

**UNIVERSITY OF MYSORE**  
**DOS IN ENVIRONMENTAL SCIENCE**  
**MANASAGANGOTRI, MYSORE-6**

**Choice Based Credit System of Syllabus**  
**Master's Degree Programme in Environmental Science**

**I Semester**

Sl. No.	Paper code	Title of the Paper	HC/SC/OE	L T P	Total Credits
1		Environmental Chemistry	HC-1	2 1 1	4
2		Environmental Geology	HC-2	2 1 1	4
3		Environmental Microbiology	HC-3	2 1 1	4
4		<b>Any two papers</b> Green Technologies	SC-1	2 1 1	4
5		Environmental Statistics	SC-2	3 1 0	4
6		Environmental Planning and Sustainable development	SC-3	3 1 0	4

**Total Credits 20**

**II Semester**

No.	Paper code	Title of the Paper	HC/SC/OE	L T P	Total credits
1		Water and Wastewater Management	HC-4	2 1 1	4
2		Environmental Toxicology	HC-5	2 1 1	4
3		EIA, Environmental Policy and Laws	HC-6	3 1 0	4
4		<b>Any one of the papers</b> Occupational Health and Safety	SC-4	3 1 0	4
&		<b>Or</b>			
5		Remote Sensing and GIS	SC-5	2 1 1	4
6		<b>Open Elective *</b>			4

**Total Credits 20**

### III Semester

No.	Paper code	Title of the Paper	HC/SC/OE	L T P	Total credits
1		Environmental Biology	HC-7	2 1 1	4
2		Air, Noise and Radiation Pollution	HC-8	2 1 1	4
3		Disaster Management	HC-9	3 1 0	4
4		<b>Any one of the Papers</b> Environmental Biotechnology	SC-6	2 1 1	4
5		<b>OR</b> Climate Change and Current Issues	SC-7	3 1 0	4
6		<b>Open Elective *</b>			4

**Total Credits 20**

### IV Semester

No.	Paper code	Title of the Paper	HC/SC/OE	L T P	Total credits
1		Conservation of Biodiversity	HC-10	2 1 1	4
2		Solid and Hazardous Waste Management	HC-11	2 1 1	4
3		Major Project work	HC-12	0 1 3	4
4		<b>Any one of the papers</b> Natural Resources Management	SC-8	3 1 0	4
5		<b>OR</b> Marine Ecology and Coastal Pollution	SC-9	3 1 0	4
6		<b>Open Elective *</b>			4

**Total Credits 20**

### Open Elective Papers\*

Sl. No.	Paper Code	Title of the Paper	HC/SC/OE	L T P	Total Credits
1		Environment and Health	OE-1	3 1 0	4
2		Environmental Pollution and Management	OE-3	3 1 0	4
3		Nuclear & Bio Medical Waste Management	OE-5	3 1 0	4
4		Ecology & Environment	OE-6	3 1 0	4

\* Courses will be offered in II, III & IV Semesters as will be decided in department council.

**I\*, II, III and IV Semesters:**

Hard Core papers -	48 Credits
Soft Core Papers -	20 Credits
Open Elective Papers -	<u>12 Credits</u>
<b>Total</b>	<u><b>80 Credits</b></u>

\* There is no Open Elective Paper for first Semester

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**I Semester**

**Hard Core Papers:**

**1. Environmental Chemistry:**

**Unit 1 – Fundamentals of Environmental Chemistry:** Stoichiometry, Gibbs' energy, Chemical potential, chemical equilibria, acid-base reactions, solubility product, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons, radionuclide's.

**Unit 2 – Atmospheric chemistry:** Chemical composition of Air: Classification of elements, chemical speciation. Particles, ions and radicals in the atmosphere. Chemical processes for formation of inorganic and organic particulate matters. Thermo chemical and photochemical reactions in the atmosphere. CFC's, Oxygen and Ozone chemistry, chemistry of air pollutants, photochemical smog.

**Unit 3 - Chemical pollution and fundamentals of chemical reactions:** Oxidation, reduction, precipitation. Toxic chemicals in the environment, biochemical aspects of Arsenic, Cadmium, Lead, Mercury CO, O<sub>3</sub>, PAN, pesticides, MIC and carcinogens in air.

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

**Practicals :**

1. Determination of pH and Conductivity of different water and soil samples
2. Determination of calcium and magnesium by EDTA complex metric method
3. Determination of total dissolved solids in water samples.
4. Determination of Carbonates and Bicarbonates in water samples
5. Determination of Chloride in water sample by AgNO<sub>3</sub> method
6. Estimation of Iodine value of given oil sample by C.A.T method
7. Determination of copper content in industrial effluents by Iodometric method
8. Determination of ferrous iron by permanganate method
9. Estimation of the amount of phenol/ Aniline in the water sample by Bromate- Bromide method
10. Determination of Saponification value of given oil samples.

**References:**

1. Analytical Chemistry of Industrial poisons, Hazards and solvents by Jacobs M.B. Inter Science. New York, (1969)
2. Environmental Chemistry, Sharma B.K. & Kaur, Goel Publishing House Meerut, (1995)
3. Chemistry for Environmental Engineering, Sawyer C.N, Mc Marty P.L. and Perkin G.F. Mc Graw Hill, (II ed) (1994)
4. Environmental Chemistry, Tyagi O.D. and Mehra M Anmol Publications, (1990)
5. Environmental Chemistry, Manahan S.E, Lewis Publications, Florida, U.S.A, (7<sup>th</sup> ed), (2000)
6. Chemistry of the Environment, Bailey R.A. Academic Press, , (1970)
7. Vogel's Text book of quantitative Inorganic analysis Bernetts.J, Denney.R.C., Jeffery.J.H. and Mendham.J

## **2. Environmental Geology:**

**Unit 1** – Environmental Geology – objectives, scope and necessity, Origin of the Earth, Earth systems and its interaction with - lithosphere, atmosphere, hydrosphere and biosphere, Interior of the Earth, Earth's Materials – Minerals and their definition. Distribution and abundance of elements in the Earth's crust, Formation and classification of Rocks. Soil-characteristics, formation of soil, erosion and conservation.

**Unit 2** – Earth's Processes – Endogenic and Exogenic Earth's processes: Earthquakes, Tsunami and Volcanism. Geological agents: River, Wind, Glaciers and Ocean action. Floods, landslides, cyclone and avalanche, Concepts of major, trace and REE, Classification of trace elements, Mobility of trace elements, Geochemical cycles. Human use of trace elements and health.

