



## M.Sc. ENVIRONMENTAL SCIENCE Semester-wise Schedule

### FIRST SEMESTER

PAPERS CODE	PAPERS NAME	INTERNAL	EXTERNAL	TOTAL
MSEVS101	Fundamentals of Ecology and Environmental Science	40	60	100
MSEVS102	Environmental Microbiology	40	60	100
MSEVS103	Environmental Pollution	40	60	100
MSEVS104	Environmental Monitoring	40	60	100
<b>PRACTICAL</b>				
MSEVS105	Practical-I	60	40	100
<b>Total</b>		<b>220</b>	<b>280</b>	<b>500</b>

### SECOND SEMESTER

PAPERS CODE	PAPERS NAME	INTERNAL	EXTERNAL	TOTAL
MSEVS201	Toxicology and Environmental Health	40	60	100
MSEVS202	Climate Change and Current Issues	40	60	100
MSEVS203	EIA and Environmental Auditing	40	60	100
MSEVS204	Waste Management	40	60	100
MSEVS205	Environmental Laws and Policy	40	60	100
<b>PRACTICAL</b>				
MSEVS206	Practical-II	60	40	100
<b>Total</b>		<b>260</b>	<b>340</b>	<b>600</b>

### **THIRD SEMESTER EXAMINATION**

<b>PAPERS CODE</b>	<b>PAPERS NAME</b>	<b>INTERNAL</b>	<b>EXTERNAL</b>	<b>TOTAL</b>
MSEVS301	Biodiversity and Conservation	40	60	100
MSEVS302	Environmental Engineering	40	60	100
MSEVS303	Natural Resource Management	40	60	100
MSEVS304	Research Methodology and Statistics	40	60	100
<b>PRACTICAL</b>				
MSEVS305	Practical-III	60	40	100
<b>Total</b>		<b>220</b>	<b>280</b>	<b>500</b>

### **FOURTH SEMESTER**

<b>PAPERS CODE</b>	<b>PAPERS NAME</b>	<b>INTERNAL</b>	<b>EXTERNAL</b>	<b>TOTAL</b>
MSEVS401	Field Visit		200	200
MSEVS402	Project		200	200
<b>Total</b>			<b>400</b>	<b>400</b>

**MSEVS101:**

**FUNDAMENTALS OF ECOLOGY  
AND ENVIRONMENTAL SCIENCE**

***UNIT I: Basics of Environmental Science***

Scope and interdisciplinary nature of Environmental Science; Environmental factors; Global environment and its segments; Structure and composition of atmosphere, hydrosphere, lithosphere and biosphere. Tolerance ranges and limiting factors. Stoichiometry, Thermodynamics: energy, entropy, enthalpy, Gibb's energy, Acid-Base reactions, redox potential.

***UNIT II: Ecosystem***

Classification; Biogeographical regions; Biomes; Biogeochemical cycles; Energy flow; Trophic relations; Ecological pyramids; Productivity and ecological efficiencies: primary and secondary producers. Gaia hypothesis, Niche, Speciation, Ecological Succession and Climax; Biological interactions - Mutualism, Parasitism, Predator- Prey relations, Competition, Positive and Negative interaction, Proto-cooperation, Commensalism, Parasitism, Predation.

***UNIT III: Population Ecology***

Characteristics-Population density, Natality, mortality, Age Pyramids/Age distribution, Population growth forms/curves, Population disturbance, population dispersal (migration, Immigration and emigration), population structure;- Isolation, distribution, population explosion-causes and control measures.

***UNIT IV: Ecological Factors - Climatic Factors***

Light - effect of light on morphology and physiology of plants, distinguishing features of Heliophytes and schiophytes.

Temperature - effect of low and high temperature on organisms- classification of vegetation - Megatherms, Microtherms, Mesotherms, Hekisotherms.

Wind - Breeze, Storm, Hurricans-Morphological and physiological effects of wind.

Humidity - hydrological cycle, Relative humidity, effect of humidity on organism.

**REFERENCES:**

1. Arora S. (2003). Fundamentals of Environmental Biology, Kalyani Publications, New Delhi.

2. Cotgreave P. and Forseth I. (2002). Introductory Ecology. Blackwell Science,UK
3. Dhaliwal G. S., Sangha G. S. and Raina P. K. (2000) Fundamentals of Environmental Science, Kalyani Publication, India.
4. Freedman B. (1995). Environmental Ecology, Academic Press, USA.
5. Jackson A. R. W. and Jackson J. M. (2000). Environmental Science – The natural environment and human impact, 2<sup>nd</sup> Edition, Longman Group, UNITED Kingdom.
6. Masters G. M. (2007). Introduction to Environmental Science and Engineering, 3<sup>rd</sup> Edition, Prentice –Hall of India Pvt Ltd, New Delhi.
7. Odum E.P. (1993). Fundamentals of Ecology, W.B.Saunders Co., USA.
8. Rana S.V.S. (2005). Essentials of Ecology and Environmental Science. Prentice –Hall of India Pvt. Ltd. New Delhi
9. Townsend C.R., Begon M. and Harper J.L. (2008). Essentials of Ecology, Blackwell Publications, UK.

