

Department of Energy and Environment  
Faculty of Science and Environment  
Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya, Chitrakoot Satna (MP)

**1<sup>st</sup> Semester**

Course code	Subject/Course	Credit (L+P)
SME501	Fundamental of Ecology & Environment	3+0
SME502	Environmental Chemistry	3+0
SME503	Atmosphere and Climatology	3+0
SME504	Environmental Geosciences	3+0
SME505	Practical-I Physico-Chemical Analysis of Water and Waste Water (Related to paper 502)	0+2
SME506	Practical-II Geo-Biological Practical (Related to 501)	0+2
	<b>Total</b>	<b>16</b>

**2<sup>nd</sup> Semester**

Course code	Subject/Course	Credit (L+P)
SME507	Environmental Pollution & Control	3+0
SME508	Remote Sensing & GIS <small>paper revised on Aug. 2017 (BO)</small>	3+0
SME509	Energy and Environment	3+0
SME510	Environmental Toxicology	3+0
SME511	Practical-I Chemical Analysis of Water and Waste Water (Related to 507)	0+2
SME512	Practical-II GIS & Remote Sensing (Related to 508)	0+2
	<b>Total</b>	<b>16</b>

**3<sup>rd</sup> Semester**

Course code	Subject/Course	Credit (L+P)
SME601	Environmental Law and Policies	3+0
SME602	Environmental Impact Assessment	3+0
SME603	Solid Waste Management	3+0
SME604	Statistics and Research Methodology	3+0
SME605	Practical-I Physico-Chemical Analysis of Air (Related to 602)	0+2
SME606	Study Tour	0+2
	<b>Total</b>	<b>16</b>

**4<sup>th</sup> Semester**

Course code	Subject/Course	Credit (L+P)
SME607	Elective (any one)	3+0
SME608	Dissertation/ Project Work	0+10

Note\* One study tour must be completed during the end of II semester but its credit will be registered in III semester.

*[Signature]*  
23/10/21

First semester

## SME501: FUNDAMENTAL OF ECOLOGY AND ENVIRONMENT

**UNIT-I:** Environment-Definition, principle and scope of environmental science, physico-chemical and biological factors in the environment.

**UNIT -II:** Ecosystem - concept, structure, function and types- abiotic and biotic components, food chain, food web; Ecological pyramids Ecological energetic - The Energy flow in Biosphere and in Ecosystems. Laws of thermodynamics, h and y shaped models, ecological efficiency, biogeochemical cycles- pools and fluxes, cycling of nitrogen, carbon, phosphorus, sulphur, calcium, Primary and secondary productivity.

**UNIT -III:** Community-analytical and synthetic characters; Ecotone, Edge effect, Ecological succession.

**UNIT -IV:** Population- Population characteristics, population regulation- biotic potential and environmental resistances (r and k selections); Factors of population regulation - density dependent and density independent; and carrying capacity; genecology, Ecads, Ecotypes, Ecospecies, Niche, Keystone species, invasive species.

**UNIT-V:** Biodiversity-Endangered and threatened species, biodiversity and its conservation, hotspots of biodiversity, strategies for biodiversity conservation, national parks and sanctuaries.

### Reference Books

- Botkin, Daniel B. and Keller, Edward A. Environmental Science: Earth as a Living Planet. 6th ed. John Wiley & Sons, USA, 2007.
- Chapman, J. L. and Reiss, M. J. Ecology: Principles and Applications. Cambridge University Press, UK., 1998.
- Cunningham, W. P. and Cunningham, M. A. Principles of Environment Science. Enquiry and Applications. 2nd ed. Tata McGraw Hill, New Delhi, India, 2004.
- Kemp, M. J. Environmental Science. The McGraw-Hill Companies. 1997.
- Nebel, B. J. and Wright, R. T. Environmental Science. Prentice Hall. 1981.
- Odum, E.P. Fundamentals of Ecology. W.B. Saunders, USA. Indian Reprint 1996, Natraj Publishers, Dehradun, India, 1991. 7

## SME502: ENVIRONMENTAL CHEMISTRY

**UNIT-I: Fundamentals of Environmental Chemistry:** Elements, compounds, mixtures, radionuclide, Stoichiometry, Gibb's free energy, enthalpy, entropy; chemical kinetics, chemical equilibria, chemical redox potential. Solubility product, Carbon cycle, Nitrogen cycle, Oxygen cycle, Hydrological cycle. *carbonate system, law of thermodynamics, phase equilibria*