**Unit 3** – Mineral resources and environment. Resources and Reserves, Environmental uses of minerals and rocks, Depletion trends of natural resources, Environmental impact of Exploitation resources. Geological features of India and Karnataka.

**Unit 4**- Land use Planning, Topographical studies of different land surfaces Environmental aspects of terrain evolution, Methods of site selection and evaluation of land in environmental planning.

### **Practicals :**

1. Identification of Minerals and Rocks.
  - a) Physical properties & chemical composition of various rock forming minerals,
  - b) Study of economic minerals
  - c) Hand specimen study of Igneous, rocks.
  - d) Hand specimen study of sedimentary rocks
  - e) Hand specimen study of metamorphic rocks
2. Classification of soils and sediment
3. Classification texture & mineralogy
4. Interpretation of Topo sheets

### **References:**

1. Earth Science and the Environment, Richard J.Ordway, D.Van Nostrand and Company, London.
2. Encounter with the Earth, L.F. Oxford press, San Francisco., Laporte,
3. Soil and water conservation Engineering, Schwab. S.O, Frevert.R.K, Edimster. T.W. and Barns, K.K., John Wiley and Sons, 1975.
4. Land Application of Wastes, Loehr, R.C.Jesel, W.J.Novak, N.D., Clarkson, W.S. and Friedeman G.S., Van Nostrand Reinhold Co., New. York., Vol-I and II, 1979
5. Environmental Geology, Valdia K.S., 1987
6. The nature of Oceanic life, Menard H.W., W.H.Freeman and Company, San Francisco, The Ocean – A Scientific American Book, (1969).
7. Essentials of Geology, Reed Wicander & James S. Monroe, Wadsworth publishing company, (2002).

### 3. Environmental Microbiology:

**Unit – 1:** Introduction, Concepts and scope of environmental microorganisms as components of ecosystem, characteristics and classification of Microorganisms, Microbial interactions. Micro organisms as bio-indicators in the environment, Role of microorganisms in bio-geo chemical cycle.

**Unit 2:** Microbial diversity of environment: Microbes in air, water and soil distribution, sampling techniques and identification. Microbes of extreme environment. , thermopiles acidophiles, alkaliphiles, halophiles, basophiles Mechanisms and adaptation by microorganisms to environmental extremes and their survival.,

**Unit 3:** Microbes for the degradation of pollutants Bioremediation- in-situ, ex-situ advantages and disadvantages. Control of pests and diseases by microorganisms, Biological Treatment of solid and liquid waste, microbial growth curves, microbial characteristic of water and wastewater.

**Unit 4 :** Microbial degradation of pesticides and heavy metals.. Microbes in metal extraction, mineral leaching and mining. Role of microbes in oil recovery, Ecological implication of genetically modified microorganisms, microbial plastics.

#### Practicals:

1. Serial dilution of soil and water
2. Preparation of different types of microbial culture media
3. Study of Gram staining techniques
4. Study of microorganisms in air
5. Isolation, enumeration and identification of microorganisms in soil samples
6. MPN Membrane filtration techniques for Coli form analysis
7. Determination of heavy metals on microbial growth
8. Determination of pesticide on soil microorganisms
9. Invic test of Enteric bacteria (Indole Production, Methyl red, Voge-Proskauer Test and Citrate utilization)

#### 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. Introduction to Microbiology. A. S. Rao
5. Microbiological examination of water and wastewater, Maria Csuros, Csaba Csuros.
6. Environmental Microbiology. Raina M. Maier, Ian L. Pepper, Charles P. Gerba - Science.
7. Text book of Environmental, Microbiology, Mohapatra - Technology & Engineering.

## Soft Core Papers:

### 4. Green Technologies:

**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, nuclear energy, natural radio activity, nuclear power plant, fast breeder reactors, nuclear fusion, gobar gas

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

**Unit 3** – Green Technology: Phyto-remediation- Hyperaccumulators- 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.

**Unit 4**- Green buildings, energy conservation in buildings, materials for green buildings waste management in buildings, essential components in Green building. Application in relation to Environment protection.

### Practicals:

1. Study and identification of energy plants
2. Adsorption and removal of chromium using different biomaterial
3. Adsorption and removal of iron using biomaterials
4. Study of biofuel /green chemistry / petroleum energy plants characteristics.
5. To study the working principles of wind plant/ nuclear energy plant / Gobar gas plant/Glacier plant
6. Luxmeters- measurement of light intensity in indoor and outdoor environment.

### References:

1. Rashmi Sanghi and Srivasta M.M., Green Chemistry, Narosa (2006)
2. Stanley E Manahan, Environmental Chemistry, Lewis Publications (2001)
3. Sharma, B.K. Kaur H., Environmental Chemistry, Goel, publishing House (1995)
4. Tyagi O.D and Mehra M, Text book of Environmental Chemistry, Anmol publications (1990)

## 5. Environmental Statistics :

**Unit 1-Sampling-** Types of sampling, **Descriptive Statistics**, Descriptive vs. Inferential, Measures of location — mean, median, mode, Measures of dispersion — variance, standard deviation, range and interpercentile ranges Dispersion Percentages, Skewness, Concepts of outliers, **Correlation and regression**-Bi-variate data and scatter diagram, Simple (linear) correlation and regression, Coefficient of correlation and regression and their properties, Fitting of regression line, Multiple and partial correlations and regressions. **Graphs and Displays**- Introduction, z-Scores and Percentile Ranks, Stem and Leaf Displays,

**Unit 2- Matrices and determinants-** Types of matrices, addition and subtraction of matrices, Multiplication of a matrix by a scalar, Products of matrices, Evaluation of  $2 \times 2$  determinants, Inverse of  $2 \times 2$  matrices, Combinations of transformations, Eigen value, Applications of matrices in Environmental Impact assessment.

**Unit 3- Probability-** Introduction, Random Variables, Definition, Expected Value, and Standard Deviation, Probability Distributions, Binomial and Poisson Distributions, **Statistical hypothesis testing**-The basic approach, Alternative hypothesis, Examples of bad practice, **One sample tests in environmental science-** Z-test on a mean with known variance, T-test on a mean with unknown variance, Z-test for non-zero correlation, **Two sample tests-** T-test on unpaired means with unknown variance, T-test on paired means with unknown variance, F-test for equal variances, Z-test for unpaired equal correlations, Chi Square test, ANOVA,

**Unit 4-** Introduction to environmental system analysis; Approaches to development of models; linear simple and multiple regression models, validation and forecasting, operating system, DOS, UNIX, LINEX, M.S. Office, Computer applications in Environmental Sciences, point source stream pollution, model, box model, Gaussian plume model, General Circulation Model(GCM) for climatic change.