## **MSEVS – 102: ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY**

### ***UNIT I: Fundamentals of Environmental Microbiology***

Introduction - autotrophy and heterotrophy, cultivation of microorganisms. Microbial growth and factors affecting microbial growth. Aeromicrobiology –sampling techniques, airborne diseases and allergies. Aquatic microbiology –sampling techniques, MPN technique, eutrophication, water borne pathogens and diseases. Soil microbiology – microbes of rhizosphere, microbial role in biogeochemical cycle. Microorganisms of extreme environment-Extremophiles. Role of microbes in environmental pollution and management.

### ***UNIT II: Microbial Ecology***

Important microorganisms in sewage treatment plant-nitrifying bacteria, ammonia-oxidizing bacteria, nitrite-oxidizing bacteria, indicator microorganisms. Microbial diversity – culturable and non-culturable microorganisms – physiological and molecular methods.

### ***UNIT III: Environmental Biotechnology***

Microbial remediation - composting, biostimulation, bioaugmentation, bioreactor, bioleaching, bioventing. Biodegradation of xenobiotics. Bioremediation of heavy metals and radio-active wastes. Microbial mediated bioconversion. Role of genetically engineered microbes in pollution control, Biofilms and microbial mats, biofouling and corrosion.

### ***UNIT IV: Industrial Biotechnology***

Bioenergy - definition, first generation biofuels - bioethanol, biodiesel, second generation biofuels - lignocellulosic biofuels; biohydrometallurgy and biomineralization; role of microbes in fermentation process in environmental cleanup; Types and role of biofertilizers and biopesticides, Biosensors and their application in environmental monitoring.

### **REFERENCES**

1. Eweis J.B., Ergas S.J., Chang D.P.Y., Schrodwer E.D. (1998.), Bioremediation Principles. New York, Mc Graw Hill.
2. Fulekar M.H. (2010), Environmental Microbiology. New York, Taylor & Francis.
3. Koukkou A.I. (2011), Microbial Bioremediation of Non-metals: Current Research. Haverhill, UK, Caister Academic Press.
4. Lederberg J. (1992), Encyclopedia of Microbiology, New York: Academic Press.
5. Maier R.M., Pepper I.L., Gerba C.P. (2006), Environmental Microbiology. San Diego, Elsevier Academic Press.
6. Passman F.J. (2003), Fuel and Fuel System Microbiology: Fundamentals, Diagnosis and Contamination Control. West Conshohocken, ASTM International.
7. Prescott L.M., Hareley J.P. Klein D.A. (2005), Microbiology (6<sup>th</sup> Edition). New York, McGraw-Hill Publishing Co. Ltd.
8. Sangeetha J, Thangadurai D, David M, Abdullah MA. (2016.), Environmental Biotechnology: Biodegradation, Bioremediation and Bioconversion of Xenobiotics for Sustainable Development, Boca Raton, Florida, USA, CRC Press.
9. Sen K., Ashbolt N.J. (2011), Environmental Microbiology: Current Technology and Water Applications. Norfolk, UK, Caister Academic Press.

## **MSEVS 103: ENVIRONMENTAL POLLUTION**

### ***UNIT I: Air Pollution***

Structure and chemistry of atmosphere, Composition of elements in the atmosphere; Temperature inversion, Atmospheric lapse rate, Adiabatic lapse rate. Chemistry of atmospheric pollutants: Photochemical smog-origin and occurrence, Ozone chemistry: Ozone layer, Chemistry of Ozone layer, Ozone depletion, Mitigation of ozone depletion; Acid rain- chemical reactions and its ecological effects; Green house effect and global warming; Effects of air pollutants on plants and animals; Air quality standards.

### ***UNIT II: Water Pollution***

Composition of pure water; Physical and Chemical properties of water. Chemical reactions and equilibria in water; Natural organic components in water - Concepts of DO, BOD and COD; Sources of water pollution; Effects of water pollution on plants and animals; Water quality standards.

### ***UNIT III: Soil Pollution***

Weathering and pedogenesis; Factors affecting soil formation, Development of soil profile; Structure of Soil; Physico-chemical characteristics of soil; Ion-exchange and adsorption processes in the soil; Classification of soil, Fate of chemicals in the soil; sources of soil pollution; Effects of soil pollution on microbes, plants and animals.

