M.E. ENVIRONMENTAL MANAGEMENT

OBJECTIVES

- To provide the engineering graduates (all disciplines) with technical expertise in Environmental Management which will enable them to have a career and professional accomplishment in the public or private sector to :

  - develop, implement, monitor and maintain environmental strategies, policies, programmes and systems that promote sustainable development
  - oversee the environmental performance including compliance with environmental legislation across the organisation, and coordinating all aspects of pollution control, waste management, environmental health and conservation
  - lead the implementation of environmental policies and practices and raise awareness, at all levels of an organisation, about the emerging environmental issues

OUTCOME

- By the time of their graduation, the students are expected to be able to :
  - understand the environmental, social and economic framework in which environmental management decisions are made understand the life cycle perspective, systems approach and environmental technologies for converting process, products and service related industrial environmental problems into opportunities to improve performance
  - Anticipate, recognize, evaluate, and control environmental issues in a variety of sectors and industries and liaison with federal, state, and local agencies and officials on issues pertaining to environmental protection
  - recognize, evaluate, and control factors in the workplace and the environment that cause health and environmental hazards and utilize quantitative knowledge and skills and modern tools and technologies to assess, analyze, plan, and implement environmental management systems
  - Obtain, update, and maintain plans, permits, and standard operating procedures.
  - Prepare, review, and update environmental monitoring and assessment Reports and Monitor progress of environmental improvement programs
  - identify, formulate, analyze, and develop management systems and formulate solutions that are technically sound, economically feasible, and socially acceptable.
  - Assess the potential environmental impact of development projects and design mitigation measures
  - audit, analyse and report environmental performance to internal and external clients and regulatory bodies
  - communicate proficiently in writing and speaking for promoting and coordinating public consultations on environmental matters and for negotiating environmental service agreements and managing associated costs and revenues
  - Collaborate with environmental engineers, planners, technicians, and other specialists, and experts in to address environmental problems.
  - find professional level employment or pursue higher studies and pursue research for contributing to the betterment of humanity and in shaping a sustainable society .

Attested

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REGULATIONS - 2013

M.E. ENVIRONMENTAL MANAGEMENT

CURRICULUM AND SYLLABUS I TO IV SEMESTERS (FULL TIME)

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	EM8101	Design of Water and Wastewater Treatment Systems	4	0	0	4
2	EM8102	Environmental Chemistry and Micro Biology	4	0	0	4
3	EM8103	Environmental Policies and Legislation	3	0	0	3
4	EM8104	Principles of Sustainable Development	3	0	0	3
5	EN8151	Solid and Hazardous Waste Management	3	0	0	3
6	MA8161	Statistical Methods For Engineers	3	1	0	4
		TOTAL	**20**	**1**	**0**	**21**

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	EM8201	Ecological Engineering	3	0	0	3
2	EM8202	Environmental Economics	3	0	0	3
3	EM8203	Environmental Quality Monitoring	3	0	1	4
4	EN8252	Industrial Wastewater Pollution - Prevention and Control	3	0	0	3
5		Elective I	3	0	0	3
6		Elective II	3	0	0	3
		TOTAL	**18**	**0**	**1**	**19**

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	EM8301	Environmental Management Systems and Auditing	3	0	0	3
2	EM8351	Environmental Impact and Risk Assessment	3	0	0	3
3		Elective III	3	0	0	3
PRACTICAL						
4	EM8311	Industrial Training (4 weeks)	-	-	-	1
5	EM8312	Project Work (Phase I)	0	0	12	6
6	EM8313	Seminar	0	0	2	1
		TOTAL	**9**	**0**	**14**	**17**

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SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
PRACTICAL						
1	EM8411	Project Work (Phase II)	0	0	24	12
		TOTAL	**0**	**0**	**24**	**12**

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE = 69

ELECTIVES FOR M.E. ENVIRONMENTAL MANAGEMENT

SL. NO.	CODE	COURSE TITLE	L	T	P	C
1	EM8001	Energy Management In Industries	3	0	0	3
2	EM8002	Life Cycle Assessment	3	0	0	3
3	EM8003	Occupational Health and Industrial Safety	3	0	0	3
4	EM8071	Climate Change and Modelling	3	0	0	3
5	EM8072	Marine Pollution and Control	3	0	0	3
6	EM8073	Remote Sensing and GIS Applications in Environmental Management	3	0	0	3
7	EN8071	Air Quality Modelling and Mapping	3	0	0	3
8	EN8072	Landfill Engineering and Remediation Technology	3	0	0	3
9	EN8073	Membrane Separation for Water and Wastewater Treatment	3	0	0	3
10	EN8074	Rural Water Supply and Onsite Sanitation	3	0	0	3
11	EN8075	Water Quality Modelling	3	0	0	3
12	EN8251	Air Pollution Control Engineering	3	0	0	3

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REGULATIONS - 2013

M.E. ENVIRONMENTAL MANAGEMENT

CURRICULUM AND SYLLABUS I TO VI SEMESTERS (PART TIME)

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	MA8161	Statistical Methods For Engineers	3	1	0	4
2	EM8102	Environmental Chemistry and Microbiology	4	0	0	4
3	EM8101	Design of Water and Wastewater Treatment Systems	4	0	0	4
		TOTAL	**11**	**1**	**0**	**12**

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	EN8252	Industrial Wastewater Pollution Prevention and Control	3	0	0	3
2	EM8202	Environmental Economics	3	0	0	3
3	EM8201	Ecological Engineering	3	0	0	3
		TOTAL	**9**	**0**	**0**	**9**

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	EM8103	Environmental Policies and Legislation	3	0	0	3
2	EM8104	Principles of Sustainable Development	3	0	0	3
3	EN8151	Solid and Hazardous Waste Management	3	0	0	3
4	EM8313	Seminar	0	0	2	1
		TOTAL	**9**	**0**	**2**	**10**

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	EM8203	Environmental Quality Monitoring	3	0	1	4
2		Elective I	3	0	0	3
3		Elective II	3	0	0	3
		TOTAL	**9**	**0**	**1**	**10**

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SEMESTER V

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	EM8301	Environmental Management Systems and Auditing	3	0	0	3
2	EM8351	Environmental Impact and Risk Assessment	3	0	0	3
3		Elective III	3	0	0	3
PRACTICAL						
4	EM8312	Project Work (Phase I)	0	0	12	6
5	EM8311	Industrial Training (4 weeks)	-	-	-	1
		TOTAL	**9**	**0**	**12**	**16**

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
PRACTICAL						
1	EM8411	Project Work (Phase II)	0	0	24	12
		TOTAL	**0**	**0**	**24**	**12**

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE = 69

ELECTIVES FOR M.E. ENVIRONMENTAL MANAGEMENT

SL. NO.	CODE	COURSE TITLE	L	T	P	C
1	EM8001	Energy Management In Industries	3	0	0	3
2	EM8002	Life Cycle Assessment	3	0	0	3
3	EM8003	Occupational Health and Industrial Safety	3	0	0	3
4	EM8071	Climate Change and Modelling	3	0	0	3
5	EM8072	Marine Pollution and Control	3	0	0	3
6	EM8073	Remote Sensing and GIS Applications in Environmental Management	3	0	0	3
7	EN8071	Air Quality Modelling and Mapping	3	0	0	3
8	EN8072	Landfill Engineering and Remediation Technology	3	0	0	3
9	EN8073	Membrane Separation for Water and Wastewater Treatment	3	0	0	3
10	EN8074	Rural Water Supply and Onsite Sanitation	3	0	0	3
11	EN8075	Water Quality Modelling	3	0	0	3
12	EN8251	Air Pollution Control Engineering	3	0	0	3

Attested

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EM8101 DESIGN OF WATER AND WASTEWATER TREATMENT SYSTEMS L T P C
4 0 0 4

OBJECTIVES:

- To educate the students on the principles and process designs of various treatment systems for water and wastewater.
- Develop an understanding of the characteristics of water and wastewater that must be considered during design of a treatment plant.
- Students will gain competency in the iterative process employed in design of treatment systems and the components comprising such systems, leading to the selection of specific process equipment items.

UNIT I PRINCIPLES OF TREATMENT 15

Pollutants in water and wastewater – characteristics, standards for performance, treatment processes – Selection criteria-types of reactor- kinetics – physical treatment principles - screening, skimming, floatation – mixing, equalization, sedimentation, filtration – gas transfer – adsorption – Isotherms – membrane separation, electrodialysis – stripping -principles of chemical treatment – neutralisation - coagulation flocculation – precipitation – stabilization – disinfection, Ion exchange – advanced oxidation /reduction – principles of biological treatment – aerobic and anaerobic treatment - kinetics of biological growth – attached and suspended growth.

UNIT II DESIGN OF WATER TREATMENT PLANTS 12

Design of treatment plant units – selection of process - upgrading existing plants – ultimate residue disposal - aerators – chemical feeding – flocculator – clarifier – filters – rapid sand filters, pressure filter, dual media filters – disinfectors- design of softeners – demineralisers –reverse osmosis plants – process flow chart Layout and Hydraulic profiles for treatment plants.

UNIT III DESIGN OF WASTEWATER TREATMENT PLANTS 15

Design of treatment units - screens- grit chamber - settling tanks - design of aerobic treatment systems - activated sludge process and variations, sequencing batch reactors, membrane biological reactors-trickling filters-Bio Tower-RBC-Moving Bed Reactors- aerated lagoons – natural treatment systems, waste stabilization ponds, constructed wet land – Disinfection – reclamation and reuse – recent trends – Design of anaerobic treatment system - UASB, up flow filters, septic tanks – Nutrient removal systems - process flow chart Layout and Hydraulic profiles for treatment plants.

UNIT IV RESIDUAL MANAGEMENT 8

Design of sludge management facilities, sludge thickening, sludge digestion, biogas generation, sludge dewatering (mechanical and gravity) - sludge drying beds - Layout hydraulics profile PID.

UNIT V CONSTRUCTION OPERATION AND MAINTENANCE ASPECTS 10

Construction, Operation and Maintenance aspects – Trouble shooting – Planning, Organising and controlling of plant operations – capacity building, case studies of Retrofitting.

TOTAL: 60 PERIODS

OUTCOMES:

- Develop conceptual schematics required for the treatment of water and wastewater.
- Ability to identify and formulate engineering problems.
- Ability to design and conduct experiments and interpret generated data as necessary to obtain process performance data.

