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COIMBATORE INSTITUTE OF TECHNOLOGY

(Government Aided Autonomous Institution Affiliated to Anna University, Chennai)

VISION AND MISSION OF THE INSTITUTE

VISION

The Institute strives to inculcate a sound knowledge in engineering along with realized social responsibilities to enable its students to combat the current and impending challenges faced by our country and to extend their expertise to the global arena.

MISSION

The mission of CIT is to impart high quality education and training to its students to make them world-class engineers with a foresight to the changes and problems, and pioneers to offer innovative solutions to benefit the Nation and the world at large.

DEPARTMENT OF CIVIL ENGINEERING

VISION AND MISSION OF THE DEPARTMENT OF CIVIL ENGINEERING

VISION

To become an international centre for Civil Engineering Education and Research.

MISSION

To impart quality education to meet the requirements of the industry and academia and an attitude for research and development in Civil Engineering through state-of-the-art infrastructure.

DEPARTMENT OF CIVIL ENGINEERING

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

1. The vital aspect of the programme is to evolve techno-managerially skilled graduates in tackling novel and diversified National and/or global environmental problems with almost self confidence and dynamism.
2. Equip them to industry ready professionals by virtue of their acquired omni potential skills.
3. Act ethically and function righteously in their chosen professional career.

DEPARTMENT OF CIVIL ENGINEERING

M.E. (ENVIRONMENTAL ENGINEERING AND MANAGEMENT)

PROGRAMME OUTCOMES (POs)

On successful completion of the programme, the tangible outcomes are envisaged as mentioned below.

1. Develop technical competency, sound analytical design capabilities, and overall managerial skills.
2. Stead fast dedication and commitment towards resource conservation and sustainable development.
3. Assimilate profound fundamental knowledge pertaining to environmental science and engineering.
4. Exhibit substantially good skills related to environmental science and engineering.
5. Acquire good technical competency with respect to appropriate quantitative laboratory analytical skills.
6. Propose green and clean processes in diversified manufacturing and/or process based industries.
7. Execute EIA process for upcoming industries, with the appropriate protocols.
8. Design, operate, and maintain the various systems and processes in mitigating environmental pollution.
9. Relate and interpret the various anthropogenic activities pertaining to cause-effect oriented development activities.
10. Evolve as leaders in framing futuristic environmental laws and regulations.
11. Develop and execute the environmental based simulations from bench-scale to real time processes.
12. Propagate and uphold environmental ethics, environmental hygiene and sanitation; human empowerment and public participation; through the memberships in selected professional societies of their interest.

COIMBATORE INSTITUTE OF TECHNOLOGY

(Government Aided Autonomous Institution Affiliated to Anna University, Chennai)

M.E. (ENVIRONMENTAL ENGINEERING AND MANAGEMENT)

Curriculum from the Academic Year 2015 - 2016 onwards

Semester I

Code No.	Course Title	L	T	P	C
15MEN11	Applied Statistics and Probability	4	0	0	4
15MEN12	Environmental Chemistry	3	0	0	3
15MEN13	Environmental Microbiology	3	0	0	3
15MEN14	Separation Processes in Environmental Engineering	3	0	0	3
15MEN15	Sustainable Development and Cleaner Production	3	0	0	3
15MEN16	Elective-I	3	0	0	3
	Total				**19**

Semester II

Code No.	Course Title	L	T	P	C
15MEN21	Design of Water and Wastewater Treatment Plants	3	0	0	3
15MEN22	Environmental Impact Assessment	3	0	0	3
15MEN23	Solid and Hazardous Waste Management	3	0	0	3
15MEN24	Air Pollution and Control	3	0	0	3
15MEN25	Elective-II	3	0	0	3
15MEN26	Elective-III	3	0	0	3
15MEN27	Process Engineering Laboratory	0	0	4	2
	Total				**20**

Semester III

Code No.	Course Title	L	T	P	C
15MEN31	Elective - IV	3	0	0	3
15MEN32	Elective - V	3	0	0	3
15MEN33	Elective - VI	3	0	0	3
15MEN34	Practical Training	-	-	-	1
	Total				**10**

Semester IV

Code No.	Course Title	L	T	P	C
15MEN41	Project and Viva Voce	-	-	-	18
	Total				**18**

Total Number of credits to be earned for the award of the degree is 67.

ELECTIVE LIST - Theory Subjects

Sl. No.	Elective Code	Name of the Subject
1	E1	Environmental Biotechnology.
2	E2	Instrumental Methods of Analysis.
3	E3	Adsorption Technology.
4	E4	Noise Pollution and Management.
5	E5	Remote Sensing and GIS Applications in Environmental Engineering.
6	E6	Ecology and Ecosystem Management.
7	E7	Energy Management.
8	E8	Transport of Water and Wastewater.
9	E9	Industrial Wastewater Management.
10	E10	Optimization of Environmental Systems.
11	E11	Environmental Economics and Legislation.
12	E12	Corrosion Engineering.

L - Lecture , T - Tutorial, P - Practical, C - Credit

15MEN11 - APPLIED STATISTICS AND PROBABILITY

L	T	P	C
4	0	0	4

BASIC STATISTICS

Measure of central tendency - Mean (arithmetic, geometric, weighted, and harmonic), median, mode and quartiles - Dispersion - Quartile deviation, mean deviation, standard deviation, variance, coefficient of variation, moments, skewness, and kurtosis - Principle of least square - Correlation and regression, rank correlation coefficient, multiple, and partial correlation coefficients. **(9)**

PROBABILITY THEORY AND RANDOM VARIABLE

Sample space and events - Axioms of probability - Independence and exclusiveness - Theorem on probability - Conditional probability - Baye's theorem and problems - Random variables - Probability mass function, density function, and distribution function - Mathematical expectation. **(9)**

PROBABILITY DISTRIBUTIONS

Discrete distributions: binomial, Bernoulli, Poisson, Pascal, geometric, and their properties - Continuous distributions: normal, log-normal, uniform, exponential, and their properties. **(9)**

THEORY OF SAMPLING AND ESTIMATION

Test of significance - Standard error - Level of significance - Error in sampling - Test of hypothesis - Small sample tests - Student t-test, F-test, and Chi-square test - Test for independence of attributes and goodness of fit - Point and interval estimates for population proportion, mean and variance for both small and large samples. **(9)**

DESIGN OF EXPERIMENTS AND QUEUING THEORY

Basic principles of experimental design - Completely randomized design - Analysis of variance for one way classification - Randomized block design - Analysis of variance for two way classification - Latin square design - Queuing theory - First in first out (FIFO) systems, single server and multi server. **(9)**

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REFERENCES

1. Freund, J.R and Miller, I.R., "Probability and Statistics for Engineers", Prentice-Hall of India, 7th Edition, New Delhi (2006).
2. Gupta.S.C and Kapoor. V.K., "Fundamental of Applied Statistics" S.Chand & Co (2003).
3. Murray R.Spiegel et al., "Schaum's Outline of Theory and Problems of Probability and Statistics", Tata McGraw-Hill, Second Edition (2004).
4. Kandasamy.P. et al., "Probability Statistics and Queuing Theory", S.Chand & Co (2004).
5. Veerarajan. T., "Probability Theory and Random Process", Tata McGraw-Hill, 2nd Edition (2004).