### ***UNIT V: Noise, Thermal and Radioactive Pollution***

Sources of noise pollution: indoor and outdoor noise pollution; Effects of noise pollution; Thermal and nuclear power plants as sources of thermal pollution. Effects of thermal pollution on aquatic flora and fauna; Control measures of thermal pollution; Sources of marine pollution; Pollution status of coastal and ocean waters; Radioactive pollution: types and sources, half-life period, natural radiation.

## **REFERENCES**

1. A.K. De (2001), Environmental Chemistry, New Age International Publishers, New Delhi.
2. Andrew D. Eaton, Lenore S. Glesceri, Eugene W. Rice and Arnold E. Greenberg (Eds) (2005). Standards Methods for the Examination of Water and Wastewater Analysis. 21st Edition, APHA, Washington DC.

3. Dara S S.,(1998), A Text Book of Environmental Chemistry and Pollution Control, S. Chand & Company Ltd, New Delhi
4. F.W. Fifield (2000). Environmental Analytical Chemistry. 2nd edition, Blackwell Publishers.
5. Howard S Peavy (2003), Environmental Engineering, Tata Mc Graw Hill Publishing Company Ltd., New Delhi.
6. Julian E Andrews et al., (2004) An Introduction to Environmental Chemistry, Blackwell Publishing.
7. Sawyer C.N., Mc Carty P.L., and Parkin,G.F (2003), Chemistry for Environmental Engineering and Science, Tata McGraw-Hill Publishing Company Ltd., New Delhi.
8. S. E. Manahan (2009), Fundamentals of Environmental Chemistry, CRC Press, USA.
9. Stanley E. Manahan (2010). Environmental Chemistry, 9th Edition, CRC Press, London.

## **MSEVS104: ENVIRONMENTAL MONITORING AND INSTRUMENTATION**

### ***UNIT 1: Separation Techniques***

Extraction and separation of inorganic and organic compounds; Chromatography: Paper chromatography, Thin layer chromatography, Column chromatography, High Performance Liquid Chromatography (HPLC), Gas chromatography and Mass Spectrometry (GC-MS), Electrophoresis: Agarose Gel electrophoresis, Poly Acrylamide Gel Electrophoresis, ELISA.

### ***UNIT II: Analytical Methods***

Microscopy: Light microscopy, Bright field microscopy, Dark field microscopy, Phase contrast microscopy, Fluorescence microscopy, Confocal microscopy, Electron microscopy: Transmission electron microscopy (TEM) and Scanning electron microscopy (SEM). Spectroscopy: Ultraviolet -Visible spectroscopy; Infrared spectroscopy, Flame emission spectroscopy; Atomic absorption spectroscopy (AAS); Raman Spectroscopy, Nuclear Magnetic Resonance Spectroscopy (NMR)

### ***UNIT III: Assays***

Assays of sugars, amino acids, proteins, carbohydrates, lipids, enzymes: alkaline phosphatase, acid phosphatase, peroxidase, Biomonitoring: tolerance levels, multiple level assessment, community level biomonitoring, assessment indices.

#### **UNIT IV: Principles of GIS and Remote Sensing**

Introduction and components of GIS, Nature of geographic information, Data sources, Data organization and storage, Data analysis, Global positioning system(GPS), Remote Sensing-Principles of remote sensing-spectral signatures, resources mapping

#### **REFERENCES:**

1. Andrew D. Eaton, Lenore S. Glesceri, Eugene W. Rice and Arnold E. Greenberg (Eds) (2005). Standards Methods for the Examination of Water and Wastewater Analysis. 21st Edition, APHA, Washington DC.
2. APHA (1998) Standards Methods for the examination of water and Waste water, 20<sup>th</sup> Edition, Washington DC.
3. B.L. Oser (1965). Hawk's Physiological Chemistry. MacGraw Hill Book Co.
4. Clair N. Sawyer (2003). Chemistry for Environmental Engineering and Science. Tata McGraw Hill.
5. Denise R. Ferrier (2013) Lippincott's Illustrated Reviews Biochemistry; Sixth edition, Ippincott Williams & Wilkins.
6. Douglas A. Skoog, F. James Holler and Timothy A. Niemen.(1998). Principles of Instrumental Analysis. 5<sup>th</sup> Edition, Saunders College Publishing, Philadelphia.
7. F.W. Fifield (2000). Environmental Analytical Chemistry. 2<sup>nd</sup> edition, Blackwell Publishers.
8. Khopkar S M (1985). Basic Concepts of Analytical Chemistry. Wiley Eastern Ltd., New Delhi.
9. Miroslav Radojevic and Vladimir N.Bashkin (1999), Practical Environmental Analysis, The Royal Society of Chemistry, Cambridge.