REFERENCES:

1. Metcalf and Eddy, "Wastewater Engineering", Treatment and Reuse, Tata McGraw Hill, New Delhi, 2003.
2. Qasim, S.R., Motley, E.M. and Zhu.G. "Water works Engineering – Planning, Design and Operation", Prentice Hall, New Delhi, 2002.

3. Manual on “Sewerage and Sewage Treatment” CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 1993.
4. Qasim, S.R. "Wastewater Treatment Plant, Planning, Design & Operation", Technomic Publications, New York, 1994.
5. Manual on Water Supply and Treatment, CPHEEO, Govt. of India, New Delhi (2003).

EM8102 ENVIRONMENTAL CHEMISTRY AND MICROBIOLOGY L T P C
4 0 0 4

OBJECTIVE:

- To impart knowledge on the relevance and applications of environmental chemistry and microbiology in managing environmental problems

UNIT I AQUATIC CHEMISTRY 12

Stoichiometry and mass balance-Chemical equilibria, acid base, solubility product(Ksp), Chemical kinetics , Fate of chemicals and typical pollutants in aquatic environment, -Characteristics of water pollution, volatilization, coagulation, partitioning, hydrolysis, photochemical transformation– Degradation of synthetic chemicals-Metals, complex formation, oxidation and reduction

UNIT II ATMOSPHERIC AND SOIL CHEMISTRY 12

Atmospheric structure –-chemical and photochemical reactions – photochemical smog. Ozone layer depletion – greenhouse gases and global warming, Acid rain- origin and composition of particulates, Nature and composition of soil-Clays- ion-exchange reactions in soil – Agricultural chemicals in soil, Heavy metals-Chemical speciation and their Toxicity- Nano materials, CNT, titania, composites,

UNIT III CLASSIFICATION AND CHARACTERISTICS OF MICROORGANISMS 12

Classification and Distribution of microorganisms - Biogeochemical cycles – Role of Micro Organism in nutrient cycle-Nutrition and metabolism in microorganisms, growth phases, carbohydrate, protein, lipid metabolism – respiration, aerobic and anaerobic-fermentation, glycolysis, Kreb’s cycle, hexose monophosphate pathway, electron transport system, oxidative phosphorylation, environmental factors, enzymes, Bioenergetics

UNIT IV PATHOGENS IN WASTEWATER 12

Water Borne pathogens and their effects, Transmission of pathogens, Indicator organisms of water – Coliforms - total coliforms, E-coli, Streptococcus, Clostridium, Concentration and detection of virus.
Factors influencing toxicity. Effects – acute, chronic, Test organisms – toxicity testing, Bioconcentration – Bioaccumulation, biomagnification, bioassay, biomonitoring, bioleaching.- Emerging Contaminants

UNIT V APPLICATIONS 12

Chemical process and their applications in water and wastewater treatment-Microbiology of biological treatment processes – aerobic and anaerobic, Nutrients Removal – BOD, Nitrogen, Phosphate. nitrification and denitrification, eutrophication

TOTAL: 60 PERIODS

OUTCOME

- Students will gain competency and understanding of the significance of chemical and biological reactions in environmental problems and solutions.

REFERENCES:

1. Sawyer,C.N., MacCarty, P.L. and Parkin, G.F., "Chemistry for Environmental Engineering and Science", Tata McGraw – Hill, Fifth edition, New Delhi 2003.
2. Colin Baird and Michael Cann ‘Environmental Chemistry’, Freeman and company, New York, 2012.

3. Manahan, S.E., "Environmental Chemistry", 8th Edition, CRC press, 2005.
4. S.C.Bhatia, Hand Book of Environmental Microbiology, Part 1 and 2, Atlantic Publisher
5. Gabriel Bitton, "Wastewater Microbiology", 2nd Edition ,
6. Raina M. Maier, Ian L. Pepper, Charles P. Gerba, "Environmental Microbiology", Academic Press.
7. S C Baatia., 'Handbook of Microbiology', vol.1, Atlantic Publications., 2007

EM8103 ENVIRONMENTAL POLICIES AND LEGISLATION L T P C
3 0 0 3

OBJECTIVE:

- To impart knowledge on the policies, legislations, institutional frame work and enforcement mechanisms for environmental management in India.

UNIT I INTRODUCTION 9

Indian Constitution and Environmental Protection – National Environmental policies – Precautionary Principle and Polluter Pays Principle – Concept of absolute liability – multilateral environmental agreements and Protocols – Montreal Protocol, Kyoto agreement, Rio declaration – Environmental Protection Act, Water (P&CP) Act, Air (P&CP) Act – Institutional framework (SPCB/CPCB/MoEF)

UNIT II WATER (P&CP) ACT, 1974 8

Power & functions of regulatory agencies - responsibilities of Occupier Provision relating to prevention and control Scheme of Consent to establish, Consent to operate – Conditions of the consents – Outlet – Legal sampling procedures, State Water Laboratory – Appellate Authority – Penalties for violation of consent conditions etc. Provisions for closure/directions in apprehended pollution situation.

UNIT III AIR (P&CP) ACT, 1981 8

Power & functions of regulatory agencies - responsibilities of Occupier Provision relating to prevention and control Scheme of Consent to establish, Consent to operate – Conditions of the consents – Outlet – Legal sampling procedures, State Air Laboratory – Appellate Authority – Penalties for violation of consent conditions etc. Provisions for closure/directions in apprehended pollution situation.

UNIT IV ENVIRONMENT (PROTECTION) ACT 1986 13

Genesis of the Act – delegation of powers – Role of Central Government - EIA Notification – Sitting of Industries – Coastal Zone Regulation - Responsibilities of local bodies mitigation scheme etc., for Municipal Solid Waste Management - Responsibilities of Pollution Control Boards under Hazardous Waste rules and that of occupier, authorisation – Biomedical waste rules – responsibilities of generators and role of Pollution Control Boards

UNIT V OTHER TOPICS 7

Relevant Provisions of Indian Forest Act, Public Liability Insurance Act, CrPC, IPC -Public Interest Litigation - Writ petitions - Supreme Court Judgments in Landmark cases.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course the students will have

- the knowledge on the National environmental legislations and the policies
- be able to plan programmes to comply with the legal requirements related to organizations

REFERENCES:

1. CPCB "Pollution Control acts, Rules and Notifications issued there under "Pollution Control Series – PCL/2/1992, Central Pollution Control Board, Delhi, 1997.

2. Shyam Divan and Armin Roseneranz “Environmental law and policy in India “Oxford University Press, New Delhi, 2001.
3. Greger I.Megregor “Environmental law and enforcement”, Lewis Publishers, London. 1994.

EM8104 PRINCIPLES OF SUSTAINABLE DEVELOPMENT L T P C
3 0 0 3

OBJECTIVE:

- To understand the environmental, social and economic dimensions of sustainability and the principles evolved through landmark events so as to develop an action mindset for sustainable development.

UNIT I SUSTAINABILITY AND DEVELOPMENT CHALLEGES 9

Definition of sustainability – Environmental, Economical and Social dimensions of sustainability - Sustainable Development Models – Strong and Weak Sustainability – Defining Development- Millennium Development Goals – Mindsets for Sustainability : Earthly, Analytical, Precautionery, Action and Collaborative– Syndromes of Global Change: Utilisation Syndromes, Development Syndromes, and Sink Syndromes – Core problems and Cross Cutting Issues of the 21 Century - Global, Regional and Local environmental issues – Social insecurity - Resource Degradation – Climate Change – Desertification

UNIT II PRINCIPLES AND FRAME WORK 9

History and emergence of the concept of sustainable development - Our Common Future - Stockholm to Rio plus 20– Rio Principles of Sustainable Development – Precautionary Principle- Polluter Pays Principle – Role of Civil Society, Business and Government -Natural Step- Peoples Earth Charter – Business Charter for Sustainable Development –UN Global Compact – Agenda 21

UNIT III SUSTAINABILE LIVELI HOOD 9

The Unjust World and inequities - Quality of Life - Poverty, Population and Pollution - Combating Poverty -Millennium Development Goals, Indicators, Targets, Status and intervention areas - Demographic dynamics of sustainability - Strategies to end Rural and Urban Poverty and Hunger – Sustainable Livelihood Framework- Health, Education and Empowerment of Women, Children, Youth, Indigenous People, Non-Governmental Organizations, Local Authorities and Industry for Prevention, Precaution , Preservation and Public participation.

UNIT IV SUSTAINABLE SOCIO-ECONOMIC SYSTEMS 10

Protecting and Promoting Human Health – Investing in Natural Capital- Agriculture, Forests, Fisheries - Food security and nutrition and sustainable agriculture- Water and sanitation - Biodiversity conservation and Ecosystem integrity –Ecotourism - Urbanization and Sustainable Cities – Sustainable Habitats- Green Buildings - Sustainable Transportation – Sustainable Consumption and Production – Sustainable Mining - Sustainable Energy– Climate Change –Mitigation and Adaptation - Safeguarding Marine Resources - Financial Resources and Mechanisms

UNIT- V ASSESSING PROGRESS AND WAY FORWARD 8

Sustainability in global, regional and national context – Rio Plus 20 - Measuring Sustainability – limitations of GDP- Ecological Footprint- Human Development Index- Human Development Report – National initiatives for Sustainable Development -Hurdles to Sustainability - Operational guidelines –- Science and Technology for sustainable development –Performance indicators of sustainability and Assessment mechanism – Inclusive Green Growth and Green Economy – National Sustainable Development Strategy Planning – Governance - Science and Technology- Sustainability Education

TOTAL: 45 PERIODS

OUTCOMES:

A student completing the course is expected to

- Develop a fair understanding of the social, economic and ecological linkage of human production and consumption
- Learn to integrate the Rio principles of Sustainable development in decision making and Contribute towards Green Economy

REFERENCES:

1. Sayer, J. and Campbell, B., The Science of Sustainable Development : Local Livelihoods and the Global Environment (Biological Conservation, Restoration &Sustainability), Cambridge University Press, London, 2003.
2. Kirkby, J., O'Keefe, P. and Timberlake, Sustainable Development, Earthscan Publication, London, 1993.
3. MoEF (2012), " Sustainable Development in India –stocktaking in the Run up to Rio plus 20", Ministryof environment and forests, Government of India, New Delhi.
4. United Nations. 2001. Indicators of Sustainable Development: Guidelines and Methodologies. New York: United Nations.
5. UNEP, 2011, Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication, www.unep.org/greeneconomy, ISBN: 978-92-807-3143-9
6. World Bank (2012), "Inclusive Green Growth – The pathway to Sustainable development, World Bank- Washington DC

EN8151 SOLID AND HAZARDOUS WASTE MANAGEMENT L T P C
3 0 0 3

OBJECTIVE:

- To impart knowledge and skills in the collection, storage, transport, treatment, disposal and recycling options for solid wastes including the related engineering principles, design criteria, methods and equipments.