**UNIT-II: Atmospheric chemistry:** Composition and structure of the atmosphere, particles, ions and radicals in the atmosphere; Thermo-chemical and photochemical reactions in the atmosphere; Oxygen and Ozone Chemistry, hydrocarbons, oxides of sulphur and nitrogen, Acid rain, Chloro-fluoro carbons, Green house effect cum Global warming. *photochemical smog*

**UNIT-III: Chemistry of Aquatic Environment:** Chemistry of water, Hydrological cycle, pH TDS, Conductivity, Salinity DO, BOD, COD; water pollutants and eutrophication, *filtration, adsorption, coagulation and advanced treatment, sedimentation, flocculation*

**UNIT-IV: Soil Chemistry:** Physico-chemical characteristics of Soil, soil clays, organic carbon, micro-nutrients and macro-nutrients, soil humus and mineralization, cation exchange capacity, soil water solution, Nitrogen pathways, C/N ratio, soil acidity, soil salinity.

**UNIT-V: Analytical Methods:** Titrimetry, gravimetry, colorimetry, spectrophotometry, chromatography, atomic absorption spectroscopy, HPLC, electrophoreses, X-ray fluorescence, X-ray diffraction, flame photometry.

### Reference Books

- Baird, C. and Cann, M. Environmental Chemistry. W.H. Freeman and Company 2008.
- Banerji, S. K. Environmental Chemistry. 2nd ed. Prentice-Hall, New Delhi, India. 1999.
- De, A. K. Environmental Chemistry. 4th ed. New Age International (P).Ltd., New Delhi, India. 2000.
- Harrison, R. M. and de Mora, S. J. Introductory Chemistry for the Environment Science. 2nd ed. Cambridge University Press, New Delhi. 1996.
- Kothandaaman, H. and Swaminathan, G. Principles of Environmental Chemistry. B.I. Publications, Chennai, India. 1997.
- Manahan, S. E. Fundamentals of Environmental Chemistry. 2nd ed. CRC Press, Inc., USA. 2001.
- Neill, P. O. Environmental Chemistry. Chapman & Hall. 1985.
- Sawyer, C.N. and McCarty, P.L. G.F. Parkin (Eds). Chemistry for Environmental Science and Engineering, Tata-McGraw-Hill Edition, 2003.

## SME503: ATMOSPHERE AND CLIMATOLOGY

UNIT-I: Atmospheric structure and components of atmosphere, major components, trace gases, thermal structure of atmosphere, troposphere, stratosphere, mesosphere, thermosphere, solar radiation and atmospheric structure, photochemistry of upper atmosphere.

UNIT-II: Different layers and their characteristics ; meteorological aspects- inversions, mixing height, wind-rose, electromagnetic radiations, solar radiation and terrestrial radiation, heat budget, Temperature measurements and controls, Environmental lapse rate, humidity, mixing ratio, dry and wet adiabatic lapse rate.

UNIT-III: Weather and Climate- Elements of Weather and Climate, classification, energy balance in atmosphere, greenhouse effect, Atmospheric general circulation, Precipitation and types of storms, Indian monsoon, El Nino , La Nina effect, and western disturbances, Geostrophic wind and gradient wind, cyclones, Atmospheric moisture: Forms of cloud condensation; Precipitation, Thunderstorms, floods and droughts. Climate variability and climate change.

UNIT-IV: Spatial and temporal patterns of climate parameters in India. Indian monsoon jet streams, general circulation. Climatic classification, Climates of Indian region, Elements of Agro-climatology, Human and Animal bio-climatology, urban climatology, causes and consequences of Global Warming, Ozone hole, Sea level rise in climate. Climatic considerations in Industrial location, city planning, landscape architecture and abatement/mitigation of pollution.

UNIT-V: Atmospheric aerosol, source of aerosol, primary aerosol, secondary aerosol, aerosol transport and deposition-dry deposition, sedimentation, dry impaction, depositional velocity, wet deposition, aerosol transport.

### Reference Books

- Botkin, Daniel B. and Keller, Edward A.. Environmental Science: Earth as a Living Planet. 6th ed. John Wiley & Sons, USA. 2007.
- Butz, S.D.. Science of Earth Systems. 2nd ed. Thomson Delmar Learning, USA 2004
- Keller, E.A.. Environmental Geology. 8th ed. Prentice Hall of India 1999.
- Introduction to Micrometeorology (1988): S. Pal Arya; Academic Press
- General Meteorology (1974): H. R. Byers; McGraw-Hill
- An Introduction to Climate (1968): G. T. Trewartha; McGraw-Hill
- Atmospheric Science – An introductory survey (1977): J. M. Wallace and P. V. Hobbs; Academic Press

## **SME504: ENVIRONMENTAL GEOSCIENCE**

**UNIT-I:** Fundamental concepts. Primary differentiation and formation of core, mantle, crust, magma, generation, eruptions and volcanoes. Formation and classification of rocks: plate tectonics – sea floor spreading, mountain formation, rock deformation and evolution of continents.