15MEN12 - ENVIRONMENTAL CHEMISTRY

L	T	P	C
3	0	0	3

PHYSICAL CHEMISTRY

Fundamental aspects - Chemical equilibrium and Le Chatelier's principle - Activity coefficients - Complex ions and their classification - Solubility product - Common and diverse ion effects - Basic laws of thermodynamics: enthalpy, entropy, and free energy - Principles of solvent extraction - Chemical kinetics and order of reactions - Consecutive reactions. **(9)**

AQUATIC CHEMISTRY

Ionization and assessment of ion activity coefficients - Ion balancing bar graph - Langelier saturation Index (LSI) - Solution to equilibrium problems - pH and px concepts - Construction and uses of logarithmic concentration diagram - Buffers and buffer index - Complex solubility relationships - Distribution and predominance-area diagrams - Oxidation-reduction equations - pE-pH diagram - Redox potential. **(9)**

SOIL AND ATMOSPHERIC CHEMISTRY

Soil horizons and significance - Soil solution chemistry - pH and CEC of soils - Aggressive and non aggressive soils - Soil sickness and salt efflorescence - Stratospheric and tropospheric ozones - Photochemical oxidants: PAN, O_3, and NO_2 - Acid rain - Green house gases and global warming - Photocatalysis. **(9)**

ORGANIC AND BIOCHEMISTRY

General properties of organic compounds - Molecular, structural, and condensed formula - Isomers - IUPAC system of representation - Typical compounds and essential reactions - Pesticides and their uses - Bioaccumulation of pesticides - Enzymes and cofactors - Enzymatic reaction - Effects of temperature, pH, and trace elements on the reactions - Biochemistry of man: catalysis of carbohydrates, fats, proteins, and vitamins. **(9)**

NUCLEAR CHEMISTRY

Basic neutron-proton concept - Isotopes - Stable and radioactive nuclides - Nature and energies of radiations - Units and measurements of radioactivity - Half-life concept -Applications of radioactivity - Effects of radioactivity on human beings - Disposal aspects of nuclear wastes. **(9)**

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REFERENCES

1. Sawyer, N.C., McCarty P.L. and Parkin, G.F., "Chemistry for Environmental Engineering and Sciences", 5th Edition, McGraw-Hill, N.Y., 2005.
2. Sincero, A.P. and Sincero, G.A., "Environmental Engineering - A Design Approach", PHI Pub., New Delhi, 1996.
3. De, A.K., "Environmental Chemistry", New Age International Ltd., New Delhi,1995.

15MEN13 - ENVIRONMENTAL MICROBIOLOGY

L	T	P	C
3	0	0	3

INTRODUCTION TO MICRO-ORGANISMS

Micro-organisms - Classification, structure, characterization, and environmental significance of bacteria, algae, fungi, and virus - Concepts of DNA, RNA, and plasmids - Distribution of microbes in the environment.

(9)

MICROBIAL METABOLISM

Enzymes and their role in metabolism - Effect of micronutrients - Typical growth in bottle culture and in environment - Metabolism of carbohydrates, fats, proteins, and lignin - ATP-ADP transfer and energy release - Photosynthesis and fermentation - Glycolysis and Kreb's cycle. **(9)**

MICROBIAL BIODEGRADATION

Pathways of degradation: aerobic, anaerobic, and anoxic - Factors affecting microbial activity: genetic potential, bioavailability, contaminant structure, and toxicity - Environmental factors: oxygen, organic matter, nutrients, temperature, pH, salinity, and water availability - Degradation of typical aliphatic, aromatic, and alicyclic compounds by bacteria and fungi. **(9)**

AQUATIC MICROBIOLOGY

Distribution of bacteria and algae in aquatic environment - Indicator organisms - Significance and differentiation of *E.coli, S.fecalis, and Clostridium velchi* - Algae-bacterial symbiosis and diurnal variation of pH - Trophic status of lakes - Cause and effects of benthic deposits - Waterborne disease causing microbes (both bacteria and virus). **(9)**

MICROBIAL CULTURE AND ASSESSMENT

Objectives and scopes of microbial cultures - MTFT and MFT methods - Use of MPN table and Thomas formula - Culture methods for bacteria, fungi, and algae - Culture techniques for specific microbes: fecal *coliforms, Salmonella spp., Staphylococcus, Pseudomonas,* and nitrifying bacteria - Immunoassays - ELISA and Western immunoblotting assay. **(9)**

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REFERENCES

1. Maier, R.M., Pepper, I.L. and Gerba, C.P.,"Environmental Microbiology", Academic Press, U.S.A., 2000.
2. Pelczar Jn., M.J. Chan, E.C.S., Noel, K.R. and Foss, P.M., "Microbiology", 5th Edition, Tata McGraw-Hill, New Delhi,1996.
3. Strainer. R.Y., Ingrahum, J.L., Wheelis, M.C. and Painter, P.R., "General Microbiology", Mac-Millan Ltd., U.S.A., 1989.