UNIT I SOURCES, CLASSIFICATION AND REGULATORY FRAMEWORK 9

Types and Sources of solid and hazardous wastes - Need for solid and hazardous waste management –- Salient features of Indian legislations on management and handling of municipal solid wastes, hazardous wastes, biomedical wastes, nuclear wastes - lead acid batteries, electronic wastes , plastics and fly ash – Elements of integrated waste management and roles of stakeholders - Financing and Public Private Participation for waste management.

UNIT II WASTE CHARACTERIZATION AND SOURCE REDUCTION 8

Waste generation rates and variation - Composition, physical, chemical and biological properties of solid wastes – Hazardous Characteristics – TCLP tests – waste sampling and characterization plan - Source reduction of wastes –Waste exchange - Extended producer responsibility - Recycling and reuse

UNIT III STORAGE, COLLECTION AND TRANSPORT OF WASTES 9

Handling and segregation of wastes at source – storage and collection of municipal solid wastes – Analysis of Collection systems - Need for transfer and transport – Transfer stations Optimizing waste allocation– compatibility, storage, labeling and handling of hazardous wastes – hazardous waste manifests and transport

UNIT IV WASTE PROCESSING TECHNOLOGIES 10

Objectives of waste processing – material separation and processing technologies – biological and chemical conversion technologies – methods and controls of Composting - thermal conversion technologies and energy recovery – incineration – solidification and stabilization of hazardous wastes

- treatment of biomedical wastes - Health considerations in the context of operation of facilities, handling of materials and impact of outputs on the environment-

UNIT V WASTE DISPOSAL 9

Waste disposal options – Disposal in landfills - Landfill Classification, types and methods – site selection - design and operation of sanitary landfills, secure landfills and landfill bioreactors – leachate and landfill gas management – landfill closure and environmental monitoring – Rehabilitation of open dumps – landfill remediation

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the student is expected to be able to

- Understand the characteristics of different types of solid and hazardous wastes and the factors affecting variation
- Define and explain important concepts in the field of solid waste management and suggest suitable technical solutions for treatment of municipal and industrial waste
- Understand the role legislation and policy drivers play in stakeholders' response to the waste and apply the basic scientific principles for solving practical waste management challenges

REFERENCES:

1. George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, "Integrated Solid Waste Management, Mc-Graw Hill International edition, New York, 1993.
2. Michael D. LaGrega, Philip L Buckingham, Jeffrey C. E vans and Environmental Resources Management, Hazardous waste Management, Mc-Graw Hill International edition, New York, 2001.
3. CPHEEO, "Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organisation , Government of India, New Delhi, 2000.
4. Vesilind P.A., Worrell W and Reinhart, Solid waste Engineering, Thomson Learning Inc., Singapore, 2002.

5 Paul T Williams, Waste Treatment and Disposal, Wiley, 2005

MA8161 STATISTICAL METHODS FOR ENGINEERS L T P C

3 1 0 4

OBJECTIVE:

- To study and understand the concepts of Statistical methods and its applications in Engineering. To study the effect of estimation theory, testing of hypothesis, correlation and regression, randomized design, and multivariate analysis.

UNIT I ESTIMATION THEORY 9+3

Estimators: Unbiasedness, Consistency, Efficiency and Sufficiency – Maximum Likelihood Estimation – Method of moments.

UNIT II TESTING OF HYPOTHESIS 9+3

Tests based on Normal, t, X^2 and F distributions for testing of means, variance and proportions – Analysis of r x c tables – Goodness of fit.

UNIT III CORRELATION AND REGRESSION 9+3

Multiple and Partial Correlation – Method of Least Squares – Plane of Regression – Properties of Residuals – Coefficient of multiple correlation – Coefficient of partial correlation – Multiple correlation with total and partial correlations – Regression and Partial correlations in terms of lower order co-efficient.

UNIT IV DESIGN OF EXPERIMENTS 9+3

Analysis of variance – One-way and two-way classifications – Completely randomized design – Randomized block design – Latin square design.

UNIT V MULTIVARIATE ANALYSIS 3

Random vectors and Matrices – Mean vectors and Covariance matrices – Multivariate Normal density and its properties – Principal components: Population principal components – Principal components from standardized variables.

L: 45 + T : 15 TOTAL : 60 PERIODS

OUTCOME:

- On completion of this course the students will be able to solve various problems in the field of engineering employing probability and statistical methods.

REFERENCES:

1. Gupta.S.C., and Kapoor, V.K., "Fundamentals of Mathematical Statistics", Sultan Chand and Sons, Eleventh Edition, 2002
2. J.E. Freund, Mathematical Statistical", 5th Edition, Prentice Hall of India, 2001.
3. Jay L.Devore, "Probability and statistics for Engineering and the Sciences", 5th Edition, Thomson and Duxbury, Singapore, 2002
4. Murray.R. SpiegelandLarry J.Stephens, "Schaum'sou Tlines- Statistics", Third Edition, Tata McGraw-Hill, 2000
5. R.A.Johnson and C.B.Gupta, "Miller & Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 7th Edition, 2007
6. Richard A.Johnson and Dean W.Wichern, "Applied Multivariate Statistical Analysis", Pearson Education, Asia, 6th Edition, 2007

EM8201 ECOLOGICAL ENGINEERING L T P C
3 0 0 3

OBJECTIVE:

- To impart knowledge on the principles of ecological engineering that strengthen the functions of ecosystems, restore devastated ecosystems, and utilize the functions of ecosystems to develop ecological engineering designs for environmental management.

UNIT I ECOSYSTEMS & ECOTECHNOLOGY 10

Aim, scope and applications of ecology – Development and evolution of ecosystems – Principles and concepts pertaining to communities in ecosystem – Energy flow and material cycling in ecosystems – productivity in ecosystems.

UNIT II SYSTEMS APPROACH IN ECOLOGICAL ENGINEERING 10

Principles, components and characteristics of systems – Classification of systems – Structural and functional interactions of environmental systems – Environmental systems as energy systems – Mechanisms of steady-state maintenance in open and closed systems – Modelling and ecotechnology – Elements modeling – Modelling procedure – Classification of ecological model s- Applications of models in ecotechnology – Ecological economics.

UNIT III ECOLOGICAL ENGINEERING PROCESSES 8

Self-organizing design and processes – Multi seeded microcosms – Interface coupling in ecological systems – Concept of energy – Determination of sustainable loading of ecosystems.

UNIT IV ECOTECHNOLOGY FOR WASTE TREATMENT 12

Ecological engineering and ecotechnology – Classification of ecotechnology – Principles of ecological engineering. Ecosanitation-Principles and operation of soil infiltration systems – Wetlands and ponds – source separation systems – Aquacultural systems – Agro ecosystems – Detritus based treatment for solid wastes – Applications of ecological engineering for marine systems.

UNIT V CASE STUDIES 5

Case studies of Integrated Ecological Engineering Systems and their commercial prospects.

REFERENCES:

1. Jorgensen, S.E. Ecological Engineering: Principles and Practice. CRC Press, 2003
2. Mitsch, W.J. Ecological Engineering and Ecosystem Restoration, Wiley 2nd Ed., 2003
3. White I.D., Mottershed, D.N. and Harisson, S.J. Environmental systems – An Introductory text, Chapman Hall, London, 1994
4. Mitsch, J.W. and Jorgensen, S.E. Ecological Engineering – An Introduction to Ecotechnology, John Wiley & Sons, New York, 1989.

EM8202 ENVIRONMENTAL ECONOMICS L T P C
3 0 0 3

OBJECTIVES:

- To provide a sufficient understanding of economic thinking so as to critically evaluate environmental issues and provide policy recommendations to improve related problems
- To apply the basic economic theory to issues involving the joint interaction of economic activity,the environment, and use of natural resources including valuing environment to introduce market based instruments and economic policies for environmental management..

UNITI INTRODUCTION TO ECONOMICS 10

Principles of Economics – Economics, Ecology and Ethics - Wealth, Welfare, Scarcity, Growth and Sustainability definitions -– Concepts of Costs, Benefits, Opportunity costs , Social Costs –Marginal Costs and Marginal Benefits - Positive and Normative criteria for decision making - Consumer Choice theory –Supply and Demand– Economic Efficiency and Markets–Static and dynamic efficiency - market failures – property rights, externalities and environmental problems – Coase Theorem - Public Goods and Externalities - Free rider problem – Tragedy of the commons

UNITII VALUATION OF ENVIRONMENTAL COSTS AND BENEFITS 9

Types of Economic value - Environmental Benefits and Environmental Costs - Valuing the Environment – Direct and indirect methods – Surrogate markets – Stated Preference and Revealed Preference methods- hedonic prices, travel cost models, contingent valuation, benefit transfer – economic valuation of ecosystem services- Assessment of Loss of Ecology - Valuation of Health impacts - Environmental accounting

UNITIII ECONOMICS OF POLLUTION PREVENTION 9

Economics of Environmental Quality- - Cost benefit analysis and Cost effectiveness analysis – Principles, methodology and Limitations – Discounting - Profitability of Pollution Prevention - Pay back period – Present value estimation – Internal rate of return – Opportunity costs – Economic analysis of Pollution Prevention Case studies –economically efficient pollution control programmes – Economics of Enforcement - Efficient allocation of pollution from mobile and stationery source – Total Cost Assessment- Life cycle costing-Green Accounting and Economic indicators -

