DAVANGERE UNIVERSITY

DAVANGERE-577007

COURSE SCHEME

AND

SYLLABUS FOR

MASTER OF SCIENCE

DEPARTMENT OF STUDIES IN EVIRONMENTAL SCIENCE

CHOICE BASED CREDIT SYSTEM

(2020-21 onwards)

SHIVAGANGOTRI
DAVANGERE UNIVERSITY
DAVANGERE-577007

M.Sc. in Environmental science
Semester scheme with Choice-Based Credit System (CBCS) Course Structure

I SEMESTER

Course	Paper Code	Paper Title	Hrs/ Week	Credits	Marks		Total
					Examination	Internal Assessment	
Core	Theory EVS-1.1	Environment and Ecosystem	4	4	70	30	**100**
	Theory EVS -1.2	Environmental Geosciences	4	4	70	30	**100**
	Theory EVS -1.3	Environmental Chemistry	4	4	70	30	**100**
Supportive	Theory EVS -1.4	Biodiversity and Wildlife Conservation	4	4	70	30	**100**
Core	Practical EVS-1.5	Environment and Ecosystem	4	2	40	10	**50**
	Practical EVS-1.6	Environmental Geosciences	4	2	40	10	**50**
	Practical EVS-1.7	Environmental Chemistry	4	2	40	10	**50**
Supportive	Practical EVS-1.8	Biodiversity and Wildlife Conservation	4	2	40	10	**50**
Mandatory credits: English language Communication skills			2	2			
Total				26	Marks		**600**

II SEMESTER

Course	Paper Code	Paper Title	Hrs/ Week	Credits	Marks		Total
					Examination	Internal Assessment	
Core	Theory EVS-2.1	Environmental Toxicology	4	4	70	30	**100**
	Theory EVS -2.2	Environmental Microbiology and Biotechnology	4	4	70	30	**100**
	Theory EVS -2.3	Radiation and Environment	4	4	70	30	**100**
Supportive	Theory EVS -2.4	Natural Resources and Management	4	4	70	30	**100**
Core	Practical EVS -2.5	Environmental Toxicology	4	2	40	10	**50**
	Practical EVS -2.6	Environmental Microbiology and Biotechnology	4	2	40	10	**50**
	Practical EVS -2.7	Radiation and Environment	4	2	40	10	**50**
Supportive	Practical EVS -2.8	Natural Resources and Management	4	2	40	10	**50**
Mandatory credits: Computer skills			2	2			
Total				26	Marks		**600**

Internal assessments for papers

1. Two sessional tests : 10Marks
2. Seminar/Tutorial/group discussions : 05Marks
3. Assignments/Filed work/submission of specimens : 05Marks
4. Attendance : 10Marks

Total : 30Mark

III SEMESTER

Course	Paper Code	Paper Title	Hrs/ Week	Credits	Marks		Total
					Examination	Internal Assessment	
Core	Theory EVS -3.1	Environmental Engineering	4	4	70	30	**100**
	Theory EVS -3.2	Environmental Sampling and Statistics	4	4	70	30	**100**
	Theory EVS -3.3	Environmental Pollution and Control	4	4	70	30	**100**
Specialization (Choice)	Theory EVS -3.4	A) Solid Waste Management B) Energy and Green Technologies	4	4	70	30	**100**
Interdisciplinary elective (Choice)	Theory EVS -3.5	Natural Resources and Conservation	2	2	40	10	**50**
Core	Practical EVS -3.6	Environmental Engineering	4	2	35	15	**50**
	Practical EVS -3.7	Environmental Sampling and Statistics	4	2	35	15	**50**
	Practical EVS -3.8	Environmental Pollution and Control	4	2	35	15	**50**
Specialization (Choice)	Practical EVS -3.9	A) Solid Waste Management B) Energy and Green Technologies	4	2	35	15	**50**
Total				26	Marks		**650**

IV SEMESTER

Course	Paper Code	Paper Title	Hrs/ Week	Credits	Marks		Total
					Examination	Internal Assessment	
Core	Theory EVS -4.1	Nanotechnology & Environment	4	4	70	30	**100**
	Theory EVS -4.2	Solid and Hazardous Waste Management	4	4	70	30	**100**
	Theory EVS - 4.3	A) Environmental Law, Audit, EIA and Occupational Health B) Climate Change and Current Issues	4	4	70	30	**100**
Specialization	Theory EVS -4.4	Dissertation	6	6	70	Viva*30	**100**
Core	Practical EVS -4.5	Nanotechnology & Environment	4	2	40	10	**50**
	Practical EVS -4.6	Solid and Hazardous Waste Management	4	2	40	10	**50**
Specialization	Practical EVS -4.7	A) Environmental Law, Audit, EIA and Occupational Health B) Climate Change and Current Issues	4	2	40	10	**50**
	EVS 4.8	**Study Trip**	-	-	-	-	**-**
Mandatory Credits : Personality Development			2	2			
Total				26	Marks		**550**

*Viva for Dissertation to be conducted at the time of end semester examination in presence of two examiners (One internal and one external)

1) Total Marks for the Course :2400
2) Total Credits for the Course: 104 (including mandatory course)

QUESTION PAPER PATTERN

Semester M.Sc. Degree Examination,
(CBCS Scheme-New Syllabus)
ENVIRONMENTAL SCIENCE
Paper ……..
Paper Code……..

Time: 3 Hours Max. Marks; 70

Note: *All parts are compulsory*

PART-A

1. Answer any **Five** of the following (2x5=10)
   a)
   b)
   c)
   d)
   e)
   f)
   g)

PART-B

Write short notes on **any four** of the following (5x4=20)

2.
3.
4.
5.
6.
7.

PART-C

Answer **any four** of the following (10x4=40)

8.
9.
10.
11.
12.
13.

Choice Based Credit System: Detailed Syllabus-2020-21 onwards

M. Sc. Environmental Science

FIRST SEMESTER

EVS 1.1: Environment and Ecosystem 64 hrs

Preamble: This paper introduces to students about concept of environment which helps to learn with complex interaction among organisms and between organisms and their environment. It makes to students understand ecological community together with its environment.

Unit 1: Environment: Definition of Environment and Ecology; Development and environment; Structure and functions; Closed and open systems; Degree of human disturbance- Natural system; Modified system and controlled systems; Growth Theory; Environmental limits; Environmental Crisis. -15 Hrs

Unit 2: Energy and Ecosystem: Definition; Types; Biotic and abiotic components; Ecological relationships; Energy of life; First and second law of thermodynamics; Concept of productivity; Food chain, food web and trophic levels; Ecological pyramids. -10 Hrs

Unit 3: Living and Physical Environment: Interaction of living organisms: Niche, competitive exclusion, Limiting factors, co-evolution, symbiosis-Mutualism, Commensalism, Parasitism; Changes in communities over time- primary and secondary succession- pioneer community, climax community; Biogeochemical cycles: Carbon cycle, Nitrogen cycle, Phosphorus cycle; Physical Environment: climate, Sun-solar energy, wind-atmospheric circulation, Oceanic currents, types, patterns and importance. -15 Hrs

Unit 4: Major Ecosystem of the World: Salient features and characteristics of biomes; major terrestrial biomes- Tundra, Taiga, Temperate forest, Grasslands, Deserts, Savanna, Tropical Rain Forests, Aquatic Biomes and Life zones. Freshwater ecosystems: Lentic and Lotic, Estuaries, Marine. -10 hrs.

Unit 5: Population and Biotic Community: Concept of population, community, biosphere; Population density: abundance, indices; Population attributes: natality, mortality, emigration, immigration, distribution; Population growth form and concept of carrying capacity, population regulation, dispersal, and population energy flow; Population interactions; Principles of Limiting factors; Liebigs law of minimum, Shelford law of tolerance; Ecological indicators; Human population explosion and consequences; Biotic community Concept, Intercommunity classification; Concept of Ecological dominance. Community analysis, Species diversity in communities, Patterns in communities; Ecotone and edge effect. -14 Hrs

Practical

Based on Theory paper

References

1. Biswarup Mukherjee, Environmental Biology, Tata McGraw Hill Co. Ltd., New Delhi.
2. Botkin, D. B and E. A. Keller, 2004. Environmental Science. 5th Ed. John Wiley and Sons
3. Cunningham, W and M.A. Cunningham, 2003. Principles of Environmental Science, 2nd Ed. McGraw-Hill, London
4. E. J. Kormondy, Concept of Ecology, Prentice Hall of India Pvt. Ltd.
5. E. P. Odum, Ecology a bridge between science & society, Sinauer associates.
6. E.P. Odum, Fundamental of Ecology, W.B. Sauders Company, USA.
7. Joseph, K and R. Nagendran, 2004. Essentials of Environmental Studies, 2nd Ed. Pearson Education, Delhi
8. P.D.Sharma, 2016, Ecology and Environment,12th Eddition, Rastogi Publications, New Delhi.
9. Santra S.C., Environmental Science, Central Book Agency Ltd., Kolkota

EVS 1.2: Environmental Geosciences 64 hrs

Preamble: This paper gives the information to students with the fundamental concepts of geo-science with improved understanding of the physical earth, geological processes, geological resources and environmental geology. It is enrich the student's knowledge on the meteorology and climatology and other importance for the existence of life on earth. Also gives the scientific knowledge among the students about various natural and man- made disasters through the teaching of policies, programs, administrative actions and operations undertaken.

