SCHEME OF EXAMINATION

AND SYLLABI

OF

MASTER OF SCIENCE (ENVIRONMENT MANAGEMENT)

(ACADEMIC SESSION AUG., 2007-2009)

GURU GOBIND SINGH INDRAPRASTHA UNIVERSITY

KASHMERE GATE, DELHI–110006

Scheme of Examination

ACADEMIC SESSION 2007 – 2009

Master of Science (Environment Management)

First Semester

Theory Papers

Code No.	Subject	L	T	P	Credits
BA-601	Mathematics	2	1	0	3
EM-601	Environmental Sampling and Data Analysis	2	1	0	3
EM-603	Environmental Microbiology and Chemistry	3	0	0	3
EM-605	Environmental Geology & Natural Disaster Management	2	1	0	3
EM-607	Water Supply and Treatment	2	1	0	3
EM-609	Energy and Environment	2	1	0	3
MS-611	Management Process and Organisational Behaviour	3	0	0	3

Practical/Viva-Voce

EM-651	Water and Wastewater	0	0	4	2
EM-653	Environmental Monitoring	0	0	4	2
IT-665	Introduction to Computers	0	0	2	1
	Total	**16**	**5**	**10**	**26**

Second Semester[1]

Theory Papers

Code No.	Subject	L	T	P	Credits
EM-602	Ecology and Sustainable Development	3	0	0	3
EM-604	Environmental Modelling	3	1	0	4
EM-606	Solid Waste Management and Disposal	3	0	0	3
EM-608	Wastewater Treatment	2	1	0	3
EM-610	Environmental Management and Planning	3	0	0	3
EM-612	Environmental Impact Assessment and Risk Analysis	3	1	0	4
EM-614	Landuse Survey and GIS Applications	3	0	0	3
Practical/Viva-Voce					
EM-652	Environmental Modelling	0	0	4	2
EM-654	Landuse Survey and GIS Applications	0	0	2	1
	Total	**20**	**3**	**6**	**26**

[1] After 2nd semester students will undergo summer training for six weeks in different industries/institutes.

Third Semester

Theory Papers

Code No.	Subject	L	T	P	Credits
EM-711	Air Pollution and Control	2	1	0	3
MS-713	Natural Resources Management and Economics	2	1	0	3
EM-715	Industrial Pollution Control	3	0	0	3
EM-717	Environmental Microbial Technology	3	0	0	3
MS-703	Project Management	3	0	0	3
EM-719	Summer Training Report[2]	0	0	0	3

*Select any **Two***

EM-721	Advanced Remote Sensing/GIS Techniques in Environmental Management	3	1	0	4
EM-723	Advanced Statistical Techniques Applied to Environmental Systems	3	1	0	4
EM-725	Energy Management and Planning	3	1	0	4
EM-727	Advanced Water and Wastewater Treatment Design	3	1	0	4
EM-729	Environmental Bio-Technology	3	1	0	4

Practical/Viva-Voce

EM-755	Environmental Microbial Technology	0	0	2	1
	Total	**19**	**4**	**2**	**27**

[2] The summer training reports will be evaluated in two parts. The Corporate Executive, under whose guidance the summer training project has been completed, shall award marks out of 50. And for the remaining 50 marks an Internal Board of Examiners shall be considered by the Vice-Chancellor on the recommendations of the Dean.

Fourth Semester

Code No.	Subject	L	T	P	Credits
EM-758	Seminar and Progress Report[3]	4	0	0	4
EM-760	Dissertation[4]	0	0	0	22
	Total	**4**	**0**	**0**	**26**

Total No. of Credits offered in all four semesters[5] **105**

[3] Evaluation will be based on the report and their presentations in the presence of at-least three faculty members of the School duly approved by the Vice-Chancellor.

[4] The student will submit a synopsis at the beginning of the semester for approval from the departmental committee in a specified format. The student will have to present the progress of the work through seminars and progress reports. Evaluation of dissertation will be based on thesis and viva/voce by the Board of Examiners comprising of the External Expert & Internal Supervisor. The names of the External Examiner shall be approved by the Vice-Chancellor by the recommendations of the Dean.

[5] The student will require to earn minimum of 100 credits for the award of the degree (Ref. GGSIPU/SMS/2000/1850, minutes of the Joint Meeting of the Curriculum Development Committee).

The student will not have the option to drop any course covered in the scheme of examination. He/she will be required to register for all the courses listed in the scheme of examination.

L	T/P	Credits
2	1	3

BA 601 - MATHEMATICS

Differential Calculus : Functions–Logarthmic, exponential, hyperbolic, limit of a function, derivative of functions, implicit functions, chain rule, application of derivative, Maxima and Minima; successive differentiation; Partial differentiation; total differentiation; Taylor's series for functions of single and multiple variables; Maxima and Minima of functions for two or more variables.

Integral Calculus : Integration : Simple techniques; Reduction formulae properties of definite integrals; Application of integration to areas, lengths, arcs, surface and volume of solids of revolution; Simpson's and Trapezoidal rule.

Differential Equations : Linear differential equations of first order and first degree (Leibnitz and Bernoulli's form), General linear differential equations with constant coefficients, Operator D. Complementary function; Particular integral.

Linear Algebra : Matrix, Determinant, Rank and inverse of a matrix, Solution of linear system of equation, Guass elimination method.

Text / References :

1. M.K. Singhal & Asha Singhal, Algebra, R. Chand & Co.
2. Shanti Narayan, Matrices, S. Chand & Co.
3. G.B. Thomas and R.L. Finney, Calculus and Analytic Geometry, Addison-Wesley/Narosa.
4. E. Kreyszig, Advanced Engineering Mathematics, 5th Ed., Wiley Eastern Ltd., 1985.
5. N.M. Kapoor, Differential Equations, Pitamber Pub Co.
6. Schaum Outline Series, Differential Equations, McGraw Hill.
7. Schaum Outline Series, Linear Algebra, McGraw Hill.

L	T/P	Credits
2	1	3

EM 601 - ENVIRONMENTAL SAMPLING AND DATA ANALYSIS

Introduction

An overview of environmental systems; Generation of environmental data; Types and objectives of environmental studies; Random processes, Stochastic processes in the environment; Significance / relevance of data analysis in environmental management.

