ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

REGULATIONS – 2015

CHOICE BASED CREDIT SYSTEM

M.E. ENVIRONMENTAL MANAGEMENT

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) :

I. 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.

II. To oversee the environmental performance including compliance with environmental legislation across the organization, and coordinating all aspects of pollution control, waste management, environmental health and conservation.

III. To lead the implementation of environmental policies and practices and raise awareness, at all levels of an organization, about the emerging environmental issues.

PROGRAMME OUTCOMES (POs):

1. 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 to 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
2. 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
3. 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
4. Obtain, update, and maintain plans, permits, and standard operating procedures.
5. Prepare, review, and update environmental monitoring and assessment Reports and Monitor progress of environmental improvement programs
6. Identify, formulate, analyze, and develop management systems and formulate solutions that are technically sound, economically feasible, and socially acceptable.
7. Assess the potential environmental impact of development projects and design mitigation measures
8. Audit, analyse and report environmental performance to internal and external clients and regulatory bodies
9. 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
10. 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

Programme Educational Objectives	Programme Outcomes									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
I	√	√				√				√
II	√	√	√					√		
III		√		√	√		√		√	

			PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
YEAR 1	SEM 1	Statistical Methods for Engineers			√	√		√			√	
		Design of Water and Wastewater Treatment Systems	√			√						
		Environmental Chemistry and Micro Biology		√								
		Environmental Policies and Legislations						√				
		Principles of Sustainable Development	√					√				
		Environmental Chemistry and Microbiology laboratory				√						
	SEM 2	Environmental Economics								√	√	
		Environmental Impact and Risk Assessment					√		√	√		
		Elective I										
		Elective II										
		Elective III										
YEAR 2	SEM 1	Environmental Management Systems and Auditing		√	√	√		√				
		Elective IV										
		Elective V										
		Industrial Training (2 weeks)										√
		Project Work (Phase I)										√
		Seminar										√
	SEM 2	Project Work (Phase II)										√

ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

M.E. ENVIRONMENTAL MANAGEMENT (FULL TIME)

REGULATIONS – 2015

CHOICE BASED CREDIT SYSTEM

CURRICULA AND SYLLABI

SEMESTER I

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	EM7101	Design of Water and Wastewater Treatment Systems	PC	4	4	0	0	4
2.	EM7102	Environmental Chemistry and Micro Biology	FC	4	4	0	0	4
3.	EM7103	Principles of Sustainable Development	PC	3	3	0	0	3
4.	MA7160	Statistical Methods for Engineers	FC	4	4	0	0	4
5.		Elective I	PE	3	3	0	0	3
PRACTICAL								
6.	EM7111	Environmental Chemistry and Microbiology laboratory	FC	2	0	0	2	1
			TOTAL	**20**	**18**	**0**	**2**	**19**

SEMESTER II

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	EM7201	Environmental Economics	PC	3	3	0	0	3
2.	EM7202	Environmental Policies and Legislations	PC	3	3	0	0	3
3.	EM7251	Environmental Impact and Risk Assessment	PC	3	3	0	0	3
4.		Elective II	PE	3	3	0	0	3
5.		Elective III	PE	3	3	0	0	3
6.		Elective IV	PE	3	3	0	0	3
			TOTAL	**18**	**18**	**0**	**0**	**18**

SEMESTER III

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	EM7301	Environmental Management Systems and Auditing	PC	3	3	0	0	3
2.		Elective V	PE	3	3	0	0	3
3.		Elective VI	PE	3	3	0	0	3
PRACTICAL								
4.	EM7311	Industrial Training (2 weeks)	EEC	-	-	-	-	1
5.	EM7312	Seminar	EEC	2	0	0	2	1
6.	EM7313	Project Work (Phase I)	EEC	12	0	0	12	6
			TOTAL	**23**	**9**	**0**	**14**	**17**