#### **MSEVS105: Practical - I (Ecology, Microbiology, Instrumentation, Pollution)**

1. Plankton Analysis – Shanon Weiner Diversity Index
2. Primary Productivity - Light and Dark bottle method & Chlorophyll method
3. Staining and inoculation techniques
4. Assessment of Water Quality by Membrane Filter/Total Coliform /E.coli/ Faecal Coliform
5. MPN Technique



6. Sampling and enumeration of airborne microorganisms
7. Heterotrophic plate count for soil microorganisms
8. Water Quality analysis
9. Spectrophotometric and flamephotometric analysis of water and soil pollutants
10. Air sampling and analysis
11. Microscopy – light, phase contrast and fluorescence microscopes
12. Separation of DNA by Gel Electrophoresis
13. Determination of Bio assays
14. TLC and paper Chromatography

## **MSEVS201: TOXICOLOGY AND ENVIRONMENTAL HEALTH**

### ***UNIT I: Environmental toxicology***

Definition and branches of toxicology, scope and importance of toxicology, Principles of toxicology. Toxicants - Classification, routes of entry, transport, storage, metabolism and excretion. Categories of toxic effects - synergistic, antagonistic and additive effects. Acute and chronic toxic effects. Dose-effect and dose-response relationships, LOAEL and NOAEL.

### ***UNIT II: Hazardous waste and metabolism of toxicants***

Hazardous effect – Polychlorinated biphenyls (PCBs), Persistent organic pollutants (POPs) and biohazards. Toxicity of pesticides, insecticides, fertilizers, heavy metals, radioactive substance, fluorides and carbon monoxide. Mode of action of toxicants, mechanism of toxicants - Biochemical and molecular effects. Bio-concentration, bioaccumulation and biomagnification of toxicants.

### ***UNIT III: Analytical methods for toxicity testing***

Principles of toxicity testing, Measurements of LC<sub>50</sub> and LD<sub>50</sub> values. Monitoring approaches - indicator populations and indicator species. Model ecosystems - microcosms and mesocosms, Bio-sensors and bio-markers in toxicology. Molecular marker to toxicants - metabolites as indicators, protein induction, cytochrome P450 enzymes, stress proteins and metallothioneins.

### ***UNIT IV: Environmental risk and health***

Environmental and occupational safety - Definitions, concept and scope, occupational exposure, occupational hazards and diseases. Control of toxic materials and protection measures - air, water and soil. Health effects of cosmetics and pharmaceuticals products, occupational health hazards-Pneumoconiosis's, Bagassorsis, Byssicosis, Asbestosis, Anthracosis, Siderosis, farmers lungs. Legislative perspective in ecological risk assessment, human health risk assessment.

## **REFERENCES**

1. B.M. Francis. (1994.), Toxic Substances in the Environment. New York, John Wiley & Sons.
2. Bryan Ballantyne, Timothy C. Marrs, Tore Syversen. (2009), General Applied Toxicology. 6 Volume Set, Third Edition. Queensland, John Wiley & Sons.
3. Cockerham L.G., Shane B.S. (1993), Basic Environmental Toxicology. USA, CRC Press.
4. Edward A. (2013), Laws. Environmental Toxicology: Selected entries from the encyclopedia of sustainability science and technology. New York, Springer-Verlag.
5. Hayes, A. W. (2008), Principles and Methods of Toxicology, 5<sup>th</sup> Edition, Boca Raton, FL, Taylor and Francis.
6. I.C. Shaw and J. Chedwick. (2004), Principles of Environmental Toxicology, Boca Raton, FL, Taylor and Francis.
7. Levy B.S., Wegman D.H. (1995), Occupational Health recognizing and preventing work related disease. Boston, MA: Little Brown & Co.
8. Walker C.H., Sibly R.M., Hopkin S.P., Peakall D.B. (2012), Principles of Ecotoxicology. Fourth Edition. USA, CRC Press.

## **MSEVS202 CLIMATE CHANGE AND CURRENT ISSUES**

### ***UNIT-I Global Environmental problems***

Ozone depletion, causes and effects. Acid Rain – formation, adverse effects. Photochemical smog, Factors responsible for photochemical smog. Green house gases – green house effect and climate change, Global warming, Drought, Water crisis, Minamata, Itai-Itai, Flurosis and Cyanosis, Bhopal gas tragedy, Chernobyl accident, Wetland conservation

## ***UNIT-II Sources of Energy***

Sources of energy, Conventional/non-conventional energy system -Wood, Coal, Thermal power energy, Hydro, Wind, Solar, Nuclear energy, Tidal energy - a brief account.