Sampling Environmental Systems

Introduction: Need and Purpose of sampling, Population and Sample, Sampling with and without replacement, Population parameters; Environmental sampling design: Methods for selecting sampling locations and times; Simple random sampling; Stratified random sampling; Two stage sampling; Compositing and three-stage sampling; Systematic sampling; Double sampling; Sampling Theory: Sampling distributions of - Means, Difference of means, Proportion, Variances; Estimation of parameters: Point and Interval estimates; Confidence interval estimation of - Means, Difference of means, Proportion, Variances; Sample size determination for different sampling designs; Tests of Hypotheses: Hypotheses testing procedure; Type I and Type II Errors; Level of significance; Parametric tests (Concerning Means, Difference of means, Proportion, Variances) – Tests of significance for large samples, Special tests of significance for small samples; Goodness-of-fit tests – Chi-Squared test, Kolmogorov-Smirnov test; Nonparametric tests – Sign test, Wilcoxon Signed-Rank test, Wilcoxon Rank-Sum test, Kruskal-Wallis test, Runs test; Analysis of variance : One-way analysis, two way analysis, Design of experiments; Factorial experimentation.

Environmental Data Analysis

Measurement Uncertainty: Elias, precision and Accuracy; Variability and Errors in environmental pollution data; Outlier detection – Different tests for outlier detection; Quality assurance and quality control (Internal and External); Control Charts: Description and Theory, Application and Limitations; Analysis of trend in the environmental data: Detecting and estimating trend, Trends and seasonality.

Environmental Standards

Uncertainty and variation associated with environmental standard setting; An overview of environmental standard setting; Broad principle of setting sound standards.

Recommended Readings

1. Joseph, A.J. (1997). *Health, Safety and Environmental Data Analysis,* Lewis Publishers : New York.
2. Pentecost, A. (1999). *Analysing Environmental Data.* Longman : London.
3. Gilbert, R.O. (1987). *Statistical Methods for Environmental Pollution Monitoring,* New York, Van Nostrand Reinhold.
4. McBeen, E.A. (1999). *Statistical Procedures for Analysis of Environmental Monitoring Data.*
5. Keith, L.H. (Ed.) (1988). *Principles of Environmental Sampling* ACS Professional References, American Chemical Society.
6. Berthouex, P.M. and Brown, L.C. (1994). *Statistical for Environmental Engineers.* Lewis Publishers, CRC Press.
7. Johnson, R.A. (1999). *Miller & Freund's Probability and Statistical for Engineers (5th edn).* Prentice-Hall of India Pvt. Ltd.: New Delhi.
8. Walpole, R.E. and Myers, R.H. (1985). *Probability and Statistics for Engineers and Scientists (3rd edn).* Macmillan Publishing Company: New York.

L	T/P	Credits
3	0	3

EM 603 - ENVIRONMENTAL MICROBIOLOGY AND CHEMISTRY

Microbes and Environment : Introduction to environmental microbiology; Diversity of microorganisms; Microbial growth and metabolism.

Microbiology and Soil Chemistry : Microbial habitat in soil; General characteristics & activities of microorganisms in surface soil, shallow subsurface environment, and Deep subsurface environment (Deep Vadose Zone and Deep Saturate Zone); Microbial plant interaction in the soil; Microorganisms and biogeochemical cycles; *Nitrogen Cycles* – Nitrogen assimilation, Mineralization; Nitrification; Denitrification; Fixation – Symbiotic and non-symbiotic nitrogen fixation; *Carbon Cycles* – Carbon assimilation; Mineralization and residue decomposition; Soil organic matter (SOM) and humus formation; Environmental consequences of bio transformation of sulfur, phosphorus, and iron in soil; Effect of ecological factor on toxicity of soil; Microbes and soil fertility improvement.

Aeromicrobiology and Chemistry : Extramural aeromicrobiology; Intramural aeromicrobiology; Important airborne pathogens; Airborne toxins; Bio aerosols; Nature of bio aerosols; Bio aerosol control; Bio safety in the laboratory; Role of microorganisms in air pollution control (bio-scrubbers and bio-filters); Microbes and global warming.

Microbiology and Aquatic Chemistry : Microbial habitat in the aquatic environment – Planktonic; Benthic; Microbial mats; Biofilms; Role of Microorganisms in Wastewater and Water Treatment; Bioassay tests for toxicity evaluation; Pathogens and Indicator microorganisms; Eutrophication of water bodies.

Toxic Chemicals in the Environment : Basic principles of bio transformation; Biodegradation and acclimatization; Biochemical aspects of arsenic, cadmium, lead, mercury, pesticides, insecticides, and carcinogens in the environment.

Text / References :

1. Salvia David M., Principles & Applications of Soil Microbiology.
2. Mark Coyne, Soil Microbiology : An Explorations.
3. Gary W. Vanloon and Stephen J. Duffy, Environmental Chemistry.
4. Alcano, Fundamentals of Microbiology.

L	T/P	Credits
2	1	3

EM 605 - ENVIRONMENTAL GEOLOGY AND NATURAL DISASTER MANAGEMENT

Atmospheric Environment : Structure of the atmosphere; Hydrostatic equation; Pressure, temperature, precipitation, humidity and radiation; Cloud classification and formation; Effective gravity and Coriolis force; El Nino phenomenon; Western disturbances; Energy balance model and energy budget of the earth.

Environmental Oceanography: Coastal oceanography; Coastal engineering; Energy propagation by surface waves; Tidal prediction; Ocean water composition, Circulation: Coral reefs and Coastal meteorology.

Terrestrial Environment : Primary differentiation and formation of core, mantle, crust, atmosphere and hydrosphere; magma generation and formation of igneous rock; weathering; erosion; transportation and deposition of earth's material by running water; river meandering and formation of ox-bow lake.

Disaster Management

Floods – River flooding, flood palins, drainage basins, nature and frequency of flooding, flood hazards, urbanisation and flooding, flood hydrographs, flood plain management and control.

Land slides – causes, human use and land slide analysis, determination of stability and safety factor.

Coastal hazards – tropical cyclone, coastal erosion, sea level changes and its impact on coastal areas and coastal zone management.

Earth quakes – causes, intensity and magnitude of earthquakes, geographic distribution of earthquakes zones, seismic waves, travel-time and location of epicenter, nature of destruction, aseismic designing, quake resistant buildings and dams.

Volcanoes – nature, extent and causes of volcanism, volcanic materials, geographic distribution of volcanoes.