SEMESTER IV

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
PRACTICAL								
1.	EM7411	Project Work (Phase II)	EEC	24	0	0	24	12
			TOTAL	**24**	**0**	**0**	**24**	**12**

TOTAL NO. OF CREDITS:66

ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

M.E. ENVIRONMENTAL MANAGEMENT (PART TIME)

REGULATIONS – 2015

CHOICE BASED CREDIT SYSTEM

CURRICULA AND SYLLABI

SEMESTER I

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	MA7160	Statistical Methods for Engineers	FC	4	4	0	0	4
2.	EM7101	Design of Water and Wastewater Treatment Systems	PC	4	4	0	0	4
3.	EM7102	Environmental Chemistry and Microbiology	FC	4	4	0	0	4
PRACTICAL								
4.	EM7111	Environmental Chemistry and Microbiology laboratory	FC	2	0	0	2	1
			TOTAL	**14**	**12**	**0**	**2**	**13**

SEMESTER II

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	EM7201	Environmental Economics	PC	3	3	0	0	3
2.	EM7251	Environmental Impact and Risk Assessment	PC	3	3	0	0	3
3.		Elective I	PE	3	3	0	0	3
4.		Elective II	PE	3	3	0	0	3
			TOTAL	**12**	**12**	**0**	**0**	**12**

SEMESTER III

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	EM7202	Environmental Policies and Legislations	PC	3	3	0	0	3
2.	EM7103	Principles of Sustainable Development	PC	3	3	0	0	3
3.		Elective III	PE	3	3	0	0	3
			TOTAL	**9**	**9**	**0**	**0**	**9**

SEMESTER IV

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.		Elective IV	PE	3	3	0	0	3
2.		Elective V	PE	3	3	0	0	3
3.		Elective VI	PE	3	3	0	0	3
4.	EM7312	Seminar	EEC	2	0	0	2	1
			TOTAL	**11**	**9**	**0**	**2**	**10**

SEMESTER V

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	EM7301	Environmental Management Systems and Auditing	PC	3	3	0	0	3
PRACTICAL								
2.	EM7311	Industrial Training (2 weeks)	EEC	-	-	-	-	1
3.	EM7313	Project Work (Phase I)	EEC	12	0	0	12	6
			TOTAL	**15**	**3**	**0**	**12**	**10**

SEMESTER VI

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
PRACTICAL								
1.	EM7411	Project Work (Phase II)	EEC	24	0	0	24	12
			TOTAL	**24**	**0**	**0**	**24**	**12**

TOTAL NO. OF CREDITS:66

FOUNDATION COURSES (FC)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.		Statistical Methods for Engineers	FC	4	4	0	0	4
2.		Environmental Chemistry and Microbiology	FC	4	4	0	0	4
3.		Environmental Chemistry and Microbiology laboratory	FC	2	0	0	2	1

PROFESSIONAL CORE (PC)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.		Design of Water & Wastewater Treatment Systems	PC	4	4	0	0	4
2.		Environmental Economics	PC	3	3	0	0	3
3.		Environmental Policies and Legislation	PC	3	3	0	0	3
4.		Environmental Management Systems and Auditing	PC	3	3	0	0	3
5.		Environmental Impact and Risk Assessment	PC	3	3	0	0	3
6.		Principles of Sustainable Development	PC	3	3	0	0	3

PROFESSIONAL ELECTIVES (PE)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	EM7001	Climate Change and Modeling	PE	3	3	0	0	3
2.	EM7002	Ecological Engineering	PE	3	3	0	0	3
3.	EM7003	Energy Management in Industries	PE	3	3	0	0	3
4.	EM7004	Environmental Quality Monitoring	PE	3	3	0	0	3
5.	EM7005	Life Cycle Assessment	PE	3	3	0	0	3
6.	EM7006	Natural Resources Management	PE	3	3	0	0	3
7.	EM7007	Occupational Health and Industrial Safety	PE	3	3	0	0	3