### References

1. Fundamentals of Mathematical Statistics by S. C. Gupta and V. K. Kapoor; S. Chand & Co.
2. Statistical Methods in Geographical Studies, by Aslam Mahmood, Rajesh Publications, New Delhi
3. Statistical Methods: An Introductory Text by J. Medhi, New Age International Ltd. Publishers
4. Practical Statistics (Vol 1&2) by Singh, Atlantic Publishers
5. Environmental Statistics and data analysis, Ott, W. R., Lewis Publishers, New Jersey.
6. Statistical Methods, G. W. Snedecor & W. G. Cochran.
7. Statistics for environmental Biology and Toxicology, W. W. Piegorsh & A. J. Bailer.

## **6. Environmental Planning and Sustainable development:**

**Unit – 1** Sustainable Development – scope and definition, parameters of sustainability, Population stabilization, integrated land use planning, Healthy cropland and grassland, wood land revegetation, conservation of biological diversity, control of pollution, development of non-polluting renewable energy systems. Recycling of wastes/residues, ecologically compatible human settlement and slum improvement, environmental education and awareness, updating environmental law.

**Unit – 2** Agriculture – sustainable agricultural rotation of crops, organic farming. Environmental degradation due to pesticides and chemical fertilizers- Sustainable Management.

**Unit – 3:** Environmental movements and role of NGO's in sustainable development. Global policy for sustainable development – world summits related to natural resources conservation.

**Unit – 4:** Urbanization and its impact on Environment. Rural and Urban planning for sustainable development Urbanization impact on land resources.

### **References:**

1. Eco-Efficiency: The Business link to Sustainable Development by Livio Desimone.
2. Planning Sustainability by Michael Kenny.
3. Environmentally Sustainable Economic Development by Asayehgn Desta



## II SEMESTER

### Hard Core Papers:

#### 1. Water and Wastewater Management:

**UNIT-1** : Hydrology, Sources of water and its characteristics, Distribution of water on Earth. Physical and Chemical properties of Water, Various types of water demands, per capita demand water quality standards for various uses. Water Pollution, sources and types of Pollution, pollution scenario of Indian Rivers, water harvesting and watershed management.

**UNIT – 2:** Ground water Hydrology, Occurrence of groundwater, Ground water zones, and Groundwater System. porosity, permeability and types of Aquifers. The Water Table, ground water flow, functions and Topography, Ground water depletion, Ground water Quality, Ground water pollution, Saltwater Intrusion, Changes in Ground water Quality.

**Unit 3**– Water purification-Screening – Treatment system, taste and odor removal (Aeration). , sedimentation, coagulation, filtration – rapid sand filter, slow sand filter, advantages and disadvantages. Disinfections – Methods of disinfections, water softening process.

**Unit 4** : Wastewater treatment: Characteristics of wastewater, Screening & Grit chambers, sedimentation, secondary treatment – Aerated lagoons, Trickling Filters, Activated Sludge process, , screening batch reactors steriochemical treatment sludge disposal management UASB Aerobic and Anaerobic decomposition of wastewater, Tertiary treatment, sludge drying beds.

#### Practicals :

1. Determination of DO in water and wastewater samples
2. Determination of BOD in wastewater samples
3. Determination of COD water and wastewater samples
4. Determination of porosity and permeability of different soils.
5. Determination of infiltration and runoff characteristics.
6. Determination of Ammonia/nitrate content of water samples
7. Determination of phosphate content of water samples
8. Visit to water & wastewater treatment plants

#### Reference :

1. Water and waste water Engineering, Vol.I and II, Fair, G.M. Geyer T.C. and Okun. D.A. (1984): John Wiley and Sons, Strauss, (1975) & (1984)
2. Waste water treatment processes, Metcalf and Eddy Inc. Academic Press, New York. (1979)
3. Standard Methods for Examination of Water and Waste Water American Public Health Association (5<sup>th</sup> Ed) (1980)
4. Waste Water Engineering, Metcalf and Eddy Tata Mc Graw Hill,
5. Physico – Chemical Process for Water quality, Weber. W.J, Ann Arbor and company, New Delhi (1974)
6. Water and waste Engineering, Vol.I and II, Fair, G.M. Geyer T.C. and Okun. D.A. (1984): John Wiley and Sons, Strauss, (1975) & (1984)
7. Waste water treatment processes, Metcalf and Eddy Inc. Academic Press, New York. (1979)

8. Standard Methods for Examination of Water and Waste Water American Public Health Association (5<sup>th</sup> Ed) (1980)
9. Waste Water Engineering, Metcalf and Eddy Tata Mc Graw Hill,
10. Physico – Chemical Process for Water quality, Weber. W.J, Ann Arbor.

## **2. Environmental Toxicology:**

**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. Dose response relationship-graded response time action curves, threshold limit value, LC<sub>50</sub> LD<sub>50</sub>, Margin of safety and toxicity curves.

**Unit – 2 :** Bioaccumulation and Biomagnifications of toxic materials in food chain, Toxicology of major pesticides-Environmental impacts of pesticides, biotransformation, biomonitoring, programs and parameters of biomonitoring, concept of bioindicator, bioindicator groups and examples. Basic concepts of Environmental forensics.

**Unit – 3 :** Concepts of Bioassay- types, characteristics. Importance and significance of bioassay, Field based microbial bioassay for toxicity testing, particulate matter sources, health impacts of specific particulate matter, chronic and acute effects of particulate matters on respiratory system mechanism of impact of particulate matters on cardio vascular system.

**Unit-4:** Toxicology of Metal Plants samples, Rose response. Metal toxicology on fishes-case study. Effect of metals studies on hormones, Impact of metals on endocrine system of fishes.

### **Practicals :**

1. Determination of solid food adulteration.
2. Methods of prevention of food poisoning.
3. Determination of liquid food adulteration.
4. Estimation of LC<sub>50</sub> value in mosquito larvae.
5. Determine the histo toxicity/ histopathology of a given sample.
6. Spot test for the detection of nitrate/nitrite poisoning.
7. Determine the differential leukocyte count (DLC) of the pesticide treated blood smear.
8. Par fins sectioning and staining techniques
9. Determination of toxic chemicals in different samples.
10. Metal toxicology on fishes

### **Reference:**

1. Environmental biology and Toxicology, by Sharma P.D. Rastogi and Lamporary., 1994.
2. Environmental pollution and Toxicology by Meera Asthana and Astana D.K., Alka printers, 1990.
3. Toxicology, by A.Sood, Sarup and sons New Delhi, 1999
4. Text book of Preventive and Social Medicine, by Park J.E. and Park K., Banosidas Bharat Publishers, Jabalpur, 1985
5. Environmental Epidemiology, by Anisa Basheer, Rawat Publication Jaipur, New Delhi 1995.
6. Toxicology, Biochemistry and Pathology of Mycotoxins, by Kenji Uroguchi a mikio, Yamazadi Kodanshoa Ltd., Tokyo, 1978.