**UNIT-II:** Weathering and soil formation, soil profile, soil classification, soils of India. Global water balance, isotherms and fluctuations of sea levels.

**UNIT-III:** Environmental Geochemistry- Concept of major, minor and trace elements. Mobility of elements, geochemical cycles. Geoindicators. Resources and reserves, Mineral resources and reserves. Oceans as new areas for exploration of mineral resources. Mineral resources of M.P.

**UNIT-IV:** Volcanism: nature, extent and causes of volcanism, volcanic materials geographic distribution of volcanoes, Earthquakes: causes, intensity and magnitude of earthquakes; geographic distribution of earthquake zones seismic waves, travel-time and location of epicenter; nature of destruction; ground subsidence; protection from earthquake hazards.

**UNIT-V:** Landslides: causes; human use and landslides; prevention and correction. Landslide hazards zone in Indian context.

### **Reference Books**

- Bennett, M. R. and Doyle, P. Environmental geology: - Geology and the Human Environment. John Wiley and Sons. 1997.
- Botkin, Daniel B. and Keller, Edward A.. Environmental Science: Earth as a Living Planet. 6th ed. John Wiley & Sons, USA. 2007.
- Butz, S.D.. Science of Earth Systems. 2nd ed. Thomson Delmar Learning, USA 2004
- Eby, N.. Principles of Environmental Geochemistry. Brooks Cole, USA. 2003
- Keller, E.A.. Environmental Geology. 8th ed. Prentice Hall of India 1999.

### **SME505: Practical-I: Physico-Chemical Analysis of Water and Wastewater**

pH, temperature, conductivity, odor, taste, hardness, alkalinity, acidity, chloride, turbidity, transparency, flow rate, DO, TSS, TDS.

### **SME506: Practical-II: Geo-Biological Practical**

Density, abundance, frequency, fresh weight biomass, dry weight biomass, minimum quadrat size. IVI (Importance Value Index), richness, evenness of species. Identification of minerals and rocks as per physical properties, soil and its profile study.

**Revised Syllabus for M.Sc. (Environment Science)- II Semester****Course Code: SME508****Name of Paper-Remote Sensing and GIS****Unit 1:**

- 1.1 Concept and Scope of Remote Sensing: Definitions, Process and Characteristics of Remote Sensing System, Advantages and limitations. Concept of Electromagnetic Radiation (EMR): Wavelength-frequency-energy relationship of EMR,
- 1.2 EMR Spectrum and its properties, EMR wavelength regions and their applications, Atmospheric windows, Interaction of EMR with matter, Spectral signatures.
- 1.3 Radiation laws: Stefan-Boltzman law, Wien's law, Kirchhoff's law etc.,
- 1.4 Black body and Real body, Radiant temperature & Kinetic Temperature.
- 1.5 Energy Interaction in the atmosphere: Scattering, absorption, transmission, atmospheric Windows. Energy Interactions with Earth Surface Features: Spectral Reflectance Curve, Concept of signatures.

**Unit 2**

- 2.1 Remote Sensor Platforms and Satellite Orbits: Ground, Airborne and Space borne Platforms, Orbital Characteristics – Coverage, Passes, Pointing Accuracy, Geostationary and sun synchronous satellite orbit.
- 2.2 Introduction: Sensor materials, Sensor System - Framing and Scanning System, Whiskbroom scanners, Push-broom scanners, Side Looking scanner
- 2.3 Types and Characteristics of Sensor: Imaging and non-imaging sensors, Active and passive sensors, Resolution of Sensors - Spectral, Spatial, Radiometric & Temporal.
- 2.4 Specification of some popular satellites – IRS, Landsat and SPOT series;
- 2.5 High resolution satellites – IKONOS, Cartosat, Quickbird, OrbView, GeoEye, WorldView; Other latest earth resource satellites.