Unit-1: Planet Earth: Theories of origin and age of the Earth; Plate Tectonics Plate Boundaries; Earth's Materials – Minerals and their definition; Distribution and abundance of elements in the major units of earth, Formation, Geochemical features and classification of Rocks; Mineral resources and Environment; Resources and reserves, depletion trends of natural resources; Mineral Resources and Conservation methods; Stratigraphy and Geological time, Geological features of India and Karnataka. **-15 Hrs**

Unit-2: Environmental Geochemistry: Concepts of major, trace and Rare Earth Elements (REE); Trace elements mobility and their Classification; Geochemical cycles; Biochemical factors in environmental health; World water balance, hydrogeology and geochemistry of surface and groundwater; water quality, use of water, conservation of water resources, impacts of climate change on water resource management. **-12 Hrs**

Unit-3: Land resources & management: Soil-characteristics, formation of soil, role of soil organisms in soil formation, types of soils. Land resources, land degradation cycle, land-use pattern, land reform, land use plan, soil surveys in relation to land use planning; methods of site selection and evaluation. **-10 hrs**

Unit-4: Disasters and Management - Definition of hazard, vulnerability, risk, disaster; Causative factors of disaster; Classification of disasters- Natural and Man Made; components of disaster management cycle-crisis management & risk management; Crisis management-quick response and relief, recovery, development; Levels of disasters in India; Causes, perception, management of various natural disasters like flood, landslides, earthquakes, tsunami, cyclones, volcanism, coastal erosion. **-15 Hrs**

Unit-5: Application of Remote Sensing and GIS: Scope, Concept of Remote Sensing and GPS; GIS for Environmental Planning and Management: Surface and Ground water, Watershed, Marine resources, Coastal zones, Wild life Ecology, Mining and Quarrying; Agriculture and rangeland management and applications; Earthquakes and flood mapping assessment. **-12 Hrs**

Practical

Based on Theory paper

References:

1. B. Padmanabha Murthy, Environmental meteorology, I.K. Interactional
2. C.W. Montgomery, Environmental Geology, Mc. Graw Hill Interactional.
3. Edward A. Keller, Environmental Geology, Prentice Hall, New Jersey.
4. Khadg Singh Valdiya, 2004, Coping with natural hazards; Indian context, Orient Longman Private limited Publication, Hyderabad.
5. Roger G. Barry and Richard J. Chorley, 2003: Atmosphere, Weather and Climate, 8th Edition, Routledge (Taylor & Francis group) London and New York.
6. Santra S.C., Environmental Science, Central Book Agency Ltd., Kolkota
7. Singh, K.K. &. Singh, A.K. 2010. Natural and manmade disasters: vulnerability, preparedness and mitigation, Vol (1&2), M.D. publications. Pvt. Ltd. New Delhi.
8. Strahler, A.N. and Strahler, A.H. 1973. Environmental Geo-science – Interaction between natural systems and man: -Santa Barbara, California, Hamilton Publishing.
9. Smith, E.L. 1984. Use of inventory and monitoring data for range management purposes. In: National Research Council/National Academy of Sciences. Developing strategies for rangeland management.
10. West, N.E., K. McDaniel, E.L. Smith, and S. Leonard. 1994. Monitoring and interpreting ecological integrity on arid and semi-arid lands of the western United States. Range Improvement Task Force, Las Cruces, NM.
11. Talwar, A.K. & Juneja, S. 2009. Flood Disaster Management, Commonwealth publishers, New Delhi.
12. Valdiya, K.S. 1987, Environmental Geology: Indian Context. Tata-McGraw Hill, New Delhi

EVS 1.3: Environmental Chemistry 64 Hrs.

Preamble: This introduce to students with the dynamics and principles of environmental Chemistry and their toxicological effects on environment and human health. Also it provides a clear knowledge about the principle and working of various analytical technique used in the environmental analysis to the students so that they can work with these tools effectively.

Unit 1: **Fundamentals of Environmental Chemistry**: Stochiometry, Gibbs'energy, chemical potential, chemical equillibria, acid bases reactions, solubility product, Solubility of Gases in Water, the Carbonate system, Atmospheric Chemistry: Chemical composition of air, Classification of elements, chemical speciation. Chemical processes for formation of inorganic and organic particulate matter; Thermo-chemical and photochemical reactions in the atmosphere; CFC's and Ozone chemistry, chemistry of air pollutants, photochemical smog. **-14 hrs**

Unit 2: **Soil Chemistry:** Soil profile, distribution of inorganic and organic components in soil, Chemical properties of Soil - Saline, Acidic and Alkaline soils; Major micro and macro nutrients of soil, Nutrient Pathways - Nitrogen, Carbon, Phosphorus and Potassium pathways in the soil. **-10 hrs**

Unit 3: Water chemistry: properties of water, water pollutants- types sources heavy metals metalloids-organic, biological and radioactive- types of reactions in various water bodies including marine environment. Chemistry of oil based and water based paints, physicochemical basis of redox processes. **-10 hrs**

Unit 4: **Chemistry of Environmental Contaminants –**Air, Water: Pesticides in water, PAN, Pesticides, Insecticides, MIC and Carcinogens in Air, Water and Soil. Chemical nature and properties of selected environmental contaminants; Polychlorinated biphenyls; chloroorganic compounds (Organochlorine : DDT and BHC, organo phosphate: parathion and malathion) **-14 hrs**

Unit 5: **Instrumentation and Analytical Techniques**: Role and importance of analytical techniques in analysis of environmental samples. Titrimetry; Gravimetry, Conductometry, pH, Colorimetry, Spectrometry, UV-Vis and IR Spectrophotometer and AAS; Nephelometry, Flame Spectrometry and fluorimetry; Chromatographic techniques: Paper, Thin Layer, GCMS, LCMS, HPLC, X-ray florescence, X-ray diffraction, PCR, SEM, TEM. **-16 hrs**

Practical
Based on Theory paper

Reference Books:

1. Sharma B.K and Kaur H. (1995). Environmental Chemistry, I Ed., Goel Publishing House.
2. De A.K (1989). Environmental Chemistry, II Ed., Wiley Eastern Limited.
3. Sawyer C.N, Mc Carty P.L and Perking G.F. (1994). Chemistry for Environmental Engineering, IIEd, Mc Graw- Hill.
4. Bailey, R.A. (1978). Chemistry of the Environment, Academic Press.
5. Tyagi O.D. and Mehra M. (1990). Text Book of Environmental Chemistry, I Ed., Anmol Publications.
6. Charles R. Goldman and Alexander J. Horene. (1983). Limnology, Mc Graw- Hill.
7. Roy L. Donahue, Raymond W. Miller and John C. Shickluna. (1987). Soil-An Introduction to soils and plant growth V.Ed., Prentice-Hall of India.
8. Biswas T.D and Mukherjee S.K. (1987). Text book of Soil Science IV Ed., Mc Graw- Hill.
9. Vogel's Textbook of Quantitative Inorganic Analysis. (1978). IV Ed., Longman Group Ltd.
10. Jacobs. (1969). Analytical Chemistry of Industrial poisons. Hazards and solvents, M.B. Inter Science. New York.
11. Sawyer C.N, Mc Marty P.L. and Perkin G.F. (1994). Chemistry for Environmental Engineering (II ed), Mc Graw Hill.
12. Tyagi O.D. and Mehra M. (1990). Environmental Chemistry, Anmol Publications.
13. Manahan S.E. (2000). Environmental Chemistry (7th Ed), Lewis Publications, Florida, U.S.A.
14. Santra S.C., Environmental Science, Central Book Agency Ltd., Kolkota

EVS 1.4: Biodiversity and Wildlife Conservation 64 Hrs

Preamble: This paper provides the students with the necessary knowledge and skills in the areas of Biodiversity, conservation and management. In particular, this paper emphasis on the consequences of excessive and unscientific utilization of wildlife resources for human comfort and imparts the ways of biodiversity and wildlife conservation, sustainable developments of healthy planet earth.