15MEN14 - SEPERATION PROCESSES IN ENVIRONMENTAL ENGINEERING

L	T	P	C
3	0	0	3

INTRODUCTION TO SEPERATION PROCESS

Objectives and scope - Physicochemical and biological processes - Types of reactors and their selection - Objectives, applications, principles, operations, and analyses of screening, flow equalization, mechanical mixing, coagulation, and flocculation processes. **(9)**

SOLID-LIQUID SEPERATION PROCESSES

Objectives, applications, principles, operations, and analyses of settling, granular medium filter, and dissolved air flotation - Types and modifications of settling - Kozeny-Carman equation for head loss.**(9)**

ADSORPTION AND GAS-TRANSFER PROCESSES

Objectives, applications, principles, operations and analyses of adsorption, aeration, and stripping processes - Basic isotherms (Langmuir and Freundlich) and break through studies - Types of aerators and oxygen-transfer assessment - Stripping of NH_3 from wastewater. **(9)**

CHEMICAL PRECIPITATION AND DISINFECTION PROCESSES

Objectives, applications, principles, operations, and analyses of chemical precipitation and disinfection processes - Phosphates and hardness removal - Chemistry and methods of chlorination - Modern methods of disinfection. **(9)**

BIOLOGICAL REMOVAL OF VOLATILE SOLIDS

Objectives, principles, and applications of aerobic, anaerobic, and anoxic processes - Applications and principles of suspended and attached growth systems - Moving media systems - Kinetics of growth and Monod kinetics - Laboratory determination of kinetic co-efficients. **(9)**

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REFERENCES

1. Metcalf and Eddy, "Wastewater Engineering: Treatment and Reuse", 3rd Edn.,Tata McGraw-Hill Pub. Com., New Delhi, 2003.
2. Karia, G.L., and Christian, R.A., "Wastewater Treatment: Concepts and Design Approach", Prentice-Hall of India Pvt., Ltd., New Delhi, 2006.

15MEN15 - SUSTAINABLE DEVELOPEMENT AND CLEANER PRODUCTION

L	T	P	C
3	0	0	3

GLOBAL RESPONSE TO SUSTAINABLE DEVELOPEMENT

Historical emergence and various definitions - Environmental issues and crisis - Industrial growth and resource depletion - Components and factors affecting the sustainable development - Complexly of growth and equity - International summits, conventions, and agreements - Transboundary issues - Action plan for implementing sustainable growth - Moral obligations and personal guideline. **(9)**

SUSTAINABLE DEVELOPEMENT OF SOCIO-ECONOMIC SYSTEMS

Socio-economic policies for sustainable development - Strategies for implementing eco development programme - Sustainable development through trade - Economic growth - Carrying capacity - Ecological footprint - Public participation. **(9)**

NATIONAL POLICY AND GLOBAL SUSTAINABLE DEVELOPEMENT

Judicial systems - Relationship between developing and developed countries in sustainable development - Demographic dynamics and sustainability - Integrated approach to resource protection and management. **(9)**

CLEANER PRODUCTION ASSESSMENT

Necessity and overview of CP assessment - Necessary procedure - Steps and skills, field or industry visit and data collection, flow and material balances and process and treatment flow sheets - Feasible CP options - Typical case studies. **(9)**

LIFE CYCLE ASSESSMENT

Definition and necessity - Elements of LCA - Life cycle cost - Green chemistry - Eco labeling - Design for the environment - International environmental standards - ISO:14001 series - Environmental audit. **(9)**

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REFERENCES

1. Bishop, P., "Pollution Prevention: Fundamentals and Practice", McGraw-Hill International Edn., New York, 2000.
2. World Bank Group, "Pollution Prevention and Abatement Hand Books towards Cleaner Production", World Bank and UNEP, Washington, D.C., 1998.
3. Kirkby, J.O., Keefe, P., and Timberlake. "Sustainable Development", Earthsean Pub., London, 2001.

15MEN21 - DESIGN OF WATER AND WASTEWATER TREATMENT PLANTS

L	T	P	C
3	0	0	3

DESIGN OF CONVENTIONAL WATER TREATMENT PLANT

Objectives and flow sheet of conventional water treatment plant - Design of rapid mixing, flocculator, clarifier, rapid and slow sand filters, chemical dosing, and disinfection units - Typical hydraulic profile in the plant. **(9)**

DESIGN OF CONVENTIONAL SEWAGE TREATMENT PLANT

Objectives and flow sheet of conventional sewage treatment plant - Design of bar rack, grit chamber with proportional flow or sutro weir, primary sedimentation, conventional ASP, and trickling filter - Design of secondary sedimentation tank. **(9)**

DESIGN OF LOW-COST WASTEWATER TREATMENT UNITS

Necessity and types - Modifications of CASP - Design of aerated lagoon, oxidation ditch, waste stabilization pond, and oxidation pond - Design of septic tank and dispersion trenches. **(9)**

DESIGN OF SLUDGE TREATMENT UNITS

Necessity, typical flow sheet, and principles involved - Design of sludge thickening, low and high rate digesters, and sand-drying beds - Composition and economic values of dried and digested sludge - Ultimate disposal of dried sludge. **(9)**

DESIGN OF INDUSTRIAL WATER TREATMENT UNITS

Necessity and principles involved - Design of softeners, demineralizers, and desalination plants - Membrane technologies and RO process - Requirement of water for industrial applications. **(9)**

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REFERENCES

1. Metcalf & Eddy, "Waste water Engineering, Treatment and Reuse", 3rd Edition, Tata McGraw - Hill Publishing Limited, New Delhi.
2. Karia, G.L., and Christian, R.A., "Wastewater Treatment: Concepts and Design Approach", Prentice-Hall of India Pvt., Ltd., New Delhi, 2006.
3. Manual on Water Supply and Treatment, CPHEEO, Ministry of Urban Development, GOI, New Delhi, 1985.
4. Manual on Sewerage and Sewage Treatment, CPHEEO, Ministry of Urban Development, GOI, New Delhi, 1985.