UNIT IV ECONOMIC INSTRUMENTS FOR ENVIIRONMENTAL PROTECTION 9

Point vs. Nonpoint Sources - Stock vs. Fund Pollutants - Nature of Marginal abatement cost and that of Marginal damage cost -Efficient level of pollution, total cost of efficient level of pollution - Polluter pays Principle –Economic Optimum level of Pollution- Marginal Damage Functions – Marginal Abatement Costs - Allocation of Stock and Fund Pollutants - Economic analysis of Environmental Policy -Regulatory versus Economic Instruments – Decentralized Policies: Liability Laws, Property Rights,and Moral Suasion - Command-and-Control Strategies - Pigovian and Pollution Taxes – Incentive-Based Strategies: Emission Charges and Subsidies– Marketable permits – Emission trading -– Non Compliance fees, bonds and deposit refunds –Evaluation of Instruments – Choice of instruments for Environmental policy

UNIT V NATURAL RESOURCE ECONOMICS 8

Types, scarcity and classification of Natural Resources – Depletable and non renewable resources – Recyclable resources – Replenishable but depletable resources – Storable renewable resources – Renewable common property Resources– Economic Theory of Depletable Resources- Optimal Use of Exhaustible Resources- – Natural resources accounting - Economics of Forestry and fisheries exploitation –Trade and environment – Income Effects and Environmental Kuznets Curves – Race to the Bottom and Pollution Haven Hypothesis - Porter Hypothesis - Economics of Climate Change

TOTAL: 45 PERIODS

OUTCOMES :

A student completing the course is expected to be able to

- understand concepts of willingness to pay, public goods, property rights, market and non-market valuation techniques
- explain why optimal pollution levels, suggest policies within the cost benefit analysis framework
- have a good appreciation of the economics of exhaustible resources and renewable resources

REFERENCES:

1. Barry Field and Martha Field, Environmental Economics: An Introduction, McGraw-Hill
2. Kolstad, Charles, (2011),"Environmental Economics", Oxford University Press, New York
3. John Asafu Adjaye, "Environmental Economics for non-Economists – techniques and policies for Sustainable Development, World Scientific,2005
4. Tom Tietenberg, "Environmental and Natural Resource Economics', 5th Edition, Harper Collins College Publishers, 2000.
5. Nick Hanley, Jaison F. Shogren and Ben White "Environmental Economics" – In theory and practice" Macmillan India Ltd, New Delhi. 1999,
6. Perman R, Y. Ma, J. McGilvray and M. Common, Natural Resource and Environmental Economics, 3rd edition, Pearson Education, Harlow (2003).

EM8203 ENVIRONMENTAL QUALITY MONITORING L T P C
3 0 1 4

OBJECTIVE:

- To educate the students on the various instrumental methods of monitoring the quality of air, water and soil.

UNIT I INTRODUCTION 9

Wet Chemistry methods and their limitations-Instrumental Methods, Selection of method- Precision and Accuracy, Error in measuring signals- Quality control & assurance- Sample preservation, Sample preparation and analyte isolation.

Attested

DIRECTOR
Centre For Academic Courses
Anna University, Chennai-600 025.

UNIT II SPECTROSCOPIC METHODS 12

Principles, techniques and applications of spectrophotometry, fluorimetry, nephelometry and turbidimetry, Atomic Absorption Spectrometry (Flame, graphite furnace , cold vapour and hydride generation), Atomic Emission Spectrometry (AES) , flame and Inducted Coupled Plasma (ICP) – TOC Analyzer

UNIT III CHROMATROGRAPHIC METHODS 8

Principles, techniques and applications of GC, GC-MS, High performance liquid chromatography (HPLC) and Ion chromatograph (IC)-Hyphenated techniques for Environmental contaminant(trace organics) analysis.

UNIT IV ELECTRO AND RADIO ANALYTICAL METHODS 8

Principles, techniques and applications of Conductometry, potentiometry, coulometry, AOX analyzer Amperometry, polarography, Neutron Activation Analysis (NAA), X-ray Fluorescence (XRF) and X-ray Diffraction (XRD) methods.

UNIT V CONTINUOUS MONITORING INSTRUMENTS 8

Principles, techniques and applications of NDIR analyzer for CO, chemiluminescent analyzer for NOx Fluorescent analyzer for SO_2- Particulates analysis- Auto analyzer for water quality using flow injection analysis.

UNIT VI LABORATORY DEMONSTRATION OF SPECTROSCOPIC INSTRUMENTS 15

TOTAL: 60 PERIODS

OUTCOMES:

- Understand the principle and the components and its function of instruments
- Able to select appropriate instrumental method for chemical analysis

REFERENCES:

1. Willard H. Merritt, L. Dean, D.A. and Settle, F.A. 'Instrumental methods of analysis Edn. Words Worth, New York, 2004.
2. Paul R. Loconto Trace Environmental Quantitative Analysis: Principles, Techniques, and Applications**,** Marcel Dekker; 1 edition (May 2001),
3. Ewing Instrumental Methods of Chemical Analysis, 5th Edition, McGraw Hill, New York.1985
4. Reeve, R.N., "Introduction to Environmental Analysis", Analytical Techniques in the Sciences, John Wiley & Sons, Chichester, UK, 2002.
5. Barceló, D.(editor), "Environmental analysis. Techniques, Applications and Quality Assurance", Elsevier, The Netherlands, 1996

EN8252 INDUSTRIAL WASTEWATER POLLUTION PREVENTION AND CONTROL L T P C

3 0 0 3

OBJECTIVES:

- To impart knowledge on the concept and application of Industrial pollution prevention, technologies, industrial wastewater treatment and residue management.
- Understand principles of various processes applicable to industrial wastewater treatment
- Identify the best applicable technologies for wastewater treatment from the perspective of yield production.

UNIT I INTRODUCTION 8

Industrial scenario in India– Industrial activity and Environment - Uses of Water by industry – Sources and types of industrial wastewater – Nature and Origin of Pollutants - Industrial wastewater and environmental impacts – Regulatory requirements for treatment of industrial wastewater – Industrial waste survey – Industrial wastewater monitoring and sampling -generation rates, characterization and

variables –Toxicity of industrial effluents and Bioassay tests – Major issues on water quality management

UNIT II INDUSTRIAL POLLUTION PREVENTION AND WASTE MINIMISATION 6

Prevention and Control of Industrial Pollution – Benefits and Barriers – Waste management Hierarchy - Source reduction techniques – Periodic Waste Minimization Assessments – Evaluation of Pollution Prevention Options – Cost benefit analysis – Pay-back period – Implementing and Promoting Pollution Prevention Programs in Industries.

UNIT III INDUSTRIAL WASTEWATER TREATMENT 12

Flow and Load Equalisation – Solids Separation – Removal of Fats, Oil and Grease- Neutralisation – Removal of Inorganic Constituents – Precipitation, Heavy metal removal , Nitrogen and Phosphorous removal, Ion exchange, Adsorption, Membrane Filtration, Eletrodialysis and Evaporation – Removal of Organic Constituents – Biological treatment Processes - Chemical Oxidation Processes - Advanced Oxidation processes – Treatability Studies.

UNIT IV WASTEWATER REUSE AND RESIDUAL MANAGEMENT 9

Individual and Common Effluent Treatment Plants – Joint treatment of industrial and domestic wastewater - Zero effluent discharge systems - Quality requirements for Wastewater reuse – Industrial reuse , Present status and issues - Disposal on water and land – Residuals of industrial wastewater treatment – Quantification and characteristics of Sludge – Thickening, digestion, conditioning, dewatering and disposal of sludge – Management of RO rejects.

UNIT V CASE STUDIES 10

Industrial manufacturing process description, wastewater characteristics, source reduction options and waste treatment flow sheet for Textiles – Tanneries – Pulp and paper – metal finishing – Oil Refining – Pharmaceuticals – Sugar and Distilleries

TOTAL: 45 PERIODS

OUTCOMES :

After completion of this course, the students is expected to be able to,

- Define the Principles of pollution prevention and mechanism of oxidation processes.
- Suggest the suitable technologies for the treatment of wastewater.
- Discuss about the wastewater characteristics
- Design the treatment systems

REFERENCES:

1. Industrial wastewater management, treatment & disposal, Water Environment Federation Alexandria Virginia, Third Edition, 2008.
2. Lawrance K.Wang, Yung . Tse Hung, Howard H.Lo and Constantine Yapijakis, " handlook of Industrial and Hazardous waste Treatment", Second Edition, 2004.
3. Metcalf & Eddy/ AECOM, water reuse Issues, Technologies and Applications, The Mc Graw- Hill companies, 2007.
4. Nelson Leonard Nemerow, " Industrial waste Treatment - contemporary practice and vision for the future", Elsevier, Singapore, 2007.
5. W.Wesley Eckenfelder, " Industrial Water Pollution Control", Second Edition, Mc Graw Hill, 1989.
6. Paul L. Bishop, 'Pollution Prevention: - Fundamentals and Practice', Mc-Graw Hill International, Boston, 2000.

EM8301 ENVIRONMENTAL MANAGEMENT SYSTEMS AND AUDITING L T P C
3 0 0 3

OBJECTIVE:

- To impart an understanding of systems approach to Environmental Management as per ISO 14001 and skills for environmental performance in terms of legal compliance, pollution prevention and continual improvement.

UNIT I ENVIRONMENTAL MANAGEMENT STANDARDS 9

Unique Characteristics of Environmental Problems - Systems approach to Corporate environmental management - Classification of Environmental Impact Reduction Efforts -Business Charter for Sustainable Production and Consumption – Tools, Business strategy drivers and Barriers - Evolution of Environmental Stewardship – Environmental Management Principles - National policies on environment, abatement of pollution and conservation of resources - Charter on Corporate responsibility for Environmental protection - Environmental quality objectives – Rationale of Environmental standards: Concentration and Mass standards, Effluent and stream standards, Emission and ambient standards, Minimum national standards, environmental performance evaluation: Indicators, benchmarking

UNIT II PREVENTIVE ENVIRONMENTAL MANAGEMENT 9

Pollution control Vs Pollution Prevention - Opportunities and Barriers – Cleaner production and Clean technology, closing the loops, zero discharge technologies – Four Stages and nine approaches of Pollution Prevention - Getting management commitment – Analysis of Process Steps- source reduction, raw material substitution, toxic use reduction and elimination, process modification – Material balance – Technical, economical and environmental feasibility evaluation of Pollution Prevention options in selected industries –Preventive Environmental Management over Product cycle.