Unit-1: Biodiversity: Definition, Source of food and improved varieties; Source of drugs and medicines; Aesthetics and cultural benefits; Sustainable development; Ecosystems services; Biodiversity hot spots of world & India and strategies for its conservation; Convention of Biological Diversity (CBD) and Agenda 21, National parks and sanctuaries, biosphere reserves; Ecological indicators. Endemic and RET species, Concept of keystone & flagship species; Biodiversity of agro-ecosystems and sacred grooves; -15HRS

Unit-2: Global Agreements and National Concerns: Endangered, Endemic and Extinct Species of India; Indian perspectives; Threatened species categories of IUCN, CITES, Red data books, threatened species of plants and animals in India and their reasons, -10HRS

Unit-3: Wildlife: Definition, General importance; Reasons for depletion of wildlife; Conservation and community conflicts; Regulations and practices of legal trade in wildlife products; Debates over the ownership of biodiversity and links to traditional knowledge; Gender and biodiversity management. -10HRS

Unit-4: Forest ecosystem: Forest influence on Climate regulation, flood & soil erosion control and wildlife habitat protection, maintaining hydrology, nutrient cycling and moisture conservation; Green belt and its influence on urban environment; Carbon sequestration and Kyoto convention; Effect of fire on forest ecosystem-soil moisture, nutrient content, micro & macro fauna, wildlife habitat. -15HRS

Unit-5: Wildlife Resource Conservation: Protected Areas Network in India: Goals of management, Strategies for planning; Wildlife habitat management-In-situ and Ex-situ conservation of Biodiversity in India; Conservation of key wildlife species-project tiger, project elephant, crocodile project; Role of Non Governmental Organizations in wildlife and forest conservation; Salient Features of Forest Act. – 14HRS

Practical

Based on Theory paper

References:

1. Dadhich.L.K. and A.P.Sharma, 2002. Biodiversity – Strategies for Conservation , APH publishing corp. New Delhi.
2. Khan. T. I and Dhari. N Al-Ajmi,1999. Global Biodiversity Conservation measures –, pointer publishers, Jaipur
3. Krishnamurthy. K.V An Advanced Text book on Biodiversity-Principles and Practice, Oxford and IBH publishing, New Delhi (2003)
4. B.B. Hosetti . 2013. Concepts in Wildlife Management 3rd revised and enlarged edition, Daya publishing House, Astral International (P) Ltd.
5. E.P. Odum, Fundamental of Ecology, W.B. Sauders Company, USA
1. Agarwal & Rana S.V.S. 1985. Environment & Natural resources, society of Biosciences.
2. Agarwal, V.G. 1985. Forests in India. Oxford and IBH, New Delhi.
3. Berthkur, S. and Ghosh, A.K. 1987. Biological pest 18. simons, I.J. eds. 1986. The ecology of natural resources.
4. Negi, S. S. 1986. Handbook of social forestry. IBH, New delhi.
5. Oliver S. Owen (1980), Natural Resources conservation - An Ecological approach, 3rd Ed., Macmillan Publishing Co.Inc. New York.
6. Raymond f. Dasmann 1984. Environmental conservation, 5th eds. John wiley & Sons.
7. Santra S.C., Environmental Science, Central Book Agency Ltd., Kolkota
8. Sapru R.K. 1987. Environment Management in India. Vol. I & II. Ashish Pub. House.
9. Shrikande R.P. and Varade S.R. 1991. Ecology of water and land management vol. 1 & 2, Chugh publishers.

SECOND SEMESTER:

EVS-2.1 Environmental Toxicology 64 hrs

Preamble: This paper providing to students with an advanced, multi-disciplinary and current understanding of the effects of chemicals on human and environmental health. It throws light on nature and types of toxins and their sources and flow in the ecosystems and their affect on the living organisms. It also provides the knowledge about a assessment of toxins and effective control measure to minimize the concentrations, accumulation of toxins in environments and also their hazardous effect of living organisms.

Unit-1: Introduction to toxicology: scope of toxicology, subspecialties of toxicology, Description and terminology of toxic effects, factors influencing toxicity, drug toxicity, biochemical basis of toxicity-mechanism of toxicity and receptor mediated events, acute and chronic toxicity; Selective toxicity; Concentration and dose, synergism and antagonism. -14 Hrs

Unit-1: **Toxicology**: Definition; Scope and basic division of eco-toxicology. Basic concept of eco-toxicology; Microbial toxins and their monitoring Eg.: Diphtheria toxin, Hemolysin, anthrax toxin, Clostridium toxin, Botulinum toxin; Plant (algal, fungal and higher plant) and animal toxins- classification, nature and chemistry of toxins; Action of poison on Human. -10 Hrs

Unit 2: **Environmental Toxicants**: Background Chemistry and toxicity of heavy metals; persistent bioaccumulative and toxic compounds-pesticides, dioxin and furan, flame retardant, polychlorinated hydrocarbons, polychlorinated biphenyls (PCBs), Polycyclic Aromatic Hydrocarbons (PAHs); Radionuclides, Trace elements; Acute and chronic toxicity. Factors influencing the toxicity: Duration; Dose and dosage, dose response relationships, interactions of toxicants, statistical concept of toxicity; margin of safety, toxicity curves. - 15 Hrs

Unit-3: **Elimination of Toxicity**: Uptake of toxicants; biological magnification: Bio-concentration, Bioaccumulations and biotransformation; Detoxification process and accumulation- biochemical toxicology-Organic Compound Detoxification, Biomarkers; Metallothioneins, Stress Proteins, Oxidative Stress and Antioxidant Response, DNA Modification, Enzyme Dysfunction and Substrate Pool Shifts. Bioaccumulation of pesticides in aquatic and terrestrial organisms, invertebrates, livestock and poultry, birds and human beings- milk, adipose tissue, blood, factors affecting the bioaccumulations; Methods employed to measure bioaccumulation. -15 hrs

Unit 4: Effect of Environmental Contaminants: Introduction, Cytotoxicity and histopathology: Gene and Chromosome Damage, Cancer. Sublethal effects to Individuals: growth, development, reproduction, physiology, immunology, behavior, detecting sublethal effects. Acute and chronic lethal effects to individuals: Effects on populations: population dynamics and demography, metapopulations, population genetics; Effects of contaminants on community, ecosystem, landscape and global effects. -12 hrs

Unit- 5: **Risk Assessment of Contaminants**: Contaminants-definition, emerging classes of contaminants; Effects of contaminants-Endocrine disrupting chemicals, agro-chemical and industrial contamination; Contamination and effect of Lead, Arsenic, Copper and Nickel in drinking water; Introduction to risk assessment, scope and importance; Population, community and ecological Risk assessment; Human risk assessment. -12 hrs

Practicals:

Based on Theory paper

Reference:

1. Anderson, D and D.M.Conning. 1990. Experimental Toxicology: The Basic issues. Royal society of Chemistry, London.
2. Dhaliwal, G.S. 1993. Pesticides: Their Ecological Impact in Developing Countries. Commonwealth Publishers, New Delhi.
3. Guithinier Perry. (1980). Introduction to Environmental Toxicology, Elsevier.
4. Moriarty, F. 1999. Ecotoxicology, 3rd ed. Elsevier Pub.
5. Peter Calow, 1993. Handbook of ecotoxicology, Blackwell Science, London.
6. Timbrell, J. 2003. Principles of Biochemical toxicology, CRC Press.

EVS-2.2: Environmental Microbiology and Biotechnology 64 hrs

Preamble: This Paper introduces to students about various scopes of environmental microbiology and biotechnology in environmental protection information on how to improve understanding, identification and prevention of environmental problems, remediation & restoration through microbial and biotechnological methods. It is emphasis on identification and enumeration of microbes in these environments and also providing information on how to improve understanding, identification and prevention of environmental problems, remediation & restoration through biotechnological methods.