15MEN22 - ENVIRONMENTAL IMPACT ASSESSMENT

L	T	P	C
3	0	0	3

IMPACT ASSESSMENT PERSPECTIVES

Introduction to impact assessment - Historical perspective - Scope and goals of EIA and EMP - Organisation responsible for EIA - International treaties and agreements on the environment and natural resources - Global warming - Climate change - Ozone layer depletion - Acid rain - National committee on environmental planning and co-ordination - Tiwari Committee, Department of Environment. **(9)**

COMPONENTS AND METHODS

Management of environmental assessment - Review and project appraisal - Area selection and siting criteria - Environmental impact assessment notification, 1991 - Environmental clearance - Procedure for clearance - List of projects requiring clearance - Composition of expert committee - Public hearing - EIA amendments - Schedule - Forms - Checklist - NRBT criteria for EIA consultants - Environmental statements and standards. **(9)**

ASSESSMENT AND MONITORING

Contents of EIA and EMP - Baseline and inventory studies - Description of existing and proposed environment - Flora, fauna, social, and cultural aspects - Environmental impact statement (EIS) - Decision making tool - Adverse impacts - Project alternation - Mitigation measures - Assessment methodologies; ad hoc, overlays, network, matrix, and checklist - Environmental auditing and cost-benefit analysis. **(9)**

CASE STUDIES

Case studies - Water related projects, air related projects, soil and solid waste related projects - Environmental quality - Public and socio-economic welfare - New ways towards environmental management - Active-protective approach - Changing concept of environmental management - Cleaner production - Environmental management system. **(9)**

LEGISLATIVE PERSPECTIVES

Hazardous waste management and handling rules, 1989; and manufacture, storage, import and export of hazardous/micro-organism/genetically engineered organisms or cells rules, 1989 - Biomedical waste (management and handling) rules,1998 - Coastal regulation zone notification, 1991. **(9)**

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REFERENCES

1. Canter, L.W., "Environmental Impact Assessment", McGraw-Hill, New York, 1996.
2. Rao, J.G., and Wotten, D.C., "Environmental Impact Analysis, Handbook", McGraw-Hill, 1980.

15MEN23 - SOLID AND HAZARDOUS WASTE MANAGEMENT

L	T	P	C
3	0	0	3

PERSPECTIVES OF SOLID WASTE

Definition, sources, and types of solid waste - Comparison of waste generation in India and other developed countries - Per capita generation rates - Sampling and characterization of solid waste - Composition of solid waste: physical (Individual contents, size, moisture content, and density) and chemical (energy and chemical content) - Typical composition of Indian MSW - Functional elements of SWM system -Legislation and responsibilities. **(9)**

COLLECTION AND TRANSPORT OF SOLID WASTE

Estimation of solid waste and factors affecting generation rates - On-site handling, storage, and processing - Collection services: municipal and commercial - Industrial services - Collection systems: hauled-container system (HCS) and stationary container system (SCS) - Vehicle and labour assessment - Assessment of collection route - Transfer and transport - Transfer station location - Means and methods of transfer.**(9)**

PROCESSING AND DISPOSAL OF SOLID WASTE

Definition and necessity - Volume reduction: manual separation, mechanical, and thermal - Land filling method: site selection methods and operations, leachate and gas generations, and movement and control of gas and leachate - Design and operations of landfills - Land farming, deep well injection, and ultimate disposal techniques - Composting: aerobic and anaerobic - Resource and energy recovery schemes - Vermi-composting application - Integrated solid waste facilities. **(9)**

PERSPECTIVES OF HAZARRDOUS WASTE

Definitions and Identifications of hazardous waste - Origin and characterization of hazardous solid waste - Typical hazardous wastes in MSW - Hazardous waste management: minimization, collection, storage, handling, transport, and compatibility - Typical industrial regulations - National and International legislation for hazardous waste management. **(9)**

TREATMENT AND DISPOSAL OF HAZARDOUS WASTE

Necessity and types of treatment - Objectives, principles, operations, analysis, and design of solidification, encapsulation, chemical oxidation, incineration, and microwave-plasma detoxification techniques - Planning, operation, and design of hazardous waste landfills - One or two case studies. **(9)**

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REFERENCES

1. Tchobanoglous, G. et al., "Integrated Solid Waste Management", McGraw-Hill Publication., N.Y., 1993.
2. Peavy, S.H., Rowe, R.D. and Tchobanoglous, G, "Environmental Engineering", McGraw-Hill Inter Edition. 1985.
3. Charles, A.W., "Hazardous Waste Management", McGraw-Hill Pub., 2002.

15MEN24 - AIR POLLUTION AND CONTROL

L	T	P	C
3	0	0	3

AIR QUALITY AND EFFECTS OF POLLUTANTS

Definitions - Sources and classification of pollutants - Natural and anthropogenic - Units and measurements - Air quality standards - Meteorology and air pollution - Atmospheric stability and inversions - Mixing height and plume behavior - Effects of air pollution on human beings, vegetation, animals, materials, and climate. **(9)**

SAMPLING AND MODELING OF AIR POLLUTION

Concept and objectives of sampling - Averaging principle - Standard methods for major air pollutants in ambient air - Isokinetic sampling - Objectives of modeling - Types and uses of models - Design of stack height - Fixed-box and Gaussian dispersion models; and important considerations - Principles and application of multiple-cell model. **(9)**

CONTROL OF PARTICULATE MATTER

Basic devices of control - Objectives, applications, principles, process descriptions, analyses, design, essential considerations, performances, limitations, and modifications of gravity settler, cyclone separator, ESP, fabric filter, and co-flow venturi scrubber. **(9)**

CONTROL OF GASEOUS POLLUTANTS

Basic devices of control - Objectives, applications, principles, process descriptions, analyses, design, essential considerations, performances, limitations, and modifications of absorption (both packed and plate columns), adsorption (only fixed-bed), combustion, and condensation processes - Typical adsorbents and scale-up procedure - Combustion kinetics - Assessment of air requirement and composition of combustion gas - Typical barometric condensers. **(9)**

INDUSTRIAL PROCESSES AND CONTROL STRATEGY

Objectives of control - Strategies and philosophies of air pollution control - typical industries and sources of pollutants from mining (both coal and copper), coal-based thermal power plant, cement industry, petroleum refineries, fertilizer industry, and iron and steel plants. **(9)**

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REFERENCES

1. Nevers, N.D., "Air Pollution Control Engineering", 2nd Edn., McGraw-Hill International Editions, N.Y., 2000.
2. Peavy, H.S., Rowe, D.R. and Tchobanoglous, G., "Environmental Engineering", McGraw-Hill Book Co., N.Y., 1985.

3. Geankoplis, C.J.,"Transport Processes and Separation Process Principles (Includes Unit Operations)", 4th Edn., PHI Pub., New Delhi, 2003.
4. Sincero, A.P. and Sincero, G.A., "Environmental Engineering-A Design Approach", PHI Pub., New Delhi, 1996.
5. Rao, M.N. and Dutta, P., "Air Pollution", Tata McGraw-Hill Book Co., New Delhi, 1989.

