

# **COIMBATORE INSTITUTE OF TECHNOLOGY**

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

**COIMBATORE - 641 014, TAMILNADU, INDIA**

**DIAMOND JUBILEE**

(1956 - 2016)



**DEPARTMENT OF CIVIL ENGINEERING**  
**M.E. (ENVIRONMENTAL ENGINEERING AND MANAGEMENT)**

**Curriculum and Syllabi**

**Under Choice Based Credit System**

( For the students admitted during 2019 - 2020 and onwards )

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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 the institute 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  
COIMBATORE INSTITUTE OF TECHNOLOGY**

**VISION AND MISSION OF THE DEPARTMENT OF CIVIL ENGINEERING**

**VISION**

To provide quality education in Civil Engineering and to become a state-of-the-art source of world-class Civil Engineers and Researchers.

**MISSION**

To impart quality education with necessary skills to meet the requirements of the industry and to perform with professional ethics and an attitude for innovation in Civil Engineering through state-of-the-art technology.

**DEPARTMENT OF CIVIL ENGINEERING  
COIMBATORE INSTITUTE OF TECHNOLOGY**

**PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)**

1. Produce Environmental Engineering Graduates with Technical and Managerial skills for solving Global and National Environmental problems.
2. Function successfully in a Professional Environment by utilizing and enhancing their problem-solving, research and communication skills.
3. Follow professional Ethics and Practices for Social issues.

**DEPARTMENT OF CIVIL ENGINEERING  
COIMBATORE INSTITUTE OF TECHNOLOGY**

**PROGRAMME OUTCOMES (POs)**

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

1. An ability to Independently carry out Research / Investigation and Development work to solve practical problems in Environmental Engineering
2. An ability to write and present a substantial Technical Report / Document
3. Students should be able to demonstrate a Degree of Mastery over the area as per the specialization of the program.
4. Exhibit substantially good skills related to environmental Engineering with exposure to modern techniques.
5. Steadfast dedication and commitment towards resource conservation and sustainable development.
6. Evolve as leaders in framing futuristic environmental laws and regulations and propagate and uphold environmental ethics.

# COIMBATORE INSTITUTE OF TECHNOLOGY

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

## M.E. (ENVIRONMENTAL ENGINEERING AND MANAGEMENT)

( Curriculum from the Academic Year 2019-2020 onwards )

### SUBJECTS OF STUDY

#### Semester I

Course Code	Course Name	Category	L	T	P	C
19MEN11	Applied Statistics and Probability	FC	3	0	0	3
19MEN12	Environmental Chemistry	PC	3	0	0	3
19MEN13	Environmental Microbiology	PC	3	0	0	3
19MEN14	Separation Process In Environmental Engineering	PC	3	0	0	3
19MEN15	Industrial Wastewater Treatment and Management	PC	3	0	0	3
	Program Elective - I	PE	3	0	0	3
19MEN16	Process Engineering Laboratory - I	PC	0	0	4	2
	<b>TOTAL</b>		<b>18</b>	<b>0</b>	<b>4</b>	<b>20</b>

#### Semester II

Course Code	Course Name	Category	L	T	P	C
19MEN21	Design of Water and wastewater treatment Plant	PC	3	0	0	3
19MEN22	Air Pollution and Control	PC	3	0	0	3
19MEN23	Solid and Hazardous Waste Management	PC	3	0	0	3
	Program Elective - 2	PE	3	0	0	3
	Program Elective - 3	PE	3	0	0	3
	Program Elective - 4	PE	3	0	0	3
19MEN24	Process Engineering Laboratory - II	PC	0	0	4	2
	<b>TOTAL</b>		<b>18</b>	<b>0</b>	<b>4</b>	<b>20</b>

#### Semester III

Course Code	Course Name	Category	L	T	P	C
	Program Elective - 5	PE	3	0	0	3
	Program Elective - 6	PE	3	0	0	3
	Open Elective / Professional Elective - VII	OE	3	0	0	3
19MEN31	Practical Training	EEC	-	-	-	2
	One credit course	EEC	0	-	2	1
	<b>TOTAL</b>		<b>10</b>	<b>0</b>	<b>2</b>	<b>12</b>

**Semester IV**

Course Code	Course Name	Category	L	T	P	C
19MEN41	Project	EEC	0	0	36	18
	<b>TOTAL</b>		<b>0</b>	<b>0</b>	<b>36</b>	<b>18</b>

**Total Credits : 70**

L - Lecture, T - Tutorial, P - Practical, C - Credit, FC - Foundation Course, PC - Professional Core, PE - Professional Elective, EEC - Employment Enhancement Course