Text / References :

1. William H. Dennen and Bruce R. Moore, WCB Publishers, Iowa, 1986.
2. John M. Wallace and Peter V. Hobbs, Atmospheric Science : An Introductory Survey, Academic Press, New York, 1977.
3. Egbort Bocker and Rienk Van Grondille, Environmental Physics, John Wiley & Sons Ltd., 1999.
4. Barbar W. Murk et. al., Environmental Geology, John Wiley & Sons, New York, 1996.

L	T/P	Credits
2	1	3

EM 607 - WATER SUPPLY AND TREATMENT

Water resources of India: Water availability in India - an overview; Water stress index, status and trend of ground water over exploitation, impact of ground water development and depletion, status and trends of surface water utilization and consumption, domestic water supply - current status, water use in industrial sector.

Public Water Supply Schemes : Planning and preparing water supply projects, predicting demand of water, population forecasting, factors effecting water demand, impurities of water, their significance and techniques of estimations, water borne diseases, standards of potable water, components of water supply schemes, Water treatment flowsheet.

Treatment Technologies

Aerations **:** Significance of aeration, gas transfer and Henry's law, fixed film and micro-eddies theory, design considerations for cascade aerator, tray aerators, spray aerators.

Coagulation and Flocculation **:** Purpose and mechanism of flocculation, coagulants used in water treatment, chemical equations, factors influencing coagulation, estimation of coagulant dose, coagulant feed devices, Rapid mixers, design consideration for mechanical and hydraulic mixers, types of flocculators, design criteria for baffle flocculators, pebble bed flocculator, Alabana type floculator, mechanical clariflocculators.

Sedimentation **:** Classification of settling, settling velocity, analysis of discrete and flocculent settling, types of sedimentation tanks, high rate sedimentation techniques.

Filtration **:** Mechanism of filtration, Selection of sand for filter beds, types of filters-slow sand filtration, rapid filtration, dual media filters, multimedia filters, Hydraulic of filtration, components of filtration unit, Backwash mechanism and sand bed expansion, design of various components of filtration unit.

Disinfection **:** Chemical and non chemical methods of disinfection, factors effecting efficiency of disinfection, rate of disinfection, chick's law.

Tertiary Treatment Techniques **:** Adsorption, Defluoridation, Desalinisation through distillation, ion exchange, Reverse Osmosis and Electrodylasis, Water softening, Removal of iron and manganese.

Text / References :

1. CPHEEO manual on Water Supply & Treatment.
2. Water purification & Wastewater Treatment & Disposal, by Fair G.M., Geyer J.C. & Okun D.A., Wiley & Toppan.
3. EPA Publications.
4. Articles published in various journals.

L	T/P	Credits
2	1	3

EM 609 -ENERGY AND ENVIRONMENT

Fundamental of Energy : Energy; work and power; different form of energy; first and second law of thermodynamics, standard cycles, heat transfer, concept of entropy and photosynthesis.

Relationship among Energy, Environment and Economical Level of Development : Resources of energy and energy use pattern in different parts of the world; Indian energy scenario for domestic, agriculture, transport and industrial sector and its impact on the environment.

Conventional Energy Sources and Technology : Coal; petroleum; natural gas; lignite; cracking of petroleum; furnace; boiler; turbines; fluidized bed systems and combined cycle systems; resources and reserves for oil, coal, natural gas; nuclear energy- fission energy, fusion energy, principles of MHD generator, MHD equation and power from MHD systems.

Renewable Energy Sources : Solar energy; Flat plate collectors, theory of Flat plate collectors, Photovoltaics & Solar Ponds. wind energy; tidal energy; geo-thermal; mini and micro hydropower development; ocean energy(OTEC); biomass gasification for thermal, electrical and mechanical power generation; biomass gasifier systems; gasifier coupled dual fuel engine systems; characteristics of producer gas; efficient & pollution free biomass stoves; bio-conservation technology; energy recovery from wastes; and environmental impacts of large scale exploitation of renewable energy.

Energy Conservation and Energy Economics : Energy efficiency at national level; Improving energy efficiency; Energy analysis; Concept of exergy (theoretical treatment); Capital recovery factor; Levelised annual cost; Economic analysis of wind electric generation and thermal power systems.

Text / References :

1. John W. Twidell and Anthony D. Weir, E. & F. N. Spon Ltd., London, 1986.
2. Edward H. Thorndike, Energy & Environment : A Primer for Scientists and Engineers, Addition-Wesley Publishing Company, Reading, 1976.
3. Thomas B. Johanson et. al., Renewable Energy : Sources for Fuels and Electricity, Earth Scan Publications Ltd., London.
4. David Merrick and Richard Marshall, Energy-Present and Future options, John Wiley & Sons, New York, 1981.
5. P. Chartier et. al., Biomass for Energy & Environment, proceedings of the European Biomass Conference, Pergamon Press, 1996.

L	T/P	Credits
3	0	3

MS 611 - MANAGEMENT PROCESS & ORGANISATIONAL BEHAVIOUR

The purpose of this course is to help students develop an understanding of management principles and functions and gain an insight into behavioural processes at work in organisations.

Management

Meaning and nature of management; Managerial functions, roles and skills; Evolution of management thought; Planning process, problem solving and decision making; Organisation structure and design; Control processes.

Organisational Behaviour

Organisational Behaviour as a field of study; Perception; Attitudes and job satisfaction; Personality; Learning; Motivation; Interpersonal and organisational communication; Group Dynamics; Leadership Organisational culture; Management of conflict; Coping with stress; Management of change.

Text / References :

1. Ancona et. al., Organisations Behaviour Processes : South-Western College Publishing, Boston, USA, 1999.
2. Jit S. Chandan, Organisation Behaviour, 2nd Ed., Vikas Publishing House Pvt. Ltd., Delhi, 1994.
3. Paul Hersey et. al., Management of Organisation Behaviour, Utilizing Human Resource, Prentice Hall of India Pvt. Ltd., New Delhi, 1998.

L	T/P	Credits
3	0	3

EM 602 - ECOLOGY AND SUSTAINABLE DEVELOPMENT

Ecosystem : Ecosystem types, Structures and functions, Abiotic and biotic components, Energy flows, Food webs, Ecological pyramids, Productivity.

Population Ecology : Population characteristics, Models of population growth and interaction - lotka - volterra model.

Community Ecology : Structure and dynamics, Community ecology and Pray predator relationships.