15MEN27 - PROCESS ENGINEERING LABORATORY

L	T	P	C
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List of Experiments to be carried out in the Laboratory

1. Obtaining Ion-balancing Bar-graph for a given Water Sample.
2. Spectrophotometric determination of Iron and Manganese in a given Water Sample.
3. Spectrophotometric determination of Fluorides in a given Water Sample.
4. Verification of Conductivity-TDS Relationship for a given Water Sample.
5. Estimation of Optimum Coagulant Dose to Treat the Turbid Water Sample.
6. Estimation of Minimum Chlorine Demand by a Wastewater Sample.
7. Adsorption Kinetics Experiment.
8. Determination of Various Solids in Water and Wastewater Samples.
9. Determination of BOD of the given Wastewater Sample.
10. Determination of COD of the given Wastewater Sample.
11. MTFT and MFT on Contaminated Water Sample.
12. Gas Chromatographic Analysis of few Chlorinated Compounds.
13. Performance of Aerators.

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REFERENCES

1. APHA, AWWA, and WEF, "Standard Methods for the Examination of Water and Wastewater", 19th Edition, 2005.
2. Sawyer, N.C., McCarty, P.L and Parkin, G.F., "Chemistry for Environmental Engineering and Science", 5th Edition, McGraw-Hill. N.Y., 2005.

E1 - ENVIRONMENTAL BIOTECHNOLOGY

L	T	P	C
3	0	0	3

GENERAL PERSPECTIVES

Definition and concepts - Essential components - Scope of environmental biotechnology - Extremophilic microorganisms and their applications - Genetically engineered microbes and their applications - Ethical, social, and economic issues. **(9)**

BIOREMEDIATION OF CONTAMINATED SOILS AND AQUIFERS

Definition and types - Merits and demerits - Bioremediation techniques and description - Chemical class and current status of technology - Essential aspects of bioremediation: microbial system, type of contaminant, and geological and chemical conditions of the soil - Characterization of contaminated site - Bioavailability: constraints, remedial measures, and general considerations - Microbial transport in aquifers - Factors to be considered - Lysimeters and applications. **(9)**

MICROBIAL-METAL INTERACTIONS

Definition and types of metals - Distribution of metals in soil and water - Factors affecting bioavailability of metals - Metal toxicity and metal resistance - Mechanisms of removal of metal ions - Biosorption and bioleaching of metals - Necessity and methods of biomass immobilization - AMD process - Bioremediation of metal-contaminated soils and aquatic systems. **(9)**

ENVIRONMENTAL BIOTECHNOLGY FOR SUSTAINABLE DEVELOPMENT

Typical applications in paper and pulp, sugarcane, palm oil, and seafood industries - Biosensors and their applications - Phytoremediation as an emerging technology - Biogas technology and sustainable development in India and other developing countries. **(9)**

ENZYME AND RECOMBINANT DNA TECHNOLOGIES

Objectives and scope of enzyme technology - Types and applications of enzymes - Definition and concepts of DNA technology - Mutation and cloning of DNA - Generation of microbial strains - Gene transfer technology - Recombinant DNA technology - Methods and applications. **(9)**

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REFERENCES

1. Maier, R.M., Pepper, I.L. and Gerba, C.P.,"Environmental Microbiology", Academy Press, U.S.A, 2000.
2. Olguin, J.E., Sanchez, G. and Hernandez, E., "Environmental Biotechnology and Cleaner Bioprocess", Taylor and Francis Ltd, U.S.A, 2000.

E2 - INSTRUMENTAL METHODS OF ANALYSIS

L	T	P	C
3	0	0	3

QUANTITATIVE CHEMISTRY

Necessity and scope - Quantitative methods: gravimetric, volumetric, and instrumental - Low level and high level instruments - Precision, accuracy, and rounding-off data - Types of errors - Detection limits - Quality assurance and quality control - Colorimetry: Beer's and Lambertz laws. **(9)**

OPTICAL METHODS

Definition and types - Absorption, emission, and dispersion and scattering methods - Ultraviolet, infrared, atomic emission, atomic absorption, and inductively coupled plasma (ICP) spectroscopes - Fluorimetry, turbidimetry, and nephelometry. **(9)**

ELECTRICAL METHODS

Definition and types - Potentiometric and polarographic analyses - Glass electrode, membrane electrode, and membrane probe - Merits, demerits, and precautions in use of electrodes - Practical applications. **(9)**

CHROMATOGRAPHIC METHODS

Definition and types - Gas chromatography (GC): packed and capillary columns, EC, FI, FP, TC, NPD, and AFI detectors - High performance liquid chromatography (HPLC) - Ion chromatography - Capillary electrophoresis. **(9)**

SPECIAL INSTRUMENTS

Necessity and applications - Mass spectroscopy (MS) - X-ray analysis - Scanning electron microscope (SEM) analysis - Nuclear magnetic resonance (NMR) spectroscopy - Radioactive measurements. **(9)**

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REFERENCES

1. Sawyer, N.C., McCarty P.L. and Parkin, G.F., "Chemistry for Environmental Engineering and Sciences", 5th Edition, Tata McGraw-Hill Pub. Comp. Ltd., New Delhi, 2005.
2. Ewing, C.W., "Instrumental Methods of Chemical Analysis", 5th Edition, McGraw-Hill, 1995.

E3 - ADSORPTION TECHNOLOGY

L	T	P	C
3	0	0	3

PRINCIPLES AND CONCEPTS

Historical background - Absorption and adsorption - Adsorbate and adsorbent - Types of adsorbents: GAC, PAC, synthetic polymers, and locally available materials - Systems of adsorption; Gas-solid and liquid-solid - Types of adsorption: physical, chemical, exchange, and specific - Steps in adsorption - surface interactions - Factors influencing the adsorption: adsorbate, adsorbent, and system parameters.

