JNTUA College of Engineering (Autonomous), Ananthapuramu
DEPARTMENT OF CHEMICAL ENGINEERING

M. Tech Environmental Engineering
Course Structure & Detailed Syllabus

I SEMESTER

Course No.	Name of the course	Periods per week			Maximum marks			Credits
		Lec	Lab	Total	Ext	Int	Total	
16D62101	Principles of Environmental Science	4	-	4	60	40	100	4
16D62102	Environmental Policies &Legislation	4	-	4	60	40	100	4
16D62103	Environmental Impact Assessment	4	-	4.	60	40	100	4
16D62104	Mathematical Modeling and Simulation	4	-	4	60	40	100	4
16D62105	Instrumental Techniques in Environmental Analysis	4	-	4	60	40	100	4
	Elective - I	4	-	4	60	40	100	4
16D62110	Lab-I: Environmental Pollution Monitoring Laboratory	-	4	4	60	40	100	2
	Total	24	4	28	420	280	700	26

Elective – I

1. **16D62106**-Water Resources Systems Management
2. **16D62107**-Occupational Health & Safety
3. **16D62108**-Environmental Economics and Management
4. **16D62109**-Environmental Biotechnology

II SEMESTER

Course No.	Name of the course	Periods per week			Maximum marks			Credits
		Lec	Lab	Total	Ext	Int	Total	
16D62201	Transport of Water and Wastewater	4	-	4	60	40	100	4
16D62202	Physicochemical Processes in Water and Waste Water	4	-	4	60	40	100	4
16D62203	Principles and Design of Biological Treatment Systems	4	-	4	60	40	100	4
16D62204	Atmospheric Environmental Pollution And Control	4	-	4	60	40	100	4
16D62205	Solid & Hazardous waste Management	4	-	4	60	40	100	4
	Elective-II	4	-	4	60	40	100	4
16D62210	Lab-II: Environmental Pollution Control Lab		4	4	60	40	100	2
15D54201	Research Methodology (Audit course)	2	-	2	-	-	-	-
	Total	24	4	36	420	280	700	26

Elective – II

1.**16D62206-**Energy and Environment
2. **16D62207-**Principles of Cleaner Production
3. **16D62208 -**Environmental Sustainability
4. **16D62209 -** RS and GIS for Environmental Management

III & IV SEMESTER

Course No.	Name of the course	Period	Max. marks		
			Exam	Sess.	Total
	Seminar	One Semester	Internal	100	100
	Project	Two Semesters	Viva-Voce	----	----

PRINCIPLES OF ENVIRONMENTAL SCIENCE

UNIT I:

Introduction:

Law of Mass Action – Chemical equilibria – Chemical kinetics – Colloidal Chemistry, Corrosion, Solubility of gases in water (Henry's Law) and the Carbonate system.

UNIT II:

Aim - scope and applications of Ecology, Ecological Engineering and Ecotechnologyandtheir relevance to human civilization - Development and evolution of ecosystems -Principles and concepts pertaining to communities in ecosystem - Energy flow andmaterial cycling in ecosystems - Productivity in ecosystems.

UNIT III:

Water Quality-Physical, Chemical and Biological parameters of water- Water Qualityrequirement - Potable water standards -Wastewater Effluent standards -Water quality indices.

UNIT IV:

Chemistry of Atmosphere &Aquatics:

Structure of the atmosphere – Photochemistry of the atmosphere – ozone layerdepletion – Acid rain – Greenhouse gases and global warming.

Soil Physical& Chemical properties – Cation Exchange Capacity. Soil pH – Salt affected soil – Trace metals in soils

Types of Reactions for Various Water bodies including Marine environment.

UNIT V:

Global Environmental Issues:

Ecological and Carbon Foot Print, Carbon Credits, Carbon sequestration, Clean Development Mechanism.

Case Studies: Major Environmental Disasters – Chernobyl Incident – Fukushima Incident – Tsunamis.

Text Books:

1. Biswarup Mukherjee, Environmental Biology, Tata McGraw Hill Publishing Company Limited, New Delhi, 1997.
2. IgnaciMuthu S, 'Ecology and Environment' Eastern Book Corporation, 2007.

References:

3. Manohaan, S.E., Environmental Science and Technology, Lewis Publication, New York, 1997.
4. Sawyer, C.N., McCarty, P.L. and Parkin, G.F. Chemistry for Environmental Engineers, 4th Edition, McGraw Hill, New Delhi, 1994.
5. De, A.K. Environmental Chemistry, New Age International Limited, New Delhi, 1995.
6. Krebs, Charles J. 2001. Ecology: The Experimental Analysis of Distribution and Abundance.5th edition.
7. Mitsch, J.W. and Jorgensen, S.E., Ecological Engineering, An Introduction to Ecotechnology, John Wiley & Sons, New York, 1989.

