment, aquatic and extreme environment. 2) General characters and basic classification of microorganisms. 3) Structure and growth of microorganisms as related to the environment. 4) Major groups of microorganisms.	15
UNIT-II	
1) Biotechnology for pollution abatement. 2) Use of microorganism in waste treatment and waste management. 3) Bioremediation: Remediation of degraded ecosystem. 4) Role of microorganisms in degradation of pesticides, chemicals, petroleum products and plastics.	15
UNIT-III	
1) Vermiculture technology. 2) Biofertilizer technology. 3) Role of microorganism in alcohol and acetic acid production, fermentation technology. 4) Composting and Biomethanation.	15
UNIT-IV	
1) Biotoxicity assays to evaluate Effectiveness of Bt spores against pest and beneficial insects. 2) Biological indicators and biosensors. 3) Bioenergy and biofuels. 4) Biopesticides and biofertilizers	15

Suggested Readings: Gardner, Simmonds, Snustad, 1991, Principles of Genetics. John Wiley, Eighth Edition.
 Mohapatra, P. K., 2006, Text Book of Environmental Biotechnology. I K International. Olguin, E., Sanchez, G. and Hernandez, E., 1999, Environmental biotechnology and cleaner bioprocesses, Taylor & Francis, London.
 Rittman, B. E., and McCarty, P. L., 2001, Environmental Biotechnology. Principles and applications. McGraw-Hill, New York.
 Scragg, A. H., 2005, Environmental Biotechnology. Oxford University of Press. Wainwright, M., 1999, An introduction to environmental biotechnology. Springer Verlag, New York.

FOURTH SEMESTER
Elective Course
Code-EnvSc-E404
ENVIRONMENTAL INSTRUMENTATION

Topics	Teaching Hours
<u>UNIT-I</u>	
Spectroscopy 1) Emission spectroscopy. 2) Atomic absorption spectroscopy 3) Flame photometry 4) Circular Dichromism Spectroscopy	15
<u>UNIT-II</u>	
Centrifugations 1) Principle 2) Types of centrifuges 3) Types of centrifugation 4) Ultra-centrifugation Air Monitoring Sampler 5) High Volume Sampler 6) Respirable Dust Sampler 7) Fine Particulate Sampler 8) Gravimetry and titrimetry	15
<u>UNIT-III</u>	
Chromatography 1) Paper chromatography, TLC 2) Column chromatography 3) GLC 4) HPLC	15
<u>UNIT-IV</u>	
1) pH meter 2) Photometry 3) Spectrophotometry 4) Nephelometry 5) Conductivity meter	15

Suggested Readings: Chatwal, Gurdeep R., Sham, Anand, K. 2016 Instrumental method of chemical analysis, Himalaya Publishing Comapany.

Chatwal, Gurdeep R, Sham, Anand, K 2016 Spectroscopy Himalaya Publishing Comapany

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Elective Course

Code-EnvSc-E405

ECOTOXICOLOGY AND ENVIRONMENTAL HEALTH

Topics	Teaching Hours
<u>UNIT-I</u>	
1) Principles in toxicology, aquatic and animal toxicity tests. 2) Statistical concept of LD50 and LC50. 3) Dose response and Dose effect relationship, Dose response curve. 4) Biological, chemical and ecological factors that influence toxicity.	15
<u>UNIT-II</u>	
1) Major classes of environmental pollutants – Heavy Metals, Gases, Pesticides and Fertilizers. 2) Biotransformation and it's processes. 3) Bioaccumulation and Biomagnification. 4) Toxicants effects – Cellular, Organismic, Population and Ecosystem level.	15
<u>UNIT-III</u>	
1) Biochemical teratogenicity and it's effect. 2) Carcinogenicity of environmental pollutants. 3) Environmental toxins and human health. 4) Microbial toxins.	15
<u>UNIT-IV</u>	
1) Water borne diseases, air borne diseases. 2) Vector transmitted diseases. 3) Food – borne diseases. 4) Occupational Health.	15

Suggested readings: Newman, M.C, Lawrence, C.A., and Unger. M.A., 2002. Ecotoxicology: Fundamentals of Ecotoxicology, 2 nd Ed., CRC Press, Boca Raton, Florida.

Walker, C.H., Hopkin, S.P., Sibly, R.M., and Peakall, D.B. 2001. Principles of Ecotoxicology. 2 nd Ed. Taylor & Francis, London.

Moore, G.S., 2002, Living with the Earth: concepts in Environmental Health Science (2 nd Ed.), Lewis publishers, Michigan.

Selinus, Alloway, Centeno, Finkelman, Fuge, Lindh, Smedley; 2005, Essential of Medical Geology; Elsevier Academic Press.

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FOURTH SEMESTER
Elective Course
Code-EnvSc-E406
ENVIRONMENTAL HAZARDS

Topics	Teaching Hours
UNIT-I	
1) Concept of geological hazards – continental drift theory. 2) Plate – tectonic theory. 3) Distinction between natural hazards and anthropogenic hazards. 4) Prediction and perception of hazards.	15
UNIT-II	
1) Geological Hazard :Earthquake, Earthquake destruction and prediction 2) Geological Hazard :Volcanism, Volcanic activity, Igneous activity and Material Extruded during eruption 3) Geological Hazard : Mass – movement, Landslide and its prediction 4) Geological Hazard: Tsunami. And its consequences, Mitigation measures and early warning	15
UNIT-III	
1) Hydrological Hazard: Floods and its types, River topography ,causes and its prediction 2) Hydrological Hazard: Drought and its types 3) Hydrological Hazard: Tropical Cyclones and Anticyclone, Hurricanes, Tornado 4) Atmospheric climatic hazards.	15
UNIT-IV	
1) Technological hazards: Bhopal, Three Mile Island and Chernobyl disasters. 2) Biophysical Hazard – frost, Epidemics. 3) Cloud Bursting and its consequences 4) Disaster management.	15

Suggested Readings: Bell. F.G, E & FN Spon, 1999, Geological Hazards: Their Assessment, Avoidance and Mitigation, e Books der ULB Darmstadt.

Burton. I, Kates. R.W and White. G.F, 1993, Environment as Hazard Guilford Press. Casale. R and Margottini. C. (Ed.), Springer, 2004, Natural Disasters and Sustainable Development

Hewitt. K., 1997, Regions of risk, Longman Press.

Henry J.G. and Heinke , G.W., 2004, Environmental Science and engineering, Pearson education, Delhi, India.

Keller. Edward A, 1996, Introduction to Environmental Geology, Prentice Hall, Upper Saddle River, New Jersey

Smith Keith, 2001, Environmental Hazards: Assessing Risk and Reducing Disaster, Routledge.

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