Bio-diversity : Definition, Bio-diversity concerns Hot spots of bio-diversity, bio-diversity conservation practices, biosphere reserves, National parks and sanctuaries.

Water Resources : Surface water and ground water, Water shed management, Water harvesting technologies.

Land Resources : Land use pattern, Eco-generation of wastelands, Soil erosion and conservation, Soil reclamation.

Forest Resources : Forest and environment, National forest resources, Forest management, National forest policy.

Wild Life Management : Wild life population pattern, Range and habitat, Endangered and rare species.

Sustainable Development : The concept of sustainable development; Environmental degradation and conservation issues; Global change and sustainability issues; Ecosystems and social processes in :
(a) Rehabilitation of degraded rural landscape, (b) Rehabilitation of unbalanced soils, (c) Rehabilitation of specialized habits, e.g. water bodies, mangroves, (d) Mined area rehabilitation; Carrying capacity and regional planning.

Text / References :

1. Richard B. Primack, Essentials of Conservation Biology.
2. Charles J. Kreb, Ecology.
3. Odum and Eugene P., Ecology and our Endangered Life Support System.
4. Owen and Oliver S., Natural Resource Conservation : An Ecological Approach.
5. Smith and Robert Leo, Element of Ecology.

L	T/P	Credits
3	1	4

EM 604 - ENVIRONMENTAL MODELLING

Introduction : Environmental systems - an introduction; An overview of mathematical models applied to various environmental issues; Concept, need, scope and objectives of environmental modelling; Role of mathematical Models in environmental quality management; Model classification – Brief review of different types of models: Mathematical (Deterministic), Numerical, Stochastic & Physical Models; Different stages involved in model building; Calibration and verification of model; Limitations in modelling.

Air Quality Modelling : Air Quality Modelling – Historical perspective; Air quality models – objectives and aim of Modelling, approaches to model building, elements of air quality models, classification of models; Gradient transport model; Eddy diffusion model; Gaussian Plume model – Point, line, area and multiple source models; Regulatory models; Models for gaseous and particulate pollutants; Atmospheric chemical reactions and transformation models; Modelling fugitive emissions; Model performance, accuracy and utilization.

Water Quality Modelling
General: Water Quality Modelling – Historical Perspective; Water Quality Models and Water Resource Management systems.
Fundamentals of Water Quality Modelling: Completely mixed system - concept of continuously stirred tank reactors (CSTR) : Mass balance approach, Different types of loading, Feedforward and feedback systems of reactors; Incompletely mixed system : steady and unsteady-state system.
Surface Water Quality Modelling: River and streams; Estuaries and Lakes; Dissolved Oxygen Models : DO sag model; BOD model; Streeter Phelps equation for point and distributed sources; Eutrophication models for lakes and flowing water.
Elements of Ground Water Modelling: Brief overview.

Hazardous Substance Modelling : Toxic chemicals and trace metal modelling.

Text / References :

1. Thomann, R.V. and Mueller, J.A. (1987). *Principles of Surface Water Quality Modelling and Control*, Harper & Row, New York.
2. Chapra, S.C. (1997). *Surface Water-Quality Modelling*. McGraw-Hill International Edition.
3. Benarie, M.M. (1980). *Urban Air Pollution Modelling* (Cambridge, MA: The MIT Press)
4. Hipel, K.W. and Mcleod, A.I. (1994). *Time series Modelling of Water Resources and Environmental Systems.* Elsevier Science B.V. Amsterdam, Netherlands.
5. Zannetti, P. (1990). *Air Pollution Modelling, Theories, Computational Methods and available Software.* Van Nostrand Reinhold, New York.
6. Buonicore, A.J. and Davis, W.T. (1994). *Air Pollution Engineering Manual*. Air and Waste Management Association, New York, Van Nostrand Reinhold.
7. Turner, D.B. (1994). *Workbook of Atmospheric Dispersion Estimates* 2nd ed., Ann Arbor, MI: Lewis Publishers.
8. Hadlock, C.R. (?). *Mathematical Modelling in the Environment*. The Mathematical Association of America.

L	T/P	Credits
3	0	3

EM 606 – SOLID WASTE MANAGEMENT & DISPOSAL

Introduction : Types and sources of solid wastes, Municipal, solid waste, Industrial solid wastes and Hazardous wastes, Present scenarios of municipal and industrial waste management in India.

Properties of Solid Wastes : Physical and chemical composition of municipal solid wastes, waste generation rates, factors effecting waste generation rates.

Management of Solid Wastes in India : Prevalent SWM practices and deficiencies : Storage of waste at source, segregation of wastes, Primary collection of waste, transportation of waste, disposal of wastes, institutional deficiencies.

Engineered Systems of Solid Waste Management : Design specifications of primary waste collection tools, waste storage bins, transportation vehicles, route selection and provision of transfer stations.

Disposal of Wastes : Site selection, rapid EIA of proposed sites, disposal technologies such as :

Composting : Aerobic composting, Anaerobic composting, mechanical composting, vermin composting; advantages and limitations of composting technologies, Economics of composting.

Anaerobic digestion : Traditional digestors such as KVIC model, Deenbandhu model, emerging technologies for waste stabilisation.

Incineration: Fuel Pellets, Refuse derived fuels, mechanical incinerators; advantages and limitations of incineration.

Sanitary landfilling : Method of preparing sanitary landfill site, land filling techniques, operation and maintenance of landfill sites including leachate collection and treatment, recovery of methane from landfill sites for power generation.

Hazardous Waste Management : The Hazards, Definition & classification of Hazardous Waste Hazardous Waste Management, Treatment Technologies, Land disposal, Biomedical Waste & its Management.

Text / References :

1. Solid Wastes Energy Principles & Management by Techno banoglus, Theisen & Elvasebm, McGraw Hills.
2. Standard handbook of Hazardous Waste Treatment & Disposal, by Freeman H.M., McGraw Hills.
3. Papers published in various Journals & Magazines.

L	T/P	Credits
2	1	3

EM 608 – WASTEWATER TREATMENT

Introduction : Disposal standards for wastewater in normal watercourse and on land, estimation of sewage quantity, flow variations, sewage characterisation, BOD growth curve and analysis, estimation of BOD rate constant by Thomas slope method.

Water Purification in Natural Streams : Self-purification of waste in streams, zones of purifications, eutrophication of lakes.

Sewage Treatment : Conventional sewage treatment plant flow sheet, variations in flow sheet for different flow conditions, Description of various units in sewage treatment plant.