ENVIRONMENTAL POLICIES AND LEGISLATION

UNIT I

Introduction: 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, Kyotoagreement, 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: Power & functions of regulatory agencies - responsibilities of Occupier Provision relating toprevention and control Scheme of Consent to establish, Consent to operate – Conditionsof the consents – Outlet – Legal sampling procedures, State Water Laboratory – AppellateAuthority – Penalties for violation of consent conditions etc. Provisions forclosure/directions in apprehended pollution situation.

UNIT III

Air (P&CP) Act, 1981: Power & functions of regulatory agencies - responsibilities of Occupier Provision relating toprevention and control Scheme of Consent to establish, Consent to operate – Conditionsof the consents – Outlet – Legal sampling procedures, State Air Laboratory – AppellateAuthority – Penalties for violation of consent conditions etc. Provisions forclosure/directions in apprehended pollution situation.

UNIT IV

Environment (Protection) Act 1986: Genesis of the Act – delegation of powers – Role of Central Government - EIA Notification– Sitting of Industries – Coastal Zone Regulation - Responsibilities of local bodiesmitigation scheme etc., for Municipal Solid Waste Management - Responsibilities ofPollution Control Boards under Hazardous Waste rules and that of occupier, authorization – Biomedical waste rules – responsibilities of generators and role of Pollution ControlBoards

UNIT V

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

REFERENCES

1. CPCB, “Pollution Control acts, Rules and Notifications issued there under “PollutionControl Series – PCL/2/1992, Central Pollution Control Board, Delhi, 1997.
2. Shyam Divan and Armin Roseneranz “Environmental law and policy in India “OxfordUniversity Press, New Delhi, 2001.
3. GregerI.Megregor, “Environmental law and enforcement”, Lewis Publishers, London.1994.

ENVIRONMENTAL IMPACT ASSESSMENT

Unit -I:

Basic concept of EIA and Methodologies: Initial environmental Examination, Elements of EIA,factors affecting EIA Impact evaluation and analysis, preparation of Environmental Base map,Classification of environmental parameters.

Unit-II:

EIA Methodologies: Introduction, Criteria for the selection of EIA Methodology, EIA methods, Ad-hoc methods, matrix methods, Network method Environmental Media Quality Index method, overlay methods, cost/Benefit Analysis.

Unit-III:

Impact of Developmental Activities and Land use. Introduction, Methodology for theassessment of soil and ground water, Delineation of study area, Identification of activities.Assessment of Impact of development Activities on Vegetation and wildlife, environmental Impactof Deforestation – Causes and effects of deforestation.

Unit-IV:

Prediction and Assessment of Impact: Quality, Impact prediction, Assessment of Impactsignificance, Identification and Incorporation of mitigation measures. EIA in surface water, Airand Biological environment: Methodology for the assessment of Impacts on surface waterenvironment, Air pollution sources, generalized approach for assessment of Air pollution Impact.

Unit-V:

Environmental Audit & Environmental legislation: objectives of Environmental Audit, Types ofenvironmental Audit, Audit protocol, stages of Environmental Audit, on-site activities, evaluationof Audit data and preparation of Audit report. Casestudies and preparation: of Environmental Impact assessment statement for various Industries.

TEXT BOOKS:

1. Environmental Impact Assessment Methodologies, by Y. Anjaneyulu, B.S.Publication, Sultan Bazar, Hyderabad.
2. Environmental Science and Engineering, by J. Glynn and Gary W. Hein Ke, Prentice Hall Publishers

REFERENCE BOOKS:

1.Cauter R.L, Environmental impact Assessment, McGrawHill International Edition,1997
2. John G Rau and David C Wooten, Environmental impact Analysis hand book, McGrawHill Book Company 1980
3. Environmental Science and Engineering, by Suresh K. Dhaneja – S.K.,Katania&Sons Publication., New Delhi
4. Environmental Pollution and Control, by Dr H.S. Bhatia – Galgotia Publication (P)Ltd

MATHEMATICAL MODELING AND SIMULATION

UNIT-1:Fundamentals of modeling:
Principles & uses of modeling, classification of mathematical models-steady state Vs dynamic models, lumped Vs distributed parameter models, deterministic Vs stochastic models.
Examples of mathematical models-Two heated tanks, constant volume CSTRs, Gravity flow tank, Dynamics of first order & second order systems (Mercury in glass thermometer, Damped vibrator)
UNIT-2:Empirical model building- method of least squares, linear, polynomial and multiple regression, non-linear regression.**Solution of simultaneous algebraic equations***:* Direct methods: Gauss-elimination method, Gauss–Jordan method, Iterative methods: Jacobi's method, Gauss-Siedal method.
UNIT-3:Solution of ODEs:Euler method, Runge-Kutta method, Milne's Predictor-Corrector method **Solution of PDEs**: Elliptic equations-one dimensional, parabolic equation-hyperbolic equation- partial differential equations-separation of variables-wave equation.