UNIT III ENVIRONMENTAL MANAGEMENT SYSTEM 10

EMAS, ISO 14000 - EMS as per ISO 14001– benefits and barriers of EMS – Concept of continual improvement and pollution prevention - environmental policy – initial environmental review – environmental aspect and impact analysis – legal and other requirements- objectives and targets – environmental management programs – structure and responsibility – training awareness and competence- communication – documentation and document control – operational control – monitoring and measurement – management review.

UNIT IV ENVIRONMENTAL AUDIT 8

Environmental management system audits as per ISO 19011- – Roles and qualifications of auditors - Environmental performance indicators and their evaluation – Non conformance – Corrective and preventive actions -compliance audits – waste audits and waste minimization planning – Environmental statement (form V) - Due diligence audit

UNIT V APPLICATIONS 9

Applications of EMS , Waste Audits and Pollution Prevention opportunities in Textile , Sugar, Pulp & Paper, Electroplating, , Tanning industry, Dairy, Cement, Chemical industries, etc

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the student is expected to be able to

- Appreciate the elements of Corporate Environmental Management sytems complying to international environmental management system standards
- Lead pollution prevention assessment team and implement waste minimization options
- Develop, Implement, maintain and Audit Environmental Management systems for Organisations

REFERENCES:

1. Christopher Sheldon and Mark Yoxon, “Installing Environmental management Systems – a step by step guide” Earthscan Publications Ltd, London, 1999.
2. ISO 14001/14004: Environmental management systems – Requirements and Guidelines – International Organisation for Standardisation, 2004
3. ISO 19011: 2002, “Guidelines for quality and/or Environmental Management System auditing, Bureau of Indian Standards, New Delhi, 2002
4. Paul L Bishop ‘Pollution Prevention: Fundamentals and Practice’, McGraw- Hill International, Boston,2000.
5. Environmental Management Systems: An Implementation Guide for Small and Medium-Sized Organizations, Second Edition, NSF International, Ann Arbor, Michigan, January 2001.

EM8351 ENVIRONMENTAL IMPACT AND RISK ASSESSMENT L T P C
3 0 0 3

OBJECTIVE:

- To expose the students to the need, methodology, documentation and usefulness of environmental impact assessment and to develop the skill to prepare environmental management plan.
- To provide knowledge related to the broad field of environmental risk assessment, important processes that control contaminant transport and tools that can be used in predicting and managing human health risks.

UNIT I INTRODUCTION 8

Historical development of Environmental Impact Assessment (EIA). EIA in Project Cycle. Legal and Regulatory aspects in India. – Types and limitations of EIA –.EIA process- screening – scoping - setting – analysis – mitigation. Cross sectoral issues and terms of reference in EIA – Public Participation in EIA

UNIT II IMPACT INDENTIFICATION AND PREDICTION 10

Matrices – Networks – Checklists –Cost benefit analysis – Analysis of alternatives – Software packages for EIA – Expert systems in EIA. Prediction tools for EIA – Mathematical modeling for impact prediction – Assessment of impacts – air – water – soil – noise – biological –– Cumulative Impact Assessment –

UNIT III SOCIAL IMPACT ASSESSMENT AND EIA DOCUMENTATION 8

Social impact assessment - Relationship between social impacts and change in community and institutional arrangements. Individual and family level impacts. Communities in transition Documentation of EIA findings – planning – organization of information and visual display materials – Report preparation.

UNIT IV ENVIRONMENTAL MANAGEMENT PLAN 7

Environmental Management Plan - preparation, implementation and review – Mitigation and Rehabilitation Plans – Policy and guidelines for planning and monitoring programmes – Post project audit – Ethical and Quality aspects of Environmental Impact Assessment- Case Studies

UNIT V ENVIRONMENTAL RISK ASSESSMENT AND MANAGEMENT 12

Environmental risk assessment framework-Hazard identification -Dose Response Evaluation – Exposure Assessment – Exposure Factors, Tools for Environmental Risk Assessment– HAZOP and FEMA methods – Event tree and fault tree analysis – Multimedia and multipathway exposure modeling of contaminant- Risk Characterization Risk communication - Emergency Preparedness Plans –Design of risk management programs-

TOTAL: 45 PERIODS

OUTCOMES:

- After the completion of course, the student will be able to understand the necessity to study the impacts and risks that will be caused by projects or industries and the methods to overcome these impacts.
- The student will also know about the legal requirements of Environmental and Risk Assessment for projects.

REFERENCES:

1. Canter, L.W., Environmental Impact Assessment, McGraw Hill, New York. 1996
2. Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrent problems, Wiley-Interscience, New Jersey. 2003
3. World Bank –Source book on EIA
4. Cutter, S.L., Environmental Risk and Hazards, Prentice-Hall of India Pvt. Ltd., New Delhi, 1999.
5. Kolluru Rao, Bartell Steven, Pitblado R and Stricoff "Risk Assessment and Management Handbook", McGraw Hill Inc., New York,1996.
6. K. V. Raghavan and A A. Khan, Methodologies in Hazard Identification and Risk Assessment, Manual by CLRI, 1990.
7. Sam Mannan, Lees' Loss Prevention in the Process Industries, Hazard Identification, Assessment and Control, 4th Edition, Butterworth Heineman, 2012.

EM8001 ENERGY MANAGEMENT IN INDUSTRIES L T P C
3 0 0 3

OBJECTIVES:

- To provide an understanding of the basics of energy conservation method and energy auditing in industries
- To understand the environmental and economical benefits associated with energy management.

UNIT I INTRODUCTION 7

Energy Scenario – India and World – Energy Resources in India – Energy consumption Pattern, Energy Conservation and Energy Efficiency – Needs and Advantages, Role of Energy Manager – Energy Conservation Act.

UNIT II AUDITING AND INSTRUMENTATION IN ENERGY MANAGEMENT 10

Energy Audit – Purpose, Types, Methodologies, Barriers with respect to Process Industries, Power Plants, Boilers and Certain Energy Intensive Industries; Energy Audit Questionnaire - Role of instrumentation in energy conservation - total energy systems - concept of total energy – advantages, limitations & Application.

UNIT III ENERGY MANAGEMENT 12

Thermal energy management-Various Energy management Measures in Steam Systems – Losses in Boiler – Methodology of upgrading Boiler programme – Energy Conservation in Refrigeration and Air-conditioning Systems - Electrical Energy management- Potential Areas for Electrical Energy management in Various Industries-Energy Management Opportunities in Electrical Heating, Lighting system, Cable selection - Energy Efficient Motors - Factors involved in Determination of Motor Efficiency Adjustable AC Drives, Applications & its use variable speed Drives/Belt Drives

UNIT IV ENERGY ECONOMICS 8

Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Life Cycle Costing, risk and Sensitivity Analysis, Financing Options, Energy Performance Contract and Role of ETCOS.

UNIT V APPLICATIONS **8**

Case studies on sugar Industry –Co generation, Thermal power plant; Petrochemical Industries.

TOTAL: 45 PERIODS

OUTCOME:

- After the completion of course the student will understand the basics of energy conservation method and energy auditing in industries and their associated environmental and economical benefits.

REFERENCES:

1. Handbook on Energy Efficiency, TERI, New Delhi, 2001
2. Jefferson W. Tester, Elisabeth M. Drake, Michael J Driscoll, Michael W. Golay, William A Peters, Sustainable Energy – Choosing among options, Prentice Hall of India, 2006
3. Murphy W.R. and Mckay G., Energy Management, Elsevier, 2007.
4. Roger A. Hinrichs and Merlin H. Kleinbach, Energy: Its Use and the Environment, Cengage Learning, 2012.
5. Barney L. Capehart, Wayne C. Turner and William J. Kennedy, Guide to Energy Management, 7th Ed., Keinnedu Fairmant Press, 2011.

EM8002 LIFE CYCLE ASSESSMENT **L T P C**
3 0 0 3

OBJECTIVE:

- To understand the concept and methodology of Life Cycle Assessment as per international standards , its potential applications to develop sustainable products and promote sustainable consumption.

UNIT I GOAL AND SCOPE DEFINITION **9**

Introduction to Life Cycle Thinking - - analytical tools for product and service systems – History and definition of LCA - International organizations and networks - The ISO 14040 framework - Life cycle of Products and services –Industrial ecology - Impacts & value creation along the life cycle –Life cycle management (LCM) and Stakeholder Expectations – LCM drivers and issues materials flow analysis –technical characteristics – applications - limitations and how to solve them- - Life cycle goal and scope definition - function, functional unit and reference flow

UNITII INVENTORY AND IMPACT ANALYSIS **9**

System boundaries, data categories, inputs and outputs, data quality, critical review and other procedural aspects - Dealing with Allocation Issues - Solutions to the multifunctionality problem - Flow diagram - Format and data categories - Attributional versus consequential LCI - LCA softwares and database - Data quality - Data collection and relating data to unit processes -Data validation - Cut-off and data estimation - Characterization factors and principle of characterization - Selection of impact categories, category indicators and characterization models – Classification - Characterization - Optional elements -normalization , grouping, weighting ,data quality analysis - Characterization models – Impact assessment Case studies

UNIT III INTERPRETATION OF LCA RESULTS **9**

Simplified/streamlined Life Cycle Assessments - procedural approaches, numerical approaches - Examples of numerical approaches - contribution analysis, perturbation analysis, uncertainty analysis, comparative analysis, key issue analysis - Treatment of uncertainties - Elements in uncertainty handling - Sensitivity of LCA results - Sustainability analysis - Extending LCA - economic dimension, social dimension - Life cycle costing - Eco-efficiency - Combining LCA and LCC – Case studies

UNIT IV ECODESIGN OF PRODUCTS AND ECOLABELLING 9

Sustainable consumption – Eco-efficiency - green consumerism - product stewardship and green engineering - Extended producer responsibility – ecodesign strategies – design for Environment – Design for Disassembly - Dematerialization, rematerialization, transmaterialization – Green procurement and green distribution - Analysis framework for reuse and recycling - Typical constraints on reuse and recycling - Communication of Life Cycle Information - - Indian ecomark scheme - Environmental product declarations – Environmental marketing

