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*DETAILED SYLLABUS*

*FOR*

*DESTANCE EDUCATION*

Post Graduate Degree Program

**MSC ENVIRONMENTAL SCIENCE  
(MSCES)**

(YEARLY SYSTEM)

**COURSE TITLE : MSCES**  
**DURATION : 2 YEARS**  
**MODE : YEAR**  
**TOTAL DEGREE MARKS: 2000**

### **FIRST YEAR**

Course Title	Paper Code	Marks				Total
		Theory		Practical		
		Internal	External	Internal	External	
Principles Of Environmental Sciences	MSCES/Y/110	40	60	00	00	100
Environmental Pollution	MSCES/Y/120	40	60	00	00	100
Environmental Toxicology	MSCES/Y/130	40	60	00	00	100
Instrumental techniques	MSCES/Y/140	40	60	00	00	100
Environmental management and sustainable development	MSCES/Y/150	40	60	00	00	100
Statistics and computer applications in environmental Management	MSCES/Y/160	40	60	00	00	100
Biodiversity and conservation	MSCES/Y/170	40	60	00	00	100
Concepts & Management Of Industrial Ecology	MSCES/Y/180	40	60	00	00	100
Occupational health and industrial safety	MSCES/Y/190	40	60	00	00	100
Practical	MSCES/Y/200	00	00	40	60	100

### **SECOND YEAR**

Course Title	Paper Code	Marks				Total
		Theory		Practical		
		Internal	External	Internal	External	
Environmental impact assessment	MSCES/Y/210	40	60	00	00	100
Waste management and bioremediation	MSCES/Y/220	40	60	00	00	100
Remote sensing and GIS	MSCES/Y/230	40	60	00	00	100
Environmental Engineering	MSCES/Y/240	40	60	00	00	100
Ecotourism	MSCES/Y/250	40	60	00	00	100
Natural disaster management	MSCES/Y/260	40	60	00	00	100
Green products	MSCES/Y/270	40	60	00	00	100
Practical	MSCES/Y/280	40	60	00	00	100
Project work and viva-voce	MSCES/Y/290	40	60	00	00	100
Industrial and field visit / report and viva-voce	MSCES/Y/300	00	00	40	60	100

## FIRST YEAR

### PRINCIPLES OF ENVIRONMENTAL SCIENCES

MSCES/Y/110

**Objective: To introduce the students to basic concepts of Environmental Sciences, Ecosystems, Natural Resources, Population, Environment and Society**

#### UNIT – I

**Ecosystem:** Definition – Components of Ecosystems – Structure and Function. Classification of Ecosystem: Biogeographical Regions – Biomes. Process in Ecosystem: Biogeochemical cycles –Energy flow – Trophic relations – Food chain, Food web and Ecological pyramids – Productivity and Ecological efficiencies – Primary and Secondary productions.

#### UNIT- II

**Population Ecology:** Definition – Population Dynamics: Density – Growth – Natality – Mortality – Population dispersal and distribution. Population Growth Factors affecting population – Carrying capacity. Population regulation. Strategies of species survivability (r-selection and k-selection). Human population: Characteristics and Trends in human population growth – Exponential growth – Age – Sex distribution – Human settlement.

**Community Ecology:** Ecological Succession and Climax – Classification – Process (Nudation, Invasion, Migration, Competition, Climax) – Succession. Community organization: Ecological Niche. Interaction between species: Competition – Predation – Mutualism – Commensalism – Parasitism - Allelopathy.

#### UNIT- III

**Natural Resources – Classification:** Land resources: Culturable and non-culturable – Wetland – Extent of wasteland in India – Desertification causes and impacts. Water resources: Water budget – Lakes and Reservoirs – Atmospheric water – Ground Water – Water resources in India. Dams- uses and impacts on environment. National Lake and River conservation programmes. Marine Resources: Biotic and abiotic resources. Energy resources: Bioenergy – Fossil fuel – Nuclear, hydroelectric power – Solar – Wind – Tidal energy – Geothermal energy.

#### UNIT- IV

**Environmental Geosciences:** Structure and composition of lithosphere, atmosphere and biosphere. Earth Structure – Composition and Density, Classification and Geochemistry of rock types – Properties of rocks – Structure of rocks – Physical and Chemical weathering – Trace and rare earth elements - Classification of trace elements – Trace elements and health – a general account.

#### UNIT- V

**Environment and Society:** Economics and Environment – Economic resources – types of economic systems - economic growth and Gross National Product – Environmental Auditing – global free trade – Solutions for reducing poverty – Earth sustaining economics. Environmental world views, ethics and sustainability – Culture and values – human centered environmental global views – Life centered and Earth centered environmental global views – Environmental awareness – Social ecology – Environmental justice. Earth ethics – ethical guidelines – Earth education.

#### REFERENCE :

1. A Text Book of Environment, Agarwal, K.M., Sikdar, P.K and Deb.S.C (2002), Mac Millan India Ltd, Kolkatta
2. Environmental Geology, III Edition, Edward A Keller, (1981) Charles E Merrill Publishing Co, Ohio
3. Fundamental and Environmental Ecology, III Edition, (1971) Odum, E.P., Prentice Hall
4. A Text Book of Geology, Mukerjee, P.K., (1995) The World Press Pvt Ltd, Kolkatta.
5. Animal and Environmental Biology, Sigh, H.R., (1989) Nagin Chand and Co, Delhi.
6. Environmental Geoscience – Interaction with Natural Systems and Man, Strahler, A.N and Strahler, A.H., (1973) Hamilton Publishing Co, California.
7. Living in the Environment – Principles, Connections and Solutions, Tyler Miller Jr. G., (1996) Wadsworth Publishing Co., New York.

## **ENVIRONMENTAL POLLUTION**

**MSCES/Y/120**

**Objective: To educate the students on water, air and soil pollution, their impacts and control measures.**

### **UNIT- I**

Structure of the atmosphere, Global and Microclimates, Sources and Classification of Air Pollutants. Transport and Diffusion of Pollutants. Plume behavior and stack dispersion, Reactions of hydroxyl radical with O<sub>2</sub>, N<sub>2</sub>, CO<sub>2</sub> and Oxides of Nitrogen, Sulphur and Carbon. Global Emission of Major Air Pollutants. Sinks of Air pollutants – Acid rain: Ozone depletion – Montreal protocol; global warning – Kyoto protocol; Gaseous pollution control measures; photo chemical smog; Automobile pollution in India; Zero emission standards; Noise pollution – Sensing, Measurement, Abatement measures. Air Protection Act. Noise Protection Act.