UNIT-4:Finite Difference: Difference operator (Δ), operator E, Interpolation, Formulation of linear and non-linear finite difference equations. **Advanced methods for Differential Equations**: method of lines, Orthogonal Collocation, Finite Volume Method.

UNIT-5:
Distributions: Binomial, Poisson and Normal distributions - Definitions, Simple problemsonly (Derivations not included). Sampling Distributions - Tests based on Normal, t, Chi-Square and FDistributions.One way and Two way classification of ANOVA.

Text Books:

1. S.C. Chapra and R.P.Canale, "Numerical methods for Engineers", Tata McGraw Hill, New Delhi, 2002.
2. Erwin Kreyzig, "Advanced Engineering Mathematics", John Wiley & Sons, 2004.

References:

1. Jenson and Jeffery, Mathematical Methods in Chemical Engineering,
2. Mickley, Reid and Sherwood, Applied Mathematics in Chemical Engineering, Tata-McGraw-Hill, New Delhi
3.Zill, Dennis and Cullen, Michael Advanced Engineering Mathematics,3rd Edition, 2006, Jones and Bartlett, Publisher

INSTRUMENTAL TECHNIQUES IN ENVIRONMENTAL ANANLYSIS

Unit I:

Treatment of Data in Quantitative Analysis: Accuracy, Precision, Standard deviation, Types of errors, Minimization of errors. Significant figures, Criteria for rejection of data, Principles of instrumentation.

Unit II:

Spectrophotometric Methods: Principles, applications, advantages & limitations of the following Spectrophotometric methods: UV Spectrophotometer,Fluorimetry, Nephelometry and Turbidimetry.

Unit III:

Spectrophotometric Methods: Atomic absorption spectrophotometry, Flame photometry, Inductively coupled plasma spectroscopy & Mass spectroscopy.

Unit IV:

Electrochemical Methods: Principles, applications, advantages & limitations of following electrochemical methods: Pulse polarography, cyclic voltametry& anode stripping voltametry, Electrophoresis.

Unit V:

Chromatography: Principles, applications, advantages & limitations of following chromatographic methods: Adsorption, Partition, Column chromatography, Paper chromatography, Gas chromatography, High Performance Liquid Chromatography (HPLC), Ion-chromatography.

BOOKS & REFERENCES:

1. Instrumental Methods of analysis, Willard H H& Dean LL, John Willey, 1976.
2. Modern Methods of chemical analysis Recsok RL, & Shields LD, John Willey & sons, Inc 1990.
3. Instrumental Methods of chemical analysis, Ewing GW, McGrw Hill Book Company, Inc. 1975.
4. Fundamental of molecules spectroscophy. Banwell CN, McGraw Hill, NY, 1990.
5. Vogels textbook of Quantitative chemical analysis, Third Ed.

ELECTIVE-I
WATER RESOURCES SYSTEMS MANAGEMENT

UNIT I

Rainwater Harvesting and Management – Different Types and Methods of Harvesting in urban and agricultural areas.

UNIT II

Design of Dams, Non gravity dams, Weirs and Barrages, Conjunctive use of Irrigation water,Quality of Irrigation water, Contaminants and their effects on various crops

UNIT III

Reservoir Planning, Management, Multi Reservoir Systems, Real Time Operation, River Basin Planning, Water Logging, Soil Salinity, Salinity Control.

UNIT IV

Draught analysis, NCA classification, Direct and Indirect losses, Drought severity assessment,Drought Monitoring, Drought Management

UNIT V

Global Efforts - Think Globally: Act Locally on water resources - Man ware on water resource management Local water organizations; WUGs, WUAs, - World water organizations; UN, GWP, WWC, etc.

REFERENCES

1. Dilip Kumar Majumdar, “Irrigation Water Management (Principles & Practices)”, Prentice Hall ofIndia (P), Ltd, 2004.
2. Water Resources Systems, “Vedula&Mujumdar”, McGrawHill, 2005.
3. Daniel P. Loucks “Water Resources systems Planning and Management(Studies and Reports inHydrology) “, 2006.

ELECTIVE-I
OCCUPATIONAL HEALTH & SAFETY

Unit – I

Introduction, Factors Contributing to the Costs of Accidents, List of some Notable accidents in the process industry/selected case histories, some common features of high cost accidents, reasons for high priority towards safety.

Unit – II

Material hazards1: Introduction Hazardous substances-categories, Toxicity, Radiation, Flammability, Ignition, Fires and explosions.

Unit – III

Material hazards 2: Fire balls, Fire damage, run away chemical reaction, incompatible materials, material safety and data sheets

Process and plant Hazards: Hazards of pressure, causes of over pressures, flow deviations, effects of leakages/releases, hazards of temperatures.