(9)

EXPERIMENTAL TESTING AND ASSESSMENT

Mode of adsorption: CMBR, FBR, and MBR - Kinetics and equilibria studies - Isotherm and its types; Langmuir, Frendlich, BET, and linear - Thermodynamics of adsorption - Rate-limiting process - Interruption tests: single and multiple types - Mass-transfer assessment. **(9)**

CONCEPTUAL DESIGN

Definition and scope - Data support: loading curve, regeneration, and others - Nature and types of breakthrough in FBR - Factors affecting breakthrough in a column - BDST model - Assessment of mass transfer zone (MTZ) and scale-up of column - Adsorption system design procedure. **(9)**

INDUSTRIAL WASTEWATER CONTROL

Use of activated carbon and synthetic polymers in industries: pesticides, organic chemicals, aromatic compounds, and VOC's in vapour - FBR regeneration: thermal, steam, acid, base, solvent, and biological - Recovery of spent solvent - Recycling of solute - Economic considerations - Disposal aspects. **(9)**

BIOMATERIALS IN ADSORPTION

Definition and scope of biosorption - Types of biomaterials: bacteria, algae, fungi, fern, and others - Metal uptake potentials - Single and multimetal systems - Functional groups and mechanisms of removal - Selectivity sequence of metals - Merits and demerits of biosorption - Futuristic of biosorption. **(9)**

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REFERENCES

1. Slejco, F.L.(E.D), "Adsorption Technology : A step by step Approach to Process Evaluation and Application", Marcel Dekker Inc, N.J., U.S.A., 1985.
2. Volesky, B. (E.D), "Biosorption of Heavy Metals", CRC, Press, N.Y. U.S.A, 1990.

E4 - NOISE POLLUTION AND MANAGEMENT

L	T	P	C
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BASIC CONCEPTS OF SOUND AND NOISE

Definitions of sound and noise - Propagation of sound in air and hearing mechanism by ear - Relationship between sound pressure, power, and intensity - Types of noise: structure-borne, air-borne, and impact - Sources and reflection of sound - Plate radiation and its analysis - Near and far fields - Periodic and aperiodic sounds - Effects of noise on human being. **(9)**

MEASUREMENT AND ASSESSMENT OF NOISE

Basic sound level meter: parts and working principle - Other devices used in measurement of sound - Octave and its analysis - Decibel addition - Noise terminology: loudness, perceived noisiness, annoyance, and nuisance - Assessment of community, airport, and industrial noise - Annoyance criteria formulation: industry, traffic, and construction site - Annoyance-dose response relationship. **(9)**

BUILDING ACOUSTICS

Sound absorption and transmission - Transmission loss coefficient - Design of partitions - Reverberation of sound and derivation of Sabine's formula - Functional absorbers - Acoustic factors in architectural designs - Design of auditorium as per IS:2463-1963.

INDUSTRIAL AND ROAD TRAFFIC NOISE

Inplant and various sources - Cost-benefit analysis - Community noise prediction - Subjective and characteristics of vehicle noise - Sources of vehicle noise - Generation of engine noise and essential considerations - Relation between noise, engine load, and operating conditions - Origin, characteristics, and mechanisms of tyre noise - Legislation aspects of noise pollution control. **(9)**

NOISE CONTROL STRATEGIES

Objectives of control - Source, transmission path, and destination strategies - Outdoor noise propagation - Attenuating factors - Noise control criteria - Vibration control methods. **(9)**

L : 45

REFERENCES

1. White, R.G. and Walker, J.G., "Noise and Vibration", Ellis Horwood Publishers, N.Y. 1982.
2. Sincero, A.P. and Sincero, G.A., "Environmental Engineering - A Design Approach", PHI Pub., New Delhi, 1996.
3. Koensberger, O.H. et al., "Manual of Tropical Housing and Building", Part1 - Climatic Design", Orient Longman Pub., Madras, 1984.

4. Papacostas, C.S., "Fundamentals of Transportation Engineering", PHI Pub., Eastern Economy Edition Pub., 1987.
5. NBC of India, Group-IV, 1983.
6. IS:2526-1963 - "Code of Practice for Acoustical Design of Auditoriums and Conference Halls".
7. IS:4954-1968 - "Recommendations of Noise Abatement in Town Planning".

E5 - REMOTE SENSING AND GIS APPLICATIONS IN ENVIRONMENTAL ENGINEERING

L	T	P	C
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CONCEPTS AND FUNDAMENTALS OF REMOTE SENSING

Definition of remote sensing - Energy sources and radiation principles - Energy interaction with atmosphere - Energy interaction with earth surface features - Types of remote sensing - Platforms - Data products - Various satellites and their sensors. **(9)**

PHOTOGRAMMETRY PERSPECTIVE

Basic geometric characteristics of photographs - Photographic scale - Ground coverage of aerial photographs - Area measurements - Relief displacement - Image parallax - Mapping with aerial photograph. **(9)**

IMAGE PROCESSING

Data analysis - Visual image interpretation - Fundamentals - Equipment - Applications - Digital image processing **(9)**

GIS PERSPECTIVES

Concept of GIS - Data base structure - Digitization - Errors - Applications - GIS software: Arcview, Arcinfo, ArcGIS, and DEM. **(9)**

RS AND GIS APPLICATION

Management and monitoring of land, air, water, and pollution studies - Conservation of resources - Water resources - Urban development - Coastal zone management. **(9)**

L : 45

REFERENCES

1. Lillesand.T.M and Kiefer .R.W., "Remote Sensing and Image Interpretation", John Wiley and Sons, 4th Edition, 2003.
2. Burrough P.A. and Mc Donnell R.A, "Principles of Geographical Information Systems", Oxford University Press, 1998.
3. Lintz and Simonent, "Remote Sensing of Environment", Addison Wesley Pub. Comp., 1994.

E6 - ECOLOGY AND ECOSYSTEM MANAGEMENT

L	T	P	C
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PERSPECTIVES OF ECOLOGY

Definition, significance, and scope of ecology - Types: aut- and syn-ecologies - Realm of ecology - Ecotechnology and its relevance to human civilization - Classification of ecotechnology - Scope and significance of ecological engineering - Interdependency of urban and rural ecologies - Coupling of two or more ecological systems. **(9)**

ECOSYSTEM PERSPECTIVES

Definition, significance, and scope of ecosystem - Biotic, abiotic, and environmental factors - Structure and functions of ecosystems - Trophic status - Producers and consumers - Types of ecosystem - Gross and net production - Energy and material flows - Essential biogeochemical cycles. **(9)**

ECOSYSTEM MANAGEMENT

Characteristics and management of agroforest, grassland, wetland, and marine ecosystems - Characteristics of desert ecosystem - Basic concepts of limnology. **(9)**

BIODIVERSITY MANAGEMENT

Definition, significance, and scope of biodiversity - Uses of biodiversity - Threat to biodiversity: encroachment, poaching, resource exploitation, superstition, and man-wildlife conflict - Hot-spots of biodiversity - Indian scenario - Conservation of biodiversity: in-situ and ex-situ approaches. **(9)**

URBAN MANAGEMENT

Characteristics of urban ecosystem - Population growth and exploitation - Resource exploitation and sustainability - Carrying capacity of the urban region and land-use pattern - Current issues in urban region: water and energy crisis; pollution and waste proposal aspects; and land use aspect. **(9)**

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REFERENCES

1. Miller, T.G., "Environmental Science", 10th Edn., Thomson Book Co., New Delhi, 2004.
2. White, I.D., Mottershed, D.N., and Harrison, S.J., "Environmental Systems", Chapman Hall, London, 1994.
3. Keerthinarayana, S. and Daniel Yesudian, C., "Principles of Environmental Science and Engineering"., 1st Edn., Anuradha Pub., Kumbakonam, 2004.