### **UNIT - II**

Properties of water – Characteristics of water bodies; Heavy metals, Speciation and Complexation, water quality. Ground water pollution, Effluent standard, DO, BOD, COD, acidity, alkalinity, salinity, hardness; drinking water quality standards; Water pollution; Eutrophication, sources and sinks and classification of water pollutants, Global discharge of heavy metals into water bodies, Purification of water by adsorption, flocculation, ion exchange and reverse osmosis methods. Alternatives of end of pipe treatments – Green Science, Radioactive pollution, Thermal pollution, Water Protection Act.

### **UNIT - III**

Soil pollution; Sources, sinks and broad classification, movement and sorption mechanisms of inorganic contaminants and their impacts on physio-chemical and biological properties of soil and plants, Sediment Pollution – Black carbon – formation and fate, Adsorbent for organics, Global discharge of heavy metals into soil, Soil pollution control measures. Environmental Protection act.

### **UNIT - IV**

Hazardous Solid Wastes – Sources, Transport, Disposal, Hospital Wastes, Socio-economic Impact in Third World Country – Basal Convention of Hazardous Wastes.

### **UNIT V**

Industrial Disaster and Pollution – Case studies-Chemical Industries – Pesticide Industries, Bhopal Disaster, Chernobyl accident, Love canal Disaster, Exxon Oil Disaster, Impact and Remedial Measures – Labeling – Laws and Regulations – Pollution Control Boards.

### **REFERENCE:**

1. India Disasters Report: Towards a Policy Initiative, Parasuaraman, S. and Unnikrishnana, P.V. (2000). Oxford University Press.

2. Disaster Management, (1994). Indu Prakash Rashtra Prahari Prakashan, Gaziabad.
3. Environmental Law and Policy in India, II Edition, Divan, S. and Rosencranz, A. (2001). Oxford University Press.
4. Pollution Control Legislation, Volume I and II, Tamil Nadu Pollution Control Board (1999). TNPC Board, Chennai.
5. Limnology, Charles Goldman and Alexander J.Horne (1983) Mc Graw Hill.
6. An Introduction to Soils and Plant Growth, 5th Ed, Roy I Donalue, Raymond W Miller and John C Shiekluna (1987) Prentice Hall of India.
7. Textbook of Soil Science, 4th Ed., Biswar, T.D and Mukherjee,S.K (1987) Mc Graw Hill
8. Encyclopedia of Environmental Pollution and Control, Trivedy,R.K (1994) Enviromedia Publications, Karad.

## **ENVIRONMENTAL TOXICOLOGY**

**MSCES/Y/130**

**Objective: To teach them the basic concepts of toxicology, the mode of action of chemicals and their fate in the environment.**

### **UNIT - I**

Toxicology - Basic Probit analysis, concepts – Toxicants – Toxicity, Acute, sub acute, chronic, dose effect, LD 50, LC 50 and response safe limits. Dose response safe limits. Dose response relationship, graphs, concentration response relationship.

### **UNIT - II**

Pest – Pesticides – Classification of pesticides – Pest surveillance, resistance, residual effects.

### **UNIT - III**

Chlorinated xenobiotics in environment – Bioconcentrations – Volatilization – Biological and nonbiological degradations. Chlorinated organics in environment and their fate. Short chained chlorinated hydrocarbons – Toxicity – Ecotoxicological relevants and degradation. PCB – Dioxins levels, fate, toxicity and their global distribution. Toxaphene – occurrence and degradation. Environmental risk assessments for chlorinated pesticides. Bioindicators- Environmental specimen banking.

### **UNIT - IV**

Bioaccumulation – Bioconcentration – Biomagnifications –mechanisms in biota – Significant influence and mechanisms – Kinetics of Bioconcentration. Cellular response to chemical stress –membrane process; intracellular fate of chemicals, cell receptors, cell injury and apoptosis. Long-term impact of chemicals in aquatic organisms. Effect of pollutants on soil invertebrates – use as biomarkers.

### **UNIT - V**

Ecotoxic modes of action of chemicals: Biotransformation – Molecular mode of action – Aromatic compounds, Alcohols, Phenolics and heavy metals. Toxicity Testing Methods – Microbiol, algal, invertebrates and alternative toxicity tests. Multimedia mass balance models – fugacity – nonfugacity models – applications of multimedia models. Future test strategies in Ecotoxicology –Legislative perspectives.

### **REFERENCE:**

1. Ecotoxicology, Schuurmann, G., and Market, G., (1998), A. John Wiley & Sons, Inc
2. Hand book of Environmental Risk Assessment and Management, Peter Callow (1998), Blackwel Science, London.
3. Environmental Impact of Chemicals: Assessment and Control, The Royal Society of Chemistry, Cambridge.

4. Health and Environmental Risk Assessment, Ricci, P and Rowe, M.D., (1985) Pergamon Press, New York.
5. Environmental Risks and Hazards, Cutter, S.L (1994), Prentice - Hall of India, New Delhi.
6. Environmental Risk Assessment Report, Benjamin, S.L., and Bellurk, D.A., (2001).
7. Information Resources in Toxicology: Wexler, Philip et al, 2000. 3rd ed. Academic press,2000.
8. The Basic Science of Poisons Companion Handbook. Klassen, Curtis.D and John.B.Watkins 1999. Ill,eds.Casarett and Doull's Toxicology 5th ed. Newyork,N.Y: McGraw-Hill,1999.
9. Environmental Toxicology and Chemistry.Crosby, Donald. G. 1998. Oxford University Press. 10. Introduction to Environmental Toxicology: Impacts of chemicals upon Ecological systems: Landis, Wayne and Hing-hoYu, Baca Raton, 1995. Lewis Publishers.

## **INSTRUMENTAL TECHNIQUES**

**MSCES/Y/140**

**Objective: To expose the students about the principles and applications of various instrumental methods in estimating the chemicals in the environment**

### **UNIT - I**

Spectroscopic Techniques: Properties of EMR – Basic Principles, Instrumentation and applications of: Ultraviolet – visible (UV-VIS) Spectroscopy. Flow injection analyzer; Infrared spectroscopy, Non-Dispersive IR Spectrometer, FT-IR, Flame Spectrometry; Atomic Absorption spectroscopy (AAS) – Inductively coupled Plasma Emission Spectroscopy, Fluorimetry – Chemiluminescence's Detector System, X-Ray Fluorescence, Microscopy, TEM, SEM, Chemical Atomic, Online analyzers.