## ***UNIT-III Basic concepts and mechanisms***

Science of climate change, global warming and greenhouse effect, radiative balance, earth's carbon reservoirs and carbon cycle, El-Nino and La Nino, greenhouse gases in the atmosphere – sources, levels and mechanisms of action. Effects: Rise in earth's temperature; effects on forests; effects on agro ecosystems; desertification; effects on freshwater ecosystems; effects on oceans; sea level rise; melting of polar ice and glaciers; effects on rainfall patterns; extreme events, socio-economic and public health consequences.

## ***UNIT-IV National and International responses***

National Action Plan on climate change; India's position and actions vis-a-vis international programmes, Intergovernmental panel for climate change (IPCC) and its role; United Nations framework convention on climate change (UNFCCC), CDM and Kyoto Protocol; the bali road map; The Copenhagen Accord; future actions; ethics of climate change.

## **REFERENCES:**

1. J. T. Hardy (2003). Climate Change: Causes, effects and solutions, John Wiley and Sons.
2. Egbert Boeker and Rienk van Grondelle (2013). Environmental Science Physical Principles and Applications, John Wiley & Sons Ltd., New York.
3. Akimasa Suni, Kensuke, F., and Ai, Hiramatsu.(2010). Adaptation and mitigation strategies for climate change. Springer.
4. Burroughs, W.J. (2007). Climate change: A multidisciplinary approach (2nd edition.). Cambridge University Press. Dash, 6. Sushil Kumar. (2007). Climate change: An Indian perspective. Cambridge University Press India Pvt. Ltd., New Delhi.
5. IPCC (2007): Summary for policymakers. In: Climate change 2007: impacts, adaptation and vulnerability. Contribution of working group II to the fourth assessment report of the

intergovernmental panel on climate change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 7- 22.

6. Nordhaus, W.D. (1994). *Managing the Global Commons: The Economics of Climate Change*, MIT Press.
7. Tyler Miller Jr. G (1996) *Living in the Environment – Principles, Connections and Solutions*, Wadsworth Publishing Co. New York.
8. Botkin, D.B. (1989) *Changing the Global Environment*, Academic Press, San Diago.

## **MSEVS203: EIA AND ENVIRONMENTAL AUDITING**

### ***UNIT I: Importance of EIA***

History and objectives – Basis for Environment Impact Assessment, Notification 1994 and 2006, Approach to EIA studies – mandatory requirements, project screening, scoping, environmental baselines, Public Participation best practices; terms of reference (ToR); Phases of EIA – Identification, Prediction, Evaluation, Decision making and Post impact Monitoring, Major limitations of Environmental Impact Assessment.

### ***UNIT II: Methodologies***

Environmental Impact Statement Process, EIA Methodologies – Adhoc Methods – Checklist Methods – Matrix Methods – Network Methods, Cost-Benefit Analysis.

### ***UNIT III: Assessment procedure***

Prediction and Assessment of Impacts on natural Resources – Biota, Surface Water, Ground Water, Air, Noise, Hazards, Historic and Cultural Resources, Transportation, Socio-economic relationships. Case studies - Land Clearing Projects – Dam sites – EIA for Aquaculture, Steel, Mines, Hydel, Thermal, Nuclear, Oil and Gas based Power Plants – Highways projects – Industrial Projects.

### ***UNITI V: Environmental auditing***

Definition of Environment Audit and its importance for industries. Types of Audit and Definitions. Life Cycle Assessment, Environmental audit: Pre-Post audit process; International organization for standardization (ISO), ISO 14000 standards and certification, Eco labelling.

## REFERENCES

1. Bregman, J. I., (1999), Environmental Impact Statements, Lewis Publishers, London.
2. Canter, L.W., (1996), Environmental Impact Assessment, Mc Graw Hill, New York.
3. Eccleston, C. H., (2000) Effective Environmental Assessment, Lewis Publishers, London.
4. Eccleston, C.H., (2000) Environmental Impact Assessment- A Comprehensive Guide to Project and Strategic Planning, John Wiley and Sons.
5. M. E. Jensen and P. S. Bourgeron (2001), A guide book for Integrated Ecological Assessments, Springer-Verlag, New York, Inc.

## MSEVS204: WASTE MANAGEMENT

### ***UNIT I: Wastes – Sources, effects and management principles***

Wastes – Classification and Quantification – Types – sources – composition of waste. Waste generation status – quantity and characterization. Issues and strategies in waste management – Waste as resource – 3Rs – Waste reduction at source – municipal and industrial wastes. Sustainable recycling - medical waste-characteristics.