### **3. EIA, Environmental Policy and Laws:**

**Unit 1** - Origin and development of EIA, Assessment and Prediction of impact on Air, water, noise and biological environments. Methods of impact analysis, EIA methodologies, public participation in Environmental decision making, Risk Assessment and mitigation measures, MOE-EIA notification, EIA case studies for infrastructure, development and industrial projects.

**Unit – 2 Environmental Audit:** General approaches to Environmental Auditing, Audit methods, benefits of environmental auditing. On-site and Post – Audit activities, statutory Environmental statements. Environmental Management System (EMS), ISO certification.

**Unit 3** – Planning: Importance of planning, local, regional, state and national planning. Zoning-Physical planning. National policy, sectorial – integration, state level policy and implementation. Organizational structure at state and central government levels.

**Unit 4** – Legal control of Environmental pollution in India with special reference to :

- i. The Wildlife protection Act – 1972
- ii. The Water prevention and control of pollution Act, 1974, amended 1988: CESS Act 1977, amended in 1991.
- iii. The Forest Conservation Act, 1980, amended in 1988.
- iv. The Air prevention and control of pollution Act, 1981, amended in 1990.
- v. The Environment protection Act. 1986.
- vi. Hazardous waste management rules-1989 & amendment rules
- vii. Municipal waste management rules 2000 & amendment rules 2016
- viii. Coastal Zone Regulation (CZR – 2018)

### **References**

1. Defense preparedness in India – Jain N.K., Joint assistance center, Adhyatma Sadhana Kendra Mehrauli, New Delhi
2. Environmental Law and Policy in India, Divan.S and Rosencranz. A, Oxford University Press, 2<sup>nd</sup> edition (2001)
3. Pollution control Legislation, Vol. I and II, Tamilnadu Pollution Control Board, Chennai (1999)
4. Environmental Chemistry by Sharma B.K. and Kaur, Goel Publishing House, Meerut (1995).
5. Law and Environment by Ahsok K Jain 2005
6. Environmental and pollution Laws cases and materials by C.S. Lall. 2003
7. Environment and pollution laws by S.K. Mohanty publication year 2013
8. Environment laws in India by Satish C Shastri 2012
9. Environment Law by Sumeet Malik 2<sup>nd</sup> edition 2012
10. Sustainability by Patrick Dixon & Johan Gorecki 1<sup>st</sup> edition 2010
11. Environment Impact Assessment, A.K. Shrivastava, published by S.B. Nangia A.P.H publishing corporation New Delhi (2003)
12. Envi. Impact Assessment Methodologies lay, Valli Manickan & M Aujaneyalu, B.S. Publication 2011.

13. Methods of Envi. Impact Assessment 3<sup>rd</sup> edition by petter moris & Riki Therivel. Taylor & Francis Groups 2009
14. Saiindia. Gov. in lenglish/home/our-product/Other Reports/Study. Report/Study. Report/Study. Report – Environment – Audit.

## **Soft Core Papers:**

### **4. Occupational Health and Safety**

**Unit – 1** Occupational Environment- Physical, Chemical, Biological agents. Occupational hazards- Physical hazards, chemical hazards, Biological hazards. Occupational diseases- Pneumoconiosis- silicosis, Anthracosis, Byssinosis, Bagassosis, Astertosis, Farmers lung, Lead poisoning, Occupational cancer, Occupational Dermatitis, Radiation hazards.

**Unit - 2** Occupational hazards of agricultural workers- somatic diseases, accidents, toxic hazards, physical hazards, respiratory diseases, accidents in industry, sickness, absenteeism, health problems associate with different industries

**Unit - 3** Measures for health protection of workers, preservation of occupational diseases- medical measures, engineering measures, Legislation- The factories Act, 1948. Human health problems due to pollution, public health programs, food poisoning- types of food poisoning prevention and control, indicators of health.

**Unit-4:** Fire safety and Equipment - Hospital Environment- sources', types, causes and control measures, of nosocomial infections, fire extinguishers, Fire alarm System, Automatic Fire detection. Fire protection tools in buildings.

### **References :**

1. Fundamental principles of occupational health and safety. Benjamin O. Alli Handbook of Occupational Safety and Health, Louis J. Diberardinis,
2. Environmental Hazards: Assessing Risk and Reducing Disaster, Keith Smith, David N. Petley.
3. Physical and Biological Hazards of the work place, Peter H. Wald, Gregg M. Stave Proctor and Hughes.,
4. Chemical Hazards of the Workplace. Gloria J. Hathaway, Nick H. Proctor, James P. Hughes.,
5. Implementation of occupational health legislation at work place, issues and concerns. G. K. Kulakarni.,
6. Disaster Management future challenges and Opportunities by Jagbir Sing, I.K. International.

## **5. Remote Sensing and GIS :**

**Unit 1** - Fundamentals of Remote sensing: Remote Sensing – history & development, definition, concept and principles, Energy Resources, radiation principles, Electromagnetic radiation, Interaction between matter and Electromagnetic radiation, Sensors: Types of sensors, Concept of Resolution – Spatial, Spectral, Temporal , Radiometric, Basic concepts and principles of Thermal , microwave and hyper spectral sensing, Spectral reflectance and their characteristics of Earth surface features, Satellites and their characteristics – Geo-stationary and sun-synchronous, Indian Space programme

**Unit 2** - Platforms –Products used in Remote sensing, Images, scale, mosaics, time and seasons of orbital cycles. Aerial photographs, photographic systems, Satellite data products. Photogrammetry – Basic principles, types, steps and elements of image interpretation, visual interpretation, interpretation equipments- digital image processing- image rectification, enhancement, classification,

**Unit 3** - Introduction to GIS: GIS and their uses for Environmental monitoring, Remote Sensing Data Products and their procurement, GIS and spatial distribution of environmental data, Data integration and analysis, Data based structure, satellite data analysis,

**Unit 4** - Data merging and biophysical modeling image processing software, GIS software. Remote sensing and GIS applications - Management and monitoring of Environment, conservation of resources, natural resources ,coastal zone management.