### **UNIT - II**

Chromatographic Techniques: Basic principles, Instrumentation and applications of Chromatography – paper, thin layer chromatography (TLC), Ion exchange chromatography – Higher performance liquid chromatography (HPLC) and Gas Chromatography (GC).

### **UNIT - III**

Radiochemical analysis: Types of radiation – radioactive decay; Carbon dating; Radioactive labeling – Isotope dilution, Radiation detectors – Geiger Muller Counter, Scintillation counters; Neutron activation analysis.

### **UNIT - IV**

Electrochemical Techniques: Introduction to Techniques – Basic principles, Instrumentation and applications of Conductometry, Potentiometry – Ion selective meter – Voltammetry – Polarography; Coulometry.

### **UNIT - V**

Turbidimetry and Nephelometry. Elemental analyzer, TOC analyzer, Portable Gas Analysis – H<sub>2</sub>S, CO<sub>2</sub>, SO<sub>2</sub>, O<sub>3</sub>, HC, Particulate analysis, Stack monitoring, Meteorological equipments.

### **REFERENCE:**

1. Vogel's Text Book of Quantitative Inorganic Analysis, Barnes, J.D. J., Denney, R.C., Jeffery, G.H and Mendham, J. (1999) 6th Edition, Pearson Education Ltd., U.K.
2. Fundamentals of Analytical Chemistry, Skoog, D.A and D.M.West, (2004) Thomson Asia Pvt Ltd, Singapore.
3. Instrumental Methods of Chemical Analysis, Ewing G.W, (1985) 5th Edition McGraw Hill, U.K.
4. Instrumental Methods of Chemical Analysis, B.K. Sharma, (2001) Goal Publishing House, Meerut., India.

5. Standard Methods for the Examination of Water and Wastewater, (1998) 20th (Ed.) APHA, Washington, D.C.
6. Environmental Monitoring and Instrumentation, Bucholtz, F., (1997) Optical Society of America, Washington D.C.
7. Environmental Sampling Analysis: A Practical Guide, Xie, L.H., Boca Raton, F.L. (1991), Lewis Publication.

## **ENVIRONMENTAL MANAGEMENT AND SUSTAINABLE DEVELOPMENT**

**MSCES/Y/150**

**Objective: To impart an understanding of system approaches, tools of environmental management, management of ecosystem and local and global environmental issues.**

### **UNIT - I**

Concept and scope of Environmental Management, Analysis and prediction of Environmental issues: Environmental Planning, Establishment of Health and Environmental standards, measuring Sustainable Development, Life Cycle Assessment, Material Flow Analysis, Environmental Auditing and Environmental Management Systems and Accounting for Eco-efficiency.

### **UNIT - II**

Principles of Risk Assessment: Human Health Risk Assessments, Ecological Risk Assessment, Probabilistic Risk Assessments, Determination of acceptable risk based limits for Environmental chemicals and development of risk based remediation goals.

### **UNIT - III**

The role of Risk Assessment in Environmental Management decisions: Evaluation of Human Health Risks Associated with airborne exposures to asbestos, a diagnostic human health risk assessment for a contaminated site problem and a risk based strategy for developing a corrective action, Response plan for petroleum – contaminated sites, Risk Management and Risk Communication.

### **UNIT - IV**

Economics of Environmental Management, International Trade and its Environmental Integrity, Ecolabelling, responsible care, design for the Environment and full-cost accounting for municipal solid waste management, International Environmental Policy and Overview of Environmental Law in India.

### **UNIT - V**

Environmental Education and Communication, Environmental Conflict Management, Sustainability of Water Resources, Sustainable Management of Forests, Sustainability in Industry, Ecosystem Management: Coastal Environments, River and Inland Water Environments, Wetlands, Desert margins, Rural and Urban Environments.

### **REFERENCE:**

1. A Practical Guide to Understanding Management and Reviewing Environmental Risk Assessment Reports Sally L. Benjamin and David, A. Bullock, (2001) Lewis Publishers, Washington D.C
2. Hand Book of Environmental Risk Assessment and Management, Peter Calow (1998), Blackwell Swence, London.
3. Environmental Management in Practice, Volume – I to III Instruments for Environmental Management, Nath, B., Hens, L., Compton, P and D. Devuyt (1998), Routledge, London and New York.
4. Risk based analysis for Environmental Managers, Kart A, Frantzen, (2001) Lewis Publishers Washington D.C.
5. Risk Assessment in Environmental Management, D. Kofi Asante – Duah, John Wiley and Sons, New York.

## **STATISTICS AND COMPUTER APPLICATIONS IN ENVIRONMENTAL MANAGEMENT**

**MSCES/Y/160**

**Objective: To provide students the concept and an understanding of statistics and to improve the computing knowledge of the student's statistical methods related to environment.**

### **UNIT - I**

Fundamentals of Statistics (Basic concept) – Collection of Data – Classification and Tabulation – Diagrammatic Representation – Measures of Central Tendencies and Dispersion – Probability and Monte Carlo Analysis – Moments, Skewness and Kurtosis – Normal, Poisson and Binomial Distributions.

### **UNIT - II**

Tests of Significance – Mass and alternative hypothesis – error level of significance – Equal and Unequal Sampling - t, z, x2 test, Analysis of variance – One way ANOVA – Two way ANOVA – Regression and correlation - simple and multiple.

### **UNIT - III**

Modeling – Computer Modeling – Lotka – Volterra Model, Leslie's Matrix Model – Point Source Stream Pollution Model – Air Quality Model. Thermal Plume and Dispersion models.

### **UNIT - IV**

Fundamental of Computer - Introduction to Computers – History of Evolution – Computer hardware - Computer Software and Operating Systems – Classification of Computers – Fundamentals of Windows, Excel, Word and Power Point – Computer and Communication – Internet, E-mail, etc.

### **UNIT - V**

Applications of Computer in Environmental Science and Management – Data Analysis using packages (SPSS) - Cost benefit analysis – Editing, Data Tabulation, Graph Plotting – Computer Programming Languages – C and Visual Basic.