Unit 1: Introduction: Concepts and scope of environmental microbiology and biotechnology in environmental protection; Microorganisms as components of ecosystem; Classification and characteristics of microorganisms based on their habitat; Microbial interactions with micro- and macro-organisms; Role of microorganisms in element cycles. -10 hrs

Unit 2: Microbial diversity of environment: Microbes in air, water, wastewater and soil; distribution, sampling and measurement techniques and identification; Microbes of extreme Environment; Mechanisms of adaptation by microorganisms to environmental extremes; Indicator microorganisms and their measurement - MPN and MF technique. -12 hrs

Unit 3: Food and Medical Microbiology – Microbes as food and probiotics and for production of value added fermented products- dairy products, beverages and medically important enzymes, proteins and antibiotics. Microbial diseases: air-borne allergens and diseases; Waterborne- soil borne- and food borne-diseases. Microbial contamination in hospital environment - Nosocomial infections: salient features and control strategies. -15 hrs

Unit-4: Bioremediation: Definition; Concept and Scope; Types; Applications in abatement of solid, liquid and gaseous pollution problems, heavy metals and radioactive substances; Phytoremediation- mechanism involved with case studies, Biotechnology and heavy metal pollution; Improved oil recovery; Biotechnology and oil spills; Hydrocarbon degradation -12 hrs.

Unit-5: Mutation and Environmental mutagens: Occurrence, kinds of Mutation, spontaneous and induced Mutation, Mutagens, detection of Mutation, Lethal Mutations, Phenotypic effects of Mutation, Mutation rate, Significance & Practical applications of Mutation; Molecular basis of Mutation, mutagenic agents -physical, chemical, biological, Effect on genetic material, Repair mechanisms. -15 hrs.

Practicals:

Based on Theory paper

References:

1. Environmental Microbiology Principles and Applications. Patrick K.Jemba.
2. Environmental Microbiology By. P D Sharma
3. Environmental bioremediation technologies. Shree N. Singh, Rudra D. Tripathi
4. Environmental Microbiology. Raina M. Maier, Ian L. Pepper, Charles P. Gerba -Science.
5. Text book of Environmental, Microbiology, Mohapatra – Technology & Engineering.
6. I.L. Pepper and C.P. Gerba, Environmental Microbiology-A Laboratory Manual, second edition: 2004, Elsevier Academic Press 30 Corporate Drive, Suite 400, Burlington, MA 01803, USA
7. Santra S.C., Environmental Science, Central Book Agency Ltd., Kolkota
8. Rein Heimer G., Aquatic Microbiology, Jhon Wiley, New Yaork
9. Mason C.F Biology of Fresh Water Pollution, Long Man, Scientific and Technology, UK
10. Evano, G.H. and Furlong, J.C. Environmental Biotechnology – Theory and Application. John Wiley and Sons, USA. 2004.
11. Rittman, B. and McCarty, P. L. Environmental Biotechnology: Principles and Applications. 2nd edition. Tata McGraw-Hill, USA. 2000.
12. Rittmann, B.E. and McCarty, P.L. Environmental Biotechnology – Theory and Application. McGraw Hill, USA. 2001.
13. Evano, G.H. and Furlong, J.C. Environmental Biotechnology – Theory and Application. John Wiley and Sons, USA. 2004.
14. Rittman, B. and McCarty, P. L. Environmental Biotechnology: Principles and Applications. 2nd edition. Tata McGraw-Hill, USA. 2000.

EVS2.3 Radiation and Environment 64 hrs

Preamble: This paper providing to students with current understanding of the natural and anthropogenic sources of radioactivity and distribution in environment and their effect on plants and animals. It also provides the knowledge about radiation protection and control measures.

Unit-1: The Radiation: Introduction; cosmic radiation; natural and anthropogenic sources of radioactivity and distribution in environment- rocks and soils, uranium and thorium ores, the atmosphere, water, food and building construction materials; Application of stable nuclides, radionuclides and ionizing radiations in the study of earth and its environment; diagnostic; medicine and other applications; Radiation physics; isotopes; radioactive elements; unit of radiation: Radiation detection and dosimetry. Nuclear energy and nuclear fuel cycle, effect of nuclear cycle on environment. -14 Hrs

Unit-2: Radiation chemistry: Ionizing and non-ionizing, microwave and fallout radiation; Effect of radiation on plants and animals**;** abnormalities and population decline; Radiation pollution: hazards of radio-active wastes; Radio isotopes and their applications-food; agriculture; medicine; industry; Industrial radiography; Radiation detection, measurements and radiation standards; Radioactive decay; Risk and benefits of radiation. -16 Hrs

Unit-3: Radiation protection and control measures: Monitoring and preventive measures: prevention at source; nuclear reactor safety measures; nuclear power plant safety measures; Occupational radiation exposure; safety measures in industry and medicine. -10 Hrs

Unit-4: Disposal of Radioactive Waste: Characterization of radioactive waste, storage and disposal; Waste Storage of waste and disposal technologies: Calcinations; vitrification; crystalline ceramic forms of stages. Disposal: space disposal; ice disposal; partitioning and transmutation; offshore disposal of waste; Drilled emplacement; Ocean dumping. Radio-active Waste management programmes. Current practices disposal of radioactive wastes in different sectors. -14 Hrs

Unit 5: Radiation Hazards episodes: Pattern of accidents and causes. Important episodes: Hiroshima and Nagasaki, Bikini atoll episode; Three Mile Island episode; Chernobyl accident; Fukushima (Japan) nuclear disaster 2011; Marcoule (France) Nuclear Accident 2011. -10 hrs

Activities: Compulsory field visit to mining area.

Practicals:

Based on Theory paper

References:

1. Chandler, S. D. Radioactive waste control and controversies. Vol-3. Gordon and Bleach Science Publishers.
2. Clare Smith: 2001. Environmental Physics, Routledge publications, 11 New Fetter Lane, London EC4P 4EE
3. Dzelalija. M.:2004 Environmental Physics, University of Molise, University of Split, Valahia University of Targoviste
4. Kopkar, S. M. Environmental Pollution – Monitoring and Control. New Age International Ltd, New Delhi
5. Miller, G.T. Environmental Science-An Introduction, Wadsworth Publishing Company, California
6. Murugeshan, R. Modern Physics. S. Chand & company, Ltd.

EVS 2.4: Natural Resources and Management 64 Hrs.

Preamble: This paper will provides basic knowledge about the kinds of natural resources, their sources and reserves on the planet earth, their role in homeostasis of environment and ecosystem and the consequence on their exploitation. It imparts the knowledge on the importance of conservation of natural and nonrenewable resources for the sustainable normal life on the earth. It also throws light on methods water, soil, minerals, forest and energy conservations and human's role.

Unit-1: Natural Resources-Classification, concepts and approaches of natural resource conservation; Natural resources of India; Role of women in natural resource. -8 Hrs

Unit-2: Water and Forest Resources Management - Concept and classification, Integrated water resource management; Participatory watershed development; rain water harvesting; National Lake and River Conservation Programmes. Wetland management; Forest resource Management: Relevance, threats and need for conservation of forest resources; Forest management – meaning and objectives. Forest - land use changes in India - future demand of forestlands;Community forest management, Social forestry, agro-forestry. -14 Hrs

Unit-3: Minerals and Soil Resource management: Resources and reserves; Mineral and population. oceans as new areas for exploration of mineral resources. oceans ore and recycling of resources; Soil resource management – Soil loss, soil erosion; Role of organic matter and its maintenance, diagnosis of nutrient deficiencies; Wasteland development – concept scope, issues and strategies. -14 Hrs

Unit-4: Conventional and Non-conventional Energy Sources: Energy content in various conventional energy sources, Types; Principles of solar thermal energy conversion; Principles of generation of wave energy, tidal, ocean thermal energy conversion, wind, geothermal energy, nuclear - fission and fusion; magneto hydrodynamic power, Power generation from waste. Biogas plants - principles of generation, designs, application of biomass technology to increase the hydrocarbon chain; Pyrolysis; Biogas from solid waste; Biofuels. -14 Hrs

Unit-5: Pest and weed management - Definition, distribution and damage caused; Chemical Pesticides and their demerits. Basis of biological pest suppression; Chemical vs biological control; Pest control models; Organisms used in Classical Biological pest control – Pathogens, Nematodes, Birds, Fish; Definition and distribution. Weed biology - a brief account; Physical and Chemical Methods of Weed control and their merits and demerits. Weed Management - Objectives of Biological control, agents of biological control. -14 Hrs

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1. Oliver S. Owen. 1980. Natural resources conservation – An Ecological approach, 3rd edition., Macmillan publishing Co. Inc. New York.
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3. Sapru R.K. 1987. Environment Management in India. Vol. I & II. Ashish Pub. House.
4. The state of India's Environment, The second citizen's report (1984-85). Center for science and environment. New Delhi.
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8. Shrikande R.P. and Varade S.R. 1991. Ecology of water and land management vol 1 & 2, Chugh publishers.
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10. Mathur H.S. 1981. Environmental resources. The crisis of development, RBSA Publishers
11. Agarwal, V.G. 1985. Forests in India. Oxford and IBH, New Delhi.
12. Negi, S. S. 1986. Handbook of social forestry. IBH, New delhi.
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15. Berthkur, S. and Ghosh, A.K. 1987. Biological pest 18. simons, I.J. eds. 1986. The ecology of natural resources.
16. Shafi, R. 1992. Forest ecosystem of the word.
17. Nalini, K.S. 1993. Environmental resources and management. Anmol publishers.
18. Aradhana, P.S. 1991. Environnemental management. Rajat publishers.