Unit – IV

Hazard analysis: process safety management, process hazards analysis, hazards analysis methods, check list, preliminary hazard analysis, what-if / check list, hazard and operability analysis, FMEA, Fault tree analysis, cause and consequence analysis.

Unit – V

Preventive and protective measures: Safety options, process safety approaches, inherent safety and design, plant layout, inherent security, explosion prevention and protection, personal protective systems, plant modifications and management change, relief valves and rupture discs, breather vents for storage tanks, explosions vents, flame arresters, flare systems

TEXT BOOK:

1. Chemical process industry safety by K S N Raju, Mc-Graw Hill education (India) Pvt.Ltd,2014
2. Chemical process Safety by Crowl

REFERENCES:

1. Chemical process safety by sanders

OUTCOMES:

- The student will be equipped with the knowledge by which thorough safety is ensured in the organization.
- Classify and identify hazards in chemical industries
- Take precautions in chemical storage and handling
- Perform fault tree and event tree risk analysis and quantify them
- Suggest and make others in the plant about emergency management plans

ELECTIVE-I
ENVIRONMENTAL BIOTECHNOLOGY

UNIT I

Environmental Biotechnology – Principles and concepts –usefulness to mankind. Degradation of highconcentrated toxic pollutants – halogenated non halogenated, petroleum hydrocarbons, metals-Mechanisms of detoxification – oxidation – dehalogenation- biotransformation of metals –biodegradation of solid wastes.

UNIT II

Biotechnological remedies for environmental pollution- decontamination of groundwaterbioremediation– Production of proteins- biofertilizers – Physical, chemical and microbiological factorsof composting – health risk- pathogens- odor management.

UNIT III

Mircobial cell/enzyme technology – adapted microorganisms – biological removal of nutrients – algalbiotechnology – extra cellular polymers – Biogas technology.

UNIT IV

Concept of rDNA technology – expression vectors – cloning of DNA mutation – construction of microbial strains – radioactive probes – protoplast fusion technology applications.

UNIT V

Environmental effects and ethics of microbial technology – genetically engineered organisms – Microbial containment – Risk assessment.

TEXT BOOKS:

1. Chaudhury, G.R. Biological degradation and bioremediation of toxic chemicals, Dioscorides Press, Oregon, 1994.
2. Martin. A.M. Biological degradation of wastes, Elsevier Applied Science, London, 1991.
3. Blaine Metting .F (Jr.,) Soil Microbiology Ecology, Marcel Dekker Inc., 1993.
4. Wainwright, M, “An Introduction to Environmental Biotechnology”, 2009

ELECTIVE-I
ENVIRONMENTAL ECONOMICS AND MANAGEMENT

Unit– I

Sustainable Development: Introduction to sustainable development - Economy-Environment inter-linkages - Meaning ofsustainable development - Limits to growth and the environmental Kuznets curve – Thesustainability debate - Issues of energy and the economics of energy – Non-renewable energy,scarcity, optimal resources, backstop technology, property research, externalities, and theconversion of uncertainty.

Unit– II

Environmental Degradation: Economic significance and causes of environmental degradation - The concepts of policy failure,externality and market failure - Economic analysis of environmental degradation - Equi-marginalprinciple.

Unit– III

Economics of Pollution: Economics of Pollution - Economics of optimal pollution, regulation, monitoring andenforcement - Managing pollution using existing markets: Bargaining solutions – Managingpollution through market intervention: Taxes, subsidies and permits.

Unit– IV

Cost – Benefit Analysis: Economic value of environmental resources and environmental damage - Concept of TotalEconomic Value - Alternative approaches to valuation – Cost-benefit analysis and discounting.

Unit – V

Economics of biodiversity**:** Economics of biodiversity conservation - Valuing individual species and diversity of species -Policy responses at national and international levels. Economics of Climate Change – strenReport

Reference Books

1. D.W. Pearce, A. Markandya and E.B. Barbier (1989), Blueprint for a Green Economy,Earthscan, London.
2. R.K. Turner, D.W. Pearce and I. Bateman (1994), Environmental Economics: AnElementary Introduction, Harvester Wheatsheaft, London.
3. D.W. Pearce and R.K. Turner (1990), Economics of Natural Resources and theEnvironment, Harvester Wheatsheaf, London.
4. Michael S. Common and Michael Stuart (1996), Environmental and ResourceEconomics: An Introduction, 2nd Edition, Harlow: Longman.
5. Roger Perman, Michael Common, Yue Ma and James McGilvray (2003), NaturalResource and Environmental Economics, 3rd Edition, Pearson Education.
6. N. Hanley, J. Shogren and B. White (2001), An Introduction to EnvironmentalEconomics, Oxford University Press.