**LIST OF PROGRAM ELECTIVES**

Course Code	Course Name
19MENE01	Environmental Biotechnology
19MENE02	Adsorption Technology
19MENE03	Instrumental Method of Analysis
19MENE04	Noise Pollution and Management
19MENE05	Ecology and Ecosystem Management
19MENE06	Optimization of Environmental Systems
19MENE07	Air and Water Quality Modelling
19MENE08	Geo Environmental Engineering
19MENE09	Transport of Water and Wastewater
19MENE10	Environmental Impact Assessment
19MENE11	Design of Environmental Engineering Structures
19MENE12	Biodegradation and Bioremediation Techniques
19MENE13	Energy Management
19MENE14	Environmental Economics and Legislation
19MENE15	Sustainable Development and Cleaner Production

**LIST OF OPEN ELECTIVES**

Course Code	Course Name
19MENOE01	Climate Change and Adaptation
19MCEOE01	Disaster Management
19MCEOE02	Energy Efficient Building
19MCMOE01	Landscaping and Architecture

**LIST OF ONE CREDIT COURSE**

Course Code	Course Name
19MCOC01	Practical Geotechnical Engineering
19MCOC02	Green Buildings
19MCOC03	Geo Informatics Laboratory
19MCOC04	Sustainable Architecture

# 19MEN11 - APPLIED STATISTICS AND PROBABILITY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

CATEGORY : FOUNDATION COURSE

COURSE OUTCOMES

*CO1 : Outline the fundamentals in probability and statistics.*

*CO2 : Apply the knowledge in experimental Design.*

*CO3 : Interpret and clearly present output from probability and statistical analyses*

TESTING OF HYPOTHESIS

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. (9)

CORRELATION AND REGRESSION

Multiple and Partial Correlation - Method of Least Squares - Plane of Regression - Properties of Residuals - Coefficient of multiple correlation - Coefficient of partial correlation - Multiple correlation with total and partial correlations - Regression and Partial correlations in terms of lower order co-efficient. (9)

DESIGN OF EXPERIMENTS

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. (9)

PROBABILITY SAMPLING METHODS

Probability sampling methods - simple random sampling with replacement, simple random sampling without replacement, stratified sampling, cluster sampling. Non- probability sampling method - convenience sampling, judgment sampling, quota sampling. (9)

PROBABILITY DISTRIBUTIONS

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

Total : 45

TEXT BOOKS

1. Freund, J.R and Miller, I.R., "Probability and Statistics for Engineers", Prentice-Hall of India, 7<sup>th</sup> Edition, New Delhi (2006).
2. Gupta.S.C and Kapoor. V.K., "Fundamental of Applied Statistics" S.Chand & Co (2003).

REFERENCES

1. Murray R.Spiegel et al., "Schaum's Outline of Theory and Problems of Probability and Statistics", Tata McGraw-Hill, Second Edition (2004).
2. Kandasamy.P. et al., "Probability Statistics and Queuing Theory", S.Chand & Co (2004).
3. Veerarajan. T., "Probability Theory and Random Process", Tata McGraw-Hill, 2<sup>nd</sup> Edition (2004).

## 19MEN12 - ENVIRONMENTAL CHEMISTRY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

CATEGORY : PROFESSIONAL CORE/FOUNDATION COURSE

### COURSE OUTCOMES

*At the end of the course, the student will be able to:*

*CO1 : Outline the fundamental aspects of Physical chemistry*

*CO2 : Apply the concepts of aquatic chemistry in Environmental Engineering*

*CO3 : Infer the reason for climate change and soil contamination*

*CO4 : Interpret the properties of organic and biochemistry*

*CO5 : Examine the role of green chemistry in current scenario*

### 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) - pH and p<sub>x</sub> concepts - pE-pH diagram - Buffers and buffer index - Complex solubility relationships - Oxidation-reduction equations - Redox potential - Phase interactions in chemical fate and transport, rivers, lakes, atmosphere and sediments. (9)

### SOIL AND ATMOSPHERIC CHEMISTRY

Soil horizons and significance - pH and CEC of soils - Agricultural chemicals in soil - Reclamation of contaminated land - Photochemical oxidants: PAN, O<sub>3</sub>, and NO<sub>2</sub> - Acid rain - Greenhouse gases and global warming - Carbon capture and sequestration. (9)

### ORGANIC AND BIOCHEMISTRY

General properties of organic compounds - 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)

### GREEN CHEMISTRY

Green Chemistry - Definition - Principles of Green Chemistry - benefits of green chemistry - Future trends in Green Chemistry - Green catalysts; Green nano-synthesis, Green polymer chemistry - Biomass conversion - Green chemistry in sustainable environment. (9)

Total : 45

### TEXT BOOKS

1. Sawyer, N.C., McCarty P.L. and Parkin, G.F., "Chemistry for Environmental Engineering and Sciences", 5<sup>th</sup> Edition, McGraw-Hill, N.Y., 2005.
2. Sincero, A.P. and Sincero, G.A., "Environmental Engineering - A Design Approach", PHI Pub., New Delhi, 2004.
3. De, A.K., "Environmental Chemistry", New Age International Ltd., New Delhi, 2005.