THIRD SEMESTER

EVS - 3.1 Environmental Engineering 64 hrs

Preamble: This paper providing to students to acquire knowledge on the technology and principles behind the processes and techniques related to the reduction of emissions to air, land and water and the effects of pollution. Also Engineering solutions to major environmental problems will be explored.

Unit-1: **Environmental Engineering:** Introduction and Scope of Environmental Engineering, Water and Wastewater standards for specific applications. Water purification processes in natural and Engineered Systems. Water Supply - Design and layout of water distribution systems. Ground water recharge, Design and planning for watershed management. **-12 hrs**

Unit-2: **Water Treatment Process:** Mechanism and Significance of Aeration, Coagulation, Flocculation, Sedimentation, Filtration. Disinfection-Chlorination (methods), Ozonation and UV; 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 Iron, Manganese and other metal ions in water, Occurrence of Fluoride in water, Significance and methods of removal of hazardous metal ions; Chemical Treatment of Defluoridation and Mechanism Health Effects. **-14 hrs**

Unit-3: **Wastewater Treatment** - Primary, Secondary and advanced treatment: Classification and application of physical Unit processes with principles and process analysis, Design and layout of Industrial and Municipal wastewater treatment systems, Wastewater Disposal and Reuse. **-10 hrs**

Unit- 4: **Air Pollution control –**Air pollution Standards, control by dilution, its limitations, control by process changes, control by engineered systems for fixed sources; Control of particulate emissions - settling chambers, centrifugal collectors, wet collectors, fabric filters and Electrostatic precipitators, their principles, techniques and devices; Control of gaseous contaminants - Adsorption and Absorption techniques; Condensation and combustion techniques; Control of Automobile emissions. **-14hrs**

Unit-5: **Soil Pollution Control: –** Introduction, sources, types of soil pollutants and their control measures; Recent advances in Disposal of Hazardous Waste, Recovery and recycling of useful solid wastes control measures for soil erosion and land reclamation; Energy conversion from agricultural waste generation; Advanced technologies for abating the pollutants. **-14hrs**

Practicals:

Based on Theory paper

Reference:

1. Duggal,K.N.1998.Elements of Environmental Engg..Chand and company Ltd.,New Delhi.
2. Kapoor,S.1997. Environmental Engineering. Khanna publishers,Delhi.
3. Masters ,G.M. 1991.Introduction Environmental Engineering and Science. Prentice-Hall of India Pvt. Ltd.,
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8. Arcadio P. Sincer and Gregoria. A Sincers Enviromental Enginnering – A design Approach. Prentice Hall of India Pvt. Ltd., New Delhi.
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10. Christian R.K. Chemical and Biological Methods for Water Pollution Studies, Prentice Hall of India Press.Company, New Delhi.
11. Nandini N, Sunitha N and Sucharita Tandon. (2007). Environmental Studies, Sapna Book House, Bangalore
12. De A.K. Environmental Chemistry, Wiley Eastern Limited, New Delhi.
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14. Garg S.K. Sewage disposal and air Pollution Engineering Khanna Publication.
15. Gilbert M. Masters. Introduction to Environmental Engineering and Science, Prentice – Hall of India Pvt., Ltd.
16. Raju. BSN., Water supply and waste water engineering, TATA McGraw Hills.,

EVS-3.2 Environmental Sampling and Statistics 64 hrs

Preamble: This paper introduces students to Environmental analysis, it comprises the processes which scan, monitor, analyze, and forecasts the variables of the environment. The paper provides a clear knowledge about the working principles applications of various analytical techniques used in the environmental analysis to the students so that they can work with these tools effectively.

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 using Respirable Dust sample/High Volume Air Sampler. **- 12 hrs**

Unit 2: Water Sampling: Necessity of Water Sampling, Objectives, Selection of Sampling Site, Types of Water Samples, Sampling Equipment, Collection methods, , Handling and Preservation, Classification of Water Quality Parameters (Inorganic, Organic and Nutrient), Parameters analyzed on the Spot, (Field Parameters) Data Interpretation, Basic Concept, Significance and Measurement of DO, BOD, COD, Phenol, Pesticides and Polynuclear Aromatic Hydrocarbon (PAH) in Water and Wastewater. **- 12 hrs**

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, Preparation of Soil Samples for Analysis, Physico-Chemical Parameters and their Significance (Quality and Productivity). **- 08 hrs**

Unit-4: Application of Statistics in Environmental Analysis: Introduction to statistics, scope, limitations of statistics and statistical method V/s Experimental method. Collection of data, sampling, classification and tabulation of data. Diagrammatic and graphic presentation of data. Descriptive Statistics: Descriptive statistics – Introduction, measure of central location, mean, mode, median, measure of shapes. Properties of mean, measure of spread, variance and standard deviation, co-efficient of variation. **-16 hrs**

Unit 5: Sampling theories and Hypothesis testing: Sampling theories, techniques and experimental designs. Testing hypothesis: Significance level and X^2 test, t and F test; Correlation, regression and ANOVA: Analysis of variance: One way and two way ANOVA, MANOVA. Regressions: Defining the fit, Correlation, polynomial regression, Multiple regression. **-16 hrs**

Practicals:

Based on Theory paper

Reference:

1. Biostatistics: P.N. Arora, P.K. Malhan, Himalaya publishing House, Delhi, 2008.
2. Basic concepts of Biostatistics: N.Arumugam, Saras Publications, Kanyakumari, 2003.
3. Biostatistics in theory and Practice: T.K.Saha, Emkay Publications, Delhi, 1992.
4. Biostatistics: P. Ramakrishnan, Saras Publications, Kanyakumari, 1995.
5. Statistical Methods: S.C.Gupta, S.Chand & Sons Publishers, New Delhi, 1997.
6. Evolution Biostatistics AND Computer Applications: A.Gopi, A.Meena, N.Arumugam, Saras Publications, Kanyakumari, 2003.
7. Fundamentals of Computer: V.Rajaraman, Prentice Hall of India, New Delhi, 2008.
8. Computer Fundamentals: Pradeep K.Sinha, Preeti Sinha, BPB Publications, New Delhi, 2007.
9. Santra S.C., Environmental Science, Central Book Agency Ltd., Kolkota

EVS-3.3: Environmental Pollution and Control 64 hrs

Preamble: This paper deals with different aspects of environmental contamination, which have adverse effects on human health. It will lay emphasis on understanding mechanisms of pollutants impacting human health by developing an understanding of different types of pollutants, their sources and mitigation measures.