**Unit – 3**

- 3.1 Environmental Pollution and types of environmental pollution.
- 3.2 Change detection studies with the help of multi temporal data.
- 3.3 Remote Sensing in pollution monitoring.
- 3.4 Remote sensing in water quality mapping monitoring and management
- 3.5 Solid waste management – introduction classification and environmental problems
- 3.6 Remote sensing and GIS in solid waste management

**Unit – 4**

- 4.1 Natural Disasters – Introduction and types
- 4.2 Role of Remote Sensing and GIS in disasters management
- 4.3 Man made disasters: Introduction, Types
- 4.4 Application of remote sensing & GIS in management of Man made disasters
- 4.5 Nuclear fuel, power plants, nuclear waste management, global and Indian scenario.
- 4.6 Forest Fire and Fire risk assessment and management using RS & GIS

**Unit – 5**

- 5.1 Impact assessment – Basic concepts, Environmental impact assessment (EIA) methods
- 5.2 Environmental analysis and environmental monitoring for sustainable development through RS & GIS

5.3 EIA of mining areas and river valley project through Remote Sensing

5.4 Environmental Management Plan (EMP), its importance and Role of GIS in preparation of EMP

#### BOOKS RECOMMENDED

Campbell, J.B. 2002: Introduction to Remote sensing. Taylor Publications

Drury, S.A., 1987: Image Interpretation in Geology. Allen and Unwin

Gupta, R.P., 1990: Remote Sensing Geology. Springer Verlag

Jensen, J.R. 2000: Remote Sensing of the Environment: An Earth resource Perspective. Prentice Hall.

Joseph George, 2003 : Fundamentals of remote sensing. Universities Press

Lillesand, T.M., and Kieffer, R.M., 1987: Remote Sensing and Image Interpretation, John Wiley.

Sabbins, F.F., 1985: Remote sensing Principles and interpretation. W.H. Freeman and company

Anji Reddy, M. 2004: Geoinformatics for environmental management. B.S. Publications

Gupta, R.P., 1990: Remote Sensing Geology. Springer Verlag.

Jensen, J. R. 2000: Remote Sensing of the Environment: An Earth resource Perspective. Prentice Hall

Lillesand, T.M., and Kieffer, R.M., 1987: Remote Sensing and Image Interpretation , John Wiley.

Skidmore A. 2002: Environmental modeling with GIS and Remote Sensing. Taylor and Francis

- Sharma, B.K. Environmental Chemistry, Goel Publishing House, Meerut. 2000.

## SME508: REMOTE SENSING AND GIS *X ed*

**UNIT-I: Fundamentals of Remote sensing:** Principles of remote sensing (Optical/Microwave) - principles of Aerial photography, Imaging systems, satellites, sensors, data generation. History of remote sensing. Hyper spectral remote sensing.

**UNIT-II: Image Interpretation:** Principles of image interpretation, visual image interpretation. Digital image processing- Image enhancement, image rectification, image classification techniques and Accuracy assessment.

**UNIT-III: Applications of remote sensing:** Remote sensing based land use/land cover mapping, urban landscape mapping, industrial land use, remote sensing of vegetation-spectral characters of vegetation, landscape ecology, remote sensing of vegetation change, remote sensing for biodiversity applications, remote sensing for climate change studies, remote sensing of desert vegetation, remote sensing of surface water, biophysical characteristics, remote sensing for soil studies, remote sensing for flood mapping, flood damage assessment, drought assessment, desertification and water shed management.

**UNIT - IV: GIS and GPS System:** GIS concepts. Basic concepts of cartography. Data structures - vector and raster data. Data inputting, Data storage, Data editing. Hardware and Software requirement. Application of GIS for environmental studies - a case study. GIS as decision support system, GPS: concepts, available constellations, accuracy and types of errors, types of GPS machines, applications for surveying and mapping, interface of GPS data with GIS.

**UNIT - V: Environmental monitoring technique:** Satellite data, changes of environmental phenomena/frequency of satellite data supply, satellite data sources for environmental monitoring. Meteorology and weather forecasting, nephanalysis, satellite cloud classification techniques, rainfall estimation, weather forecasting system.

### Reference Books

- George Joseph, Fundamentals of remote sensing, Universities press (India) Pvt Ltd., Hyderabad, 2003.
- Jenson, J.R. Introductory Digital Image Processing: Prentice Hall Series, 1996
- Jensen, J.R., Remote Sensing of the Environment - An Earth Resources Perspective, Pearson Education, Inc. (Singapore) Pvt. Ltd., Indian edition, Delhi, 2000.
- Lillesand, Thomas M. and Kiefer, Ralph, W., Remote Sensing and Image Interpretation, John Wiley and Sons, New York, 2000.