8.	EM7008	Remote Sensing and GIS Applications in Environmental Management	PE	3	3	0	0	3
9.	EM7009	Rural Water Supply and Onsite Sanitation	PE	3	3	0	0	3
10.	EN7071	Air Pollution Control Engineering	PE	3	3	0	0	3
11.	EN7072	Solid and Hazardous Waste Management	PE	3	3	0	0	3
12.	EN7251	Industrial Wastewater Pollution- Prevention and control	PE	3	3	0	0	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.		Industrial Training (2 weeks)	EEC	-	0	0	0	1
2.		Project Work (Phase I)	EEC	12	0	0	12	6
3.		Seminar	EEC	2	0	0	2	1
4.		Project Work (Phase II)	EEC	24	0	0	24	12

EM7101 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, electro dialysis – stripping -principles of chemical treatment – neutralization - 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, 2012.
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 Systems Part A, Part B &Part C” CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 2013.

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.

EM7102 ENVIRONMENTAL CHEMISTRY AND MICROBIOLOGY L T P C
4 0 0 4

OBJECTIVES:

- 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. Chemistry for Environmental Engineering and Science, Sawyer,C.N., MacCarty, P.L. and Parkin, G.F Tata McGraw – Hill, Fifth edition, New Delhi (2003).
2. Environmental Chemistry', Freeman and company, New York, (2012).
3. Environmental Chemistry, Eighth Edition, Colin Baird and Michael Cann Manahan, S.E., CRC press(2005)

4. Hand Book of Environmental Microbiology, S.C.Bhatia, Vol 1, 2 and 3, Atlantic Publisher, 2008.
5. Text Book of Environmental Microbiology, Pradipa K. Mohapatra, I.K. International Publishing House pvt. Ltd., 2008
6. A Text Book of Microbiology, R.C. Dubey and D. K. Maheswari S. Chand & Company Ltd - New Delhi, 2013

EM7103 PRINCIPLES OF SUSTAINABLE DEVELOPMENT L T P C
3 0 0 3

OBJECTIVES:

- 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, Precautionary, Action and Collaborative– Syndromes of Global Change: Utilization 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

Nature of sustainable development strategies and current practice**-** Sustainability in global, regional and national context – Rio Plus 20 - Approaches to measuring and analyzing 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. Barry Dalal Clayton and Stephen Bass, Sustainable Development Strategies- a resource book", Earthscan Publications Ltd, London, 2002.
2. Karel Mulder, Sustainable Development for Engineers - A Handbook and Resource Guide, Green Leaf Publishing, 2006.
3. MoEF " Sustainable Development in India –stocktaking in the Run up to Rio plus 20", Ministry of Environment and Forests, Government of India, New Delhi. 2012,
4. UNEP, , Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication, www.unep.org/greeneconomy, ISBN: 978-92-807-3143-9, 2011
5. World Bank "Inclusive Green Growth – The pathway to Sustainable development, World Bank- Washington DC, 2012

MA7160 STATISTICAL METHODS FOR ENGINEERS L T P C
4 0 0 4

OBJECTIVES:

- This course aims at providing the necessary basic concepts of a few statistical methods and apply them to various engineering problems.

UNIT I ESTIMATION THEORY 12

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

UNIT II TESTING OF HYPOTHESIS 12

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 12

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 coefficients.

UNIT IV DESIGN OF EXPERIMENTS 12

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

UNIT V MULTIVARIATE ANALYSIS 12

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.

TOTAL : 60 PERIODS

OUTCOME:

- It helps the students to have a clear perception of the power of statistical ideas, tools and would be able to demonstrate the applications of statistical techniques to problems drawn from industry, management and other engineering fields.