Treatment Technologies : Physical processes : Screen chamber, Grit chamber, primary settling tanks, secondary settling tank, sludge drying beds, filter press, vacuum filtration, belt press.
Biological treatment : Biology of sewage treatment, biological growth and biological oxidation, kinetics of biological growth; process description of aerobic and anaerobic processes.
Operational Principles and Design of – activated sludge process, extended aeration, Step aeration etc.
Introduction to High Rate Anaerobic Treatment Technologies – Upflow anaerobic sludge blanket clarifier, Anaerobic fixed film fixed bed reactor, anaerobic fluidised bed reactor; Anaerobic digestors for sludge stabilization.

Low Cost Treatment Technologies : Septic tank; Imhoff tank; Oxidation ponds; Aerobic lagoons.

Status of Water Quality in India : Assessment of causal factors responsible for the deterioration in water quality, status of surface and ground water quality in India, National river action plan.

Text / References :

1. CPHEEO manual on Sewerage & Sewage Treatment
2. Water purification & Wastewater Treatment & Disposal, by Fair G.M., Geyer J.C. & Okun D.A., Wiley & Toppan.
3. Wastewater Engineering Treatment, Disposal and use by Metceff & Eddy, Inc. Revised, Tata, McGraw Hills.
4. Papers published in various Journals & Magazines.

L	T/P	Credits
3	0	3

EM- 610 : ENVIRONMENTAL MANAGEMENT AND PLANNING

Environmental Policies and Strategies : Evolution of environmental policy and major policy parameters; role of regulatory agencies; role of NGO's; public participation for environmental management role of court and appellate authorities in environmental protection, national and international conventions.

Legal Frame work for Environmental Planning : Environmental legislation; public policy strategies in pollution control; wild life protection act 1972 as amended 1991; forest conservation act, 1980; Indian forest act (revised) 1982, air (prevention and control of pollution) act 1981; motor vehicle act, 1988; the water (prevention and control pollution) act, 1974; water (prevention and control of pollution) CESS act, 1977; the environment (protection) act, 1986.

Pollution Prevention and Total Quality Environmental Management : Environmental indicators; Pollution prevention methodology; methods for waste minimization; types of recycling; recycling of waste material; recovery effort index; ISOTC-207 standards; environmental audit; ISO 14000 series and environmental labelling.

Sustainable Development Tools and Life Cycle Assessment : Population development and environment; logistic equation and its solution; maximum sustainable yield; defining resources; classification of environmental resources; the economics of harvesting of a renewable resource; economic development and resource use - natural resource accounting; integrating economic and environmental accounts; depletion of natural capital; defensive expenditure; greening of national accounts; evolution of life cycle analysis (LCA); technical frame work for LCA; life cycle design; life cycle inventory and methodology with case study.

Text / References :

1. Steven L. Erickson & Brian J. King, Fundamentals of Environmental Management, John Wiley & Sons, New York, 1999.
2. S.N. Charry & Vinod Vyasulu, Environmental Management, An Indian Perspective, Macmillan India Ltd., 2000.
3. Marry Ann Curran, Environmental Life-Cycle Assessment, McGraw Hill, New York, 1996.
4. Chirstopher Sheldon and Mark Yoxon, Installing Environmental Management Systems, Earthscan, London, 1999.

L	T/P	Credits
3	1	4

EM 612 - ENVIRONMENTAL IMPACT ASSESSMENT & RISK ANALYSIS

Introduction and Principles : Introduction to environmental impact assessment; Purpose of EIA; Environmental components, projects and its environmental impacts, Environmental impact statement; Projects screening and project scoping; Establishing the environmental baseline.

Impact Assessment Methodology : Checklists applications; Matrices; Networks; Overlay maps; Multi attribute utility theory; Environmental evaluation system; Transnational effects of projects; Impact identification; Impact prediction; Evaluation and mitigation; Monitoring and auditing in EIA process; Regional and strategic EIA, Environmental management plan; Cost benefit analysis and its dimensions; Influence of EIA on project and organisation; Problems of EIA in developing countries; Public participation in environmental decision making, presentation and review; EIA report and its contents.

Case Studies : Case studies of thermal power plants; river valley projects; opencast mining projects; pulp & paper mill; urbanisation and linear development.

Risk Analysis : Definition of risk; Environmental risk analysis; Fundamentals of hazard, exposure and risk assessment; Risk assessment and management; Basic steps in risk assessment – Hazard identification, dose response assessment, exposure assessment and risk characterization; Quantified risk assessment for industrial accidents; Design of risk management programmes; Risk assessment application to environmental management problems.

Text / References :

1. Larry W. Canter, Environmental Impact Assessment, 2nd Ed., McGraw Hill, New York, 1996.
2. John Glasson, Riki Therivel and Andrew Chadwick, Introduction to Environmental Impact Assessment, 2nd Ed., UCL Press, Philadelphia, USA, 1994.
3. Environmental Assessment, CIRIA special publication, Dept. of Environment, U.K., 1996.
4. Richard K. Morgan, Environmental Impact Assessment : A methodological perspective, Kluwar Academic Publications, Boston, 1998.

L	T/P	Credits
3	0	3

EM 614 - LANDUSE SURVEY AND GIS APPLICATION

Introduction to Remote Sensing : Definition of remote sensing; introduction to concepts and systems; Electromagnetic radiation; electromagnetic spectrum; image characteristics; remote sensing systems; remote sensing platform; sources of remote sensing information; advantages of remote sensing.

Microwave Sensing : Types of microwave systems, advantages, band designation, range resolution, azimuth resolution, real and synthetic aperture systems, radar equation, radar return and image signatures, dielectric properties and interaction with vegetation

Surveying : Levelling, Triangulation, Geodatic survey.

Aerial Photographs and Satellite Imageries : Interaction between light and matter; characteristics of aerial photographs; visual interpretation of aerial photographs and satellite imageries; instruments used in interpretation; Path and Row Index Maps; selecting and ordering images.

Digital Image Processing : Introduction; image rectification and restoration; image enhancement; manipulation; image classification; the output stage; data merging; conclusion.

Application of Remote Sensing in Environmental Management: Natural resource management - forest resources, water resources, land resources and mineral resources.

Hazard and disaster mapping and management.