Unit 1: Air pollution: Definition, Sources and Classification of air pollutants. Major Incidents of Air pollution. Transport and diffusion of pollutants. Gas laws governing the behavior of pollutants in the atmosphere. Meteorological parameters, scale of meteorology, Effect of pressure temperature, precipitation, humidity, 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. Effects of air pollution on man, animal, plants, inanimate objects and climate. Ambient air quality standards and air pollution indices. -13 hrs

Unit 2: Air sampling and monitoring techniques - settle able and suspended particulate matter - Dust fall jar and Impingement Method, RDS/HVS samplers (Ambient Air monitoring); Stack gas/dust Sampling technique and other techniques of air monitoring for pollutants. Automobile pollution in Indian cities. Monitoring and control of exhaust emissions. 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. -13 hrs

Unit 3: Aquatic Pollution: Definition; Sources and classification of aquatic pollutants. Cause and consequences of pollution on surface, subsurface and marine water sources. Coastal water intrusion. Oil leakage and industrial effluents. Water quality indices. Thermal pollution: Sources, causes and effects. Preventive and Control measures. -14 hrs

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. Physico-chemical and bacteriological analysis of different soil. Industrial waste effluents and heavy metals, their interactions with soil components. Integrating of soil pollution control Measures-Physical, Chemical and biological etc., -14 hrs

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. - 10 hrs

Practicals:

Based on Theory paper

Reference:

1. Nandini N, Sunitha N and Sucharita Tandon. (2007). Environmental Studies, Sapna Book House, Bangalore
2. Stern A.C. (1986). Air Pollution Vol.I-VIII, Academic Press.
3. Henry C. Perkins. (1974). Air Pollution, Mc Graw Hill.
4. William L. Donn. (1975). Meteorology 4th Ed., Mc Graw Hill.
5. Furry R, Baddel.R and Haurker L. (1985). Air Pollution and Lichens.
6. Mansfiels M.R. (1989). Effects of air pollutants on plants.
7. Lodge. (1994). Methods of air sampling and analysis.
8. Trivedy R.K and Goel P.K. (1995). An Introduction to air Pollution, Techno 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 P and Venkattasubbayya N. (1990). Air pollution and Control. Divyajyothi Prakashan, Jodhpur.
13. Santra S.C., Environmental Science, Central Book Agency Ltd., Kolkota

EVS-3.4A Solid Waste Management 64 Hrs

Preamble: This paper provides an overview of the basic concepts of solid wastes, their generation and hazards on environment and living organisms. Students will learn Characteristics and collection system of different solid wastes, their separation, processing and conversion. Disposal of wastes by sanitary land filling and by advanced methods. This throw lights on kinds of Hazardous Wastes and their management. Waste Minimization; Pollution Prevention and control strategies

Unit 1 -- Introduction: scope and concept of solid waste management; definitions, kinds of wastes, and their sources, characteristics and composition; solid wastes generated per capita- Global and National scenario. Introduction to Solid Waste management. -12 Hrs

Unit 2 – Municipal solid wastes: Introduction and defination, solid wastes: generation, sources, collection, Storage, segregation and transportation. Disposal methods-sanitary landfills and types, composting, vermin-composting, aerobic and anaerobic digestion, incineration, types of incineration, pyrolysis. -13 Hrs

Unit 3– Industrial and Agricultural solid wastes: Introduction, characteristics, sources and classification; collection, segregation, storage and transportation; Reuse, recycling, treatment and disposal methods. E-wastes: definition, sources, segregation, recycling, reuse, storage and methods of disposal. Classification of hazardous waste and handling of hazardous solid wastes. Radioactive wastes- sources, pollution, types of radioactive waste and its control and management. -13 Hrs

Unit 4 - Biomedical wastes: Concept and scope of medical waste; Definition, sources, classification of medical solid wastes; Mode of collection, segregation at source and transportation to disposal points; awareness, education and training for generators and handlers of medical wastes; Advances in handling disposal of biomedical waste and their disposal. -13 Hrs

Unit 5 – Solid Waste management – waste minimization program, typical material recovery facility (TMRF) operation, Reuse and recycling of paper, glass, metals, plastic and rubber. Advanced techniques for conversion of waste to wealth. Plastic waste status in India, effect of plastic wastes on environment, management of plastic waste. Bring awareness in the public on generation and disposal of solid wastes and 4R's concept. -13 Hrs

References

1. Botkin, D. and E. K. Future, 1995. Environmental Science – Earth as a living planet
2. Sindhu, P. S. 2004. Environmental chemistry. New Age Int. Publishers
3. Wright R. T. and B. J. Nebel. 2002. Environmental science – towards sustainable future. Prentice Hall India Pvt. Ltd. New Delhi
4. Abbasi, S. A. and E. Ramasami, 1996. Biotechnological methods of pollution control.
5. Cunningham, W. P. and M. A. Cunningham, 2003. Principles of Environmental Science. Tata McGraw Hill Publ. New Delhi
6. Trivedi, P. R. and G. Raj. 1992. Solid waste pollution. Akshadeep Publishing House, New Delhi
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8. Brumer, R. Calvin, 1993. Hazardous waste incineration, McGraw Hills, Singapore
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11. Anonymous, 1973. Health hazardous of Human Environment, WHO
12. Reinhardt, P. A and J. G. Gordon, 1991. Infectious and medical Waste management, Lewis Publ. New York
13. Santra S.C., Environmental Science, Central Book Agency Ltd., Kolkota

EVS 3.4B Energy and Green Technologies 64 hrs

Preamble: This paper providing to students with concepts of energy, energy management and green technologies. Students will have an understanding of energy sources, knowledge of working principle of various energy systems Capability to carry out basic design of renewable energy systems and green technology for environmental conservation.

Unit- 1: Introduction: Renewable energy sources, non-renewable energy sources, non-conventional and inexhaustible energy resources. Geothermal energy, wind driven power station, Tidal power plants, Glacier power plants, solar energy.

Unit -2: Energy management : solar energy input conventional fuels – oil, coal, natural gas, uranium, risk of nuclear accidents, bio energy – biomass and biofuels, biogas- biogas technology, petroplants energy plantations and crops. Waste as renewable sources of energy- types of waste, classification based on chemical nature and physical state, composition of the waste, conversion of methane in to synthetic gas, factors effecting methane formation.

Unit-3: Bio-oils and Composting: Materials and Methods and its applications, Alcoholic Fermentation Process, Technologies and its applications. Composting Process Material and operational, Parameters, characteristics of manure, applications. Vermi-composting: Process, Types of Species, Materials and Methods, Characteristics of Manure, Applications.

Unit-4: Green Energy and Sustainable Development: Green Economy; International agreements / conventions on energy and sustainability- United Nations Framework Convention on Climate Change (UNFCC); Green nanomaterials: biomaterials, biopolymers, bioplastics and composites; Nanomaterials for Fuel Cells and Hydrogen.

Unit-5: Green Technology: Phyto-remediation- Hyper-accumulators- biotic interactions, biofilm, Green chemistry- introduction- inception and evolution- importance of solvents- types of catalysts and their role- Biological alternatives- applications; Principles of green chemistry, advances in green chemistry.

Practicals:

Based on Theory paper

References:

1. Abbasi S A and Naseema Abbasi, "Renewable Energy Sources and their Environmental Impact", PHI Private Limited, 2001.
2. Bent Sorensen, "Renewable Energy", Academic Press, 2004.
3. Frank Kreith and Yogi Goswami D, "Handbook of Energy Efficiency and Renewable Energy", CRC Press, 2007.
4. Kothari P, Singal K C and RakeshRanjan, "Renewable Energy Sources and Emerging Technologies", PHI Pvt. Ltd., New Delhi, 2008.
5. Rai G D, "Non Conventional Sources of Energy", Khanna Publishers, 2006.
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9. Deka, M.M. Joint Forest Management of Water Projects (2002)
10. Dubey, R.C. Text book of Biotechnology
11. Gangstad, E.O. Environment Managements of Water Projects (2002)
12. Khenshoo, T.N. Environment Concerns and Strategies.
13. Maitra, M.K. Watershed Management; Project, Planning, Development and Implementation (2002)
14. Rajendra Maneria, Environment Conservation and Planning.

EVS 3.5: Natural Resources and Conservation 64 Hrs

Preamble: This paper provides the students with the necessary knowledge and skills in the areas of natural resources, conservation and management. In particular, this paper emphasis on the consequences of excessive and unscientific utilization of natural resources for human comfort and imparts the ways of biodiversity conservation, sustainable developments of healthy planet earth.

Unit-1: Natural Resources: Concept, Classification, current status of natural resources and their reserves. Oceans are new areas for exploration of mineral resources, ores and recycling of resources; Natural resources of India and their management; Role of empowerment in natural resource management. **-12 hrs**

Unit-2: Water resources Management - Concept and classification of water resource, current status, Integrated water resource management; Participatory watershed development; rain water harvesting and recharging of resources; Soft water resources in coastal area and their conservation; Wetlands-concept, reclamation and management, sustainable development; Interlinking of River and their impacts. **-12 hrs**

Unit-3: Soil resources and Conservation- Concept, scope, types of soils, role of organic matter in soil fertility maintenance, diagnosis of nutrient deficiencies. Conservation of soil: protect loss of soil fertility, soil erosion and Methods of soil conservation; Wasteland development and Conservation: concept, scope, issues and strategies; water logging and salinity impacts. **-15 hrs**

Unit 4: Mineral Resource management: Resources and reserves; Metals and Non-Metals, Formation of Mineral Deposits, Consequences of over Exploitation and Conservation of Mineral resources of India and their Distribution; Oceans as new areas for exploration of mineral resources; Oceans ore and recycling of resources. **-10 hrs**.