### **Practicals :**

1. Survey of a given area using Chain survey method
2. Survey of a given area using Plane table survey method
3. Survey of a given area using Compass survey method
4. Survey of a given area using GPS survey method
5. Image interpretation of land use/water, vegetation and lithology
6. Study of geological /contour/drainage pattern maps
7. Assessment of pollution status of the given map

### **Reference :**

2. Environmental Radioactivity from Natural, Industrial and Miltry sources, Merrill Eisenbud and Thomas Gessell Academic Press, London
3. Radiation and Man – Jain.H.C, National Book trust, New Delhi
4. Remote Sensing a better view – Rudd.R.D. (1974)
5. Remote sensing techniques for Environmental Analysis, Estes. J.E. and Senger.L.W
6. Remote sensing of Environment – Lintz.J and Simonnet.D.S (1976)
7. Remote Sensing and GIS for Environmental Planning – Murli Krishna.I.V. (1995).
7. Essential of Remote Sensing – (S.Srikantaswamy 2008)

## III SEMESTER

### Hard Core Papers:

#### 1. Environmental Biology:

**Unit 1-** Ecosystems- Structure, functions, biotic and abiotic components, food chain, types of food chain, food web, Diversity Stability rule, Homeostasis. Ecological niche, spatial functional, Ecological Dominance. Energy flow in ecosystem, Lindeman model, Ecotone & Edge effect, Ecological Pyramids.

**Unit 2 –** Environmental factors- Limiting factors, climatic factors, influence of light on morphology and physiology of plants, characteristics of heliophytes and sciophytes, temperature – thermo periodicity, effect of low and high temperature on plants and animals. Atmospheric humidity-relative humidity in relation to metabolism of organism with suitable examples. Wind-mechanical effects of wind; lodging, breakage, deformation, anemophily and anemochory, physiological effects of wind. Edaphic factor-soil complex-soil erosion and soil conservation, fire factor, Plant indicators.

**Unit 3 –**Population ecology-Global and national scenario, Characteristics, population density, natality, mortality, age distribution, population growth, causes for population explosion, population control.

**Unit 4-** Biological interactions- Intraspecific and interspecific interactions, types of interspecific interaction- neutralism, positive interaction- negative interactions, both positive and negative interactions-Amensalism, mutualism, commensalism, parasitism and predation.

#### Practicals:

1. Study of binocular compound microscope/ Positive/ Negative staining of bacterial sample
2. Study of microbial flora/planktons found in water/soil samples including pond bottom sediments
3. Determination of Total alkalinity of different water samples
4. Estimation of chloride in the water samples
5. Determination of DO in water sample by modified Winkler's method
6. Estimation of Nygaard's algal indices in a given water sample
7. Identification of specimen/culture/materials of ecological interest.
8. Determination of Total Hardness of different water samples

#### References:

1. General Ecology – Kumar H.D et. al, Vikas publishing house Pvt. Ltd. New Delhi (1995)
2. Fundamental Ecology, Odum E.P.III Ed, Saunders, (1971)
3. Ecology – Culvinvux P, John Wiley and Sons, (1986)
4. Ecology and Environment – P.D.Sharma, Rastogi Publications, Meerut India

5. Ecology – Krebs J, II ed, Harper international
6. The Ecology of Tropical lakes and Rivers Payne A.I. John Wiley (1986)
7. Concepts of Ecology – Kormondy-Prentice Hall
8. Cell biology and evolution. P.S.Verma and Agarwal I ed. Chand

## **2. Air, Noise and Radiation Pollution:**

**Unit – 1** Air pollution; Natural and anthropogenic sources. Transport and dispersion of pollutants, Lapserate, meteorological conditions: Plume behavior, windrose Properties of air pollutants, Air quality: air quality monitoring- objectives, conventional monitoring, Non conventional approaches, sampling methods, gaseous sampling, stack monitoring, monitoring of particulates and smoke- Air quality standards.

**Unit- 2** Air pollution effects on vegetation, animals and humans, Air pollution control measures, pollution rose, Indoor Air pollution: Sources-Indoor chemicals used, Checking the Indoor pollution, Indoor air quality. Odour pollution, preventive measures of odour pollution, Vehicular Pollution: Automobile emission- Types of emissions- Exhaust emissions, evaporative emissions, crank-case emissions. Prevention and control of automobile pollution.

**Unit- 3** Noise. Source of noise, Reasons for Noise pollution, physical characteristics of sound waves: anatomy of sound, Theory of noise measurement – Sound pressure, loudness, sound intensity. Effects of noise pollution- Physico-chemical, social and psychological effects of noise, Prevention and control of noise pollution, Industrial noise control. Government rules to check noise pollution.

**Unit-4** Radioactivity-Introduction, Disintegration types, units of radioactivity, interaction of radiation with matter, ionization, types of exposure, detection and measurement of radiation, Dosimeters, Biological effects of radiation. Stochastic and deterministic effects, Radiation protection, system of dose limitation, protection methodology.

### **Practicals :**

1. Determination of SO<sub>2</sub> by PRA method
2. Determination NO<sub>x</sub> by spectrophotometric method
3. Basic radioactive measurement procedures using GM counter
4. Studies on indicators of air pollution
5. Measurement of noise level in different environments by sound level meter (SLM)
6. Determination of particulate matters PM<sub>10</sub> and PM<sub>2.5</sub> and TSPM
7. Determination of radiation in a given area using dosimeter
8. Determination of air pollutant toxicity by depletion of DTT assay
9. Determination of Air pollutant toxicity by depletion of antioxidant (Ascorbic acid)
10. Estimation of dose accumulation on polluted and non polluted area (Plants)

### **References:**

1. Environmental Chemistry by Sharma B.K & Kaur, Goel publishing House, Meerut (1995)
2. Environmental Science by Santra S.C., New Central Book agency, Pvt. Ltd., Kolkata

3. Chemistry for Environmental Engineering, Sawyer C.N, Mc Marty P.L. and Perkin G.F. Mc Graw Hill, (II ed) (1994)
4. Environmental Chemistry, Tyagi O.D. and Mehra M Anmol Publications, (1990)

### **3. Disaster Management:**

**Unit – 1** Environmental Disasters- Types of Hazards- Natural and Man made hazards- Nature of Hazards, Environmental security and Hazard zoning. Strategies of hazard mitigation. Concept of residence time and rates of natural cycles.

**Unit – 2** Catastrophic- geological Hazards. Earthquake and seismic Hazards- effects of earthquake, stability of structures and risk evaluation, seismic topography. Prediction of earthquake, Volcanic Hazards- Nature of volcanic hazards, volcanic belt, prediction and mitigation of volcanic Hazards.