### ***Unit II: Municipal solid waste management***

Methods of waste collection, collection techniques, waste container compatibility, waste storage requirements, transportation of solid wastes. Material and resource recovery/recycling from solid wastes. Treatment and disposal techniques for solid wastes–composting, vermin-composting, autoclaving, microwaving, incineration, non-incineration, thermal techniques, use of refuse derived fuels, landfilling.

### ***UNIT III: Industrial solid waste management***

Types – sources – composition of waste – Waste Audit – recycling of waste for Industrial, Agricultural and Domestic Purposes; Recycling of Metals, Reuse, recovery and reduction of paper and plastics; Recycling in Food Manufacturing, Beverages, Apparel, Leather, Paper, Pulp, Chemical and other industries; Fly ash management. E-waste and biomedical waste management. Waste disposal methods – anaerobic digestion, composting, incineration,

pyrolysis.

#### ***UNIT IV: Hazardous waste management***

Characteristics and sources – Hydrocarbons, Phenols, Chlorophenolic compounds, Polycyclic Aromatic hydrocarbons (PAH), Heterocyclic Compounds, Cyanide, Dioxins. Waste Minimization approaches – Monitoring and Management strategies. Radioactive waste – Sources, half-life of radioactive elements, modes of decay. Effects on Plants, Animals and Man. Low and High-level Radioactive Waste Management – Waste Minimization and Treatment, Radiation standards. Remediation measures – microbial and phytoremediation.

#### **REFERENCES:**

1. David H.F. Liu, Bela G. Liptak (1999), Hazardous Waste and Solid, CRC Press
2. Kanti L. Shah(1999), Basics of Solid and Hazardous Waste Management Technology, Prentice hall
3. Lawrence K. Wang, Yung-Tse Hung, Howard H. Lo and Constantine Yapijakis (1992), Handbook of Industrial and hazardous waste treatment, Marcel Dekker, Inc, Basel, New York
4. Michael D. LaGrega, Philip L.Buckingham, Jeffrey C.Evans (2001), Hazardous waste management, Waveland Press, Inc, Long Grove, USA
5. Riser-Roberts, E., (1998), Remediation of Petroleum Contaminated Soils - Biological, Physical and Chemical processes, Lewis Publisher, New York.
6. Russel Boulding, J (1995), Vadose-Zone and Ground Water Contamination - Assessment, Prevention and Remediation, Lewis Publishers, Tokyo.
7. Solid Waste Technology & Management, Thomas H. Christensen (2011), A John Wiley and Sons, Ltd., Publication, UK
8. Tandon (1995), Recycling of Crop, Animal and Human Waste in Agriculture, Mc Graw Hill Publishing Co

### **MSEVS205 ENVIRONMENTAL LAWS AND POLICY**

#### ***UNIT I: Environmental Policies***

Environmental policy in Ancient India, Medieval India, British India, during post independent era, the seventies, eighties and nineties. International environmental policy –the instruments of international environmental policy – international law, soft law, scientific cooperation - fund support, dispute settlement procedures, non-state actors and international environmental policy - Transnational environmental policies – the Indus river basin, the Ganga – Brahmaputra river basin system.

### ***UNIT II: International Environmental Laws and Conventions***

International Environmental laws - hazardous wastes-Basal convention – Necessity for International Environmental Court. United Nations Environment Programme [UNEP] role on international environment laws. Case studies for International environmental disputes.

### ***UNIT III: Pollution Control Acts and Rules***

The water act 1974, the water cess act 1977, the air act 1981, Solid Waste Management Rules, 2016; Biomedical Waste Management Rules, 2016; Fly ash Management Rules, 1999. Hazardous and Other Waste Management Rules, 2016, E-Waste Management Rules, 2016, Plastic wastes management and handling rules, 2016.

### ***UNIT IV: Acts, Rules and Notifications on Environmental Protection***

The Environmental Protection Act 1986, The Public Liability insurance act 1991, National Green Tribunal Act 2010. The Factories Act 1948, The Mines And Minerals Act 1957, The Atomic Energy Act 1962, The Motor Vehicles Act 1988 (amendment 2016). Case studies one each in the protection of forests, rivers and wild life.

### **REFERENCES:**

1. Gurudeep Singh (2005). Environmental law in India, Mc Millan, New Delhi.
2. ShyamDiwan and Armin Rosencrany (2001), Environmental law and policy in India, Oxford University Press, New Delhi.
3. Pollution Control Legislations, Vol. I and II, 1999, Tamilnadu Pollution Control Board, Chennai.
4. Nath B., Hens, L., Compton, P and D. Devuyt (1998), Environmental Management in Practice, Vol I, Routledge, London and New York.
5. Pollution control acts, rules and notifications issued there under, CPCB, 2010, New Delhi, PCLS/ 02/ 2010.