REFERENCES:

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

EM7111 ENVIRONMENTAL CHEMISTRY AND MICROBIOLOGY LABORATORY L T P C
0 0 2 1

A: Environmental Chemistry

1. Estimation of hardness and Chloride in Water sample by volumetric titration
2. Spectrophotometric / Colorimetric determination of sulphate and phosphate
3. Determination of Solids, COD and BOD in wastewater sample

B: Environmental Microbiology

1. Preparation of culture media, Isolation and Culturing of Microorganisms
2. Gram Staining of bacteria
3. Bacteriological analysis of wastewater (Coliforms & Streptococcus) – MPN and MF Techniques

TOTAL: 30 PERIODS

REFERENCES:

1. APHA, "Standard Methods for the Examination of Water and Wastewater", 22nd Ed. Washington, 2012
2. "Laboratory Manual for the Examination of water, wastewater soil, Rump, H.H. and Krist, H. – Second Edition, VCH, Germany, 3rd Edition, 1999.
3. Charles P. Gerba, "Environmental Microbiology: A laboratory manual", Elsevier Publications, 3 rd, 2014

EM7201 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.

UNIT I 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

UNIT II 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

UNIT III 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 - Payback 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 - 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, 2012.Tom Tietenberg, and Lynne Lewis "Environmental and Natural Resource Economics', 9th Edition, Pearson Publishers, 2012.
2. Kolstad, Charles, Environmental Economics", Oxford University Press, New York, 2011
3. R, Y. Ma, J. McGilvray and M. Common, Natural Resource and Environmental Economics, 3rd edition, Pearson Education, Harlow (2003).
4. John Asafu Adjaye, "Environmental Economics for non-Economists – techniques and policies for Sustainable Development, World Scientific, 2005

EM7202 ENVIRONMENTAL POLICIES AND LEGISLATIONS L T P C
3 0 0 3

OBJECTIVES:

- The Third World dilemma between Environment and Development with special reference to economic approaches and human rights concerns will be considered. The course will analyze the legislative and judicial responses to environmental problems and the administrative system of environment related laws such as air, water, land, and hazardous substances etc. Environment advocacy and approaches for using litigation in environment protection will receive special attention

UNIT I INTRODUCTION TO ENVIRONMENTAL LEGISLATIONS INTERNATIONAL SCENARIO 12

Significance of Environmental Law **-**International Environmental Law **-**Development of International Environmental Law **-**Source and General principals of International Environmental Law **-**General rights and obligations of States **-**General Issues of the international law related to environmental protection **-**Stockholm Declaration**-**Rio Declaration on Environment and Development**-**Basel Convention on the Control of Trans boundary Movement of Hazardous Wastes and their disposal**-** Convention of Biological Diversity**-**U.N Frame Work Convention on Climate Change**-**Montreal Protocol on Substances that deplete Ozone Layer**-**Kyoto Protocol**.**

UNIT II POLLUTION CONTROL - INDIAN SCENARIO 6

Indian Constitution and Environmental Protection -Constitutional provisions concerning Environment Articles 14,15,(2) (b) 19 (e),21,31,32,38,39,42,47, 48-A,49,51,51-A: Indian Environmental Policy 2006 Administrative machinery for pollution control Common Law & Criminal Law Nuisance, Negligence, Strict liability and Absolute liability, Provisions of IPC relating to environmental problems (public nuisance u/s 268 and others (Sections 269,270,277,284,285,286,425 to 440) Section 133 of Cr.P.C.

UNIT III REMEDIES FOR ENVIRONMENTAL POLLUTION 6

Common Law Remedies/Remedies under Law of Tort – Penal Remedies – Indian Penal Code and Code of Criminal Procedure – Remedies under Constitutional Law – Writs – Public Interest Litigation - Public Liability Insurance Act, 1991 – The National Green Tribunal Act 2010

UNIT IV MAJOR INDIAN LEGISLATIONS 12

Water Act (1974) Air Act (1981) Environmental Protection Act (1986) Major Notifications, The Municipal solid Wastes (Management and Handling) Rules 2000-Bio Medical Wastes (Management and Handling) Rules 1998- Hazardous Wastes (Management and Handling Rules 1989- Environment Impact Assessment Notifications- Coastal Regulation Zone Notification- Public Hearing Notifications