ENVIRONMENTAL POLLUTION MONITORING LABORATORY

1. To determine pH of a given sample using (i) Universal indicator (ii) pH paper (iii) Digital pH meter
2. To determine the total dissolved solids content indistilled water double distilled water, tap water and reverse osmosis water.
3. To measure mineral acidity and total acidity
4. To determine the alkalinity of given samples.
5. To illustrate the various operations involved in gravimetric analysis and to determine the various categories of solids that are commonly defined in water and wastewater.
6. Energy Auditing of various Engineering Departments of Institute
7. Experiment on determination of total hardness
8. Experiment on determination of Residual chlorine of a given sample
9. Heavy Metal Ion detection using AAS
10. Estimation of Calorific Value of Hazardous Waste

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II SEMESTER
TRANSPORT OF WATER AND WASTEWATER

Unit – I:

General hydraulics and flow measurement: Fluid properties; fluid flow – continuity principle,energy principle and momentum principle; frictional head loss in free and pressure flow, minorheads losses, Carrying Capacity–Flow measurement.

Unit – II:

Water transmission and distribution: Need for Transport of water and wastewater-Planning of Water System –Selection of pipe materials, pipe thickness calculations. Water transmission maindesign- gravity and pumping main; Selection of Pumps- characteristics-economics; Specials,Jointing, laying and maintenance, water hammer analysis.

Unit – III:

Water distribution systems: Water distribution pipe networks, Methods, Design, analysis andoptimization – appurtenances – corrosion prevention – minimization of water losses – leakdetection Storage reservoirs.

Unit – IV:

Wastewater collection and conveyance: Planning factors – Design of sanitary sewer; partialflow in sewers, economics of sewer design. Handling and transport of slurry. Wastewaterpumps and pumping stations- sewer appurtenances; material, construction, inspection andmaintenance of sewers; Design of sewer outfalls-mixing conditions; conveyance of corrosivewastewaters.

Unit – V:

Storm water drainage: Necessity- - combined and separate system; Estimation of storm water run off Formulation of rainfall intensity duration and frequency relationships- Rational methods.

REFERENCES:

1. Bajwa, G.S. Practical Handbook on Public Health Engineering, Deep Publishers, Simla, 2003
2. “Manual on water supply and Treatment”, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 1999.
3. “Manual on Sewerage and Sewage Treatment”, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 1993.

PHYSICOCHEMICAL PROCESSES IN WATER AND WASTEWATER

Unit-I

Mixing, Clarification - Sedimentation; Types; Aeration and gas transfer – Coagulation andflocculation, coagulation processes - stability of colloids - destabilization of colloids, transportof colloidal particles.

Unit-II

Adsorption, adsorption equilibria- adsorption isotherms,
Disinfection - chlorine dioxide;chloramines; ozonation; UV radiation, Ion Exchange-processes

Unit-III

Filtration - theory of granular media filtration; Classification of filters; slow sand filter andrapid sand filter; mechanism of filtration; modes of operation and operational problems;negative head and air binding; dual and multimedia filtration.

UNIT IV

Membrane Processes and Systems: Microfiltration – Ultrafiltration- Nano Filtration – Reverse Osmosis – Electro dialysis-Pervaporation. Membrane Modules: Plate and Frame, Spiral Wound, Tubular, Hollow Fiber module.

UNIT V

Membrane Bioreactors: Introduction and Historical Perspective of MBRs, Biotreatment Fundamentals, BiomassSeparation MBR Principles, Fouling and Fouling Control, MBR Design Principles, DesignAssignment, Alternative MBR Configurations, Commercial Technologies, Case Studies

Books:

1. Weber, W.J. *Physicochemical processes for water quality control*, John Wiley and sons, Newyork, 1983.
2. Peavy, H.S., Rowe, D.R., Tchobanoglous, G. *Environmental Engineering*, McGraw Hills, New York 1985.
3. Metcalf and Eddy, *Wastewater engineering, Treatment and Reuse*, Tata McGraw-Hill, New Delhi, 2003.
4. M.J. Hammer, *Water and Waste Water Technology*, John Wiley & Sons, 1986

PRINCIPLES AND DESIGN OF BIOLOGICAL TREATMENT SYSTEMS

Unit – I:

Principles

Objectives of biological treatment – significance – aerobic and anaerobic treatment kinetics of biological growth – Factors affecting growth – attached and suspended growth Determination of Kinetic coefficients for organics removal – Biodegradability assessment - Selection of processreactors-batch-continuous type-kinetics

Unit – II:

Design of Aerobic Treatment Systems

Design of sewage treatment plant units –Activated Sludge process and variations, Sequencing Batch reactors, Membrane Biological Reactors-Trickling Filters-Bio Tower-RBC-Moving Bed Reactors-fluidized bed reactors, aerated lagoons, waste stabilization ponds – nutrient removal systems – natural treatment systems, constructed wet land – Disinfectant – disposal options – reclamation and reuse – Flow charts, layout, hydraulic profile, recent trends.