### **REFERENCE:**

1. Business Mathematics and Statistics, Vittal, R.R. (1986) Murgham Publications.
2. Programming with C, Byron S Gottfried (1996) Hill Publishing Co, New Delhi.
3. Statistical Methods, Gupta, S.P. (1996) Sultan Chand & Sons Publications, New Delhi
4. Environmental Science Methods, Haynes, R (1982) Chapman & Hall, London.
5. Fundamentals of Bio-Statistics, Khan, I.A and Kanum, A., (1994) Ukaaz Publication, Hyderabad.
6. Quantitative Techniques, Kothari, C.R (1996) Vikas Publishing Housing Pvt Ltd, Hyderabad.
7. Statistics for Advanced Level, Miller, J., (1989) Cambridge University Press.
8. Statistical Methods, Snedcor, G.W. and Cochran, W.G. (1982) Academic Press.

## **7) BIODIVERSITY AND CONSERVATION**

**MSCES/Y/170**

**Objective: To impart understanding on the occurrence and distribution of various flora and fauna, their existence and conservation.**



## **UNIT - I**

Biological Diversity – Systematics in Diversity – Environment and Genetic Variations – Nature and Origin; Biological Classification – Phylogenetic Relationship – Enumeration of Biodiversity – Ecological Biodiversity – Species Concept – Biological and Phylogenetic Concepts; Species Inventory – Global Patterns - Biodiversity hot spots. IUCN categories – Red data book.

## **UNIT II**

Species Diversity – Global Distribution of Species – Diversity in terrestrial, marine and freshwater – Micro-organisms-lower and higher plants – lower and higher invertebrates and vertebrates; Species extinction and Endangered species; Monitoring indicator species and habitats; Diversity loss – causes and remediation.

## **UNIT III**

Habitats and Ecosystem – Classification – Ecosystem mapping, tropical forests, grasslands, wetlands, coral reefs, mangroves; Economics of Ecosystem, Green Revolution, Food Plants, medicinal and ornamental plants, animal uses – livestock and fisheries; Biodiversity and Industry – Pharmaceutical – Aquaculture – Apiculture.

## **UNIT - IV**

Conservation and Management – National Legislation – Protection of Wild flora and Fauna - Protection of National Habitats - National and International Protected Areas – Current Practices in Conservation - in *situ* Conservation and *ex situ* Conservation of Threatened Species – Biodiversity Bill 2002 – Patent Act – Agenda 21 – Multilateral Treaties – Biodiversity Conventions.

## **UNIT - V**

Species Diversity – Case Studies – Deciduous Forests - Desert Lizard communities – Coral Reef - Fish Communities - Island species – Environmental ethics – Biodiversity – a Socio – Political Perspective – Western and Eastern Ghats - Himalayas.

## **REFERENCE:**

1. Global Biodiversity – Status of the Earth's Living Resources, Brian Groombridge (1992) Chapman & Hall, London
2. Ecology of Natural Resources, Francois Ramade (1991), John Wiley.
3. Global Biodiversity and Strategy, IUCN (1992).
4. Biodiversity, Science and Development, Francesco di castri (1996) Backhuys Publishers, The Netherlands.
5. The Biology of Biodiversity, Kato, M (1999), Springer Verlag, Tokyo
6. Biodiversity Conservation – In Managed forest and Protected areas, Kotwal, P.C. and S. Banerjee (2002). Agrobios, India.
7. Global Biodiversity, Sinha, R.K (1997), INA Shree Publishers, Jaipur.
8. Megadiversity Conservation, flora, Fauna and Medicinal Plants of India's hot spots, Chaudhuri, A.B. and D.D. Sarkar (2003), Daya Publishing House, Delhi.
9. Conservation of Biodiversity and Natural Resources. Singh, M.P., B.S. Singh and Soma S. Dey (2004) Daya Publishing House, Delhi.
10. Biodiversity – Strategies for Conservation, Dadhich L.K. and A.P. Sharma (2002) APH Publishing Corporation, New Delhi.
11. Global Biodiversity – Conservation Measure, Khan, T.I and Dhari N Al Ajmi (1999), Pointer Publishers, Jaipur.
12. An Advanced Textbook on Biodiversity – Principles and Practice, Krishnamurthy, K.V (2003). Oxford and IBH Publishing, New Delhi.

## **CONCEPTS OF INDUSTRIAL ECOLOGY**

### **Unit I – The Environment and the Anthrosphere**

The environment and the anthrosphere: Definition, the environment, the anthrosphere, effects of the anthrosphere on earth, integration of the anthrosphere into the total environment, the anthrosphere and industrial ecology.

### **Unit II - Industrial Ecology and Industrial Systems**

Levels of materials utilization, links to other environmental spheres, consideration of environmental impacts in industrial ecology, Key attributes – energy, materials and diversity.

### **Unit III - Relevance of Biological Ecology to Technology**

Considering the Analogy, Biological and Industrial Organisms, Food Chains: Networks of Nutrient and Energy transfer, Population Ecology, Classification of Special linkages, The Utility of Ecological Approach

### **Unit IV - Principles of Industrial Metabolism**

Industrial metabolism and biological analogies, material and energy flow in industrial metabolism, industrial metabolism, internalization of materials cycle, system integration and industrial metabolism, Eco-efficiency.

### **Unit V - Industrial Ecosystems**

Components of the industrial ecosystem, overview of an integrated industrial ecosystem or symbiosis, examples of symbiotic industrial ecosystems, designing and developing symbiotic industrial ecosystem.

### **References**

1. Industrial Ecology: Environmental Chemistry and Hazardous Wastes, Stanley E Manahan, (1999). Lewis, New York, USA
2. Industrial Ecology. T.E.Graedel and B.R.Allenby, (2003). Printice Hall, New Jersey, USA.

## **MANAGEMENT OF INDUSTRIAL ECOLOGY**

### **Unit I - Life Cycles: Products, Processes and Facilities**

Life Cycles: Expanding and Closing the Materials Loop, Life Cycle Assessment, Materials and Product Budgets, Consumable, Recyclable and Service Products, Design for Environment, Design for Recycling, Kinds of Materials Recycled, Efficient use of materials through Industrial Ecology

### **Unit II - Status of Resources**

Depletion Times, Under abundant Resources, Hitchhiker Resources, Energy Resources, Energetically Limited Mineral Resources, Geographically Influenced Resource Availability, Environmentally Limited Resources, Cumulative Supply Curves, Water Resources.