GIS : Introduction to GIS; principle of GIS; terminology used in GIS; space and time in GIS; maps and its characteristics, map scale, map symbology; spatial relationship; data structure and spatial analysis in GIS; GIS data; softwares used in GIS.

Application of GIS in Environmental Management : Natural resources management; Disaster management; environmental monitoring assessment; action plan development of environmental fragile area; environmental monitoring assessment; GIS and landuse planning.

Text / References :

1. Floyd F. Sabins Jr., Remote Sensing, Principles and interpretation, W.H. Freeman & Company, New York, 2nd Ed., 1987.
2. T.M. Lillesand & R.W. Kiefer, Remote Sensing and Image interpretation, John Wiley & Sons, New York, 1994.

L	T/P	Credits
2	1	3

EM 711 - AIR POLLUTION AND CONTROL

Introduction : Air resource management system; Air quality management; Scales of air pollution problem; Sources and classification of pollutants and their effect on human health, vegetation and property; Global implications of air pollution (Depletion of ozone layer, Green house gases, Acid rain and Photochemical smog).

Air Pollution Meteorology: *Meteorology Fundamentals:* Meteorological scales of motion; Temperature in the lower atmosphere-pressure and temperature relationships in the lower atmosphere, Vertical temperature variation; Moisture; Atmospheric stability; Adiabatic diagrams; Mixing height; Winds, Wind roses and pollution roses. *Micrometeorology:* Atmospheric turbulence - mechanical and thermal turbulence; Wind profiles - affect of different parameters on wind profiles; Flux and Gradient Richardson numbers and their significance in determining atmospheric stability; Pasquill stability classes; Ventilation coefficient.

Atmospheric Diffusion : Elementary overview of various atmospheric diffusion theories; Steady-state atmospheric diffusion equation; Diffusion models : Gaussian concentration distribution - Gaussian plume idea, Gaussian plume derivation as solution of the atmospheric diffusion equation, dispersion parameters in Gaussian models, Pasquill-Gifford Curves; Plume Rise - Momentum and Buoyant Plumes.

Sampling and Monitoring Air Matrices : Scope, Purpose and Objectives of Air Quality Monitoring Programme; Preliminary information required for planning an air quality survey; Guidelines for planning a survey; Design of an air quality surveillance network; Period, frequency and duration of sampling; Averaging times; Sample size determination; Principles and instruments for measurement of – (i) ambient air pollutants; and (ii) stack emissions (monitoring).

Air Pollution Control : *Air pollution control philosophies:* The emission standard philosophy, The air quality standard philosophy, Emission tax philosophy and Cost-benefit philosophy; General ideas in air pollution control: Alternative control measures, Improving dispersion, Building tall stacks, Intermittent control schemes, Relocation of plant, Process change, Use of downstream control device. *Control of Particulate Contaminants:* Nature of particulate contaminants; Particle size distribution; Distribution by weight and number; Behaviour of particles in the atmosphere; Particulate Control Methods and Devices: Wall collection devices - Gravity settlers, Centrifugal separators, Electrostatic precipitators; Dividing collection devices - surface filters, Depth filters, Scrubbers; Selection of particulate collection device. *Control of Gaseous Contaminants:* Gaseous control methods and devices - Absorption, Adsorption, Combustion and Condensation. *Control of Mobile Source Emissions.*

Indoor Air Pollution: Indoor air pollutants; Models; Control of indoor air quality.

Text / References :

1. Perkins, H.C. (1974), Air Pollution, McGraw Hill.
2. Stern, A.C. (1980), Air Pollution, Vol. 1-VIII, Academic Press.
3. Nevers, Nod, D. (2000), Air Pollution Control Engineering, McGraw Hill Int.
4. Sunfield (1998), Chemistry and Physics of Atmospheric.

L	T/P	Credits
2	1	3

(Elective Course)

MS - 713 : NATURAL RESOURCES MANAGEMENT AND ECONOMICS

Renewable Resources : Optimal management, common property and open access, fishery : models of growth with open access, optimal harvest. Forestry : optimal stopping rules, the faustmann model and commercial forestry.

Non-Renewable Resources : The hotelling rule and social welfare, variations on the hotelling rules : exploration, uncertainty in demand and reserves. Growth with exhaustive resources, concepts and measures of resources scarcity. Natural resource accounting.

Environmental Economics : Relevance of Environmental economics, economic development in India and its implication on natural resources and environment, Benefits and costs, supply and demand, economic efficiency and markets, the economics of environmental quality, framework of analysis, costs-benefit analysis, cost criteria for environmental evaluation. Decentralized policies, command and control strategies, incentive based strategies, emission taxes and subsidies, Transferable discharge permits, environmental Crutznet curve,

Environment and foreign trade : Role of institutions- IMF, W.T.O., G.E.F., World bank etc., international agreements.

Text References :

1. Roger Perman et. al., Natural Resources & Environmental Economics, 2nd Ed., Longman, USA, 2000.
2. M. Comman, Environmental & Resources Economics, Longman, New York, USA, 1996.
3. John M. Hart Wick & Nancy D. Olewiler, The Economics of Natural Resource Use, Addison Wesley, 2nd Ed., Reading, 1997.

L	T/P	Credits
3	0	3

EM 715 – INDUSTRIAL POLLUTION CONTROL

Regulatory requirements of pollution control in industries, magnitudes of industrial waste generation and their characteristics, Methods of waste reduction such as volume and strength reduction, segregation, reuse, recycle, neutralization, equalization, proportioning.

Physico-chemical treatment technologies for wastewater : Oil and grease removal, cyanide removal, removal of nitrogen and phosphorus.

Combined effluent treatment for industrial estates, selection procedure for physical, chemical and biological methods of industrial wastewater treatment, management of industrial wastes from small scale industries.

Process description, waste/emission generation sources, pollution prevention, and treatment for the following industries :

CEMENT
PULP AND PAPER
DISTILLERY
SUGAR
FERTILISER
TANNERY
DAIRY
TEXTILE
OIL REFINERIES
PHARMACEUTICAL

Text / References :

1. W.W. Ecrenfelder (1990), Industrial Pollution Control : McGraw Hill Int. Ed.
2. Various publication of CPCB (about 20 in numbers)
3. Papers published in various Journals & Magazines.