Unit – III:

Anaerobic Treatment of Wastewater

Attached and suspended growth, Design of units – UASB, up flow filters, Fluidized beds, septic tank and disposal – Nutrient removal systems – Flow chart Layout and Hydraulic profile – Recenttrends.

Unit – IV:

Sludge Treatment and Disposal

Design of sludge management facilities, sludge thickening, sludge digestion, biogas generation, sludge dewatering (mechanical and gravity) Layout PID hydraulics profile – upgrading existing plants – ultimate residue disposal – recent advances.

Unit – V:

Construction Operations and Maintenance Aspects

Construction and Operational Maintenance problems – Trouble shooting – Planning, Organising and Controlling of plant operations – capacity building, Case studies – sewage treatment plants – sludge management facilities.

References:

1. Arceivala, S.J., Wastewater Treatment for Pollution Control, TMH, New Delhi, Second Edition, 2000.
2. Manual on “Sewerage and Sewage Treatment” CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 1999.
3. Metcalf & Eddy, INC, ‘Wastewater Engineering – Treatment and Reuse, Fourth Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2003.
4. Qasim, S.R. Wastewater Treatment Plant, Planning, Design & Operation, Technomic Publications, New York, 1994.

ATMOSPHERIC ENVIRONMENTAL POLLUTION AND CONTROL

UNIT I

Introduction: sources, effects on – ecosystems, characterization of atmospheric pollutants, air pollution episodes of environmental importance. Indoor Air Pollution– sources, effects.

UNIT II

Meteorology - composition and structure of the atmosphere, wind circulation, solar radiation, lapse rates, atmospheric stability conditions, wind velocity profile, Maximum Mixing Depth (MMD), Temperature Inversions, Windrose diagram.

UNIT III

General characteristics of stack emissions, plume behaviour, heat island effect. Pollutants dispersion models – description and application of point, line and areal sources.

Monitoring of particulate matter and gaseous pollutants –respirable, non-respirable and nano - particulate matter. CO, CO_2, Hydrocarbons (HC), SO_X and NO_X, photochemical oxidants.

UNIT IV

Air Pollution Control equipment for particulate matter & gaseous pollutants– gravity settling chambers, centrifugal collectors, wet collectors, fabric filters, electrostatic precipitator (ESP).

– Adsorption, Absorption, Scrubbers, Condensation and Combustion.

UNIT V

Noise - sources, measurements, effects and occupational hazards. Standards, Noise mapping, Noise attenuation equations and methods, prediction equations, control measures, Legal aspects of noise.

REFERENCES

1. WarkK ., Warner C.F., and Davis W.T., "Air Pollution - Its Origin and Control", Harper & Row Publishers, New York.
2. Lee C.C., and Lin S.D., "Handbook of Environmental Engineering Calculations", McGraw Hill, New York.
3. Perkins H.C., "Air Pollution", McGraw Hill.
4. Crawford M., "Air Pollution Control Theory", TATA McGraw Hill.
5. Stern A.C., "Air Pollution", Vol I, II, III.
6. Seinfeld N.J.,, "Air Pollution", McGraw Hill.
7. Stern A.C. Vol. V, "Air Quality Management".
8. M N Rao and HVN Rao, Air Pollution" Tata McGraw Hill publication

SOLID AND HAZARDOUS WASTE MANAGEMENT

UNIT-I

Types and Sources of solid and hazardous wastes - Need for solid and hazardous wastemanagement - Legislations on management and handling of municipal solid wastes,hazardous wastes, and biomedical wastes, E-waste.

UNIT-II

Waste generation rates – Composition - Hazardous Characteristics – TCLP tests – wastesampling- Source reduction of wastes – Recycling and reuse.

UNIT-III

Handling and segregation of wastes at source – storage and collection of municipal solidwastes – Analysis of Collection systems - Need for transfer and transport – Transfer stations -labeling and handling of hazardous wastes.

UNIT-IV

Waste processing – processing technologies – biological and chemical conversiontechnologies – Composting - thermal conversion technologies - energy recovery –incineration – solidification and stabilization of hazardous wastes - treatment of biomedical
wastes.

UNIT-V

Disposal in landfills - site selection - design and operation of sanitary landfills- securelandfills and landfill bioreactors – leachate and landfill gas management – landfill closure andenvironmental monitoring – landfill remediation.Elements of integrated waste management

Books:

1. George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, Integrated *Solid Waste Management,*
McGraw- Hill, New York, 1993
2. CPHEEO, *Manual on Municipal Solid waste management, Central Public Health and EnvironmentalEngineering Organization*, Government of India, New Delhi, 2000.
3. Vesilind P.A., Worsel, W.A., and Reinhart, D. R., *Solid waste Engineering*, Thomson Brooks/code, 1st Ed 2002
4. Lagrerer, M.D., Buckingham, P.L and Evans, J.C, *Hazardous Waste Management*, 2ndEdn, McGrawhill, 2011

ELECTIVE-II
ENERGY AND ENVIRONMENT

Unit-I:
Importance of Energy, Focus on Energy & Environment, Definition of Energy & Energy Terms, Overview of Energy Sources & Sinks, Basic Energy Problems.