### **Unit III - Society and Culture, Governments, Laws and Economics**

Society, Culture and Industrial Ecology, Cultural Constructs and Temporal Scales, The Private Firm in a Social Context, Environmentalism, Technology and Society. National Governmental Structures and Actions, International Governance Considerations, Industrial Ecology and the Legal System, Economics and Industrial Ecology, Finance, Capital and Investment

### **Unit IV - Industrial Product and Process Design**

The Product and Process Challenge, Conceptual Tools for Product Designers, Design of X, Product Design Teams, The Product Realization Process, The Process Life Cycle, Approach to Process Analysis, Guidelines for Process Design and Operation, Implications for Corporation

### **Unit V - Material Selection and Energy Efficiency**

Material Selection Considerations, Materials and Environmental Hazards, Material Sources and Principle Uses, Material Substitution, Multiparameter material Selection, Guidelines, Energy and Industry, Primary,

Intermediate Processing Industries, Analyzing Energy Use, General Approaches to Minimizing Energy Use.

### **References**

1. Industrial Ecology: Environmental Chemistry and Hazardous Wastes, Stanley E Manahan, (1999). Lewis, New York, USA.
2. Industrial Ecology. T.E.Graedel and B.R.Allenby, (2003). Printice Hall, New Jersey, USA.

### **OCCUPATIONAL HEALTH AND INDUSTRIAL SAFETY**

**MSCES/Y/190**

**Objective : To impart knowledge on various occupational health hazards and also safety measures to be taken in the work place.**

#### **UNIT - I**

Parameters of safety - Factors affecting the conditions of occupational and Industrial safety – Concept of safety organization and Management - Safety Regulations. Definition and Role of Ergonomics in Designing Work Place - Work Environment - Effects of Light, Ventilation, Vibration, Noise etc - The Work Physiology and their Relevance to Safety - Performance Evaluation of Man – Environment systems.

#### **UNIT - II**

Occupational Health and Safety – Occupational Health and Hazards – Physical, Chemical and Biological hazards. Occupational Diseases and their Prevention and Control. Health Protection Measures for Workers. Principles of Arthropod Control. Health Education Medical First-Aid and Management of Medical Emergencies.

#### **UNIT - III**

Industrial Safety Management Techniques - Industrial Safety Standards. Accidents-Definition, Frequency Rate, Prevention and Control. Work Study - Method of Study and Measurement. Measurement of Skills. Safety - Cost of Expenses. Principles and Functions in Safety Management Case Study - Visit to an Industry - Preparation of report on safety measures followed in Airport/Industry.

#### **REFERENCE:**

1. Environmental Strategies–Hand Book, Kolluru R. V, (1994) Mc Graw Hill Inc., New York.
2. A B C of Industrial Safety, Walsh, W and Russell, L, (1984) Pitma Publishing United Kingdom
3. Environmental and Industrial Safety, Hommadi, A. H. (1989). I.B.B Publication, New Delhi

### **PRACTICAL**

**MSCES/Y/200**

#### **PRACTICAL – I**

1. Environmental Inventory Studies – Quadrate Method
2. Plakton Analysis – Phytoplankton – Zooplankton. Counting – Biomass – Identification – Frequency, Primary Productivity.
3. Water – Quality of Water – DO, BOD, COD, Hardness, conductivity, Chloride, Alkalinity, Acidity, Sulphate, Phosphate, Nitrate, TDS, TSS, Silicate, Calcium. Indicator Organisms –Estimation of THB.
4. Air Quality – SPM – SO<sub>2</sub>, NO<sub>x</sub> – Microflora.
5. Noise: Measurement of noise.
6. Soil - Physical, Chemical and Biological Properties – Soil Profile (Sand, Silt, Clay) – Porosity - pH – conductivity, Sulphate, Phosphate, NPK, TOC, Pesticides – Metals. Soil Bacterial and Fungi.
7. Bioassay – LC 50, LD50, Probit Analysis, Protein Carbohydrate, Fat.

#### **PRACTICAL – II**

1. Instrumental Methods of Analysis, DO, BOD, COD, TDC, TKN, Spectrophotometric. Methods of Estimation: Fluoride, Phosphate, Calcium, Chromium, Malathion.
2. Data Analysis using packages: Data Entry – Tabulation – Preparation of graphs.
3. Modeling Ecological Models – Air, Water, Population, and Noise.
4. Biodiversity: Population of Chlorella, Spirogyra, Gaillardia, Fungal and Bacterial Diversity, Plant and Animal Diversity index.

## **SECOND YEAR**

### **ENVIRONMENTAL IMPACT ASSESSMENT**

**MSCES/Y/210**

**Objective: To expose the candidates to the recent methods, programmes and projects, preparations of EA and EIA reports and institutional requirements of assessment of environmental impacts of policies and plans.**

#### **UNIT - I**

Objectives – Legal Basis for Environment Impact Assessment – Screening of Projects – Environmental Assessment – Environmental Assessment Procedures – Writing the Environmental Assessment and Checklists, Concept of Significant Impact – Case Studies - Project Alternatives.

#### **UNIT - II**

The Environmental Impact Statement Process. EIA Methodologies – Adhoc Method – Checklist Methodologies – Matrix Methods – Network Methods – Preparing EIS and Checklists.

#### **UNIT - III**

Prediction and Assessment of Impacts on Earth Resources – Biota, Surface Waters, Ground Water, Air, Noise, Hazards and Nuisances, Historic and Cultural Resources, Transportation, Socio-economic Relationships. Interlinking of rivers and River Basin Management.

#### **UNIT - IV**

Notification – Public Participation, Regional and Sectoral Impact Assessment, Major limitation of Environmental Impact Assessment.

#### **UNIT - V**

Case studies - Land Clearing Projects – Dam sites – EIA for Hydel, Thermal, Nuclear, Oil and Gas based Power Plants – Highways projects – Industrial Projects.

#### **REFERENCE:**

1. Environmental Impact Assessment, Canter, L.W., (1996) Mc Graw Hill, New York.
2. Environmental Impact Statements, Bregman, J.I., (1999) Lewis Publishers, London.
3. Environmental Assessment, Singleton, R, Castle, P and Sort, D (1999), Thomas Telford Publishing, London.
4. Effective Environmental Assessment, Eccleston, C.H., (2000) Lewis Publishers, London.
5. Environmental Impact Assessment- A Comprehensive Guide to Project and Strategic Planning, Eccleston, C.H., (2000) John Wiley and Sons.