## SME509: ENERGY AND ENVIRONMENT

**UNIT-I :Concept of Energy:** Energy, law of conservation of energy, sources, renewable and non-renewable forms of energy, Fossil fuels-classification, coal, natural oil, natural gas, energy content of coal, Gross-calorific value and Net-calorific value .Audit and Management of energy.

**UNIT-II :Solar Energy:** Introduction, solar radiation and its spectral characteristics, Harnessing of solar energy, Solar energy collectors, solar heaters ,Solar cooker, solar dryers, solar lamp, solar pump solar ponds, photovoltaic power station community, solar farm.

**UNIT-III: Nuclear energy:** Nuclear Fission and fusion, Nuclear fuels – mining and processing of Uranium, Nuclear reactors, Nuclear power plant Waste Disposal and management - Concentration and Containment at Storage Site including at deep underground facilities , Delay for Decay of short lived radio nuclides, Dilution & Dispersion of residual waste; Bioaccumulation.

**UNIT-IV: Biomass energy:** Biomass production, conservation of biomass into bio-energy, biogas or gobar gas generator, factors affecting biodegradation, wega gram, biogas or gobar gas. Wind energy- harnessing of wind energy, wind mill; Generation of hydropower, tidal energy, ocean energy; Geothermal energy,

**UNIT-V :Chemical Energy :** Sources, types, theory of chemical energy, Fuel cells, Theory and principle, Hydrogen-Oxygen Fuel cells, Carbon Mono oxide Fuel cells, Emissions of CO<sub>2</sub> in developed and developing countries including India, conversion efficiency of fuel cells.

### Reference Books

- Andrew R.W., Jackson & Julie M. Jackson, Environmental Science – The Natural Environment and Human Impact, Addison Wesley Longman Limited, 1996.
- Carless, Jennifer, Renewable Energy : A Concise Guide to Green Alternative, Walker, New York, 1993
- Ebbing, D.D., General Chemistry, (International 4th Edition) MA : Houghton Mifflin, Boston, 1993.
- Eisenbud, M.. , Environmental Radioactivity, Academic Press, Orlando, USA,1987.
- Fowler, John M., Energy and the Environment, 2nd Edition, McGraw Hill, New York, 1984.
- Santra, S.C. Environmental Science, 2nd Edition, New Central Book Agency (P) Ltd, Kolkata, India, 2005.
- Weast R.C., Handbook of Chemistry and Physics, CRC Press, 1994.

## **SME510: Environmental Toxicology**

**UNIT-I: Eco-toxicology:** Introduction to ecotoxicology, Principles of toxicology, Types of toxic substances - degradable and non-degradable; Influence of ecological factors on the effects of toxicity; Sigmoid relationships, Corollary of toxicology.

**UNIT-II: Toxicants in the Environment:** Toxic substances in the environment, their sources and entry routes, Eco-system influence on the fate and transport of toxicants; Transport of toxicants by air and water; Transport through food chain - bio-transformation and bio-magnification

**UNIT-III: Occupational Safety and Health:** The relationship of occupational hygiene/ safety and disease; Principles and methods of occupational health, Health problem due to industrial dust, heat, chemicals, noise, toxic gases and metals, Health hazard in agriculture - Pesticides and environment, Pesticides and human health.

**UNIT-IV: Environmental Diseases:** Asbestosis, Silicosis, Synosis, Asthma, Fluorosis and allergies; Epidemiological issues - Malaria and Kalaazar.

**UNIT-V: Man and Environmental Toxins:** Routes of toxicants to human body – entry through inhalation, skin absorption, indigestion and injection; Response to toxin exposures – Dose response, Frequency response and cumulative response; Lethal and sub-lethal doses; Dose-Response relationships between chemical and biological reactions. Analysis of NOEL, LD 50, LC 50 and MLD; Detoxification in human body - detoxification mechanisms, organs of detoxification.

### **Reference Books**

- Principles of Environmental Toxicology: I. C. Shaw and J. Chadwick; Taylor & Francis Ltd
- Basic Environmental Health (2001): Annalee Yassi, Tord Kjellström, Theo de Kok, Tee Guidott
- Environmental Health : Monroe T. Morgan
- Handbook of Environmental Health and Safety – principle and practices : H. Koren; Lewis Publishers

### SME511: Practical-I: Chemical Analysis of Water and Wastewater

Nitrite, nitrate, ammonia, fluoride, phosphate, sulphate, silica, iron, COD, BOD, Na<sup>+</sup>, K<sup>+</sup>, Li<sup>+</sup>, Ca<sup>+</sup>.