6. K. Thakur (2013), Environmental protection law and policy in India, Deep and Deep Publications, New Delhi.

## **MSEVS206**

## **PRACTICAL**

## **II**

### **(Environmental Toxicology and Waste Management)**

1. Toxic effects of xenobiotics on behaviour and physiological changes in fish
2. Determination of lethal concentration of pollutants
3. Toxic effect on the seed germination and growth of plants
4. Toxic effect on chlorophyll and carotenoid content of the plants
5. Calculation of Carrying capacity of land
6. Vermi-Composting
7. Analysis of micro and macronutrients in composting

## **MSEVS301 BIODIVERSITY AND CONSERVATION**

### ***UNIT-I: Introduction***

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-II: Threats to Biodiversity***

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-III: Issues**

Causes for depletion of biodiversity in India, Biodiversity of Western Ghats, conservation measures of biodiversity, Sacred grooves. Prospects and Perspectives of keystone species with special reference to Tiger.

### **UNIT-IV: Conservation Strategies**

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

### **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 (1999), Global Biodiversity Conservation measures –Al-Ajmi Pointer Publishers, Jaipur.
3. Krishnamurthy. K.V (2003), An Advanced Text book on Biodiversity – Principles and Practice – Oxford and IBH publishing, New Delhi.
4. Chiras D. D and Reganold J. P. (2011), Natural Resource Conservation: Management for a sustainable future, 10/E Prentice Hall.
5. Gaston K.J. and Spicer J. (2004), Biodiversity an introduction. Blackwell Publications, UK
6. Henry RJ. (1997), Practical Application of Plant Molecular Biology. Chapman and Hall Publication, London
7. Krishnamurthy K.V. (2003), Advanced text book on Biodiversity. Oxford & IBH, New Delhi
8. Maiti P.K. and Maiti P. (2011), Biodiversity- Perception, Peril and Preservation. PHI Learning. New Delhi

## **MSEVS302: ENVIRONMENTAL ENGINEERING**

### **UNIT – I: Hydraulics**

Hydraulics – Pressure- Hydrostatic Pressure, Pressure Head,

Measurement of Pressure, Flow, Design of Pressure Pipes – Darcy – Weisbach Formula, Manning’s Formula, Hazen – William’s Formula – limiting velocities, Minimum and Maximum Test Pressure and Working Pressure in pipes – selection of pipe material – Pump types, Characteristic Curves – selection and determination of capacity.

***UNIT – II: Designing of Water and Wastewater Treatment Plant***

Flash Mixer – Design – Clariflocculator – parameters for design – Filtration - Rapid sand filter and Pressure filter; Disinfection - calculation of chlorine dosage, chlorine demand, and residual chlorine. Physical and Chemical unit Operations and Applications - Design Parameters and Design of Primary and Secondary Settling Tanks – Activated Sludge Process – types and modifications – Design of Aeration Tanks– Diffusers and Mechanical Aerators. Design criteria for Trickling Filters.

***UNIT – III: Sludge Processing and Disposal Methods***

Sludge Processing and Disposal Methods- Design of Anaerobic Digester and Sludge Drying Bed – Reverse Osmosis – Ion Exchange – Incinerators and Multiple Evaporators.

***UNIT – IV: Air Pollution Control Design***

Minimum Stack Height – Plume Rise, Ground Level Concentration of Pollutants. Design of Settling Chamber, Cyclones, Fabric filters and Electrostatic Precipitators. Wet Scrubber. Case studies: Distillery, Dyeing, Electroplating, Paper and Pulp, Steel, Tannery - Industrial Effluent Treatments.

**REFERENCES**

1. Environmental Engineering: A Design Approach, Sincero A. P and Sincero G. A. (1999), Prentice-Hall of India Pvt. Ltd., New Delhi.
2. Gilbert M. Masters (2004), Introduction to Environmental Engineering and Science, Prentice-Hall of India Pvt. Ltd., New Delhi.
3. Howard S Peavy (2003), Environmental Engineering, Tata Mc Graw Hill Publishing Company Ltd., New Delhi.
4. Frank R. Spellman, (2003), Handbook of Water and Wastewater Treatment Plant Operations, Lewis Publishers, London.
5. Metcalf and Eddy (2003), Wastewater Engineering: Treatment and Reuse, Tata Mc Graw Hill Publishing Company Ltd., New Delhi.