### **WASTE MANAGEMENT AND BIOREMEDIATION**

**MSCES/Y/220**

**Objective: To impart knowledge on the management of solid and liquid wastes from municipal, industrial sources and principles of remedial measures of recycling, reuse and wealth from the wastes.**

#### **UNIT - I**

Waste – Classification and Quantification – Solid Waste Management and Disposal: Sources and Generation of Solid Waste – characterization, composition and classification. Hazardous Waste Management: Cyanides, Dioxins, Detergents, Plastics, Nylon and Paper. Waste Minimization approaches – Monitoring and Management strategies. Radioactive Waste: Sources, half life of radioactive elements, modes of decay. Effects on Plants, Animal and Man. Low and High-level Radioactive Waste Management – Waste Minimization and Treatment. Radiation standards.

#### **UNIT - II**

Recycling of Wastes – Types – sources – composition of waste – 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 utilization. Waste Disposal Methods – composting, incineration, pyrolysis, medical waste disposal strategies.

#### **UNIT - III**

Microbial Activity in Soil and Ground Water, Lithosphere as Microbial habitat, Microorganisms in rock and minerals, Mineral soil and Organic soil. Physiological groups of prokaryotes, Geomicrobial transformations – Biodegradation of carbonates – Biomobilization of silicon, phosphate, nitrogen. Geomicrobiology of fossil fuel, methane, peat, coal and petroleum.

#### **UNIT - IV**

Principles of Bioremediation – Rapid growth and Metabolism- Genetic plasticity – Metabolic pathways for the degradation of xenobiotics, hydrocarbons – Microbial site characterization – Biodegradation potential – Bioprocess design, optimization – Microbial removal rates – inherent problems associated with biotreatment studies. Microbiological methodologies – Standard biotreatability protocols – Quantification of biodegradation.

#### **UNIT - V**

Aerobic Bioremediation: Bioremediation of Surface Soils: Fate and transport of contaminants in the Vadose zone – Biodegradation in soil ecosystems – Types of soil treatment systems – Bioreactors. Subsurface Aerobic Bioremediation: Selection of bioremediation system – *in situ* Bioremediation – *in situ* Bioventing – *in situ* treatment of Harbour Sediments – *in situ* Lagoon treatment. Bioremediation in fresh water and marine systems: Factors affecting bioremediation – Bench Scale and Pilot Scale studies – *in situ* Bioreactor treatment of sediments – *in situ* Bioremediation of contaminated lagoon sediment – *in situ* treatment in marine ecosystem. Anoxic/Anaerobic Bioremediation: Anoxic/Anaerobic Environment – Potential anaerobic Bioremediation – Anoxic/Anaerobic Processes – Fermentation, Degradation of xenobiotics – Anoxic/Anaerobic bioremediation of hydrocarbons, Chlorophenolic compounds, Phenols, Polycyclic Aromatic Hydrocarbons (PAH), Heterocyclic Compounds, Cyanide Remediation, Radioactive wastes. Factors influencing anaerobic Bioremediation - Phytoremediation. Legislation, Regulation and Policy - Current Regulations and programs of interest – Hazardous Waste Management Act.

#### **REFERENCE:**

1. Microbial Ecology, IV Ed., Atlas, R.M and Bartha, R., (2000) Addison Wesley Longman Inc.
2. Bioremediation, Baker, K.H. and Herson, D.S., (1994) Mc Graw-Hill Inc.
3. Biology of Microorganisms, VII Ed., Brock, T.D., Madigan, M.T. Martinko, J.M. and Parker, J (1994) Prentice Hall, New Jersey.
4. Geomicrobiology, Ehrlich, H.L (1996) Marcel Dekker Inc., New York.
5. Bioremediation – Principles, Eweis, J.B., Ergas, S.J, Change, D.P.Y and Schroeder, E.D (1998) Mc Graw-Hill Inc.
6. Environmental Engineering, Kiely, G (1998) Irwin/Mc Graw Hill International, U.K.

7. Hazardous Waste Management, II Ed, LaGrega,M.D.,Buckingham,P.L., and Evans,J.C (2001) Mc Graw Hill Inc.
8. Microbial Degradation of Xenobiotics and Recalcitrant Compounds, Leisinger, T, Cook,A.M., Hutter,R and Nuesch,J (1981) Academic Press, London.
9. Hazardous Wastes and Solid Wastes, Liu, D.H.F and Liptak,B.G (2000),Lewis Publishers, New York.
10. Microbiology, Pelezar, M.J.Jr., Chan, E.C.S and Kreig,N.R (1993) Tata Mc Graw Hill, Delhi.
11. Remediation of Petroleum Contaminated Soils – Biological, Physical and Chemical processes, Riser-Roberts, E., (1998) Lewis Publisher, New York.
12. Vadose-Zone and Ground Water Contamination – Assessment, Prevention and Remediation, Russel Boulding, J (1995), Lewis Publishers, Tokyo.
13. Recycling of Crop, Animal and Human Waste in Agriculture, Tandon (1995), Mc Graw Hill Publishing Co.

## **REMOTE SENSING AND GIS**

**MSCES/Y/230**

**Objective: To teach the principles and application of spatial information technologies viz RS, GPS and GIS in the resources distribution. To give on hand training in the use of GIS packages.**

### **UNIT - I**

Introduction to Geographical Information Systems -map data representation. Analysis in GIS. Definition of Remote Sensing, EMR and interaction with the earth. Atmospheric windows. Black, white and grey bodies, sources of EMR.

### **UNIT - II**

Concepts and foundations of remote sensing. Image interpretations. Aerial photo-classification based on attitude of camera lens, distortions caused due to flight irregularities, overlaps, scale, relief displacement and its effects. Photo recognition elements and factors controlling them. Different types of photographs.

### **UNIT - III**

Elements of photographic systems and computer applications. Land stat. IRS and other satellite systems-satellite data. Principals involved in thermal IR image and microwave image interpretation. Applications of different types of images in earth Sciences, Environmental Sciences, Archeology, Marine studies, Forestry, Soils, Hazard management etc.