## REFERENCES

1. Colin Baird, Michael Cann, "Environmental Chemistry", Macmillan Learning, 2012.
2. Manahan, S.E., "Environmental Chemistry", 8<sup>th</sup> Edition, CRC press, 2005.
3. Ronald A. Hites, "Elements of Environmental Chemistry", Wiley, 3rd Edition, 2012
4. R. P. Schwarzenbach, P. M. Gschwend, D. M. Imboden: Environmental Organic Chemistry, J. Wiley and Sons, Inc., 3<sup>d</sup> Edition, 2016.
5. A. G. Howard: Aquatic Environmental Chemistry, Oxford Science Publ., 1998.
6. V.K. Ahluwalia & M.R. Kidwai: New Trends in Green Chemistry, Anamalaya Publishers, 2007.

# 19MEN13 - ENVIRONMENTAL MICROBIOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

CATEGORY : PROFESSIONAL CORE /FOUNDATION COURSE

## COURSE OUTCOMES

*At the end of the course, the student will be able to*

*CO1 : Outline the fundamentals of micro-organisms*

*CO2 : Analyze the role of enzymes in metabolism*

*CO3 : Delineate the concepts of microbial biodegradation*

*CO4 : Infer the role of aquatic organisms in Environment*

*CO5 : Assess microbial culture and its techniques*

## 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 Krebs 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 immune blotting assay. (9)

Total : 45

## TEXT BOOKS

1. Maier, R.M., Pepper, I.L. and Gerba, C.P., "Environmental Microbiology", Academic Press, U.S.A., 2014
2. Pelczar Jn., M.J. Chan, E.C.S., Noel, K.R. and Foss, P.M., "Microbiology", 5<sup>th</sup> Edition, Tata McGraw-Hill, New Delhi,2005.
3. Strainer. R.Y., Ingrahum, J.L., Wheelis, M.C. and Painter, P.R., "General Microbiology", Mac- Millan Ltd., U.S.A., 1999.

## REFERENCES

1. S.C.Bhatia, "Hand Book of Environmental Microbiology", Part 1 and 2, Atlantic Publisher.
2. Gabriel Bitton, Wastewater Microbiology, 4<sup>th</sup> Edition, Wiley-Blackwell, 2011.
3. Raina M. Maier, Ian L. Pepper, Charles P. Gerba, "Environmental Microbiology", Academic Press.
4. SVS. Rana, "Essentials of Ecology and Environmental Science", 3<sup>rd</sup> Revised Edition, Prentice Hall of India Private Limited, 2007

# 19MEN14 - SEPERATION PROCESSES IN ENVIRONMENTAL ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

CATEGORY : PROFESSIONAL CORE

## COURSE OUTCOMES

*At the end of the course, the student will be able to:*

*CO1 : Outline the various physicochemical and biological treatment options for water and wastewater*

*CO2 : Summarize the analytical aspects and conceptual schematics required for the feasible design of treatment unit*

*CO3 : Demonstrate the treatment mechanisms and their pros and cons*

*CO4 : Employ an appropriate advanced treatment processes in combination with unit operations and processes*

*CO5 : Interpret and comprehend the various theoretical problems associated with different treatment processes*

## 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 analysis of settling, Filtration - Mode of operation and operational problems : Rapid sand filter and slow sand filter, Theory of granular media filtration, and flotation types- Types and modifications of settling. (9)

## ADSORPTION AND GAS-TRANSFER PROCESSES

Objectives, applications, principles, operations and analysis of adsorption, aeration, and stripping processes - Basic isotherms (Langmuir and Freundlich) and break through studies - Types of aerators and oxygen-transfer assessment - Stripping of  $\text{NH}_3$  from wastewater. (9)

## CHEMICAL PRECIPITATION AND DISINFECTION PROCESSES

Objectives, applications, principles, operations, and analysis 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 - attached and suspended growth systems, anaerobic - attached and suspended growth systems and anoxic processes - Kinetics of growth and Monod kinetics - Laboratory determination of kinetic co-efficients. (9)

Total : 45

## TEXT BOOK

1. Metcalf and Eddy, "Wastewater Engineering: Treatment and Reuse", 4th Edn. Tata McGraw-Hill Pub. Com., New Delhi, 2005.