Unit-II:
Oil & Gas Exploration & Production, Oil & Gas Refining, Distribution & Markets, Conventional & Unconventional Reserves & Resources, Oil & Gas Industry Impacts on Water Resources.

Unit-III:
Electric Industry Overview, Ongoing Evolution of the Electric Industry, Electric Industry Impacts on Air Quality, The Science of Climate Change, The Evidence for and Emerging Impacts of Climate Change. Buildings & Energy, Transportation & Energy.

Unit-IV:
Biofuels, Wind Energy, Solar Energy, Other Renewables: Geothermal & Ocean Energy.

Unit-V:
Nuclear Energy, Nuclear Waste, Carbon Capture & Storage, Domestic Energy Policy, International Energy Policy.

TEXT BOOK:

1. Twidell, J.W. and Weir, A., Renewable Energy Sources, 3rd Edn. T&F Ltd., 2015
2. Sukhatme, S.P., Solar Energy, Tata McGraw Hill, 1984.
3. Daniel B. Botkin and Edward A. Keller, Environmental Science: Earth as a Living Planet,New York: John Wiley and Sons, 2014, 9th Edition.

REFERENCES:

1. Kreith, F and Kreider, J. F., Principles of Solar Engineering, McGraw-Hill, 1978.
2. Godfrey Boyle, Renewable Energy, Power for a Sustainable Future, Oxford University Press, U.K, 1996.
3. Veziroglu, T.N., Alternative Energy Sources, Vol 5 and 6, McGraw-Hill, 1990
4. Anthony San Pietro, Biochemical and Photosynthetic aspects of Energy Production,Academic Press, 1980.
5. Bridgurater, A.V., Thermochemical processing of Biomass, Academic Press, 1981.
6. Hart, A.B., and Womack, G. J., Fuel Cells: Theory & Applications, Prentice Hall, 1997.
7. Khandelwal K.C, Mahdi S.S., Biogas Technology - A Practical Handbook, Tata Mc-Graw Hill, 1986.

ELECTIVE-II
PRINCIPLES OF CLEANER PRODUCTION

UNIT-I:

Industrial Activity and Environment – Industrialization and Sustainable Development – Indicators of Sustainability-Sustainability Strategies – Barriers to Sustainability – Industrial Ecology – Pollution Prevention (PP) and Cleaner Production (CP) in achieving Sustainability-Prevention versus Control of Industrial Pollution - Environmental Policies and Regulations to encourage Pollution Prevention and Cleaner Production – Regulatory versus Market-based approaches

UNIT-II:

Concept of Pollution Prevention and Cleaner Production – Definition – Importance - Historical Evolution – Benefits - Promotion - barriers – Role of Industry, Government and Institutions - Environmental Management Hierarchy – Source Reduction techniques – Process and Equipment Optimization, Reuse, Recover, Recycle, Raw material substitution - Internet information and Other PP and CP Resources

UNIT-III:

Pollution Prevention and Cleaner Production- Project development and implementation – Overview of CP Assessment steps and skills, Preparing the site, Information gathering, and Flow diagram, Material balance, PP and CP Option generation, Technical and Environmental Feasibility analysis, Total Cost analysis - PP and CP Financing, Establishing a Program - Organizing a Program- Preparing a program plan - Measuring progress – Pollution Prevention and Cleaner Production Awareness Plan - Waste Audit- Environmental Statement

UNIT-IV:

Life Cycle Assessment and Environmental Management Systems: Elements of LCA - Life Cycle Costing – Eco labeling – Designs for the Environment - International Environmental Standards- ISO 14001 - Environmental Audit.

UNIT-V:

Case Studies: Industrial Applications of PP and CP, LCA, EMS and Environmental Audits.

Reference Books:

1. Paul L. Bishop, “Pollution Prevention: Fundamentals and Practice”, McGraw-Hill International, 2000.
2. World Bank Group, “Pollution Prevention and Abatement Handbook-Towards Cleaner Production”, World Bank and UNE, Washington D.C., 1998.
3. Freeman, H.M, Industrial Pollution Prevention Handbook”, McGraw Hill”, 1995.
4. James G. Mann and V.A. Liu, “Industrial Water Reuse and Wastewater Minimization”, McGraw Hill, 1999.
5. Prasad Modak, C. Visvanathan and MandarParasnis, “Cleaner Production Audit Environmental System Reviews”, No. 38, Asian Institute of Technology; Bangkok, 1995.