L	T/P	Credits
3	0	3

EM 717 - ENVIRONMENTAL MICROBIAL TECHNOLOGY

Microbes and Environment : *Microorganisms and Organic Pollutants* – Environmental factors affecting biodegradation; Biodegradation of Organic Pollutants – Pollutant sources and types, Aerobic conditions, Anaerobic conditions; Bioremediation of organic pollutants; *Microorganisms and Metal Pollutants* – Metal bioavailability in the environment; Mechanisms of microbial metal resistance and detoxification; Bio remediation of metal-contaminated soils, sediments and aquatic systems; Microbes & bio-transformation of xenobiotics; *Microbes and Environmental Consequences of Microbial Activities* – Microbially Influenced Corrosion – Metal corrosion, Concrete corrosion; Acid mine drainage, Metal recovery and desulfurization of coal; Biomethylation of metals and metalloids; Bioleaching; Biofouling; Nitrate contamination of groundwater; Biogenesis of halomethanes and other organohalogens.

Microbes and Agriculture : *Micorrhizal Symbioses* – Global perspective, Types of mycorrhizae, Uptake and transfer of soil nutrients, Interactions with other soil organisms, Mycorrhizae in reforestation; Problems and potential of inoculum production and use; Soil biological control of plant diseases; Concept of bio-fertilizer; Bio-pesticides; Microbial and Vermi composting.

Microbes & Industry : Fermentation technology; Alternative energy source using microorganisms; Role of microbes in effluent treatment; Recovery of vital elements.

Text / References :

1. Raina M. Maier, Environmental Microbiology.
2. Gabriel Bitton, Wastewater Microbiology, 2nd Ed., Wiley-Liss, New York, 1999.
3. Nester, Roberts, Microbiology.
4. Black, Jacquelyn G., Microbiology : Principles and Explorations.

L	T/P	Credits
3	0	3

MS 703 - PROJECT MANAGEMENT

Introduction : Project management overview; Forms of project organisation; Project planning; Project control.

Project Identification and Presentation : Socio-economic consideration in project formulation; Social infrastructure projects for sustainable development; Investment opportunities; Project screening and presentation of projects for decision making; Expansion of capacity; Diversification.

Market and Technical Analysis : Market and demand analysis – Market survey, Demand forecasting, Uncertainties in demand forecasting; Technical Analysis – Product mix, Plant capacity, Materials and inputs, Machinery and equipment.

Project Costing and Finance : Cost of project; Cost of production; Break even analysis; Means of financing project; Tax aspects in project finance; Role of financial institution in project finance.

Project Appraisal : Time value of money; Project appraisal techniques – Payback period, Accounting rate of return, Net present value, Internal rate of return, Benefit cost ratio; Social cost benefit analysis; Effective rate of protection.

Risk Analysis : Measures of risk; Sensitivity analysis; Simulation analysis; Decision tree analysis.

Project Scheduling/Network Techniques in Project Management : CPM and PERT analysis; Float times; Crashing of activities; Contraction of network for cost optimisation, updating; Cost analysis of resources allocation.

Multiple Projects : Project dependence; Capital rationing; Ranking methods of projects; Mathematical programming approach; Linear programming model; Post Project Evaluation.

Text / References :

1. Bhavesh M. Patel, Project Management : Strategic Financial Planning Evaluation and Control, Vikas Publishing House Pvt. Ltd., 2000.
2. Kahkonen K. Editor, Managing Risk in Project, E. & F. N. Spon, London, U.K., 1997.
3. Wysochi, Robert K., Bick Robert and Crane David B., Effective Project Management, John Wiley & Sons, USA, 2000.

L	T/P	Credits
3	1	4

EM 721 - ADVANCED REMOTE SENSING / GIS TECHNIQUES IN ENVIRONMENTAL MANAGEMENT

Monitoring the environment : Concept of environment, economic benefits of remote sensing, the geographical uses of remote sensing, sensors for environmental monitoring.

Application of Remote Sensing : Weather analysis and forecasting, Water in environment, Soil and landforms, Rocks and minerals, Ecology, conservation and resource management, Landuse/landcover and crops, The built environment, Hazards and disasters, Siting for waste, Coastal zone management, Groundwater prospects.

A case study

Problems and Prospects : The limitation of costs on satellite remote sensing, security restriction, handling large quantities of data, the interface between technologist and user, Future development.

GIS Perspectives : Environmental research, the state of GIS for environmental problem-solving, GIS and environmental modeling.

GIS for modelers : Role of GIS software venders in integrating GIS and environmental modeling.

Understanding the scope of GIS : Its relationship to environmental modeling.

Data models and data quality : Problems and prospects.

GIS in Environmental modeling : Hydrological modeling, atmospheric modeling, landsurface-subsurface modeling, biological/ecological modeling, infrastructure development planning , disaster management and risk modeling

A case study

Text / References :

1. T.M. Lillesand & R.W. Kiefer, Remote Sensing and Image Interpretation, John Wiley & Sons, New York, 1994.
2. Stan Morain, GIS solutions in Natural Resource Management, Onward Press, USA, 1999.
3. F. Kuehn et. al. Editors, Remote Sensing for site characterization, springer-verlag, Germany, 2000.
4. Anne Virner Moudon & Michael Hubner, Monitoring Land Supply with GIS, John Wiley & Sons, New York, 2000.
5. P.J. Gibson and C.H. Power, Introductory Remote Sensing : Digital Image Processing and Applications, Taylor & Fransis, 2000.

L	T/P	Credits
3	1	4

EM 723 – ADVANCED STATISTICAL TECHNIQUES APPLIED TO ENVIRONMENTAL SYSTEMS

Time Series Analysis : Introduction; Correlogram analysis; Autocorelation and partial autocorrelation function; Trend and moving average analysis; Introduction to autoregressive and moving average models; Yule walker equations; Identification, Estimation and diagnostic checking of various stochastic models; Application of univariate models for daily average pollutant concentration series.

Spatial Data Analysis : Optimising estimation – Kriging; Introduction; Point kriging; Properties of kriging; Variogram analysis; Practical aspects of kriging.

Risk and Reliability Analysis : Application of probabilistic models in risk estimation; Catastrophic failure models; Hazard models; Introduction to fuzzy logic theory in risk analysis; Uncertainty in risk assessment and decision making; Reliability concepts : MTTF, MTBF; Bath tub curve; Hazard rate and failure dencity functions; System measures; Fault tree analysis; System reliability of series, parallel and non-series-parallel systems; Reliability approximations and bounds; Reliability improvement – component improvement and redundancy concept; Reliability allocation and optimisation.