Unit-5: E**nergy Sources and conservation**: Concept, energy content in various conventional energy sources, Types; Principles of solar thermal energy conversion; Principles of generation of wave energy, tidal, ocean-thermal-energy conversion, wind and geothermal energy, Power generation from waste. Biogas plants - principles of generation, designs and application. **-15 hrs.**

Practical

Based on Theory paper

References:

1. Agarwal & Rana S.V.S. 1985. Environment & Natural resources, society of Biosciences.
2. Agarwal, V.G. 1985. Forests in India. Oxford and IBH, New Delhi.
3. Berthkur, S. and Ghosh, A.K. 1987. Biological pest 18. simons, I.J. eds. 1986. The ecology of natural resources.
4. Chauhan, D. S and S. K. Srivastava. Non-conventional energy resources, New Age International Publisher, New Delhi
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8. Negi, S. S. 1986. Handbook of social forestry. IBH, New delhi.
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15. Sharma V.K. 1985. Water resources planning and management, Himalaya Pub. House.
16. Shrikande R.P. and Varade S.R. 1991. Ecology of water and land management vol 1 & 2, Chugh publishers.
17. Singh,B.1992.Social forestry for rural rural development Anmol publication, NewDelhi

FOURTH SEMESTER

EVS-4.1 Nanotechnology and Environment 64 Hrs

Preamble: This paper introduces to students about the new concept of Nanotechnology and Environment. The paper also provides the scientific background for research and other careers across a broad spectrum of type and preparation and application of nanoparticles for environmental protection, focusing particularly on the risk and health issues of nanoparticles in the environment

Unit -1: Nanoscale Materials: Introduction; Definitions; Classification: Origin, Composition and Structure, Free versus Fixed Nanoparticles; Properties: Overview, Effect of Increased Surface Area, Influence of Quantum Effects, Influence of Quantum Effects; Types of Nanomaterials and Applications: Carbon, Inorganic Nanotubes, Metals, Metal Oxides, Clays, Quantum Dots, Surface Enhanced Raman Spectroscopy (SERS), Dendrimers,

Unit 2: Preparation of Nano-Materials: Introduction; Methods of synthesis; physical-mechanical and vapour; chemical-colloids, chemical reactions, Sol-gel techniques and biological-Green synthesis; Flame synthesis; Solid state combustion; Solution combustion synthesis; Catalyst- types and Characterization of Catalyst.

Unit-3: Analysis of Nanoparticles: Nanoparticle Imaging: Size, Shape, and Chemical Composition-Electron Microscopy, Scanning Probe Microscopy (SPM); Compositional Analysis: Single Particle Mass Spectrometer, Particle-Induced X-Ray Emission (PIXE); Surface Area: Product Characterization and Air Monitoring- The Brunauer Emmett Teller (BET) Method, Epiphaniometer, Aerosol Diffusion Charger; Size Distribution: Electrostatic Classifiers, Real-Time Inertial Impactor: Cascade Impactors, Electrical Low Pressure Impactor (ELPI), Dynamic Light Scattering (DLS).

Unit-4: Environmental Remediation: Nano-remediation- Identification and characterization of Hazardous waste, Air-Water-Soil Contaminants; Environmental Nano-Remediation Technology- Physico-Chemical and Biological Methods, Nano-Filtration for treatment of waste-removal of organics & inorganics and pathogens, Nanotechnology for water remediation and purification. Treatment of hi-tech industrial waste waters using nano particles/ modified structures/devices. Environmental Benefits of nanomaterials.

Unit-5: Sustainable Nanotechnology: Application of industrial ecology to nanotechnology, Fate of nanomaterials in environment, environmental and health impacts of nano materials, toxicological threats, exposure to nano particles-biological damage, threat posed by nano materials to humans; Nano materials in future - implications.

Practical:
Based on Theory Paper

References:

1. Nanotechnology and the environment, by Robert V. Neumann, Nova Science Publishers, Inc. New York, 2010.
2. Nanotechnology: Consequences for Human Health and the Environment by R.E. Hester and R.M. Harrison, RSC publication, 2007
3. Nanotechnology and the environment by Kathleen Sellers, Christopher Mackay, Lynn L. Bergeson, Stephen R. Clough, Marilyn Hoyt, Julie Chen, Kim Henry, Jane Hamblen, CRC Press , New York, 2009
4. Nanotechnology for Environmental Remediation: by Sung Hee Joo, I. Francis Cheng, spinger Publications, 2006.
5. Nanoscience and Nanotechnology: Environmental and Health Impacts: by Vicki H. Grassian, John Wiley & Sons, Inc., Hoboken, New Jersey, 2008
6. Nanotechnology- Toxicological Issues and Environmental Safety: by P.P. Simeonova, N. Opopol, M.I. Luster, Spinger Publications, 2006
7. Green Nanotechnology: Solutions for Sustainability and Energy in the Built Environment: by Geoffrey B. Smith Claes G. Granqvist, CRC Press, New York, 2011.
8. Environanotechnology by Mao Hong fan, Chin-pao Huang, Alan E Bland, Z Honglin Wang, Rachid Sliman, Ian Wright. Elsevier, 2010.
9. Nanotechnology: Importance and Application by M.H. Fulekar, IK International, 2010.
10. Nanotechnologies, Hazards and Resource efficiency by M. Steinfeldt, Avon Gleich, U. Petschow, R. Haum. Springer, 2007.
11. Nanotechnlogy: Health and Environmental risk by Jo Anne Shatkin. CRC press, 2008.
12. Handbook of Nanofabrication. Edited by Gary Wiederrcht. Elsevier, 2010.
13. Nanoporous materials: Advance techniques for characterization, Modeling and Processing. Edited by Nick Kanello Poulos. CRC press, 2011.
14. Inorganic Nanoparticles: Synthesis, Application and Perspectives. Edited by Claudia Altavilla and Enrico Ciliberto. CRC Press, 2011.
15. Nanostructured conductive polymers. Edited by Ali Eftekhari. Wiley, 2010.
16. Adsorption and diffusion in nanoporous material by Rolando M.A. Raque Malherbe. CRC press, 2007.
17. Introduction to Nanoscience by Gabor L. Hornyak, Joydeep Dutta, Harry F. Tibbals, Anil K. Rao. CRC Press, 2008.

EVS-4.2: Solid and Hazardous waste Management 64 hrs

Preamble: Every human activity ends up in the generation of unwanted waste product. This paper throws light on the current scenario of solid and hazardous waste generation and problem in its handling and management. It also deals with the different governmental policies that explain proper transportation, handling and disposal of solid and hazardous waste to minimize its effect on environment. Also it provides knowledge on methods for conversion of waste to wealth.

Unit 1: Solid Waste: Introduction- definition, types, sources, characteristics, and impact on environmental health. Waste generation rates in world and in India. Handling of waste: collection, segregation at source and transport of solid wastes; Methods for separation of reusable, recyclable and disposable Solid Wastes and their processing. Recovery of the Bio Products, Public Health Aspect Related to Solid Waste, Status of Municipal Solid Waste in Indian cities. **-14 hrs**

Unit 2: Solid Waste Management: Introduction, 4R's concept; preparation of fuel cakes, Thermo chemical conversion includes incineration, pyrolysis and gasification. Conversion of organic solid waste into organic manure by Composting, types of composting; Vermiculture and Biogas poduction for domestic fuel and light; Disposable of waste by Landfill (Site Selection, Site Investigation and Site Characterization), types of landfills; Landfill Planning and Designing, Construction and Operational Practices, Landfill Quality and Control and Incineration; Indian Scenario and Legislative Control. **-10 hrs**

Unit 3: Hazardous Waste: Definition, Classification, Identification, Sources and Characteristics of Hazardous Waste, Integrated Approach for Minimization of Air, Water and Solid Pollutants, Collection, Storage, Transportation, Hazardous Waste Testing in Terms of Toxicity. **-12 hrs**

Unit 4: Hazardous Waste Treatment: Physico-Chemical, Biological and Thermal Destruction of Hazardous Wastes: Incineration, Pyrolysis, Wet Air Oxidation. Containment Technologies, Secured Landfill, Land Farming, Bioremediation, Biodegradation of Recalcitrant, Xenobiotics Treatment; Guidelines for safe disposable of Hazardous Wastes at different places-institutions, industries, energy producing sites, at accidents and during natural disasters; Leachate Management Waste Minimization, Recycle and Reuse of Hazardous Waste, Recovery of Chemicals from Hazardous Wastes. **-12 hrs**