## REFERENCE

1. Karia, G.L., and Christian, R.A., "Wastewater Treatment: Concepts and Design Approach", 2nd Edn., Prentice- Hall of India Pvt., Ltd., New Delhi, 2013.

# 19MEN15 - INDUSTRIAL WASTEWATER TREATMENT AND MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

CATEGORY : PROFESSIONAL CORE

## COURSE OUTCOMES

*At the end of this course the students will be able:*

*CO1 : Outline the waste water characteristics and environmental implications of various industrial effluents*

*CO2 : Summarize the various pollution prevention options*

*CO3 : Assess the remedial technologies for removal of pollutants in industrial effluents*

*CO4 : Employ the design solutions for the treatment and disposal of treated effluents*

*CO5 : Implement and comprehend the pollution control methods for specific industries*

## CONSTITUENTS IN WASTEWATER

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

## WASTEWATER MINIMIZATION AND REUSE

Waste volume reduction - Waste strength reduction - Standards for disposal of effluent on land and in inland waters - Need for zero discharge and zero damage - Wastewater reuse applications - Public health and Environmental issues in water reuse - Risk Assessment for water reuse - water reclamation technologies. (9)

## WASTEWATER TREATMENT

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

## PROCESS-BASED INDUSTRIAL WASTEWATER MANAGEMENT

Origin and characteristics 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

Origin and characteristics of pollution - Process flow and treatment flow sheets of typical industries: pulp and paper, fertilizer, pharmaceutical, sugar, iron and steel, petrochemical and tannery industries. (9)

Total : 45

## TEXT BOOK

1. Rao, M.N., and Dutta, "Wastewater Treatment", 3rd Edn. Oxford and IBH Pub. Com. Pub. Ltd., New Delhi, 2007.

## REFERENCES

1. Metcalf and Eddy, "Wastewater Engineering: Treatment and Reuse", 4th Edn. Tata McGraw-Hill Pub. Com., New Delhi, 2005.
2. Eckenfelder, W., Jr., "Industrial Water Pollution Control", McGraw-Hill Book Co., 2000.

## 19MEN16 - PROCESS ENGINEERING LABORATORY - 1

L	T	P	C
0	0	4	2

### COURSE OUTCOMES

*At the end of the course, the student will be able to*

*CO1 : Ascertain the suitability of water sample for various purposes*

*CO2 : Determine the characteristics of the given wastewater sample*

*CO3 : Select the degree of treatment based on the result of water / wastewater samples*

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 sulphates in a given Water Sample. .
3. Verification of Conductivity-TDS Relationship for a given Water Sample.
4. Estimation of Optimum Coagulant Dose to Treat the Turbid Water Sample.
5. Estimation of Minimum Chlorine Demand by a Wastewater Sample.
6. Determination of Various Solids in Water and Wastewater Samples.
7. Determination of BOD of the given Wastewater Sample.
8. Determination of COD of the given Wastewater Sample.

### 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.

# 19MEN21 - DESIGN OF WATER AND WASTEWATER TREATMENT PLANTS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

CATEGORY : PROFESSIONAL CORE

## COURSE OUTCOMES

*At the end of the course, the student will be able to:*

*CO1 : Outline about the design of conventional treatment of water and waste water treatment*

*CO2 : Summarize the bioreactor designs based on bio kinetics*

*CO3 : Demonstrate and evaluate the performance of low cost lab scale bioreactors*

*CO4 : Employ the appropriate facilities for handling, treatment and disposal of various sludge generated within the treatment plant*

*CO5 : Interpret and comprehend the needs of advanced treatment systems suitable for specific industries*

## 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 sutor weir, primary sedimentation, flotation units, 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)

TOTAL : 45

## TEXT BOOK

1. Metcalf and Eddy, "Wastewater Engineering: Treatment and Reuse", 4<sup>th</sup> Edition Tata McGraw-Hill Pub. Com., New Delhi, 2005

## REFERENCES

1. Karia, G.L., and Christian, R.A., "Wastewater Treatment: Concepts and Design Approach", 2<sup>nd</sup> Edition Prentice- Hall of India Pvt., Ltd., New Delhi, 2013.
2. Manual on Water Supply and Treatment Systems, CPHEEO, Ministry of Urban Development, GOI, New Delhi, 1999.
3. Manual on Sewerage and Sewage Treatment, CPHEEO, Ministry of Urban Development, GOI, New Delhi, 1993.
4. Latest Manual on Sewerage and Sewage Treatment, CPHEEO, Ministry of Urban Development, GOI, New Delhi, 2013.