ELECTIVE-II
ENVIRONMENTAL SUSTAINABILITY

UNIT-I

Valuing the Environment: Concepts, Valuing the Environment: Methods, Property Rights, Externalities, and Environmental Problems

UNIT-II

Sustainable Development: Defining the Concept, The Population Problem, NaturalResource Economics: An Overview, Energy, Water, Agriculture

UNIT-III

Biodiversity, Forest Habitat, Commercially Valuable Species, Stationary-Source Local AirPollution, Acid Rain and Atmospheric Modification, Transportation

UNIT-IV

Water Pollution, Solid Waste and Recycling, Toxic Substances and Hazardous Wastes,Global Warming.

UNIT-V

Development, Poverty, and the Environment, Visions of the Future, Environmentaleconomics and policy by Tom Tietenberg, Environmental Economics.

REFERENCES

1. Andrew Hoffman, Competitive Environmental Strategy -A Guide for the ChangingBusiness Landscape, Island Press.
2. Stephen Doven, Environment and Sustainability Policy : Creation, Implementation,Evaluation, The Federation Press, 2005.

ELECTIVE-II
RI AND GIS FOR ENVIRONMENTAL MANAGEMENT

UNIT I

Environment

Water - Air-Land-Marine Environment Global Climatologic, urbanEnvironment:

UNIT II

Introduction to Remote Sensing

Role of RS in different types of Environments - Air, Water, Land.GIS formarineenvironment, urban environment.

UNIT III

Concept of Geology

Introduction - spectral characteristics of water, soil, rock-water parameter,pollution studies.

UNIT IV

Introduction to GIS

GIS-introduction-role of GIS - data analysis-thematic maps preparation,modeling.

UNIT V

Application of GIS

GIS for - soil erosion-Land degradation-Ecology-degradation-Coastal marinestudies-water Quality, monitoring and management.

REFERENCES

1. Lilliesand, T.M. and Kiefer, R, W., *"Remote Sensing and ImageInterpretation"*, John Wily and sons, 2004.
2. Burrough, P.A. and, McDonnell, R.A., *"Principles of Geographical Information Systems"*, Oxford University Press, 2009.
3. Lintz, J. and Simonet, *"Remote Sensing of Environment"*, AddisonWesley Publishing Company, 2004.

ENVIRONMENTAL POLLUTION CONTROL LAB

1. Detection of Metals using Atomic Absorption Spectrometer (AAS)
2. Determination of Absorption spectra of liquid samplesusing UV-Vis Spectrometer
3. Determination of IR spectra of liquid samples using FTIR spectrometer
4. Determination of crystallite size of standard crystalline samples using X-ray Diffractometer (XRD)
5. Separation and analysis of compounds using Gas Chromatograph (GC)
6. Separation and analysis of compounds using High Performance Liquid Chromatography (HPLC)
7. Determination of oxidative and reductive peaks of Ferri/Ferro Cyanide couple using Potentiostat.

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RESEARCH METHODOLOGY

(Audit Course For M.Tech. –II Semester Program from 2015 admitted batches onwards)

UNIT I

Meaning of Research – Objectives of Research – Types of Research – Research Approaches – Guidelines for Selecting and Defining a Research Problem – research Design – Concepts related to Research Design – Basic Principles of Experimental Design.

UNIT II

Sampling Design – steps in Sampling Design –Characteristics of a Good Sample Design – Random Sampling Design.

Measurement and Scaling Techniques-Errors in Measurement – Tests of Sound Measurement – Scaling and Scale Construction Techniques – Time Series Analysis – Interpolation and Extrapolation.

Data Collection Methods – Primary Data – Secondary data – Questionnaire Survey and Interviews.

UNIT III

Correlation and Regression Analysis – Method of Least Squares – Regression vs Correlation – Correlation vs Determination – Types of Correlations and Their Applications

UNIT IV

Statistical Inference: Tests of Hypothesis – Parametric vs Non-parametric Tests – Hypothesis Testing Procedure – Sampling Theory – Sampling Distribution – Chi-square Test – Analysis of variance and Co-variance – Multi-variate Analysis.

UNIT V

Report Writing and Professional Ethics: Interpretation of Data – Report Writing – Layout of a Research Paper – Techniques of Interpretation- Making Scientific Presentations in Conferences and Seminars – Professional Ethics in Research.

Text books:

1. Research Methodology:Methods and Techniques – C.R.Kothari, 2nd Edition,New Age International Publishers.
2. Research Methodology: A Step by Step Guide for Beginners- Ranjit Kumar, Sage Publications (Available as pdf on internet)
3. Research Methodology and Statistical Tools – P.Narayana Reddy and G.V.R.K.Acharyulu, 1st Edition,ExcelBooks,New Delhi.

References:

1. Scientists must Write - Robert Barrass(Available as pdf on internet)
2. Crafting Your Research Future –Charles X. Ling and Quiang Yang (Available as pdf on internet)