E7 - ENERGY MANAGEMENT

L	T	P	C
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ENERGY PRESPECTIVES

Conventional and nonconventional energies - Merits and demerits - Total energy potential in India - Necessity and principles of conservation - Energy consumption pattern in rural and urban sectors - Public and government commitments in energy conservations. **(9)**

THERMAL ENERGY CONSERVATION

Definition of thermal energy - Energy production in power plants - Low, moderate, and energy intensive industries - Methods of energy conservation in steam generating systems and boilers, pumps, fan blowers, compressors, refrigeration, and air conditioning system, and AC drives - Conservation in nuclear power plants. **(9)**

TOTAL ENERGY CONSERVATION

Definition and concept of total energy - Typical systems - Merits and demerits of conservation - Possible alternatives for steam turbine, prime movers, and engines - Potentiality and economics of total energy systems - Energy conservation in typical buildings. **(9)**

ENERGY AUDITING

Definition and significance - Basic principles and methodology - Electrical energy conservation in various industries - Electrical heating and lightning systems - Cable losses and its selection - Energy efficiency motors and factors to be considered in increasing its efficiency - Chain, belt, and gear drives - AC drives: both constant and variable speeds. **(9)**

ENERGY ECONOMICS

Measurement and assessment of energy in industries - Energy economics - Discounts rate, payback period, internal rate of return, and life cycle costing methods - Cost-benefit analysis - Risk versus economy - Future perspectives. **(9)**

L : 45

REFERENCES

1. Write and Larcy, C., "Industrial Energy Management and Utilization", Hemisphere Pub., Washington, U.S.R., 1998.
2. Smith, C.B., "Energy Management Principles, Pergamon Press", New Port, 1981.
3. Trivedi, P.K and Jorka, K.R., "Energy Management", Common Wealth Publication, New Delhi, 1998.

E8 - TRANSPORT OF WATER AND WASTEWATER

L	T	P	C
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BASIC FLUID MECHANICS

Review of fluid properties - Continuity equation, energy equation, and impulse-momentum equation applicable to pipe flow (no derivation) - Applications - Pressure and pressure head and its measurement-

Hydrostatic pressure on immersed surfaces. **(9)**

HYDRAULICS OF PIPE FLOW

Concepts of gravity and pressure flows in pipes - Various head losses through pipes - Flow between reservoirs - Flow through siphon pipes - Pipe flow over summits and along valleys - Flow measurements

- Analysis of pipe networks. **(9)**

TRANSPORT OF WATER

Continuous and intermittent supply - Population forecasting - Per capita demand - Estimation of design discharge - Hydraulic design of water supply mains - Application of pipe network analysis - Design of pipe thickness - Necessity, requirements and provision of various pipe appurtenances - Pipe jointing and joint

efficiency - Pipe materials. **(9)**

TRANSPORT OF WASTE WATER

Hydraulics of pressure flow and partial flow in sewers - Various shapes of sewers and their hydraulic parameters - Combined and separate systems - Development and discharge estimation of storm water - Flow of storm water through open drains - Design flow of sewage -Design of sewers - Sewer outfalls -

Necessity, requirement, and provision of sewer appurtenances, and storm relief structures. **(9)**

PUMPS AND PUMPING

Concepts and working principles of various types of pumps used in the transportation of water and wastewater - Pump discharge and power requirement - Selection of pumps - Performance aspects of pumps - Detailed study of centrifugal pumps - Multistage pumps for head and discharge - Cavitations in

pumps - Screw pumps. **(9)**

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REFERENCES

1. Modi, P.N. and Seth, S.M., "Hydraulics and Fluid Mechanics including Hydraulic Machines", Standard Book House, Delhi, 2005.
2. Streeter, V.L., "Fluid Mechanics", McGraw-Hill Book Co., 1998.

E9 - INDUSTRIAL WASTEWATER MANAGEMENT

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WASTEWATER PERSPECTIVES

Characteristics and analysis of wastewater - Physical, inorganic nonmetallic, and metallic, organic, and biological - Toxicity constituents in wastewater - Advanced wastewater treatment - Unit operations and unit process. **(9)**

WASTEMINIMIZATION PERSPECTIVES

Waste volume reduction - Waste strength reduction - Self purification, stream pollution and Streeter - Phelps equations - Eutrophication - Standards for disposal of effluent on land and in inland waters - Need for zero discharge and zero damage - Wastewater reuse applications and issues - Effluent treatment plants : individual and common. **(9)**

WASTE TREATMENT PERSPECTIVE

Aerobic sequencing batch reactors - Attached growth denitrification process - Anaerobic suspended growth process - Anaerobic sludge blanket process - Attached growth anaerobic process. **(9)**

PROCESS-BASED INDUSTRIAL WASTE MANAGEMENT

Orgin and charactersitics of pollution - Process flow and treatment flow sheets of typical industries : brewery, winery, distillery, dairy, textile dyeing, and oil refinery industries. **(9)**

MANUFACTURING-BASED INDUSTRIAL WASTE MANAGEMENT

Orgin and charactersitics of pollution - Process flow and treatment flow sheets of typical industries : pulp and paper, fertilizer, pharmaceutical, sugar, iron and steel, petrochemical, and tannery industries.

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REFERENCES

1. Metcalf and Eddy, "Wastewater Engineering: Treatment and Reuse", 3rd Edn.,Tata McGraq-Hill Pub. Com., New Delhi, 2003.
2. Rao, M.N., and Dutta, "Wastewater Treatment", Oxford and IBH Pub. Com. Pub. Ltd., New Delhi, 2007.
3. Eckenfelder, W., Jr., "Industrial Water Pollution Control", McGraw-Hill Book Co., 1989.