## 19MEN22 - AIR POLLUTION AND CONTROL

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

CATEGORY : PROFESSIONAL CORE

COURSE OUTCOMES

*At the end of this course the students will be able to:*

*CO1 : Outline the classification of air pollutants and to understand their effects on environment and the human health*

*CO2 : Summarize the design concepts of various sampling techniques*

*CO3 : Demonstrate the working principle involved in the air pollutant control devices*

*CO4 : Employ the suitable air pollution prevention technologies for various particulates and gaseous pollutants*

*CO5 : Interpret and comprehend the general air quality monitoring and controlling practices in the various industries*

**AIR POLLUTION SOURCES AND METEOROLOGY**

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 behaviour - 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 modelling - 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. (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)

Total : 45

**TEXT BOOKS**

1. Nevers, N.D., "Air Pollution Control Engineering", 2<sup>nd</sup> Edn. McGraw-Hill International Editions, N.Y., 2000.
2. Rao, M.N. and Dutta, P., "Air Pollution", Tata McGraw-Hill Book Co., New Delhi, Reprint on 2007.

## REFERENCES

1. Peavy, Rowe, Tchobanoglous, "Environmental Engineering", 5<sup>th</sup> Edition, McGraw Hill Publishers, New Delhi, 2017.
2. Geankoplis, C.J., "Transport Processes and Separation Process Principles (Includes Unit Operations)", 4<sup>th</sup> Edition, PHI Pub., New Delhi, 2003.
3. Sincero, A.P. and Sincero, G.A., "Environmental Engineering - A Design Approach", PHI Pub., New Delhi, 2004.

# 19MEN23 - SOLID AND HAZARDOUS WASTE MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

CATEGORY : PROFESSIONAL CORE

## COURSE OUTCOMES

*At the end of the course, the student will be able to:*

*CO1 : Comprehend the sources and types of solid waste and its regulatory framework*

*CO2 : Assess the various systems of collection and transport of solid waste*

*CO3 : Analyze the processing and disposal aspects of solid waste*

*CO4 : Understand the identification and characterization of hazardous waste*

*CO5 : Apply the basic scientific principles for solving practical waste management challenges*

## 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 - Integrated solid waste management. (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 labor 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. (9)

## PERSPECTIVES OF HAZARROUS WASTE

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

## TREATMENT AND DISPOSAL OF HAZARDOUS WASTE

Necessity and types of treatment - Objectives, principles, operations, analysis of solidification, encapsulation, chemical oxidation, incineration, and microwave-plasma detoxification techniques - Planning, operation, design and analysis of hazardous waste landfills, landfill remediation. (9)

Total : 45

## TEXT BOOKS

1. George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, "Integrated Solid Waste Management, Mc-Graw Hill International Edition, New York, 1993.
2. Peavy, Rowe, Tchobanoglous, "Environmental Engineering", 5<sup>th</sup> Edition McGraw Hill Publishers, New Delhi, 2017.
3. Charles, A.W., "Hazardous Waste Management", McGraw-Hill Pub., 2002.

## REFERENCES

1. CPHEEO, "Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organisation, Government of India, New Delhi, 2016.
2. Michael D. LaGrega, Philip L Buckingham, Jeffrey C. E vans and "Environmental Resources Management, Hazardous waste Management", Mc-Graw Hill International edition, New York, 2001.
3. Vesilind P.A., Worrell W and Reinhart, "Solid waste Engineering", Thomson Learning Inc., Singapore, 2002.
4. Paul T Williams, "Waste Treatment and Disposal", Wiley, 2005.

## 19MEN24 - PROCESS ENGINEERING LABORATORY - II

L	T	P	C
0	0	4	2

### COURSE OUTCOMES

*At the end of the course, the student will be able to:*

*CO1 : Analyze Na & K level in the given water / wastewater sample*

*CO2 : Assess particulate matter and gaseous pollutant in the selected location*

*CO3 : Assess the noise pollution in the selected location*

*CO4 : Analyze the given sample using gas chromatography*

List of Experiments to be carried out in the Laboratory

1. Flame photometric analysis of Na and K.
2. Air pollution assessment - PM10
3. Air pollution assessment - PM2.5
4. Air pollution assessment - gaseous pollutant
5. Noise pollution assessment
6. Gas Chromatographic Analysis of few selected compounds/gases.