UNIT V ENVIRONMENT AND DEVELOPMENT CASE LAWS 9

Meaning and concept of development - Its impact on environment; conflict between environment and development, Concept of Sustainable Development., Polluter Pay Principle, Precautionary Principle,PublicTrustDoctrine. Landmark Judgments **-** Olium gas leakage case, Rural Litigation and Entitlement Kendra, Dehradun, (1985) Supp SCC 487) Vellore Citizen Welfare Forum v. Union of India, (1996) 5SCC 647) Ganga Pollution case (1988) I SCC) S. Jagannath v. UOI (1997) SCC867) Vellore Citizens welfare forum case M.C. Mehta V. Kamalnath (1997) I SCC 388)

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course the students will have

- To know the origins and sources of environmental laws, and understand how and by whom environmental laws are made and interpreted.
- To understand the key principles of, and actors within, environmental laws
- To critically analyze environmental laws within various contexts and to evaluate laws against procedural and substantive criteria.
- On completion of the course, Student will have through legal knowledge and the Legal system operating in India and will be in a position to prepare compliance reports for getting environmental clearance.

REFERENCES:

1. Leelakrishnan P., Environmental Law in India, Butterworths,1998
2. Leelakrishnan P., Environmental Case Book, Lexis Nexis,2000
3. Shanthakumar S. , Environmental Law – An Introduction, Butterworths,2004
4. ShyamDiwan and Armin Rosencranz, EnviromentalLaw and Policy in India, Oxford,2001
5. Statutory Materials
6. Bare Act/s
7. Hand Book of International Environmental Law UNEP Publication
8. Alan Boyle and Patricia Bernie, International Law and Environment, Oxford,1997
9. Philippe Sands, Principles of International Environmental Law, Cambridge,1998
10. Elli Louka, International Environmental Law, Cambridge,1999

EM7251 ENVIRONMENTAL IMPACT AND RISK ASSESSMENT L T P C
3 0 0 3

OBJECTIVES:

- 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-EIA Consultant Accreditation.

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.

UNIT IV ENVIRONMENTAL MANAGEMENT PLAN 7

EIA Report preparation. 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. Raghavan K. V. and Khan A., 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.

EM7301 ENVIRONMENTAL MANAGEMENT SYSTEMS AND AUDITING L T P C
3 0 0 3

OBJECTIVES:

- 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 audit 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 system 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 Organizations.

REFERENCES:

1. Philipp Weir and Jörg Bentlage, Environmental Management Systems and Certification, Baltic University Press, Uppsala 2006
2. Lennart Nilsson, Per Olof Persson Lars Rydén, Siarhei Darozhka and Audrone Zaliauskiene, Cleaner Production-Technologies and Tools for Resource Efficient Production, Baltic University Press, Uppsala, 2007
3. Christopher Sheldon and Mark Yoxon, "Installing Environmental management Systems – a step by step guide" Earth scan Publications Ltd, London, 1999.
4. ISO 14001/14004: Environmental management systems – Requirements and Guidelines – International Organization for Standardization, 2004
5. ISO 19011: 2002, "Guidelines for quality and/or Environmental Management System auditing, Bureau of Indian Standards, New Delhi, 2002
6. Paul L Bishop 'Pollution Prevention: Fundamentals and Practice', McGraw- Hill International, Boston, 2004.
7. Marek Bugdol and Piotr Jedynak, Integrated Management Systems, Springer International, 2015.

EM7311 INDUSTRIAL TRAINING L T P C
0 0 0 1

OBJECTIVE:

- To train the students in the field work so as to have a firsthand knowledge of practical problems related to Environmental Management in carrying out engineering tasks.
- To develop skills in facing and solving the field problems.