**Unit 3** – Landslides and Mud flows- Types of mass movement, strength of materials and instability of slopes, controlling the landslides. Floods and flood management- causes of floods, management of floods. Floods control measures. Avalanches- Types of avalanches, monitoring of avalanches.

**Unit 4** – Man made Disasters and Hazards- Improper Irrigation, deforestation, Industrial hazards- safety in industry. Management of dangerous materials in Industry, Safety system in industry. Disaster and accident prevention. Safety versus production, application of advanced techniques in disaster monitoring and assessment Disaster and its management- case studies. Disaster Management Act, 2005

### **References :**

1. Industrial Hazards and Safety, Kind. R.W. and Magic J, Handbook, Butterworth (1982)
2. Introduction of Safety Science, Khulman A, TUV Rheinland, (1986)
3. Explosion Hazards & Evaluation, Barkey, W.E.Elsevier, Amsterdam (1983)
4. Management of Disasters and How to prevent them, Wharband O.P. and Stallworthy, E.A. (1986)
5. Disaster Management – Shailendera, K Singh, Subash. C Kundu and Shobu Singh, Mittal Publications, New Delhi (1998)
6. Disaster Management – Induprakash, Rasthra Prahari Prakashan, Gaziabad (1994).
7. Disaster Preparedness in India – Narendrakumar Jain, Adhytma Sadhan Kendra Mehrauli, New Delhi.



## **Soft Core Papers:**

### **4. Environmental Biotechnology:**

**Unit – 1:** Biotechnology and Biodiversity: conservation and utilization methods, their merits and demerits. Role of Biotechnology in energy production and management. Biosensors - Response of Biosensors, Types of biosensors, Application of Biosensors. Advantages of micro biosensors. Biochips – Biosurfactants,

**Unit – 2:** Biotechnological approaches for the degradation of petrochemical, tannery, industrial wastes, natural dyes, synthetic dyes, semisolid sludge, paper and distillery effluents. Technologies for environmental monitoring with special reference to prevention and detection. Concept of GMO's and genetic engineering approaches to waste treatment and environmental pollution management.

**UNIT-3:** Biotreatment of waste, Biofilters-types and applications. Bio fertilizer, importance and classification. Vermitechnology-vermicomposting and vermiculture. Role of biotic and abiotic factors in production of vermicompost. Organic farming and its applications. Microbial cellulolytic degradation of organic waste.

**UNIT-4** Bio-pesticides, Introduction, Classification and application. Integrated pest management, genesis of IPM concept, National and International prospective of IPM. Transgenic plants and animals.

### **Practicals :**

1. Determination of anti oxidant capacity by phosphomolybdate method.
2. Study of biomass in polluted soil and water.
3. Determination of catalase activity in a water sample.
4. Study of cellulolytic degradation of organic waste.
5. Determination / Identification of Biofertilizers.
6. Determination of Natural/ Synthetic dyes.
7. Extraction of DNA from a tissue (mammalian liver/fish liver).
8. Extraction of RNA from plant/animal sources
9. Study of transgenic plants/animals/Biosensors/Biofertilizers Biochips.

### **Reference:**

1. Text book of Environmental Biotechnology by Pradipta Kumar Mohapatra
2. Text book of Environmental Biotechnology by Indu Shekhar Thakur
3. Text book of Biotechnology by R.C. Dubey
4. Text book of Environmental Biotechnology by B.D.Singh
5. Text book of Environmental Chemistry by Ajay Kumar Bhagi & G.R.Chatwal
6. Text book of Microbiology by Pelzar

## **5. Climate Change and Current Issues:**

**Unit – 1** Global Environmental problems - Ozone depletion, causes and effects. Acid Rain Formation, adverse effects of acid rain. Photochemical smog, Factors responsible for photochemical smog, London Smog, Los Angeles Smog

**Unit – 2** Green house gases – green house effect and climate change, Global warming Factors – Effects of Global warming – control and remedial measures of green house effect, global warming and climate change, impacts of sea level rise

**Unit – 3** Man and Ecodegradation of Natural Environment, Present status of wasteland in India. Problems and prospects of wasteland development. Wasteland reclamation through Social Forestry, Bioaesthetic planting for pollution abatement impact of Climate Change on Natural Resources of in India

**Unit– 4.** Eutrophication and restoration of Lakes. Drug abuse and alcoholism as a threat to environment. Environmental ethics - stewardship ethics and lifeboat ethics of Garret Hardin. Fly ash utilization, wet land conservation, Deforestation and its Impact National action plan on climate change IPCC and its role, Conventions on climate change and sustainable development.

### **References :**

1. Environmental Education – Nanda. A.N. (1996)
2. A text book of Environment – Agarwal. K. M. Sikdar. P. K. and Deb. S. C, MacMiller India Ltd., Calcutta (2002)
3. Living in the Environment – Principles, Connections and Solutions – Tyler Miller Jr. G, Wadsworth Publishing Co. New York (1996)
4. Botkin, D.B.Changing the Global Environment, Academic Press, San Diago (1989)

## Hard Core Papers

### 1. Conservation of Biodiversity:

**Unit – 1** Biodiversity – Genetic diversity, Species diversity and ecosystem diversity, alpha, beta, and Gamma diversity, values of Biodiversity – consumptive use value, optional values, productive use value, social value. Biowealth, endemism, significance of the endemism, Hot spots of Biodiversity,

**Unit - 2** Brief account of endangered flora and fauna of India. Red data book and IUCN categories, endangered species, vulnerable species. Rare species. Man- Wildlife conflicts. Ecological consequences of reduction in biodiversity. Biodiversity issues – Deforestation and its impact. Two paradigms of Biodiversity, Convention on Biological diversity (CBD), Man and biosphere programme (MAB).

**Unit – 3** Causes for depletion of biodiversity in India, Biodiversity in Karnataka, conservation measures of biodiversity in Karnataka, Sacred grooves. Prospects and Perspectives of keystone species with special reference to Tiger.

**Unit – 4** Biosphere Reserves – concept of conservation – objectives and management, Nilgiri Biosphere Reserve - Biosphere Reserves in India, *In situ* and *ex situ* conservation, Role of Zoos, National Parks and Sanctuaries in conservation, Biological Diversity Act of India

### Practicals :

1. Determination of density of species using quadrant method
2. Determination of suitability point of a vegetation
3. Determination of frequency and relative frequency of species in a given area
4. Determination of abundance of species in a given area
5. Identification of endangered species of flora and fauna
6. Economic potentialities of selected plants and animals
7. Identification of ecological features of selected flora and fauna.
8. Study of adaptive features of hydrophytes
9. Study of adaptive features of xerophytes
10. Determination of Shannon-Weiner Index, Simpson Index, IVI.