### REFERENCES

1. *Sawyer, N.C., McCarty, P.L and Parkin, G.F., "Chemistry for Environmental Engineering and Science", 5<sup>th</sup> Edition, McGraw-Hill. N.Y., 2005.*
2. *Nevers, N.D., "Air Pollution Control Engineering", 2<sup>nd</sup> Edn. McGraw-Hill International Editions, N.Y., 2000.*
3. *B.K. SHARMA, "Instrumental Methods of Chemical Analysis", 31<sup>st</sup> Edition, Krishna Prakashan Media (P) Ltd., 11, Shivaji Road, Meerut, U.P, 2018.*

# 19MENE01 - ENVIRONMENTAL BIOTECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

CATEGORY : PROFESSIONAL ELECTIVE

COURSE OUTCOMES

*At the end of this course the students will be able to:*

*CO1 : Outline the vital concepts, components and application of Environmental biotechnology*

*CO2 : Summarize the different methods for bioremediation of environment and metal sequestration process*

*CO3 : Impart the methods of removal of nutrients in the biological system*

*CO4 : Employ the suitable biotechnological concepts in various sustainable technologies in process-based industries*

*CO5 : Interpret and comprehend the current trends in recombinant DNA technologies for the betterment of environment*

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 BIOTECHNOLOGY 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)

Total : 45

TEXT BOOK

1. Maier, R.M., Pepper, I.L. and Gerba, C.P., "Environmental Microbiology", 3<sup>rd</sup> Edition, Academy Press, U.S.A, 2014.

## REFERENCES

1. *Olguin, J.E., Sanchez, G. and Hernandez, E., "Environmental Biotechnology and Cleaner Bioprocess", Taylor and Francis Ltd, U.S.A, 2000.*
2. *Chaudhury, G.R., Biological degradation and Bioremediation of toxic chemicals, Dioscorides Press, Oregon, 1995.*
3. *Bhattacharya, B. C. and Banerjee R., Environmental Biotechnology, Oxford University Press, India, 2007.*
4. *Martin.A.M, Biological degradation of wastes, Elsevier Applied Science, London, 1991.*
5. *Blaine Metting.F (Jr.) Soil Microbiology Ecology, Marcel Dekker Inc., 1993.*

# 19MENE02 - ADSORPTION TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

CATEGORY : PROFESSIONAL ELECTIVE

## COURSE OUTCOMES

*At the end of the course, the student will be able to:*

*CO1 : Impart knowledge on the principles and application of adsorption in environmental engineering*

*CO2 : effectively understand the intrinsic properties of sorbents, sorbets, and system parameters associated with sorption technology*

*CO3 : Analyse and understand the Adsorption studies/Kinetics*

*CO4 : Appropriately understand the design, operation, and maintenance of practical sorbers*

*CO5 : Understand the various regeneration aspects with economics*

## 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, Freundlich, 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)

**Total : 45**

## TEXT BOOKS

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. *Ruthven D.M., "Principles of Adsorption and Adsorption process", A Wiley-Interscience Publications, New York, 1984.*

## REFERENCES

1. *Volesky, B. (E.D), "Biosorption of Heavy Metals", CRC, Press, N.Y. U.S.A, 1990.*
2. *Diran Basmadjian., "The Little Adsorption Book: A Practical Guide for Engineers and scientists", U.S.A., 1996.*
3. *Rouquerol F., Rouquerol J., and Sing K., "Adsorption by Powders and Porous solids - Principles Methodology and Applications", U.S.A., 1999*

## 19MENE03 - INSTRUMENTAL METHOD OF ANALYSIS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

CATEGORY : PROFESSIONAL ELECTIVE

### COURSE OUTCOMES

At the end of this course the students will be able to:

*CO1 : Outline the various quantitative-based instruments in environmental monitoring*

*CO2 : Infer different methods for analysis of samples using instrumentation.*

*CO3 : Analyse the samples using optical, electrical and chromatography methods.*

*CO4 : Comprehend the proper utilization of Advance instruments.*

*CO5 : Employ the advanced analytical techniques in environmental quality monitoring*

### 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) spectrometers - 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)

Total : 45

### TEXT BOOKS

1. B.K. SHARMA, "Instrumental Methods of Chemical Analysis", 31<sup>st</sup> Edition, Krishna Prakashan Media (P) Ltd., 11, Shivaji Road, Meerut, U.P, 2018.
2. Williard Merritt, Dean Settle "Instrumental Methods of Analysis", 7<sup>th</sup> Edition, CBS publishers & distributors, Copyright WordsWorth Publishing Company U.S.A., 1989

### REFERENCES

1. Sawyer, N.C., McCarty P.L. and Parkin, G.F., "Chemistry for Environmental Engineering and Sciences", 5<sup>th</sup> Edition, McGraw-Hill, N.Y., 2005.
2. Ewing, C.W., "Instrumental Methods of Chemical Analysis", 5<sup>th</sup> Edition, McGraw-Hill, 1995.