6. Hammer M.J. and Hammer Jr M. J. (2001), Water and Wastewater Technology, Prentice Hall of India Pvt. Ltd., New Delhi.

## **MSEVS303: NATURAL RESOURCES MANAGEMENT**

### ***UNIT-I 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-II Forest resources***

Forest vegetation, status and distribution, contribution as resource. Use and over-exploitation, deforestation. Timber extraction, mining, dams and their effects on forest and tribal people, Forest products.

### ***UNIT- III 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.

### ***UNIT-IV Soil, Water and Mineral resources***

Soil resource, Soil fertility management, waste land-National scenario, waste land management through social forestry programmes.

Water resources: Sources and utilization, water demand, conflicts over water, dams-benefits and problems, conservation of water

Mineral resources: Use and exploitation, environmental effects of mining, conservation of minerals.

### **REFERENCES:**

1. Francois Ramade 1984. Ecology of Natural Resources. John Wiley & 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.
4. Cunningham, W.P., Cunningham, M.A. & Saigo, B. (2004) Environmental Science, a Global Concern. (8th edition). McGraw-Hill (Boston)
5. Heywood, V.H. & Watson, R.T. 1995. Global Biodiversity Assessment. Cambridge Univ. Press.
6. Miller T.G. Jr. Environmental Science, Wadsworth Publishing Co. (TB)
7. Townsend C., Harper J, and Michael Begon. Essentials of Ecology, Blackwell Science.
8. Wright, R.T. (2005) Environmental Science - toward a Sustainable Future. (9th International Edition), Pearson Education International, Prentice Hall Publishers.

## **MSEVS304 RESEARCH METHODOLOGY AND STATISTICS**

### ***UNIT – I: Research Documentation and Ethics***

Scientific documentation, literature collection, design, planning and execution of investigation, Preparation of scientific documents, general articles, research papers, review articles, editing of research papers, methods of citation and thesis writing. Stakeholders in research, Publication and research industry, Publication process; Ethics in Environmental Research; Plagiarism and its consequences; Good laboratory practice and Laboratory safety.

### ***UNIT II: Descriptive statistics***

Fundamentals of Statistics– Collection of Data – Classification and Tabulation – Diagrammatic Representation – Measures of Central Tendencies and Dispersion – Moments, Skewness and Kurtosis – Normal, Poisson and Binomial Distributions.

### ***UNIT III: Standard distributions***

Tests of Significance – Mass and alternative hypothesis – error level of significance – Equal and Unequal Sampling - t, z,  $\chi^2$  test, Analysis of variance – One way ANOVA – Two way ANOVA – Regression and correlation - simple and multiple. Cluster analysis – PCA, Graph Plotting.

#### **UNIT – IV: Environmental Models**

Lotka – Volterra Model, Leslie’s Matrix Model – Point Source Stream Pollution Model – Air Quality Model. Thermal Plume and Dispersion models. Decision Support Systems – Data Analysis using packages (SPSS).

#### **REFERENCES**

1. Bliss, G.I. (1970). Statistics in Biology. Mc Graw Hill Book Company, Vol. I and II. New Delhi.
2. Vittal, R.R. (1986), Business Mathematics and Statistics, Murgham Publications.
3. Haynes, R (1982), Environmental Science Methods, Chapman & Hall, London.
4. Khan, I.A and Kanum, A., (1994), Fundamentals of Bio-Statistics, Ukaaz Publication, Hyderabad.
5. Gupta, S.P. (1996), Statistical Methods, Sultan Chand & Sons Publications, New Delhi.
6. Byron S Gottfried (1996), Programming with C, Hill Publishing Co, New Delhi.
7. Wardlaw, A.C. (1985), Practical Statistics for Experimental Biologists. Wiley Chichester.
8. Kothari, C.R (1996), Quantitative Techniques, Vikas Publishing Housing Pvt Ltd, Hyderabad
9. Miller, J., (1989), Statistics for Advanced Level, Cambridge University Press.

#### **MSEVS305 Practical-III (Biodiversity, Environmental Engineering, Statistical Analysis)**

1. Determination of density of species using quadrat 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. Calculation and designing of Sedimentation Tank
7. Calculation and designing of Activated Sludge Processes
8. Calculation and designing of Trickling Filter
9. Calculation and designing of Disinfection Process
10. Calculation and Designing of minimum stack height
11. Calculation and Designing of Cyclone, Electrostatic Precipitator
12. Collection of Data: Primary data - Secondary data - Classification and Tabulation - Diagrammatic Representation
13. Data Analysis using software: SPSS and Excel stat: Editing, Data Tabulation
14. Analysis: Descriptive statistics - Correlation - Regression - Factor analysis - Cluster analysis - Principal Component Analysis (PCA), Graph Plotting - One way ANOVA - Two way ANOVA.

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