SYLLABUS:

The students individually undertake training in reputed Industries during the summer vacation for a specified period of two weeks. At the end of training, a detailed report on the work done should be submitted within ten days from the commencement of the semester. The students will be evaluated through a viva-voce examination by a team of internal staff.

OUTCOME:

- They are trained in tackling a practical field/industry orientated problem related to Environmental management

EM7312 SEMINAR L T P C
0 0 2 1

OBJECTIVE:

- To work on a specific technical topic in Environmental Management and acquire the skills of written and oral presentation.
- To acquire writing abilities for seminars and conferences.

SYLLABUS:

The students will work for two hours per week guided by a group of staff members. They will be asked to give a presentation on any topic of their choice related to Environmental Management and to engage in discussion with the audience. A brief copy of their presentation also should be submitted. Similarly, the students will have to present a seminar of not less than fifteen minutes and not more than thirty minutes on the technical topic. They will defend their presentation.

Evaluation will be based on the technical presentation and the report and also on the interaction shown during the seminar.

TOTAL: 30 PERIODS

OUTCOME:

- The students will be trained to face an audience and to tackle any problem during group discussion in the Interviews.

EM7313 PROJECT WORK (PHASE I) **L T P C**
0 0 12 6

OBJECTIVE:

- To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature.
- To develop the methodology to solve the identified problem.
- To train the students in preparing project reports and to face reviews and viva-voce examination.

SYLLABUS:

The student individually works on a specific topic approved by faculty member who is familiar in this area of interest. The student can select any topic which is relevant to his/her specialization of the programme. The topic may be experimental or analytical or case studies. At the end of the semester, a detailed report on the work done should be submitted which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work. The students will be evaluated through a viva-voce examination by a panel of examiners including one external examiner.

TOTAL: 180 PERIODS

OUTCOME:

- At the end of the course the students will have a clear idea of his/her area of work and they are in a position to carry out the remaining phase II work in a systematic way.

EM7411 PROJECT WORK (PHASE II) **L T P C**
0 0 24 12

OBJECTIVE:

- To solve the identified problem based on the formulated methodology.
- To develop skills to analyze and discuss the test results, and make conclusions.

SYLLABUS:

The student should continue the phase I work on the selected topic as per the formulated methodology. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report should be prepared and submitted to the head of the department. The students will be evaluated through based on the report and the viva-voce examination by a panel of examiners including one external examiner.

TOTAL: 360 PERIODS

OUTCOME:

- On completion of the project work students will be in a position to take up any challenging practical problem and find better solutions.

EM7001 CLIMATE CHANGE AND MODELING L T P C
3 0 0 3

OBJECTIVES:

- 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. "A Climate Modelling Primer, Third Edition, John Wiley & Sons, Ltd, Chichester, UK. ,2005
3. Neelin David J, "Climate Change and Climate Modelling", Cambridge University Press
4. Thomas Stocker, "Introduction to Climate Modelling", Advances in Geophysical and Environmental Mechanics and Mathematics. Springer Publication.

EM7002 ECOLOGICAL ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

- 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.

TOTAL: 45 PERIODS

OUTCOMES:

A student completing the course is expected to be able to:

- Understand the concepts of ecological engineering and its role in waste treatment.
- Understand the ecosystems and Eco technology and their applications.
- Understand and appreciate the functions of an ecosystem and nutrient turnover.

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.
5. Alan Sitkin. Principles of Ecology and Management, Good Fellow Publishers.,2011
6. Michael, J.G. Van and Eeten Emery Roe.. Ecology, Engineering and Management, Oxford Univ. Press. ,2002.

EM7003 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.

EM7004 ENVIRONMENTAL QUALITY MONITORING L T P C
3 0 0 3

OBJECTIVES:

- 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.

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.

TOTAL: 45 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; 2nd Edition , 2005,
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

EM7005 LIFE CYCLE ASSESSMENT L T P C
3 0 0 3

OBJECTIVES:

- 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 . Eco design 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 Life Cycle Initiative website, http://www.uneptie.org /sustain / initiative, 2004.