# 19MENE04 - NOISE POLLUTION AND MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

CATEGORY : PROFESSIONAL ELECTIVE

COURSE OUTCOMES

*At the end of the course, the student will be able to:*

*CO1 : Appropriately understand the fundamental aspects of noise characterization and nomenclature*

*CO2 : Effectively assess the various categories of noise - community traffic, airport, and industrial*

*CO3 : Analyse the effects of noise pollution.*

*CO4 : Understand the various strategies in controlling indoor and outdoor noise, including design of Auditoria as per BIS*

*CO5 : Infer various noise pollution regulations for Control.*

**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. (9)

**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)

Total : 45

**TEXT BOOKS**

1. Chhatwal G.R., Mehra M.C., Satake M., "Environmental Noise Pollution and its control", Anmol Publications, Bangalore, 2001.
2. White, R.G. and Walker, J.G., "Noise and Vibration", Ellis Horwood Publishers, N.Y. 1982.
3. Sincero, A.P. and Sincero, G.A., "Environmental Engineering - A Design Approach", PHI Pub., New Delhi, 2004.

## REFERENCES

1. Koensberger, O.H. et al., *"Manual of Tropical Housing and Building", Part1 - Climatic Design*, Orient Longman Pub., Madras, 1993.
2. Singal, S.P., *"Noise pollution and Control strategy"*, Narosa publishing house, Madras, 2005.
3. Chhatwal G.R., Mehra M.C., Satake M., *"Environmental Noise Pollution and its control"*, Anmol Publications, Bangalore, 2001.
4. Bhata S.C., *"Textbook of Noise Pollution and its Control"*, Atlantic Publishers and Distributors, Madras, 2007
5. NBC of India, Group-IV, 2005.
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"*.

## 19MENE05 - ECOLOGY AND ECOSYSTEM MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

CATEGORY : PROFESSIONAL ELECTIVE

### COURSE OUTCOMES

*At the end of the course, the student will be able to:*

*CO1 : Outline the overall perspectives and concepts of ecology and various ecosystems*

*CO2 : Summarize the ecosystem related issues and biodiversity management in Indian scenario*

*CO3 : Demonstrate structural and functional interactions of ecosystems*

*CO4 : Employ and understand the effective management concepts of various ecosystems*

*CO5 : Interpret and comprehend the appropriate protocols to be followed in the improvement of the resources management and urban ecology*

### PERSPECTIVES OF ECOLOGY

Definition, significance, and scope of ecology - Types: aut- and syn-ecologies - Realm of ecology - Eco technology and its relevance to human civilization - Classification of Eco technology - 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 - Structure and functions of ecosystems - Law of Thermodynamics - Trophic status - Gross and net production - Energy and material flows - Essential biogeochemical cycles. (9)

### ECOSYSTEM MANAGEMENT

Characteristics and management of agro forest, grassland, wetland, desert ecosystem - Basic concepts of limnology - Forest: Ecological and Economic consequences of deforestation and management - Aquatic Ecosystem: Structure and functional attributes diversity, lentic and lotic habitats, economic importance and management. (9)

### BIODIVERSITY MANAGEMENT

Definition, significance, and scope of biodiversity - Factors governing biodiversity - Uses of biodiversity - Threat to biodiversity - Hot-spots of biodiversity - Indian scenario - Conservation of biodiversity: in-situ and ex-situ approaches - Endemic and Epidemic species in India. (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)

TOTAL : 45

### TEXT BOOK

1. Miller, T.G., "Environmental Science", 10<sup>th</sup> Edition Thomson Book Co., New Delhi, 2004.

### REFERENCES

- White, I.D., Mottershed, D.N., and Harrison, S.J., "Environmental Systems", Chapman Hall, London, 1994.
- Keerthinarayana, S. and Daniel Yesudian, C., "Principles of Environmental Science and Engineering", 1<sup>st</sup> Edition, Anuradha Pub., Kumbakonam, 2004.