### SME512: Practical-II: Remote sensing and GIS

Map readings, map projections, preparation of base maps, slopes maps, drainage maps, study of SOI topographical maps & satellite imageries, theme generation from toposheet and satellite imageries, symbolization of map, quantitative thematic mapping, graphic representation of numeric data, flow line map creation, isoline map creation, water shed area demarcation, watershed area calculation, choropleth and dasimetric map construction, exercise on map reference system of Indian and adjacent country, international system of map reference numbering, reading of geological map, interpretation of remotely sensed data.

## Third Semester

### SME601: ENVIRONMENTAL LAWS AND POLICIES

**UNIT-I: Environmental protection-** issues and problems, national efforts for environment protection, duties and responsibilities of citizens for environment protection, environmental policies in ancient India, role of ministry of environment & forests, central and state pollution control boards.

**UNIT-II: The water (prevention and control of pollution) act 1974** (amended in 1981), the water (prevention and control of pollution) act 1977 (amended in 1991), Air (prevention and control of pollution) act 1981 (amended in 1987).

**UNIT-III: Noise pollution act** <sup>1987</sup> law of crimes and noise control, police act, 1861 and noise control, railway act 1890 and noise control, civil aviation law and noise control, motor vehicle act, 1939 and noise control, factory Act, 1948 and noise control, the air (prevention and control of pollution) act 1981 and noise control, the environment (protection) act, 1986 and noise control.

**UNIT-IV: The wildlife protection act** <sup>1972</sup> the forest conservation act 1981, environment (protection) act 1986.

**UNIT-V: Hazardous waste (management and handling) rules (1989)**, biomedical waste (management and handling) rules, 1998.

### Reference Books

- Constitution of India [Referred articles from Part-III, Part-IV and Part-IV-A].
- CPCB, 2010, [Revised], Pollution Control Acts, Rules and Notifications Issued

\* Amended Air (Prevention and Control of Pollution) Act - 1987 - Air Act was enacted in 1981 and amended in 1987 to include noise as an air pollutant.

there under.

- Declaration of: The Stockholm Conference, Rio, Rio+5 and Rio+10.
- Jaswal, P.S. and Jaswal, N. Environmental Law. Pioneer Publications, Delhi. 2003.
- Leelakrishnan, P. Environmental Law in India. LexisNexis Butterworths Wadhwa, Nagpur. 2005.
- Shastri, S.C. Environmental law in India. Eastern Book Co, Lucknow. 2008.
- The Wildlife [Protection] Act, 1972 [as amended up to 1991, Natraj Publishers, Dehradun, India, 1994.
- Tiwari, R. K. Global Environmental Policies. A B D Publishers.2007.

## **SME602: ENVIRONMENTAL IMPACT ASSESSMENT**

**UNIT-I: Overview of EIA;** Objectives and development of EIA. Benefits of EIA, Indian directions of EIA. Rapid and comprehensive EIA perspectives. Sources and collection of data for EIA.

**UNIT-II:EIA Methodology:** Outline of EIA process, Screening, Scoping, Purpose of scoping, impact implications, Baseline studies and superimposition of projected plant emission impacts; reliability of database; intrinsic and external database supports and interpretation; checklist, matrices, Overlays and Geographical Information System, Impact analysis and Predictions, Environmental Impact Statement [EIS]; Public hearing as part of EIA; EIA report.

**UNIT-III: Environmental Management and ISO Certification:** Environmental Management Systems (EMS), ISO 14000 (EMS). Components of Environmental Management System- Objectives, Policies, Implementation and Review. Life Cycle Analysis -LCA. Waste minimization and product augmentation.

**UNIT-IV: Public Participation:** Social impact assessment (SIA), Strategic Environmental Assessment (SEA), Public involvement, Public Hearing compulsion, restoration and rehabilitation methodologies, Mitigation criteria, Project modification, Post project analysis.

**UNIT-V:Framework of Environmental Assessment:** Description of environmental setting; Environmental impact factors and area consideration, Prediction and assessment of impact on air, water, noise and biological environment; Prediction and assessment of impact on the cultural and socio-economic environment; Methods of impact analysis; Public participation in environmental decision making, Integration and Optimization criteria for Multipurpose Development Projects, Environmental auditing.