EM7006 NATURAL RESOURCES MANAGEMENT L T P C
3 0 0 3

OBJECTIVE:

- To understand the importance of natural resources and strategies for its sustainable management.

UNIT I INTRODUCTION 9

Importance of the Environment and Natural Resources - A brief account of natural resources and their utilization and conservation in India. Sustaining the Environment -Resource Conservation - Population Demands. International and National Policy instruments. Principles of integrated Natural Resource Management.

UNIT II LAND AND WATER RESOURCES MANAGEMENT 9

Locations of minerals and their importance. - Soil Resources - Erosion- Land use and management issues - Range management. Conservation Practices. Water use plans. Marine, Brackish and Freshwater habitats and their management. Integrated water resources management- Water allocation, markets, pricing, and conservation.

UNIT III BIORESOURCES MANAGEMENT 9

Wetlands preservation and management. Forestry-trees and their growth-products and benefits-management of pest and disease-principal of land surveys-estimating timber and wood product volume. Aquaculture -fisheries-optimal harvesting, stock recovery, and assessing extinction risk. Wildlife management - -habitat requirements of wildlife. The human impact on wildlife -Sustaining wildlife. Recent trends in wildlife management.

UNIT IV ENERGY RESOURCES 9

Renewable and Non renewable sources of energy and their management- Fossil fuel management - coal, oil and petroleum, oil shale, natural gas. Wind Energy- prospects and limitations. Solar energy – applications for rural and urban energy subsidy. Wave, Tidal, Geothermal energy. Bio-energy – wood , fuels from crops - ethanol production and its importance-biodiesel production and its importance.

UNIT V ECONOMICS OF NATURAL RESOURCES 9

Systems approach in natural capital management. Fundamentals of renewable and non-renewable resource economics. Valuation of natural resources - Environmental accounting, Ecological footprints, Bioprospecting for genetic resources - Principles of handling risk, uncertainty, and sensitivity. Decision making under uncertainty and option value. Understanding the Stakeholders approach- Subsistence groups- Governments- Academic institutions- Conflicts and competing uses

TOTAL: 45 PERIODS

OUTCOMES:

- The students will understand the importance of natural resources
- Development of Water and land resource management strategies
- Management of Bioresources

REFERENCES:

1. Natural Resource Management: Need for 21st Century/Sunit Gupta and Mukta Gupta. 1998, Community-Based Natural Resource Management: Issues and Cases from South Asia by Ajit Menon, Praveen Singh, Esha Shah, Sharachchandra Lélé, Suhas Paranjape and K.J.Joy, SAGE, 2007
2. Natural Resources Management Practices: A Primer. by Peter F. Ffolliott, Luis A. Bojorquez- Topia, Mariano Hernandez-Narvaez, 2001, Iowa State University Press Remote Sensing And Gis For Natural Resource Management, Bir Abhimanyu Kumar, Academic Excellence Publishers, 2007.
3. Sustainable Natural Resource Managemant,Abiud Kaswamila, CBS Publishers and Pvt Ltd.,India, 2012.

EM7007 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 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.

EM7008 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 10

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 CASE STUDIES 9

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

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
- Ability to employ modern engineering tools in environmental studies
- Ability to function on a multi-disciplinary team

REFERENCES:

1. Lillesand, T.M. and Kiefer, R.W, "Remote sensing and image interpretation", John Wiley and sons, New York, 2014.
2. Golfried Konechy, Geoinformation: "Remote sensing, Photogrammetry and Geographical Information Systems", CRC press, 1st Edition, 2012.
3. Burrough, P.A. and McDonnell, R.A., "Principles of Geographic Information systems" Oxford University Press, New York, 2011.
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, 2011.