### **UNIT - IV**

GIS Applications – Fundamentals of GIS – Layers and Themes – Modelling – Weighing – Specific Applications - Infrastructure – Ground Water – Rainfall – Runoff etc. GPS applications – Principles of Accuracy – Applications to Agriculture - Water Management – Database Creation – Networking of Data, Map scaling

### **UNIT - V**

Environmental Applications of GIS – Impact Assessment – Pollution Monitoring – Water – Air – Ocean Pollution – Land Degradation – Desertification – Industry – Mining – Ground Water Modeling – Damage Assessment – Coastal and Marine applications – Future Sensors – Satellite System – ENVISAT – Megha Tropiques – TRMM – EOS Missions – Integral Earth Observation Studies – Global Change-Case studies.

## **REFERENCE**

1. Remote Sensing and image interpretation, Lilles and Keifer, 2004. John wiley and sons,NewYork.
2. Remote Sensing Techniques for Environmental Analysis, Estes J.E., and Senger, L.W (1973). John Wiley and Sons NY.
3. Remote Sensing of Environment, Lintz, J and Simonett, D. S (1976) Addition - Wesley.

4. Geographic Information Systems – Spatial Modeling and Policy Evaluation, Fischer, M.M and Nijkamp, P (1993). Springer - Verlay
5. Remote Sensing and GIS for Environmental Planning, Muralikrishna, I.V (1995). Tata- McGrow Hill
6. Environmental Monitoring: Applications of Remote Sensing and GIS, Singh, R.B (1992), Geocartheo International Centre, Hongkong.
7. Environmental Remote Sensing from Regional and Global Scales, Rood, G.M and Curran, P.J. (1994)
8. Advances in Environmental Remote Sensing, Danson, F.M and Plummer, S.E (1995)
9. Space Remote Sensing Systems – An Introduction, Chen, H.S (1985)
10. Introduction to Environmental Remote Sensing, Barrett, E.C and Curtis, L.F (1982)
11. Digital Image Processing, William K Pratt (2001) John Wiley & Sons.
12. Observation of Earth and its Environment – Survey of Missions and Sensors, Kramer J. Herbert (2002), Springer-Verlag
13. Fundamentals of Remote Sensing, George Joseph (2003), Universities Press (India) Ltd., Hyderguda, Hyderabad.

## **ENVIRONMENTAL ENGINEERING**

**MSCES/Y/240**

**Objective: To educate the students in detailed design concept of water distribution system, sewer network, working principles and design of various physical, chemical and biological treatment systems of water and waste water.**

### **UNIT - I**

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 as per BIS standards – selection of pipe material – Pump types, Characteristic Curves – selection and determination of capacity. Sanitary appliances.

### **UNIT - II**

General layout of Water Treatment Plant – Aerators – types and design. Flash Mixer – Design – Clariflocculator – parameters for design – Filtration - rapid sand filter and pressure filter and design chlorine demand, residual chlorine and chlorine dosage.

### **UNIT - III**

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 and Oxidation Ditch – Diffusers and Mechanical Aerators. Trickling Filters and Design. Duncan Mara Systems (Waste Stabilization Ponds).

### **UNIT - IV**

Sludge Processing and Disposal Methods – Design of Anaerobic Digester and Sludge Drying Bed – Reverse Osmosis – Ion Exchange – Incinerators and Multiple Evaporators. Land filling – Composting, Vermicomposting – Bioprocessors.

### **UNIT - V**

Air Pollution – Minimum Stack Height – Plume Rise, Ground Level Concentration of Pollutants. Design of Settling Chamber, Cyclones, Fabric filters and Electrostatic Precipitators. Scrubber – Draught, Exhaust. Case studies: Sago, Dyeing, Paper and Pulp, Distillery, Tannery, Electroplating - Industrial Waste Water Treatment.

## **REFERENCE**

1. Environmental Engineering, Mackenzie L. Davis and David A. Cornwell (1991), Mc Graw - Hill International Editions, New York.

2. Elements of Public Health Engineering, Duggal K.N. (1985), S.Chand and Company Ltd., New Delhi.
3. Environmental Engineering, Narayana Rao M. and Thanikachalam (1995), Mc Graw Hill Publishing Company Ltd., New Delhi.
4. Introduction to Environmental Engineering and Science, Gilbert M.Masters (2004), Prentice-Hall of India Pvt. Ltd., New Delhi.
5. Wastewater Treatment, Rao M.N. and Datta, A.K (1987), Oxford & IBH Publishing Company Pvt. Ltd., India.
6. Water and Wastewater Technology, Hammer M.J. and Hammer Jr M.J.(2001), Prentice-Hall of India Pvt. Ltd., New Delhi.
7. Wastewater Engineering: Treatment and Reuse, Metcalf and Eddy (2003), Tata Mc Graw Hill Publishing Company Ltd., New Delhi.
8. Standard Handbook of Environmental Engineering, Robert A.Corbitt (1989), Mc Graw Hill Publishing Company Ltd., New Delhi.
9. Sewage Disposal and Air Pollution Engineering, Garg S.K. (1990) Khanna Publishers, India.
10. Chemistry for Environmental Engineering and Science, Sawyer C.N., Mc Carty P.L., and Parkin, G.F (2003) Tata McGraw-Hill Publishing Company Ltd., New Delhi.
11. Environmental Guidelines and Standards in India, Goel P.K. and Sharma K.P (1996), Technoscience Publications, Jaipur, India.
12. Advances in Industrial Wastewater Treatment, Goel P.K. (1999) Technoscience Publications, Jaipur, India.
13. Environmental Engineering, Howard S Peavy (2003), Tata Mc Graw Hill Publishing Company Ltd., New Delhi.
14. Environmental Engineering: A Design Approach, Sincero A.P and Sincero G.A. (1999), Prentice-Hall of India Pvt. Ltd., New Delhi.

## **ECOTOURISM**

**MSCES/Y/250**

**Objective: To teach the students the importance of tourism and ecotourism activities**

### **UNIT - I**

Concepts of Tourism - Classification – Religious Tourism – Cultural Tourism – Heritage Tourism – Monumental Tourism – Adventure Tourism – Mass Tourism – Sustainable Tourism – Consumptive and Non-Consumptive Tourism. Principles of Ecotourism – Types of Ecotourism – Concepts of Ecotourism – Origin of Ecotourism – Objectives of Ecotourism – Benefits of Ecotourism – Trends affecting Ecotourism.