UNIT V LCA CASE STUDIES 9

LCA case studies from International Journal of Life Cycle Assessment, Journal Cleaner Production and Journal of Industrial Ecology etc. on Product Design, Product Improvement, Product Comparison and Policy development.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the student is expected to be able to

- Appreciate the elements of Life Cycle Assessment of Products and services complying to international environmental management system standards
- Lead Life Cycle assessment team and implement design for environment over product cycle
- Develop, Implement, maintain and Ecolabelling Schemes for Products

REFERENCES:

1. Marry Ann Curan, Environmental Life Cycle Assessment, Mc Graw Hill New York 1996
2. International Organization for Standardization: ISO 14040 series of Standards for Life Cycle Analysis , 1997
3. Wimmer W, Zust R, Lee K . Ecodesign Implementation: A systematic guidance to integrating environmental considerations into product development. Springer, 2004
4. International Organization for Standardization: ISO TR 14062 Environmental management - Integrating environmental aspects into product design and development, 2002.
5. David F Ciambrone , Environmental Life Cycle Analysis, CRC Press LLC, 1997

6 UNEP/SETAC UNEP/SETAC LifeCycle Initiativewebsite, http://www.uneptie.org /sustain / lcinitiative , 2004.

EM8003 OCCUPATIONAL HEALTH AND INDUSTRIAL SAFETY L T P C

3 0 0 3

OBJECTIVES:

- To educate about the health hazards and the safety measures to be followed in the industrial environment.
- Describe industrial legislations (Factories Acts, Workmen's Compensation and other laws) enacted for the protection of employees health at work settings
- Describe methods of prevention and control of Occupational Health diseases, accidents/emergencies and other hazards

UNIT I INTRODUCTION 9

Need for developing Environment, Health and Safety systems in work places - Accident Case Studies - Status and relationship of Acts - Regulations and Codes of Practice - Role of trade union safety representatives. International initiatives - Ergonomics and work place.

UNIT II OCCUPATIONAL HEALTH AND HYGIENE 11

Definition of the term occupational health and hygiene - Categories of health hazards - Exposure pathways and human responses to hazardous and toxic substances - Advantages and limitations of environmental monitoring and occupational exposure limits - Hierarchy of control measures for occupational health risks - Role of personal protective equipment and the selection criteria - Effects on humans - control methods and reduction strategies for noise, radiation and excessive stress.

UNIT III WORKPLACE SAFETY AND SAFETY SYSTEMS 11

Features of Satisfactory and Safe design of work premises – good housekeeping - lighting and colour, Ventilation and Heat Control – Electrical Safety – Fire Safety – Safe Systems of work for manual handling operations – Machine guarding – Working at different levels – Process and System Safety.

UNIT IV HAZARDS AND RISK MANAGEMENT 7

Safety appraisal - analysis and control techniques – plant safety inspection – Accident investigation - Analysis and Reporting – Hazard and Risk Management Techniques – major accident hazard control – Onsite and Offsite emergency Plans.

UNIT V ENVIRONMENTAL HEALTH AND SAFETY MANAGEMENT 7

Concept of Environmental Health and Safety Management – Elements of Environmental Health and Safety Management Policy and methods of its effective implementation and review – Elements of Management Principles – Education and Training – Employee Participation.

TOTAL: 45 PERIODS

OUTCOMES:

After completion of this course, the students is expected to be able to:

- Describe, with example, the common work-related diseases and accidents in occupational setting
- Name essential members of the Occupational Health team
- What roles can a community health practitioners play in an Occupational setting to ensure the protection, promotion and maintenance of the health of the employee

REFERENCES:

1. "Fundamentals of Industrial Safety" and Health by Dr.K.U.Mistry, Siddharth Prakashan, 2012
2. "Environmental and Health and Safety Management" by by Nicholas P.Cheremisinoff and Madelyn L. Graffia, William Andrew Inc. NY, 1995
3. The Facility Manager's Guide to Environmental Health And Safety by Brian Gallant, Government Inst Publ., 2007.
4. "Effective Environmental, Health, and Safety Management" Using the Team Approach by Bill Taylor, Culinary and Hospitality Industry Publications Services,2005.
5. William F.Martin, and Steven P.Levine, " Protecting Personnel at Hazardous waste Sites", Second Edition, Buttorworth. Heinemann, 1994.

EM8071 CLIMATE CHANGE AND MODELLING L T P C

3 0 0 3

OBJECTIVE:

- To introduce the emerging concepts of climate modeling and projecting future climate change, understand data analysis and application.

UNIT I CLIMATE CHANGE AND CLIMATE VARIABILITY 9

Introduction – Atmosphere - weather and Climate - climate parameters (Temperature ,Rainfall, Humidity, Wind etc) – Equations governing the atmosphere - Numerical Weather Prediction Models - Introduction to GCMs - Application in Climate Change Projections.

UNIT II IPCC SRES SCENARIOS 9

Intergovernmental Panel on Climate Change (IPCC) - An Overview - Key Assumptions - Scenario Family - Storyline (A1, B1, A2, B2).

UNIT III GLOBAL CLIMATE MODEL (GCM) AND REGIONAL CLIMATE MODEL (RCM) 9

Some typical GCMs (HadCM3Q-UK Met Office) - Issues with GCMs - Introduction to RCMs and LAMs - some typical RCMs like PRECIS, SimCLIM, MAGICC/SCENGENE - Advantages and Disadvantages of GCMs and RCMs.

UNIT IV DOWNSCALING GLOBAL CLIMATE MODEL - AN OVERVIEW 9

Need for downscaling - Selection of GCMs for regional climate change studies - Ensemble theory – Selection of - Ensembles, Model Domain (Spatial domain and temporal domain), Resolution and climate variables - Lateral boundary conditions - Methods of downscaling (Statistical and Dynamical) - examples from each and their limitations.

UNIT V ANALYSIS /POST PROCESSING 9

a. Model validation - post processing – Introduction to Analysis tools - Ferret, R, Grads, IDL, SPSS, ArcGIS
b. Climate change Impact - Vulnerability assessment – adaptation strategies.

TOTAL: 45 PERIODS

OUTCOME:

- After the completion of the course, the students will know the causes of climate change, effects of climate change on various environments and various models.

REFERENCES:

1. IPCC Fourth Assessment Report, Cambridge University Press, Cambridge, UK.
2. McGuffie, K. and Henderson-Sellers, A. (2005) "A Climate Modelling Primer, 3rd Edition, John Wiley & Sons, Ltd, Chichester, UK.
3. Neelin David J, "Climate Change and Climate Modelling", Cambridge University Press
4. Thomas Stocker, "Introduction to Climate Modelling", Advances in Geophysical and Environmanetal Mechanics and Mathematics. Springer Publication.

EM8072 MARINE POLLUTION AND CONTROL L T P C
3 0 0 3

OBJECTIVES:

- To educate the Coastal and Marine environment.
- To educate the ocean dynamics
- To sources of marine pollution and methods for monitoring, modeling and control.

UNIT I MARINE ENVIRONMENT 7

Seas and oceans, Continental area, Coastal zone, Properties of sea water, Principles of Marine Geology, coastal features – Beaches, Estuaries, Lagoons–The oceans and climate

UNIT II OCEAN HYDRODYNAMICS 10

Wave Theory, Waves in shallow waters – Refraction, Diffraction and Shoaling, Approximations for deep and shallow water conditions – Tidal Classification - General circulation of ocean waters - Ocean currents - Coastal sediment transport - Onshore offshore sediment transport - Beach formation and coastal processes - Tsunamis, storm surge, El Niño effect.

UNIT III MARINE POLLUTION SOURCES AND EFFECTS 8

Sources of Marine Pollution – Point and non-point sources, Pollution caused by Oil Exploration, Dredging, Offshore Structures, Agriculture Impacts of pollution on water quality and coastal ecosystems – Marine discharges and effluent standards

UNIT IV MONITORING OF MARINE POLLUTION 10

Basic measurements - Sounding boat, lead lines, echo sounders – current meters - tide gauge - use of GPS – Measurement of coastal water characteristics – sea bed sampling – Modeling of Pollutant transport and dispersion - Oil Spill Models - Ocean Monitoring satellites – Applications of Remote Sensing and GIS in monitoring marine pollution

UNIT V MARINE POLLUTION CONTROL AND ICZM 10

Design of out falls-Pollution Control strategies – Selection of optimal Outfall locations - National and International Treaties, Coastal Zone Regulation – Total Maximum Daily Load applications – Protocols in Marine Pollution – ICZM and Sustainable Development

TOTAL: 45 PERIODS

OUTCOMES:

- Ability to know about marine environment. ould have learnt the physical concepts lying behind the oceanic currents and natural processes of various activities happening over the marine environment.
- Acquired knowledge on the marine pollution and the effect of the same on the ecology.
- Should have gained knowledge on remote sensing and various other techniques for measuring and monitoring oceanic environment parameters.
- Should have acquired knowledge on control of marine pollution and sustainable development

REFERENCES:

1. Marine Pollution (5th Edition) R.B. Clark, C. Frid and M Atttrill Oxford Science Publications, 2001
2. Marine pollution Dr.P.C.Sinha , Anmol Publications Pvt. Ltd, 1998.
3. Problems of Marine Pollution : India and Canada, Raghavan, Sudha , Eastern Book Corporation, Delhi, India,
4. Laws, E.A., Aquatic pollution, an introductory text. John Wiley and Sons, Inc., New York, 2000

EM8073 REMOTE SENSING AND GIS APPLICATIONS IN ENVIRONMENTAL MANAGEMENT

L	T	P	C
3	0	0	3

OBJECTIVES:

- To educate the students on aspects of Remote Sensing
- Develop the different remote sensing technique
- To educate the students on aspects of GIS and data management
- Develop the GIS Applications for monitoring and management of environment

UNIT I REMOTE SENSING ELEMENTS 8

Historical Perspective, Principles of remote sensing, components of Remote Sensing, Energy source and electromagnetic radiation, Electromagnetic spectrum, Energy interaction, Spectral response pattern of earth surface features, Energy recording technology

UNIT II REMOTE SENSING TECHNOLOGY 9

Classification of Remote Sensing Systems, , Aerial photographs, Photographic systems – Across track and along track scanning, Multispectral remote sensing, Thermal remote sensing, Microwave remote sensing – Active and passive sensors, RADAR, LIDAR