EM7009 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. Manual on Sewerage and Sewage Treatment, Govt. of India, 1999.
2. Metcalf & Eddy, Wastewater Engg. Treatment and Reuse, Tata McGraw Hill, New Delhi, 2000.
3. Todd, D.K. Ground Water Hydrology, John Wiley & Sons, New York, 2000.
4. Manual on Water Supply and Treatment, Govt. of India (CPHEEO) (2013).
5. Hand Book of Drinking Water Quality, 2nd Edition, DeZuane J. John Wiley & Sons, New York 2013.

EN7071 AIR POLLUTION CONTROL ENGINEERING L T P C
3 0 0 3

OBJECTIVE:

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

UNIT I INTRODUCTION 7

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

UNIT II AIR POLLUTION MONITORING AND MODELLING 7

Ambient and Stack Sampling and Analysis of Particulate and Gaseous Pollutants -Effects of meteorology on Air Pollution - Fundamentals, Atmospheric stability, Inversion, Wind profiles and stack plume patterns- Transport & Dispersion of Air Pollutants – Modeling Techniques – Air Pollution Climatology.

UNIT III CONTROL OF PARTICULATE CONTAMINANTS 10

Factors affecting Selection of Control Equipment – Gas Particle Interaction, – Working principle, Design and performance equations of Gravity Separators, cyclones, 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 10

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 AUTOMOBILE AND NOISE POLLUTION 11

Vehicular Pollution: Automobile emission- Types of emissions- Exhaust emissions, evaporative emissions, crank-case emissions- Prevention and control of vehicular pollution.

Noise Pollution: Sources and Effects of Noise Pollution – Measurement – Standards –Control and Preventive measures. Sources types and control of indoor air pollutants, sick building syndrome types – Radon Pollution and its control.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Apply sampling techniques and Suggest suitable air pollution prevention equipments and techniques for various gaseous and particulate pollutants.

REFERENCES:

1. Lawrence K. Wang, Norman C. Parelra, Yung Tse Hung, "Air Pollution Control Engineering", Tokyo, 2004.
2. Noel de Nevers, "Air Pollution Control Engg"., 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”, Fourth Edition,2008.

EN7072 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- Integrated solid 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,

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-remediation of contaminated sites.

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
- Design the different elements of waste management systems.

REFERENCES:

1. George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, “Integrated Solid Waste Management, Mc-Graw Hill International edition, New York, 1993.
2. CPHEEO, “Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organization Government of India, New Delhi, 2014.
3. William A. Worrell, P. Aarne Vesilind, Solid Waste Engineering, Cengage Learning, 2012.
4. Michael D. LaGrega, Philip L Buckingham, Jeffrey C. E vans and "Environmental Resources Management, Hazardous waste Management", Mc-Graw Hill International edition, New York,2010.
5. John Pitchtel,Waste Management Practices, CRC Press,Taylor and Francis Group,2014.
6. Frank Kreith, George Tchobanoglous ,Handbook of Solid Waste management,Mc Graw Hill, 2002

EN7251 INDUSTRIAL WASTEWATER POLLUTION - PREVENTION AND CONTROL

L T P C
3 0 0 3

OBJECTIVE:

- To impart knowledge on the concept and application of Industrial pollution prevention, cleaner 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.

UNITI 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 & WASTE MINIMISATION 8

Prevention vis a vis 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 & Promoting Pollution Prevention Programs in Industries.

UNIT III INDUSTRIAL WASTEWATER TREATMENT 10

Flow and Load Equalization – Solids Separation – Removal of Fats, Oil & Grease- Neutralization – Removal of Inorganic Constituents – Precipitation, Heavy metal removal, Nitrogen & Phosphorous removal, Ion exchange, Adsorption, Membrane Filtration, Eletrodialysis & 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”, Elsevier, 2007.
5. Wesley Eckenfelder W., “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.
7. Waste water Treatment for pollution control and reuse by soil J.Arceivala, Shyam.R.Asolekar, Tata Mcgraw Hill, 2007