## **References :**

1. Biodiversity – Strategies for Conservation – Dadhich.L.K. and A.P.Sharma, APH publishing corp. New Delhi, 2002
2. Global Biodiversity Conservation measures – Khan. T.I and Dhari. N Al-Ajmi, pointer publishers, Jaipur (1999)
3. An Advanced Text book on Biodiversity – Principles and Practice – Krishnamurthy. K.V, Oxford and IBH publishing, New Delhi (2003)

## **2. MAJOR PROJECT WORK**

### 3. Solid and Hazardous Waste Management:

**Unit 1** – Waste – Introduction, sources, characteristics, composition, classification, waste generated per capita- Global scenario. Solid Waste – collection, Storage, segregation- transportation and disposal methods- sanitary landfills and types, composting, anaerobic digestion, incineration, types of incineration, pyrolysis and medical waste, Biomedical waste Management.

**Unit 2** – Hazardous waste-Introduction, characteristics, resource conservation and recovery act, listed hazardous waste, listing criteria. Classification of hazardous waste and handling of hazardous solid wastes, Radioactive wastes- sources, pollution, types of radioactive waste and its control and management.

**Unit 3** – Waste management – waste minimization program, typical material recovery facility operation (TMRF), Reuse and recycling of paper, glass, rubber. Plastic wastes status in India, effect of plastic wastes on environment, management of plastic wastes.

**Unit 4**- Plastic waste (management and handling) rules-2016, E-waste, Sources, classification and management rules 2016, fly ash management rules-1999, Waste auditing, concept of 3 R's, 4 R's & 5 R's biodegradable plastic, plastic, Biomedical waste management rules.

#### Practicals :

1. Characterization of solid waste from different sources.
2. Designing of secured/sanitary land fills.
3. To study of methods of management of biomedical waste.
4. Characterization of (TCLP) toxicity characteristic leaching test procedure hazardous waste from different sources.
5. Determination of organic carbon in compost/NPK in Compost.
6. Determination of inorganic phosphate in leachate samples.
7. Determination of kjeldhal nitrogen in leachate
8. Determination of TSS/TDS in leachate sample.
9. Field trip to municipal solid waste/zero waste management sites/ Biomedical waste plant.

#### References :

1. Hazardous Wastes and Solid Wastes- Lie, D.H.F. and Liptak, B.G. (2000), Lewis publishers, New York.
2. Solid Waste management in Developing countries – Indian National Scientific documentation center- Bhide and Sundaresan, New Delhi. (2000)
3. Solid waste management- George Tehobanaglou- Miliary Theiren and Samuel A vigil, Integrated, Mc Graw Hill Inc, (1993).
4. WHO Manual on solid waste management
5. CPHEEO Manual on solid waste management
6. Hazardous Waste Management, II Ed, La Grega, M.D., Buckingham, P.L. and Evans J.C., Mc Graw Hill Inc., (2001)
7. Bioremediation, Baker, K.M. and Herson, B.S, Mc. Grqw-Hill Inc., (1994)

## **Soft Core Papers:**

### **3. Marine Ecology and Coastal Pollution:**

**Unit- 1** Marine ecology; Introduction to marine environment, marine bioresources and their economic importance, Marine Symbioses sources and causes for marine pollution, scope: effect of oil on marine environment, sea level rise and erosion, Tides and types of tides.

**Unit- 2** Coastal pollution; Man made pollution in coastal environment, Human impact on the Marine environmental coastal dumping, Status of biodiversity in coastal area, Brief account of benthic fauna, coral reefs and their economic importance.

**Unit-3** Sustainable use and conservation of marine living resources, marine environmental protection, Marine protected Areas- benefits of MPA (MPA) Red tides and their significance, Sustainable development of small islands. Conventions related to marine and coastal environment.

**Unit- 4** Coastal zone management – Specific issues: Habitation, Agricultural land, shrink area, industries, gas fields and Sunderban. Ecologically sound coastal zone management program wastewater discharge into marine environment and its impact near fields mixing fields mixing

### **References:**

1. Biodiversity – Strategies for Conservation – Dadhich.L.K. and A.P.Sharma, APH publishing corp. New Delhi, 2002
2. Global Biodiversity Conservation measures – Khan. T.I and Dhari. N Al-Ajmi, pointer publishers, Jaipur (1999)
3. An Advanced Text book on Biodiversity – Principles and Practice – Krishnmurthy. K.V, Oxford and IBH publishing, New Delhi (2003)
4. Coastal Environments V.Subramanian
5. Coastal Environment and water quality Y.Jon xu and Vijay P. Singh
6. Economic Analysis for Ecosystem – Applications to Marine and coastal Environments Daniel S.Holland, James N.Sanchirico Robert J.Jhonsson, Deepak, Joglekar
7. An Introduction to Marine Ecology, 3<sup>rd</sup> Edition R.S.K.Barnes, R.N.Hughes
8. Marine conservation Ecology Jonday, Mark Zacharias, John Roff
9. Oil Pollution and Marine Ecology Anthony Nelson- Smith

## **4. Natural resources management:**

### **Unit 1: Introduction**

Concept of resource, classification of natural resources- renewable and non renewable resources. Factors influencing resource availability, distribution and uses. Interrelationships among different types of natural resources. Ecological, Social and economic dimension of resource management Natural resources and development.

### **Unit: 2 Problems on resources**

Food and energy resources: World food problems, changes caused by agriculture and over-grazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies, Environmental effects of mining.

### **Unit: 3 Forest Resources**

Vegetation type of India status and distribution Non Timber Forest Product (NTFP) uses, causes for depletion of forest resources. Timber extraction, Economical potential of forest products, effects of mining, dams on forest and tribal people.

### **Unit: 4 Wildlife management in India**

Present scenario in India-present status of Tiger and Elephant population in India, Medicinal importance of Tiger pants, Management of conflicts between man and leopard, elephant. Priorities of wildlife conservation Ecotourism as a tool for wildlife conservation.

### **Reference:**

1. Francois Ramade 1984, Ecology of Natural Resources. John Wiley and Sons Ltd.
2. Odum, E.P.1971. Fundamentals of Ecology. W.B. Saunders Co. USA, 574p
3. Cunningham, W.P Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publishing House.

# Open Elective

## **1. Environment and Health**

**Unit – 1** Environmental Health Problems: Health problems related to the environmental degradation, vulnerable groups in society. Environmental factors that can potentially affect health, environment and health indicators, major environmental and health issues, Specific pollutants or issues, indoor and outdoor environment Health problems, Human Bio monitoring.