UNIT III SATELLITE REMOTE SENSING 9

Satellites and their sensors, satellite orbits, Indian space programme - Research and development - ISRO satellites, LANDSAT, ERS, SPOT, TERRA and NOOA satellite series, Characteristics of Remote Sensing data ,Satellite data Products

UNIT IV IMAGE PROCESSING AND GEOGRAPHICAL INFORMATION SYSTEM 10

Photogrammetry – Visual image interpretation, Digital image processing – Image rectification, enhancement, transformation, Classification, Data merging, GIS Concepts – Spatial and non spatial data, Vector and raster data structures, Data analysis, Database management – RS – GIS Integration, Image processing software, GIS software

UNIT V REMOTE SENSING AND GIS APPLICATIONS 9

Monitoring and management of environment, Conservation of resources, Sustainable land use, Coastal zone management – Limitations

TOTAL: 45 PERIODS

OUTCOMES:

- Ability to identify the environmental problems using Remote sensing
- Ability to apply the principle of RS and GIS for solving Environmental problems
- Ability to assess the Environmental Impacts using RS and GIS

REFERENCES:

1. Lillesand, T.M. and Kiefer, R.W, "Remote sensing and image interpretation", John Wiley and sons, New York, 2004.
2. Golfried Konechy, Geoinformation: "Remote sensing, Photogrammetry and Geographical Information System"s, CRC press, 1st Edition, 2002.
3. Burrough, P.A. and McDonnell, R.A., "Principles of Geographic Information systems Oxford University Press", New York, 2001.
4. Lintz, J. and Simonet, "Remote sensing of Environment", Addison Wesley Publishing Company, New Jersey, 1998.
5. "Pmapler and Applications of Imaging RADAR", Manual of Remote Sensing, Vol.2, ASPR, 2001.

EN8071 AIR QUALITY MODELING AND MAPPING L T P C
3 0 0 3

OBJECTIVES:

- To introduce the fundamentals of air pollution with a background on historical perspective on air pollution.
- To introduce the theory of dispersion of air pollution in the atmosphere. To discuss the major approaches for air pollution modeling
- To demonstrate the features and the use of most widely used commercial and freely available air quality models

UNITI MODELING CONCEPT 8

Overview of different types of models-deterministic and stochastic approach- Steps in model development- numerical and simulations models- calibration and validation of models- Limitations-Transport phenomena- Mass balance analysis-Model development and decision making.

UNIT II AIR POLLUTION MODELING 11

Chemistry of air Pollutants - Atmospheric reactions, sinks for air pollution –Transport of air Pollutants - Meteorological settling for dispersal of air pollutants – Vertical structure of temperature and stability, atmospheric motions, Wind and shear, self cleaning of atmosphere; transport and diffusion of stack emissions – atmospheric characteristics significant to transport and diffusion of stack emission – stack plume characteristics.

UNIT III AIR QUALITY MODELS 12

Types modeling technique, modeling for nonreactive pollutants, single source, short term impact, multiple sources and area sources, Fixed box models- diffusion models – Gaussian plume derivation-modifications of Gaussian plume equation- long term average-multiple cell model- receptor oriented and source oriented air pollution models- model performance, accuracy and utilization-air Quality Index -air quality mapping

UNIT IV INDOOR AIR QUALITY MODELS 8

Indoor Air Pollutants - Volatile Organic Compounds , Inorganic Gaseous Pollutants Respirable Particulates ,Bioaerosols, Radon and its decay products-Infectious disease transmission- A/C units in indoor- Odours and sick building syndrome-Indoor Air quality Models.

UNIT V SOFTWARE PACKAGE APPLICATIONS 6

Commercial air quality models -ADMS, Airviro and USEPA models

TOTAL: 45 PERIODS

OUTCOME:

- Developed conceptual schematics required for air quality modeling and an ability to translate pertinent criteria into air pollution control.

REFERENCES:

1. Zanneti, P. 1990. Air Pollution Modeling Theories, Computational Methods and Available Software. Van Nostrand Reinhold, New York.
2. R.W.Boubel, D.L. Fox, D.B. Turner & A.C. Stern, Fundamentals of Air Pollution Academic Press, New York, 1994
3. J.L.Schnoor, Environmental Modeling Fate and Transport of Pollutants in Water, Air and Soil, John Wiley & Sons Inc., New York, 1996.
4. Arthur C.Stern Air Pollution (Third Ed.) Volume I – Air Pollutants, their transformation and Transport, (Ed.), Academic Press, 2006.
5. Deaton and Wine Brake, “Dynamic Modeling of Environmental Systems”, Wiley & Sons, 2002.

EN8072 LANDFILL ENGINEERING AND REMEDIATION TECHNOLOGY L T P C
3 0 0 3

OBJECTIVE:

- To understand the important characteristics and design principles of the waste containment and remediation industry as well as know the relevant regulations and engineering design requirements of landfills and contaminated site remediation

UNIT I LANDFILL BASICS 8

Waste management Hierarchy- Need for landfills –Environmental Protection by Landfills- Landfill Classification – Sanitary and Secure Landfills - Components and Configuaration - Legal framework for landfilling – Landfill Site investigation- Regional Landfills- Environmental control using site design – - Landfill Design Tasks

UNIT II LANDFILL LINERS AND COVER SYSTEMS 10

Landfill barrier system components – Design of Compacted clay liners: Factors affecting hydraulic conductivity , Water content-density criteria, Thickness, Desiccation - Geosynthetic Clay Liners and Geomembranes; types, manufacturing, handling, seaming and testing - Asphalt Barriers and Capillary barrier - Composite Liner system design- liner construction and quality control- Leakage through Liners- vapor transmission and chemical compatibility - Installation of Geomembranes - Liner Leakage Mechanism – Diffusion - Controls on advection through liners - Single phase flow-advection-diffusion- Landfill cover systems- Design of Cover Systems – Daily Cover – Intermediate Cover – Final Cover -

Flow through Landfill Covers- Design and Analysis of Slope Stability- Anchor Trenches- Access ramps - Erosion control

UNIT III LEACHATE AND LANDFILL GAS MANAGEMENT 9

Waste decomposition in landfills - Factors affecting leachate and landfill gas generation – Factors affecting Leachate Quantity in active and post closure conditions- Hydrologic Evaluation of *Landfill* Performance (HELP) model – Leachate Drainage Layer – Geotextile and Geonet design – Leachate Collection and Removal systems-Temporal trends in leachate composition – Design of Landfill gas collection and removal systems- Gas condensate issues & knockouts - Leachate treatment methods (biological and physico-chemical)- Leachate re-circulation & bioreactor landfills- monitoring and control of leachate and Landfill gas- Landfill Settlement

UNIT IV LANDFILL OPERATION AND CLOSURE 8

Landfill Construction and Opeartional Controls – Fill Sequencing Plans – Cell Construction- Dozer and Compactor operations-Selection of Landfill Equipment- Landfill Administration-Record Keeping - Topographic mapping-Environmental Controls – Odour, Vector and Litter Control – Landfill Safety - Fire Control – Ground and Surface water Monitoring – Methane Gas monitoring - Audits of landfill environmental performance and management – Post Closure care and use of landfills – Landfill Economics- landfill construction and operational cost estimation – establishing tipping fees

UNIT V CONTAMINATED SITE REMEDIATION 10

Contaminaed sites - Fate and behaviour of toxics and persistent substances in the environment – Engineering Issues in Site Remediation - Site Characterization - Framework for risk assessment at landfill sites - Remediation Principles: Source Control and Management of Migration Covers, Cut-off Walls, Solidification / Stabilization - Pump-and-Treat Systems - Solvent Vapor Extraction, Air Sparging, Soil Flushing – Bioremediation - Natural Attenuation - Remedy Selection and Risk Assessment – Geotechnical Aspects of In Situ Remediation Technology - Specific case studies in contaminated site remediation – Rehabilitation of Open dumps- Landfill Mining

TOTAL: 45 PERIODS

OUTCOMES :

On Completion of the Course, the Candidate should:

- Have an overview of the Indian and international landfill regulations and guidelines for the design, construction, operation and management of landfills
- understand the design and construction of landfills, processes in landfills, methods for management and treatment of landfill gas and leachate
- have an in-depth understanding of the key pollutants in leachate and gas, their potential environmental impacts and the engineering design and performance of control systems used to manage and treat pollutant and waste emissions from sites.
- Be able to apply a risk based assessment of contaminated sites and implement site remediation technologies

REFERENCES:

1. Robert M. Koerner and Donald H Gray (2002), Geotechnical aspects of Landfill Design and Construction, Prentice Hall, New Jersy.
2. Neal Bolton P.E (1995), “The Handbook of Landfill Operations”, Blue Ridge Services Inc., Atascadro, CA – ISBN 0-9646956-0-x
3. David E Daniel and Robert M. Koerner (2007), “ Waste Containment Facilities –Guidance for construction Quality Assurance and Construction Quality Control of Liner and Cover Systems, American Socirty of Civil Engineers, ASCE Press.
4. Donald L Wise and Debra J Trantolo (1994), “Remediation of Hazardous Waste Contaminated Soils, Marcel Dekker Inc., New York
5. George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, “Integrated Solid Waste Management, Mc-Graw Hill International edition, New York, 1993.

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6. Hari D Sharma and Krishna R. Reddy (2004), Geoenvironmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Techonolgies, John Wiely, New Jersy
7. Oweis, I.S. and Khera, R.P (1998) Geotechnology *of Waste Management*, 2nd Edition, PWS Publishing Co., Boston, MA

EN8073 MEMBRANE SEPARATION FOR WATER AND WASTEWATER TREATMENT **L T P C 3 0 0 3**

OBJECTIVE:

- To introduce the concept and principles of membrane separation and its applications in water and wastewater treatment .