## Reference Books

- Anjaneyulu, Y. and Manickam, V. Environmental Impact Assessment Methodologies. B.S. Publications. 2002.
- Boland, R.G.A. (Ed) Environmental Management Training. Sterling Publishers Pvt. Ltd. New Delhi, 1993.
- Canter, L. Environmental Impact Assessment. 2nd Edition. McGraw-hill Book Company, New York. 1996.
- Cutter, S.L. Environmental Risks and Hazards. Prentice Hall of India, New Delhi. 1999.
- Glasson, J. Therivel, R. and Chadwick, A.. Introduction to Environmental Impact Assessment. Routledge, London. 2006.
- Kulkarni, V. and Ramachandra, T.V.. Environmental Management. Capitol Pub. Co., New Delhi. 2006.
- Morris, P. and Therivel R. (Eds) Methods of Environmental Impact Assessment. 2nd Edition, Spon Press London. 2001.
- Paliwal, U.L. Environment Audit. Indus Valley Publications. Jaipur 2002
- Petts, J. Handbook of Environmental Impact Assessment- Volume 1 and 2. Blackwell 28 Publishers, UK 2005.

## SME603: SOLID WASTE MANAGEMENT

**UNIT-I: Solid Wastes and their management:** Introduction, sources, types, characteristics of solid wastes, segregation, collection: methods and their merits and demerits, transportation: selection of route, precautions during transportations, disposal: composting, incineration, land filling, landfilling methods and operation. Leachate and Landfill gas, Leachate management;

**UNIT-II: Municipal Solid Waste:** Introduction, types, physico-chemical characterization, pollution and adverse impacts, collection, transportation, treatment, management cum disposal.

**UNIT-III: Industrial Solid Waste :** Introduction, Solid waste from Petrochemical, Oil Refineries, textile, sugar, pulp and paper, cement, distilleries, dairy, food processing, mining industries pollution and adverse impacts, collection, segregation, transportation, treatment and disposal. Concept of zero disposal.

**UNIT-IV: Biomedical Solid Wastes:** Introduction, Types, characterization. Evaluation of infectious and non infectious BMW, colour coding of BMW containers, On site and off site

transportation, treatment: chemical disinfection, pollution and adverse impacts methods of disposal of biomedical wastes as per their categories *hazardous waste management and handling rules - 1986 (amended)*.

**UNIT-V: Radioactive waste:** Introduction, sources, types, physico-chemical characterization, pollution and adverse impact, collection, treatment cum management and disposal.

### Reference Books

- Acharya, D.B. and Singh, M. Hospital Waste Management. Minerva Press, Delhi. 2003.
- Alleman, J. E. and Karanagh, J. T. Industrial Waste. Ann Arbor Science. 1982.
- Bhatia, S.C. Solid and Hazardous Waste Management. Atlantic Publishers. 2007.
- Blackman, W.C. Basic Hazardous Waste Management. CRC Press, USA. 2001.
- Evans, G. Biowaste and Biological Waste Treatment. James and James (Science Publishers) Ltd, U.K. 2005.
- Hasan Syed E. Geology and Hazardous Waste Management, Prentice Hall, USA, 1996.
- Kreith, F. Handbook of Solid Waste Management. McGraw Hill Publishers, USA. 22 1999.
- LaGrega M.D., Buckingham, P.L. and Evans J.C., Hazardous Waste Management, McGraw Hill International Publications, Singapore, 1994 – Revised Edition Available – ISBN 0-07-113454-9.
- Pichtel, J. Waste Management Practices: Municipal, Hazardous, and Industrial. CRC Press, USA. 2005.
- Shah, K. L. Basics of Solid and Hazardous Waste Management Technology. McGraw Hill, USA. 1999.
- Tchobanogloas, G. Integrated Solid Waste Management: Engineering, Principle and Management. McGraw Hill, USA. 1993.
- Williams, P.T. Waste Treatment and Disposal. John Wiley and Sons, USA. 2005.
- *Solid Waste Management, CRC, New Delhi.*
- *Basic Environmental Technology.*

## SME604: STATISTICS AND RESEARCH METHODOLOGY

**UNIT-I: Statistical Analysis:** Sampling, Data collection and recording, Central tendency – concept, arithmetic mean, mode, median for ungrouped and grouped data.