Unit 5: Hazardous and Bio-medical Waste management: Collection and storage of hazards wastes; Planning of Hazardous Waste disposable: Type of disposable methods deep underground storage, deep well injection, Incinerator and other latest methods; Contaminated Site Remediation- Ex-Situ and In-Situ Approach, Landmark Episodes. Bio-medical Waste Management- Generation and Characterization, Types, quantity, segregation, treatment and disposal; Biomedical waste management in developed countries and in India- legal aspects; E-waste, composition, sources; E-waste management in global & national scenario, Recycling and disposal strategies. **-16 hrs**

Practicals:

Based on Theory paper

References

1. Botkin, D. and E. K. Future, 1995. Environmental Science – Earth as a living planet
2. Sindhu, P. S. 2004. Environmental chemistry. New Age Int. Publishers
3. Wright R. T. and B. J. Nebel. 2002. Environmental science – towards sustainable future. Prentice Hall India Pvt. Ltd. New Delhi
4. Abbasi, S. A. and E. Ramasami, 1996. Biotechnological methods of pollution control.
5. Cunningham, W. P. and M. A. Cunningham, 2003. Principles of Environmental Science. Tata McGraw Hill Publ. New Delhi
6. Trivedi, P. R. and G. Raj. 1992. Solid waste pollution. Akshadeep Publishing House, New Delhi
7. Bhoyar, R. V., S. K. Titus, A. D. Bluide and P. Kanna, 1996. Municipal and Industrial Soild waste management in India. J. IAEM, 23: 53-64
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9. Shah, K. L. 2000. Basics of solid and hazardous waste management technology, Prentice Hall, New Jersey
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11. Anonymous, 1973. Health hazardous of Human Environment, WHO
12. Reinhardt, P. A and J. G. Gordon, 1991. Infectious and medical Waste management, Lewis Publ. New York
13. Santra S.C., Environmental Science, Central Book Agency Ltd., Kolkota

EVS- 4.3 A: Environmental Law, Audit, EIA and Occupational Health 64 hrs

Preamble: This paper introduces students to the legal structure of India and fundamentals of environmental legislation and policy making. Each unit will help the students to develop basic concepts of Environmental auditing in Government and Non-Government sectors.

Unit-1: **Environmental laws**: An introduction. Legal meaning of environment; Forms of pollution-causes and effects; Need for legal control; Fundamental principles of environmental protection: sustainable development; Polluter pays principle, precautionary principle, Intellectual Property Right (IPR), Patent, copyright. **-10 Hrs**

Unit-2: Environmental Protection Legislations: The Water (Prevention and control of Pollution) Act 1974; The Air (Prevention and Control of Pollution) Act 1981; The Environment (Protection) Act 1986; Indian Forest Act 1927; Forest Conservation Act 1980; The Wild Life Protection Act 1972; Biodiversity Act 2002; The Noise Pollution (Regulation) 2000; Legal control of Hazardous waste – Biomedical waste, genetic waste, e-waste. Salient Features of Coastal Zone Regulations (CZR) Notification, the Convention of Biodiversity. (Several Case Studies to be given as Assignment). **-12 Hrs**

Unit-3: **Environmental Audit**: Definition, Scope and Objectives; Types and Benefits of EA; 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, Concept of ISO 9000 and ISO 14000 series in Environmental System Management. **-12 Hrs**

Unit -4: Environmental Impact Assessment (EIA): Definition; Scope, objectives and principles, types and stages; EIA guidelines, Environmental Impact Statement (EIS), Environmental Management Plan (EMP) and Environmental Management System (EMS); Merits and Demerits; EIA techniques**:** Ad-hoc method; checklist method; overlay mapping method; matrix method; Assessment, Prediction and evaluation of impacts on Air, water, noise and biological environment; Mitigation measures; EIA in project planning and implementation section; EIA of water resource projects, industries, mining, oil refineries and highway construction, Life Cycle Assessment (LCA). **-15 Hrs**

Unit-5: Occupational Health & Safety: Definition**;** Industrial Hygiene**:** Definition and objectives; Environmental factors and their effects on Health of workers; Hazards at work places; Hazard recognition and evaluation procedure. Control measures; Industrial Safety: Definition of safety, accident Hazard, near misses, Risk perception and loss control; Impact of accidents on society, individual and industry safety issues; Economic, social and legal reasons for accident prevention. Accident costs; Personal Protective Equipments (PPEs): Types; Use care and maintenances of PPEs; Need and importance of safety policy; Formulation of accident prevention program; Functions of safety and health personnel; Concept of ISO 450001:2018 (OHSAS 18001) **-15 Hrs**

Prtacticals:

Based on Theory paper

Reference

1. Environmental Impact Assessment, by Larry W. Canter, Mc Graw- Hill International Editions, Civil Engineering series
2. Environmental Impact Assessment-Theory and practice, by Wathern P Routledge, Unwin Hyman London.
3. Environmental Justice, APH Publishing Corporation, N. Delhi Leelakrishnan. P, 2004,
4. Environmental Law and Policy in India, Divan.S and Rosencranz. A, Oxford University Press, 2nd edition (2001)
5. Environmental Law and Policy. Hughes David, 1992, Environmental Law, Butterworths. Jariwala C.M., 2004,
6. Environmental Risks and hazards, Ulter S.L. (1994). Prentice Hall of India, New Delhi.
7. Handbook of Environmental Impact Assessment, Peter Calow. (1998).Mc Graw Hills Inc., New Delhi.
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9. International Environmental Law, Singh Gurdip, 2003, International Law, Macmillan.
10. Methods of Environmental Impact Assessment by Morris P and Theirvel R UCL press Ltd., London
11. Patty's Industrial hygiene and toxicology, Harris, R.L., Cralley, L.V. and Cralley, L.J.. -3A. Wiley. 1994
12. Safety, Health and Environmental Auditing: A Practical Guide, 2nd Edition, Simon.W. Pain, CRC Press.2018
13. Environmental Health and Safety Audits, 9th Edition, Lawrence B. Cahill, Lawrence B. Cahill, 2011

EVS 4.3B: Climate Change and Current Issues 64 Hrs

Preamble: This paper introduces to students about the new concept of climate change. The paper also provides the scientific background for research and other careers across a broad spectrum of meteorology-related science, focusing particularly on the links between the atmosphere and the land surface environment.

Unit-1: Climate Change: Origin and evolution of the earth's atmosphere; Overview of key concepts- weather and climate; Atmospheric Chemistry; Climatic classification-Koppen's climatic classification; Climatic variability - temperature, rainfall, wind speed & direction; El-Nino, La Nino and their impacts; Effect of various anthropogenic activities on earth's atmosphere.

Unit-2: Hazards and climatology: Natural hazards: Earthquakes, Volcanoes, Landslides, avalanches, Cyclones, Streams, Tsunami, Flooding & Floods Indian context. Climatic change in recent times: identification and characteristics of bio- and agro-climatic regions of India; urban climatology; climate and human comfort; Nuclear and Alternative Energy; Cold and Hot ocean currents and their affect on climate; El-Nino and La Nina effects on India.

Unit 3: Greenhouse Effect: Global warming and greenhouse effect-major greenhouse gases, sources and sinks of greenhouse gases; analytical techniques of monitoring greenhouse gases; Urban Heat Islands; Ozone layer depletion, issues and Advance research to protect the Ozone layer and consequences; ground level ozone and air pollution; sea level rise and its impact; Heat and cold waves; global dimming; Implications of Climate Change, monitoring and assessment; climate change models.

Unit-4: Policy Frameworks: History of international climate change policies. United Nation Framework Convention on climate change (UNFCCC) - Key provisions of the UNFCCC, its structure, and different party groups under the convention -Annex I, Annex II and Non-Annex I countries; The Kyoto protocol and its associated bodies; Overview of Conference of Parties (CoP); Main climate change negotiations evolved over the past years and highlights some key issues relevant for a future climate change regime.

Unit 5: Climate change adaptation and mitigation: The concept of climate change adaptation; Linkage between climate change adaptation and development; International adaptation initiatives and programs; Definitions of mitigation and present an overview of emissions levels and mitigation targets per country. Integrate mitigation into development planning through low emission development strategies. International mechanisms created to assist countries in planning and implementing mitigation actions; Climate Change and Sustainable Development.

Practical
Based upon theory

References:

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.
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6. John E. Oliver, John J. Hidore. 2002. Climatology: An Atmospheric Science, Second Edition. Prentice Hall publication.
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