**Unit – 2** Environmental Risks and the Disease Burden: Environmental risks and the disease burden in different regions of countries and in India, Environmental factors, the burden of disease in India. The health effects of air pollution. Health risks associated with agricultural and industrial pollution.

**Unit – 3** Environmental Health Risks, Assessment and intervention : Introduction, Determination of risk, Risk assessment, Risk assessment methods, Risk monitoring, Risk communication, protecting the public, Risk assessment in public health, Environmental impact studies.

**Unit – 4** Occupational hazards of agricultural workers, somatic disease, accidents, toxic hazards, physical hazards, respiratory diseases, accidents in industry, sickness, absenteeism, health problems due to industrialization.

### **References :**

1. [http://ec.europa.eu/environment/health/index\\_en.htm](http://ec.europa.eu/environment/health/index_en.htm)
2. [http://ec.europa.eu/environment/health/index\\_en.htm](http://ec.europa.eu/environment/health/index_en.htm)
3. Biosafety and Bioethics by Sateesh M.K
4. Essentials of Environmental Health By Robert H Friis
5. Environmental health: ecological perspectives by Kathryn Hilgenkamp
6. Understanding Environmental Health: How We Live in the World by Nancy Irwin Maxwell,
7. Environmental Epidemiology: Principles and Methods by Ray M.Merrill,
8. Environmental Studies by Major Tiwari, Kapil Kulbe, Archana Tiwari, I.K.International.



## **2. Environmental Pollution and Management**

**Unit 1-** Water and Thermal pollution- Introduction, types of water pollution, sources of water pollution, effects of water pollution, Primary, Secondary, Tertiary and Advanced treatments for control of water pollution, Thermal pollution- sources, harmful effects, prevention and control.

**Unit 2-** Classification of atmosphere, Air pollution- sources, classification, properties of air pollutants, effects of air pollution on plants and human beings, Control methods for industrial air pollution-fugitive emission and source emission. Automobile pollution and mitigation measures.

**Unit 3-** Soil pollution and Noise pollution- Soil pollution- sources, effects and control measures, noise pollution, sources, effects and control methods. Measurement of noise pollution.

**Unit 4-** Radiation and Bio pollution- Radiation pollution- types of radiations: non ionizing and ionizing, alpha, beta and gamma radiations, cosmic rays and X-rays, sources of radioactive pollution, impact of radiation pollution on human health, preventive measures, bio pollution- aeroallergens, pollen grains, fungi, bio pollutants as biological components.

### **References :**

1. Environmental Chemistry by Sharma B.K. and Kaur, Goel Publishing House, Meerut (1995).
2. Environmental Biology and Toxicology by Sharma P.D. Rastogi and Lamporary 1994.
3. Environmental pollution and Toxicology by Meera Asthana and Astana D.K., Alka printers, 1990.
4. Environmental Science by S.C.Santra New central Book agency (Private) Limited Kolkata.
5. Ecology and Environment by P.D.Sharma, Rostogi Publications Meerut.
6. A Text book of microbiology by R.C.Dubey and W.K.Maheshwari S.Chand and Co. New Delhi.
7. Environmental Geology valdia. K.S Tata Mac Graw Publishers
8. Soil and water conservation Engineering – Schwab, S.G.et al John Wiley and sons 1975.
9. Soil Resources & the Environment – U. Aswathanarayana, oxford & IBH publishing, New Delhi.

### **3. Nuclear and Biomedical Waste Management**

**Unit – 1** Nuclear wastes – composition, Decay, scenario of nuclear wastes in the soil, nuclear fuel cycle, Nuclear energy, Management techniques-simple and high level nuclear waste management – Geological disposal. National & International management plans.

**Unit – 2** Introduction, quality of hospital waste, sources of biomedical waste, classification and sources, pathological wastes, sharp pharmaceutical wastes, Genetonic wastes, Chemical wastes, waste contaminated with heavy metals.

**Unit – 3** Measures to reduce biomedical wastes, Treatment of hazardous biomedical wastes, Biomedical waste management in developed countries and in India – legal aspects.

**Unit – 4** E-waste, composition, sources. E-waste management in global and national scenario, Recycling and disposal strategies.

#### **References :**

1. Radiation and Man – Jain H.C. National Book Trust, New Delhi
2. Environmental Radioactivity from Natural, Industrial and Military sources, Merrill Eisenbud and Thomas Gessell Academic Press, London.
3. Hazardous wastes and solid wastes / Lie DHF and Liptak B.G (2000), Lewis Publishers, New York
4. Hazardous waste Management, II Ed, La Grega M.D., Buckingham P.L. and Evan J.C MC Graw Hill Int. (2001)

## 4. Ecology and Environment

**Unit – 1** Fundamentals of Ecology- Definition, principles, and scope of ecology, objectives and sub-divisions. Concept of levels of organization, Ecological Dominance, Population ecology. Characteristics, population density, natality, mortality, age distribution, population growth, causes for population explosion, population control.

**Unit – 2** Ecosystems- Structure, functions, biotic and abiotic component, food chain, food web, Homeostasis, Ecological Niche, Ecological Dominance. Types of ecosystems : aquatic and terrestrial ecosystem.

**Unit – 3** Resources of environment – Habitat- classification – reasons for depletion of natural resources – conservation of natural resources ; air, water, soil, minerals, forests & wildlife.

**Unit – 4** Ecological Adaptation ; ecological adaptation of hydrophytes, ecological adaptation of mesophytes, ecological adaptation of xerophytes, ecological adaptation of halophytes. Deep sea adaptation, osmoregulatory adaptation

### References :

1. Fundamentals of Ecology 3<sup>rd</sup> Ed. W.B.Saunders & Co.Philadelphia
2. Systems Analysis & Simulation in Ecology Patten B.C. (Ed) 1971 Academic press London
3. An Introduction to Cybematics Chapman & Hall Ltd. Ashby W.R. 1956
4. Ecology & Environment seventh edition P.D.Sharma Rastogi publication Rajsons Printers, New Delhi (2004)
5. Plants and the Eco-system Macmilan & Co.Laondon Billings W.D 1964
6. Population Ecology A Unified study of Animals & Plants Blackwell Oxford, Begon M and Mortimer. M 1981
7. Environmental Concerns and strategies Indian Environmental Society Khoshoo T.N. 1984
8. Ecology with special Reference to Animals and Man Prentice- Hall New Jersey, Kendeigh S.C. 1974