E10 - OPTIMIZATION OF ENVIRONMENTAL SYSTEMS

L	T	P	C
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PROBLEM FORMULATION

Need and objectives - Essential features of optimization problems - General procedure - Constraints - Fitting models to data - Investment costs and operating costs - Time value of Money - Measures of profitability. **(7)**

OPTIMIZATION PERSPECTIVES

Unimodal and multimodal functions - Concave functions - Differential calculus - Single variable and multivariable functions with and without constraints - Inequality constraints. **(7)**

LINEAR PROGRAMMING AND APPLICATIONS

Basic concepts - Graphical solution - Standard LP form - Simplex method - Revised simplex method - Sensitivity analysis - Duality theory - LP Applications. **(7)**

UNCONSTRAINED OPTIMIZATION

Exhaustive and unrestricted search - Region elimination methods - Polynomial approximation methods - Direct methods - Indirect methods of first order - Second order - Secant methods. **(8)**

CONSTRAINED OPTIMIZATION

Direct and indirect methods - Penalty function methods - Random search methods - Optimization of staged and discrete processes.

Quadratic programming, geometric programming, dynamic programming, and integer programming **(8)**

APPLICATIONS OF OPTIMIZATION

Fluid flow systems - Optimal pipe diameter - Economic operation of treatment plants for water and wastewater systems - Optimization of evaporator design - Optimization of reactors - Optimization of large scale plant design and operations. **(8)**

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REFERENCES

1. Edgar, T.F and Himelblau D.M., "Optimization of Chemical Process", McGraw- Hill Book Company, Singapore, 1989.
2. Rao, S.S., "Engineering Optimization: Theory & Practice", New age International Publishing, New Delhi, 2001.
3. Taha, H., "Operations Research", McGraw Hill Book Co., 2002.

E11 - ENVIRONMENTAL ECONOMICS AND LEGISLATION

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PRESPECTIVES OF ENVIRONMENTAL ECONOMICS

Environment and economy - Resource utilization - Consumer choice theory - Efficiency and welfare - Monetary economy and markets - Competition and efficiency - Monopoly - Public goods - Externalities - Trade and environment - International environmental arguments. **(9)**

ECONOMIC INSTRUMENTS AND RESOURCE EXPLOITATION

Regulatory and economic instruments - Taxes and subsidies - Pollution taxes - Polluter pays principle - Evaluation and choice of instruments for environmental policy - Renewable and non-renewable resources and their scarcity - Production and environmental costs - Efficient and optimal uses of resources - Economics of forestry and fisheries. **(9)**

VALUATION AND PROFITABILITY ANALYSIS

Cost-benefit principle - Environmental valuation: direct and indirect methods - Non market valuation - Alternatives to valuation - Assessment of resource scarcity and ecological loss - Uncertainties - Environmental accounting and indicators - Payback period and present-worth estimation - Internal rate of return and opportunity costs - Economic analysis of pollution prevention option. **(9)**

PRESPECTIVES OF ENVIRONMENTAL LEGISLATION

Fundamentals of jurisprudence - Environmental laws: common and criminal - Pollution control laws - Fundamental rights - Constitution, powers, responsibilities, accountabilities, and audits of central and state pollution control boards - Equitable remedies for pollution control. **(9)**

POLLUTION CONTROL LAWS

Environmental protection act (1986) - Water, air, noise (prevention and control of pollution) acts with subsequent amendments - Solid and hazardous waste management and handling act with subsequent amendments - Wildlife and forest management act - National coastal zone management act - Public liability insurance act (1991). **(9)**

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REFERENCES

1. Nick, H., Jaison, F.S. and Ben, W., "Environmental Economics in Theory and Practice", McMillan India Ltd., New Delhi, 1999.
2. John, W., "Sustainability and Environmental Economics", Addison Wesley Inc., Singapore, 1997.
3. Tiwari, H.N., "Environmental Law", Allahabad Law Agency, 1997.
4. Rosencrany, A., Divan, and Nable, M., "Environmental Law and Policy in India (Cases, Materials, and Statutes), Tripati Pub., Bombay, India, 1997.

E12 - CORROSION ENGINEERING

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CORROSION PRINCIPLES

Corrosion engineering - Cost and classification of corrosion: dry and wet types - Corrosion environments and damage - Corrosion rate expressions - Electrochemical aspects - Environmental effects - Metallurgical aspects and others. **(9)**

FORMS OF CORROSION

Different forms of corrosion - Environmental factors, mechanism, and occurrence of uniform attack, crevice corrosion, filiform corrosion, pitting corrosion, intergranular corrosion, knife-line attack, erosion-corrosion, and stress corrosion - Selective leaching: characteristics and mechanism of dezincification - Graphitization and other alloy systems - Environmental factors, mechanism, and characteristics of hydrogen damage.

(9)

CORROSIVE ENVIRONMENTS

Organic acids- Alkalies - Atmosphere - Seawater - Fresh water - Soils - Biological corrosion: micro-and macro-organisms - Sewage and wastewater treatment plants - Dew-point corrosion - Corrosion under insulation - Rebar corrosion - Hydrogen peroxide. **(9)**

CORROSION TESTING

Necessity and classification - Steps in testing: materials and specimens, surface preparation, measuring and weighing, exposure techniques, and cleaning specimens after exposure - Duration and planned-interval tests - Aeration and standard expressions for corrosion rates - Nomograph for corrosion rates - Huey, Warren, and NACE tests - Invivo corrosion - Paint tests - Corrosion of plastics. **(9)**

COROSSION PREVENTION

Materials selection: metals, alloys, and non metals - Alteration of environment: changing media and inhibitors - Design of structures: wall thickness and design rules - Cathodic and anodic protections - Coatings: metallic, inorganic, and organic - Corrosion control standards. **(9)**

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REFERENCES

1. Fontana, M.G., "Corrosion Engineering", 3rd Edn., McGraw- Hill Book Co., N.Y., 1986.
2. Jastrzebski and Zbigniew, D., "Engineering Materials", Toppan Printing Co. Ltd., 1998.

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Curriculum and Syllabi

FIRST TO FOURTH SEMESTER

(For the students admitted during 2014 - 2015 onwards)

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