UNIT I MEMBRANE FILTRATION PROCESSES **10**

Solid Liquid separation systems- Theory of Membrane separation – mass Transport Characteristics - Cross Flow filtration - Membarne Filtration- Flux and Pressure drop -Types and choice of membranes, porous, non porous, symmetric and assymmetric – Plate and Frame, spiral wound and hollow fibre membranes – Liquid Membranes

UNIT II MEMBRANE SYSTEMS **10**

Microfiltration principles and applications – Ultrafiltration principles and applications - Nano Filtration principles and applications – Reverse Osmosis: Theory and design of modules, assembly, plant process control and applications – Electro dialysis : Ion exchange membranes, process design- Pervaporation – Liquid membrane – Liquid Pertraction – Supported Liquid Membrane and Emulsion Liquid membrane - Membrane manufatures – Membrane Module/Element designs – Membrane System components – Design of Membrane systems - pump types and Pump selection – Plant operations – Economics of Membrane systems

UNIT III MEMBRANE BIOREACTORS **9**

Introduction and Historical Perspective of MBRs, Biotreatment Fundamentals, Biomass Separation MBR Principles, Fouling and Fouling Control, MBR Design Principles, Design Assignment, Alternative MBR Configurations, Commercial Technologies, Case Studies

UNIT IV PRETREATMENT SYSTEMS **8**

Membrane Fouling – Control of Fouling and Concentration Polarisation-Pretreatment methods and strategies – monitoring of Pretreatment – Langlier Index, Silt Density Index, Chemical cleaning , Biofoulant control

UNIT- V CASE STUDIES **8**

Case studies on the design of membrane based water and wastewater treatment systems – zero Liquid effluent discharge Plants – Desalination of brackish water

TOTAL: 45 PERIODS

OUTCOMES:

On Completion of the Course the student will

- be familiar with main membrane processes, principles, separation mechanisms, and applications
- understand the selection criteria for different membrane processes
- know the principle of the most common membrane applications and
- carry out design of project for a particular membrane technology application.

REFERENCES

- Water Environment Federation (WEF), Membrane Systems for Wastewater Treatment, McGraw-Hill, USA, 2005.
- Symon Jud, MBR Book – Principles and application of MBR in water and wastewater treatment, Elservier, 2006.

- K. Yamamoto and Urase T, Membrane Technology in Environmental management, special issue, Water Science and technology, Vol.41, IWA Publishing, 2000.
- Jorgen Wagner, Membrane Filtration handbook, Practical Tips and Hints, 2nd Edition, Revision 2, Osmonics Inc., 2001.
- Baker, R.W., Membrane technology and applications, 2nd ed., John Wiley 2004
- Noble, R.D. and Stern, S.A., Membrane Separations Technology: Principles and Applications, Elservier,Netherlands,1995.
- Stephenson, T., Brindle, K., Judd, S., Jefferson, B.Membrane Bioreactors for Wastewater Treatment, IWA Publishing, London , 2000

EN8074 RURAL WATER SUPPLY AND ONSITE SANITATION L T P C
3 0 0 3

OBJECTIVES:

- To educate the students on the principles rural water supply and sanitation.
- Development of water resources.
- Develop an understanding of the characteristics of water and wastewater that must be considered during design of a treatment plant.
- Develop understanding of events governing the rural water supply and sanitation.

UNIT I DEVELOPMENT OF WATER SOURCES 9

Sources of water – Surface and ground water sources – Development of deep bore wells; Estimation of yield – Alternate ways of water supply – Rain water harvesting pumps – Types and selection of pumps for deep bore wells – Construction, inspection and maintenance.

UNIT II WATER TREATMENT 9

Quality of water - Standard conventional water treatment – Technologies for removal of specific contaminants; Iron, Arsenic, Fluoride, T.D.S; Disinfection – Alternate disinfection methods.

UNIT III SANITATION 9

Basic requirement of sanitation; Decentralized / onsite wastewater management; small bore / settled effluent sewer.

UNIT IV SEWAGE TREATMENT 9

Fundamentals of sewage treatment; Decentralized sewage treatment; Septic tank with depression – DEWATS, Intermittent sand filters.

UNIT V SEWAGE DISPOSAL AND REUSE 9

Methods of disposal, Land disposal, sewage farms – Artificial recharge of ground water; Recycle and Reuse of sewage – Grey water Harvesting – Salt water intrusion and remediation – Ground water pollution and remediation.

TOTAL: 45 PERIODS

OUTCOMES:

- Ability to identify and formulate problems for rural application.
- Develop conceptual schematics required for the treatment of water and wastewater for rural application.
- Ability to function on a multi – disciplinary team.
- An ability to identify pertinent criteria constraining the design of systems and processes.

REFERENCES:

1. CPHEEO Manual on Water Supply and Treatment, Govt. of India (2003).
2. Manual on Sewerage and Sewage Treatment, Govt. of India (1999).
3. Metcalf & Eddy, Wastewater Engg. Treatment and Reuse, Tata McGraw Hill, New Delhi (2000).
4. Todd, D.K. Ground Water Hydrology, John Wiley & Sons, New York (2000).

EN8075 WATER QUALITY MODELING L T P C
3 0 0 3

OBJECTIVES:

- To introduce the fundamentals of mathematical models for water quality and the importance of model building.
- To acquaint with various water flow models and their kinetics.
- To educate about the water parameters modeling and various ground water quality modeling.
- To demonstrate the features and the use of most widely used computerized models for water quality

UNIT I MODELING CONCEPTS 9

Engineers and water quality-Mathematical models-Overview of different types of models-- Steps in model development - Importance of model building.- balance –calibration and verification of models-conservation of mass- mass balance analysis -chemical reaction kinetics – Law of mass action, Rate constants, reaction order, types of reactions, equilibrium principles.

UNIT II COMPLETELY AND INCOMPLETELY MIXED SYSTEM 10

Transport phenomena – Advection, diffusion, dispersion- simple transport models – Plug flow models-Application of PFR model to streams-MFR model to estuaries-Steady state and time variable solutions-completely mixed systems, concept and models in Completely Stirred Tank Reactors, mass balance equations, loading types, feed forward vs. feedback reactor systems.

UNIT III WATER QUALITY ENVIRONMENTS 12

Lakes and impoundments – Water quality response to input ; water quality modeling process – model sensitivity – assessing model performance; Models for dissolved oxygen, pathogens and BOD-Streeter Phelps equations for point and distributed sources - Modified Streeter Phelps equations - Toxicant modeling in flowing water-Eutrophication model-Trophic state correlations.

UNIT IV GROUNDWATER QUALITY MODELING 8

Mass transport of solutes, degradation of organic compounds, application of concepts to predict groundwater contaminant movement, seawater intrusion – basic concepts and modeling

UNIT V COMPUTER METHODS 6

Exposure to computer models for surface water and groundwater quality - QUAL2E Model and its application

TOTAL: 45 PERIODS

OUTCOME:

- Developed conceptual schematics required for modeling and an ability to translate pertinent criteria into system requirements

REFERENCES:

1. Steven C.Chapra, Surface Water Quality Modelling, The McGraw-Hill Companies, Inc., New Delhi, 1997.
2. J.L.Schnoor, Environmental Modeling Fate and Transport of Pollutants in Water, Air and Soil, John Wiley & Sons Inc., New York, 1996.

3. Deaton and Wine Brake, “Dynamic Modeling of Environmental Systems”, Wiley & Sons, 2002.
4. Hipel, K.W and A.I. McLeod. 1994. Time Series Modelling of Water Resources and Environmental Systems. Elsevier Science.
5. Thomann, R.V. and J.A. Mueller. 1987 .Principles of Surface Water Quality Modelling and Control, Harper and Row.

EN8251 AIR POLLUTION CONTROL ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

- To impart knowledge on the principles and design of control of indoor/particulate/gaseous air pollutant and its emerging trends
- Design and selection of air pollution control equipment

UNIT I INTRODUCTION 8

Structure and composition of Atmosphere – Sources and classification of air pollutants - Effects of air pollutants on human health, vegetation and animals, Materials and Structures – Effects of air Pollutants on the atmosphere, Soil and Water bodies – Long- term effects on the planet – Global Climate Change, Ozone Holes – Ambient Air Quality and Emission Standards – Air Pollution Indices – Emission Inventories – Ambient and Stack Sampling and Analysis of Particulate and Gaseous Pollutants.

UNIT II AIR POLLUTION MODELLING 5

Effects of meteorology on Air Pollution - Fundamentals, Atmospheric stability, Inversion, Wind profiles and stack plume patterns- Transport and Dispersion of Air Pollutants – Modeling Techniques – Air Pollution Climatology .

UNIT III CONTROL OF PARTICULATE CONTAMINANTS 12

Factors affecting Selection of Control Equipment – Gas Particle Interaction – Working principle, Design and performance equations of Gravity Separators (cyclone) - Centrifugal separators Fabric filters, Particulate Scrubbers, Electrostatic Precipitators – Operational Considerations - Process Control and Monitoring – Costing of APC equipment – Case studies for stationary and mobile sources.

UNIT IV CONTROL OF GASEOUS CONTAMINANTS 12

Factors affecting Selection of Control Equipment – Working principle, Design and performance equations of absorption, Adsorption, condensation, Incineration, Bio scrubbers, Bio filters – Process control and Monitoring - Operational Considerations - Costing of APC Equipment – Case studies for stationary and mobile sources.

UNIT V INDOOR AIR QUALITY MANAGEMENT 8

Sources types and control of indoor air pollutants, sick building syndrome types – Radon Pollution and its control – Membrane process - UV photolysis – Internal Combustion Engines - Sources and Effects of Noise Pollution – Measurement – Standards –Control and Preventive measures.

TOTAL: 45 PERIODS

OUTCOMES :

After completion of this course, the students is expected to be able to:

- Apply sampling techniques
- Apply modeling techniques
- Suggest suitable air pollution prevention equipments and techniques for various gaseous and particulate pollutants to Industries.
- Discuss the emission standards

REFERENCES:

1. Lawrence K. Wang, Norman C. Parelra, Yung Tse Hung, "Air Pollution Control Engineering", Tokyo, 2004.
2. Noel de Nevers, "Air Pollution Control Engineering", Mc Graw Hill, New York, 1995.
3. David H.F. Liu, Bela G. Liptak 'Air Pollution', Lweis Publishers, 2000.
4. Anjaneyulu. Y, 'Air Pollution & Control Technologies' Allied Publishers (P) Ltd., India, 2002.
5. Arthur C.Stern, 'Air Pollution (Vol.I – Vol.VIII)', Academic Press, 2006.
6. Wayne T.Davis, 'Air Pollution Engineering Manual', John Wiley & Sons,Inc.,2000.
7. Daniel Vallero " Fundamentals of Air Pollution", 4th Edition,2008.