**UNIT-II: Measures of dispersion:** absolute and relative measures, range, standard deviation (grouped and ungrouped data), variance, quartile deviation, coefficient of variability. Skewness, Kurtosis; Probability - normal, poisson and binomial

**UNIT-III: Probability and Tests of Significance, Statistical Methods:** Hypothesis testing, significance and correlation. Correlation. Linear models and regressions. Pearson and other correlation coefficients. Multiple Regressions, Distribution- Normal, t and chi square test, Difference among means: F-test: 1 way ANOVA; F-test: 2 ways ANOVA.

**UNIT-IV: Research Methodology:** Basic principles of research design, execution and reporting; Concept of research articles, research papers, reviews, scientific popular articles.

**UNIT-V: Components of a Research Article** (title, author-line, address, abstract, summary, hypothesis, keywords, introduction, methodology, observations, discussion, conclusion).

### Reference Books

- Bailey, N.T.J. Statistical Methods in Biology. 3rd ed. Cambridge University Press, Cambridge, UK. 1994.
- Banerjee, P.K.. Introduction to Biostatistics. S. Chand and Co., New Delhi. 2004.
- Gardiner, W. P. Statistics for biosciences. Prentice hall, Hamel Hempstead.1997.
- Kothari, C.R. Research Methodology – Methods and Techniques. 2nd revised ed. New Age International (P) Ltd. Publishers, New Delhi. 2007.
- Marden, M. P. Research Methods for Science 1st edition. Paperback March.2011.
- McKillup, S. Statistics Explained. An Introductory Guide for Life Scientists. Cambridge University Press, Cambridge, UK. 2006.

## SME605: Practical-I: Physico-chemical Analysis of Air

Wind velocity, temperature relative humidity, suspended particulate matter, respirable particulate matter, non respirable particulate matter, CO, SO<sub>2</sub>, NO<sub>x</sub>, H<sub>2</sub>S, hydrocarbons.

## SME606: Practical-II: Study Tour

Fourth Semester (Elective any one paper)

**SME607: INDUSTRIAL POLLUTION AND ITS TREATMENT**

**UNIT-I:** Concept of industrial pollution, types of industrial pollution, physico-chemical and biological characteristics of industrial effluent produce from various popular industries, changes in water quality due to discharge of such industrial effluents, standard for disposal of effluent.

**UNIT-II:** Air pollution control methods and equipments, control of particulate and gaseous emission, air quality standards.

**UNIT-III:** Process of pulp, paper, tannery and textile industry, characteristics of their effluent, adverse impact on environment and treatment.

**UNIT-IV:** Process of pesticide, fertilizer and pharmaceutical industry, characteristics of their effluent, adverse impact on environment and treatment.

**UNIT-V:** Process of bakery, dairy, soft drink industry, characteristics of their effluent, adverse impact on environment and treatment.

**Reference Books**

- Bhatia, S.C. Solid and Hazardous Waste Management. Atlantic Publishers.2007.
- Evans, G. Biowaste and Biological Waste Treatment. James and James (Science Publishers) Ltd, U.K. 2005.
- Hasan Syed E. Geology and Hazardous Waste Management, Prentice Hall, USA, 1996. 1999.
- Pichtel, J. Waste Management Practices: Municipal, Hazardous, and Industrial. CRC Press, USA. 2005.
- Shah, K. L. Basics of Solid and Hazardous Waste Management Technology. McGraw Hill, USA. 1999.
- Sloan, William M., (Ed). Site Selection for New Hazardous Waste Management Facilities, WHO Regional Publications, European Series 46, 1993.
- Williams, P.T. Waste Treatment and Disposal. John Wiley and Sons, USA. 2005.

information of cube bricks, road tiles and cement mortar, recycling of plastic waste into fresh plastic as well as fuel, heat and electricity, recycling of waste paper, glass and metallic turnings into usable forms.

**Unite-IV: Electronics waste:** Introduction, types, characterization environmental impact, recycling and reuse, valuable elements e.g. lead, iron, aluminum, copper, silver, gold, platinum, etc. from recycling of audio-visual electronics components i.e, TV, VCR, stereo equipment, mobile phones, other hand held devices, computers etc. management of e-waste.

**Unite-V: Rules and regulations:** Introduction, rules for MSW management, rules for industrial solid waste management, rules for public health and sanitation, rules for disposal of waste in air, water, environment, etc.

#### **SME608: DISSERTATION/ PROJECT WORK**

Dissertation/Project work topic may be allotted by the department at the beginning of the IV semester. Evaluation and viva voce will suffice the entire practical of IV semester. Projects may be related to any topic of environment/ecology. However, an emphasis should be given to: Air, water, mining, ground water, noise, EIA, RS & GIS and other environmental related issues.