Extreme Values Statistics : Introduction to extreme values; Applications – Forecasting floods, Environmental pollution; Identifying outlying observations; Families of distributions; Analysis extreme value data; Extremes of data containing trends; Parameter estimation; Extremes of small samples; Reliability computations for extreme value distributions.

Text / References :

1. Berthouex, P.M. and Brown, L.C. (1994). Statistics for Environmental Engineers. Lewis Publishers, CRC Press.
2. Gilbert, R.O. (1987). *Statistical Methods for Environmental Pollution Monitoring*, New York, Van Nostrand Reinhold.
3. Keith, L.H. (Ed.) (1988). *Principles of Environmental Sampling* ACS Professional References, American Chemical Society.
4. Barnett, V. and Turkman, K.F. (1997). *Statistics for the Environment 3: Pollution Assessment and Control*. Wiley, Chichetser
5. Barnett, V. and Turkman, K.F. (1994). *Statistics for the Environment 2: Water related Issues*. Wiley, Chichetser

L	T/P	Credits
3	1	4

EM 725 - ENERGY MANAGEMENT AND PLANNING

Energy Policy & Planning : Energy (and power) policies in the country, tariffs and subsidies, energy utility interface, private sector participation in power generation, energy and development , National energy plan , role of modelling in energy policy analysis, Reference energy systems, Energy demand analysis, Econometric models, Economics of utilisation of depletable and renewable resources, energy investment planning and Energy pricing.

Energy Economics and Energy Audit : Energy Audit Concepts, Elements, measurements , mass and energy balances, evaluation of energy conserving opportunities. Presentation of reports, case studies, discounted cash flow, present value concept, annual investments and rate of return.

Energy, Emissions to Air and Energy Management : Fossil fuels and combustion, combustion calculation, emissions to air, energy accounting, pollution accounting, energy uses and options for improvement.

Renewable energy management and Environmental impact : Techno–Economics of electric power generation through renewable sources, hydropower and its constraints, Decentralized versus grid electricity for rural India. Wind energy, technology & economics of wind energy, Economics of solar water heating systems, photo voltaic technology, thermal gasification of Biomass, economics of wood gasifier systems, Global climate change, CO_2 reduction potential through renewable energy.

Text / References :

1. Paul W. O'Callaghan, Integrated Environmental Management Hand Book, John Wiley & Sons, Chichester, 1996.
2. Paul W. O'Callaghan, Energy Management : A comprehensive guide to reducing costs by efficient energy use, McGraw Hill Book Company, London, 1993.
3. Harol W. Henry, Fredric W. Symonds etc., Energy Management : Theory and practice, Marcel Dekker, Inc., New York, 1980.
4. Hiren Sarkar and Gopal K. Kadekodi, Energy pricing in India : perspectives, issues and options, 1988.

L	T/P	Credits
3	1	4

EM 727 – ADVANCED WATER AND WASTEWATER TREATMENT DESIGN

Elementary Fluid Mechanics; energy and momentum equation; Flow through pipes; Open channel flow.

Design of conventional water treatment and sewage treatment plant for a given population and water supply (Design shall include, Aeration - flow control & measurement devices, Flash mixture, Clari-Flocculater, filtration, Backwashing, Chlorination & Storage, Screen Chamber, Grit Chamber, Flow control & measurement, Primary Sedimentation, Activated Sludge Process, Anaerobic Digestor, Sludge drying beds.); hydraulic profile diagram.

Advance Wastewater Treatment Techniques : Design of up flow anaerobic sludge blanket clarifier, Anaerobic digestors, design considerations for Anaerobic fixed film fixed bed reactors, Hybrid reactor.

Text / References :

1. CPHEEO manual on Water Supply & Treatment.
2. Wastewater Treatment Plants-Planning, Design & Operation by Qasim S.R.
3. EPA Publication.
4. CPHEEO manual on Sewerage & Sewage Treatment
5. Water purification & Wastewater Treatment & Disposal, by Fair G.M., Geyer J.C. & Okun D.A., Wiley & Toppan.
6. Wastewater Engineering Treatment, Disposal and use by Metceff & Eddy, Inc. Revised, Tata, McGraw Hills.
7. Papers published in various Journals & Magazines.

L	T/P	Credits
3	1	4

EM 729 – ENVIRONMENTAL BIO-TECHNOLOGY

Biosensors in Detection of Environment Pollutants – BOD sensor, Methane biosensor, Ammonia and nitrate biosensor.

Biotechnology and organic pollution; Biodegradation of halogenated hydrocarbons; Polycyclic aromatic hydrogen; Pesticides and Detergents.

Biotechnology and Radioactive Pollution – Bioleaching; Biosorption and Biodepollution of soils contaminated by radio elements.

Use of Biotechnology and commercial blends of Microorganism and Enzymes in wastewater treatment, Production of immobilised Enzymes, Entrapped microbial cultures and their utility in environmental biodegradation process, Potential application of Recombinant DNA technology in waste treatment, Application of genetically engineered microbes.

Xenobiotics and microbial biotransformation – Recalcitrance of Xenobiotics, Co-metabolism, Genetic regulation of Xenobiotic Biodegradation, Biodegradation of toxic organic pollutants by Aerobic & Anaerobic and Anoxic biological processes.

Forestry and Biotechnology :- Reforestation through micro-propagation; Somaclolal variations; Induction of genetic variability and heriditability; Conservation of endangered species; Biotechnology in preservation of bio-diversity; In situ and ex situ conservation through gene banks.

Phytoremediation :- Phytoremediation of xenobiotics and bioaccumulation of metals using plants.

Biodegradation of petroleum constituents and associated heavy metal, case study :- Bioremediation of Exxon Valdez Alaskan oil SpillBiological desulphurization and denitification.

Microorganisms in mineral and energy recovery and fuel and biomass production

Environmental biotechnology in research and education; Planning and management of bioremadiation and environmental biotechnology processes.

Text / References :

1. Gabriel Bitton, Wastewater Microbiology, 2nd Ed., Wiley-Liss, New York, 1999.
2. James M., Lynch & Alan Wiseman, Environmental Bio-monitoring : The Biotechnology Ecotoxicology Interface, Cambridge University Press, 1998.
3. S.K. Sikdur & R.L. Irvine, Bio-remediation Technologies, Technomic Publishing Co., USA, 1998.
4. C. Ronnecael, Biotechnology for Waste Management and Site Restoration.