### **UNIT - II**

Places of interests of Ecotourism – Ecocircuit of the Western Ghats – Infrastructural Facilities for Ecotourism – Maintenance of Ecological Centers – Important Biosphere Reserves. Target group of Ecotourism – Ecotourism and Conservation – Study of different Ecosystem – Rain forest Ecotourism – Mountain Ecotourism – Polar, Islands and Coasts Ecotourism – Wilderness – Marine Ecosystem. Sanctuaries and National Parks.

### **UNIT - III**

Impact of Ecotourism – Economic Impacts (Fiscal Impacts, Concept and Methods) – Types and Degree of Impacts from Ecotourism activities – Socio-cultural Impacts – Ecotourism related organization – Ecotourism Research. Disasters and Ecotourism.

### **REFERENCE:**

1. The Encyclopedia of Ecotourism, Weaver, D.B (2001) CABI Publishing, U.K.
2. Encyclopedia of Ecotourism, Volume I, II and III, Sinha, P.C (2003) Anmol Publications Pvt. Ltd., New Delhi.



3. Ecotourism and sustainable Development. N. Mukherjee (2008). Cybetech Publications, New Delhi.
4. Global Ecotourism, Prabhas Chandra (2003). Kaniskha Publishers, New Delhi.

## **NATURAL DISASTER MANAGEMENT**

**MSCES/Y/260**

**Objective: To expose them about the natural disasters and management of natural disaster.**

### **UNIT - I**

Natural Disaster – Nature and Extent and Educative – Cyclone – Tornadoes – Avalanches – Flood – Drought – Volcanic – Earthquakes – Fire – Landslides. Forecasting and Warning System: Cyclone Disaster Education - Cyclone Safety – Earthquake – Avalanche – Safety and Flood Safety – Impact on Environment.

### **UNIT - II**

Disaster Management. Predisaster Planning-Toning of Disaster – prone areas – prioritization – regulations – protection measures during disaster - Post disaster. Relief Camp Organization – Survey Assessment. Disaster Management Cycle – Vulnerability Analysis – Warning system – Disaster Training – Legal Aspects – case studies for disasters and management, Safety Measures – a general account, Disaster Management plans.

### **UNIT - III**

Disaster Preparedness and Training. Community Preparedness in Natural Disaster. Role of Voluntary Organization (NGO) and Army Training for Disaster Reduction – Mitigation Strategies. Training needs – Target Groups – Local Condition.

### **REFERENCE**

1. Natural Disasters – A Guide for Relief Workers, (1980) JAC Adhyatma Sadhna Kendra- Mehrauli, New Delhi 110 030.
2. Disaster Planning: The Preservation of Life and Property, Harold D. Foster (1980) Springer Verlay, New York.
3. Disaster Manangement, Shailendra K Singh, Subash C.Kundu and Shobu Singh (1998) Mittal Publications, New Delhi.
4. India Disasters Report: Towards a Policy Initiative, Parasuram, S and Unnikrishnan, P.V (2000) Oxford University Press.
5. Disaster Management, Indu Prakash (1994) Rashtra Prahari Prakasan, Gaziabad.
6. At Risk: Earthquakes and People's Vulnerability, Shudhirendar Sharma Energy and Environment Group, New Delhi.
7. Natural Disaster Reduction, Girish K Misra ad Mathur, G.C (1993), Reliance Publishing House, New Delhi.
8. Disaster Preparedners in India, Narendra Kumar Jain, Adhyatma Sadhna Kendra – Mehrauli, New Delhi.

## **GREEN PRODUCTS**

**MSCES/Y/270**

### **Unit I - Industrial Ecology and Waste Minimization**

Waste Management for Resource Recovery, Recycling, Waste Oil Utilization and Recovery, Recovery of solutes from Wastewater, Recovery of Water from Wastewater, Solvent Recovery

### **Unit II - Industrial Ecology and Waste Treatment**

Physical methods of waste Treatment, Chemical Treatment of Wastes, Acid/Base Neutralization, Chemical Precipitation, Chemical Flocculation, Oxidation/Reduction, Electrolysis, Chemical Extraction, Chemical Destruction of PCBs, Biological Destruction of PCBs, Photolytic reaction, Thermal Treatment

### **Unit III - Industrial Ecology of Waste Disposal**

Immobilization, Chemical Fixation, Physical Fixation, Ultimate Disposal, *In Situ* Treatment *Anx.33 A - M.Sc. Env. Sci(2007-08) + CBCS Regulations Page 32 of 32*

### **Unit IV - Earth System Engineering and Management**

Concept, Examples of ESEM, Implemented and Proposed – Brownfield Restoration, Dredging the waters, Restoring Regional Scale Wetlands, Combating Global Warming, The Principles of ESEM – Theoretical, Governance principles of ESEM, Design and Engineering Principles of ESEM

### **Unit V - Future of Industrial Ecology**

Industrial Ecology in the Midst of Change, The Industrial Ecology Hardware Store – Tools for Product and Process, Service Provider, Systematist and Policy Maker, Industrial Ecology as an Emerging Science, An Industrial Ecology Research Roadmap

### **References**

1. Industrial Ecology: Environmental Chemistry and Hazardous Wastes, Stanley E Manahan, (1999). Lewis, New York, USA
2. Industrial Ecology. T.E.Graedel and B.R.Allenby, (2003). Printice Hall, New Jersey, USA.

## **PRACTICALS**

**MSCES/Y/280**

### **PRACTICAL – III**

1. EIA: Area Classification, Mapping – Preparation of EIA Reports.
2. Solid waste : Collection, Disposal – Composting, Vermicomposting – Bacteriological Analysis.
3. Metal and Drug resistant Bacteria. Removal of metals by microorganisms.– Immobilization of Microbial cells.
4. RS and GIS: Preparation of Thematic maps – Baseline Map – Transportation Network and Settlement Maps – Drainage Maps – Counter Map – Interpretation of Satellite data. Land use /Land cover classification from Satellite Data – Study of aerial photographs – GIS Applications .
4. Chemical Coagulation Test – Jar Test – Apparatus.
5. Drinking Water Treatment (measure of five parameters before and after treatment – pH, chloride, nitrate, phosphate, total solids).
5. Domestic Wastewater Treatment (Parameters as given above).
6. Industrial Effluent Treatment (Metals and other parameters as given above).

## **PROJECT WORK AND VIVA-VOICE**

**MSCES/Y/290**

## **INDUSTRIAL AND FIELD VISIT/REPORT AND VIVA-VOICE**

**MSCES/Y/300**