# 19MENE06 - OPTIMIZATION OF ENVIRONMENTAL SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

CATEGORY : PROFESSIONAL ELECTIVE

## COURSE OUTCOMES

At the end of the course, the student will be able to:

*CO1 : Describe clearly a problem, identify its parts and analyse the individual functions.*

*CO2 : Understand the selection and implementation of proper optimization tools in proposing optimization solutions*

*CO3 : Effectively assimilate the standard algorithms and protocols of optimization of systems and processes*

*CO4 : Effectively adopt the optimization tools especially for real-time and kinetics systems*

*CO5 : Investigate, study, develop, organize and promote innovative solutions for various applications.*

## PROBLEM FORMULATION AND OPTIMIZATION PERSPECTIVES

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 - Unimodal and multimodal functions - Concave functions - Differential calculus - Single variable and multivariable functions with and without constraints - Inequality constraints. (9)

## LINEAR PROGRAMMING AND APPLICATIONS

Basic concepts - Graphical solution - Standard LP form - Simplex method - Revised simplex method - Sensitivity analysis - Duality theory - LP Applications (9)

## UNCONSTRAINED OPTIMIZATION

Exhaustive and unrestricted search - Region elimination methods - Polynomial approximation methods - Direct methods - Indirect methods of first order - Second order - Secant methods (9)

## 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. (9)

## 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. (9)

Total : 45

## TEXT BOOKS

1. Edgar, T.F and Himmelblau D.M., "Optimization of Chemical Process", McGraw- Hill Book Company, 2<sup>nd</sup> Edition, New York, 2011.
2. Rao, Singaresu.S., "Engineering Optimization: Theory & Practice", New age International Publishing, 4<sup>th</sup> Edition, New Delhi, 2009.

## REFERENCES

1. Taha, H., "Operations Research - An Introduction", 10<sup>th</sup> Edition, Pearson, New York, 2017.
2. Mital K.V., "Optimization methods", Wiley Eastern Ltd, Delhi, 1986
3. Kalyanmoy Deb, "Optimization for Engineering Design: Algorithms and Examples", 2<sup>nd</sup> Edition, Prentice Hall of India, Delhi, 2004.

# 19MENE07 - AIR AND WATER QUALITY MODELLING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

CATEGORY : PROFESSIONAL ELECTIVE

## COURSE OUTCOMES

*At the end of this course the student will be able to,*

*CO1 : Outline the significance and need for modelling.*

*CO2 : Summarize the suggestions regarding the modelling to be adopted for different scenarios and also discuss the long-term uses of those models.*

*CO3 : Assess the fate and transport of various pollutants in air and water.*

*CO4 : Employ various modelling concepts to monitor the quality of polluted water and air in future.*

*CO5 : Interpret and comprehend the adoptability of models for the scenario under study.*

## MODELING CONCEPT

Overview of different types of models-identification of dependent and independent variables-Deterministic and stochastic approach-Steps in model development-numerical and simulations models-calibration and validation of models- Limitations Transport phenomena- Mass balance analysis-Model development and decision making. (9)

## AIR QUALITY MODELS

Air quality parameters - air Quality Index -Types, modelling technique, modelling for nonreactive pollutants, single source, short term impact, multiple sources and area sources, Fixed box models- diffusion models - Gaussian plume derivation- modifications of Gaussian plume equation- long term average-multiple cell model receptor oriented and source oriented air pollution models-model performance, accuracy and utilization -air quality mapping (9)

## INDOOR AIR QUALITY MODELS

Indoor Air Pollutants - Volatile Organic Compounds , Inorganic Gaseous Pollutants Respirable Particulates ,Bio-aerosols, Radon and its decay products-Infectious disease transmission- A/C units in indoor- Odours and sick building syndrome-Indoor Air quality Models (9)

## WATER QUALITY MODELLING

Water quality parameters- water quality index- Historical development of water quality models - rivers and streams water quality modelling; Lakes and impoundments - water quality response to inputs; water quality modelling process - model sensitivity - assessing model performance. (9)

## SOFTWARE MODELLING

The principles and application of computer modelsfor surface water quality, and air quality. (9)

Total : 45

## TEXT BOOKS

1. Nevers, N.D., "Air Pollution Control Engineering", 2<sup>nd</sup> Edn, McGraw-Hill International Editions, N.Y., 2000.
2. Chapra S.C (1997), Surface water Quality modelling MC Graw Hill International Edition

## REFERENCES

1. *Thomann R V & Mueller JA (1987), Principles of Surface Water Quality Modelling and Control Harper*
2. *Todd DK (1980) Ground Water Hydrology John Wiley And Sons*
3. *Douw.G. Steyn, (2011) Air Pollution Modelling and its application XXIV Springer*

# 19MENE08 - GEO ENVIRONMENTAL ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

CATEGORY : PROFESSIONAL ELECTIVE

## COURSE OUTCOMES

*At the end of this course the student will be able to,*

*CO1 : Outline the soil-water interaction and hydrological Parameters.*

*CO2 : Summarize the transport of the containments through soil and its interaction*

*CO3 : Apprehend the potential remedial techniques like biological, mechanical and electrical permittivity of soils.*

*CO4 : Apply the regulatory requirements for landfill and surface impoundment covers and to gain knowledge on monitoring process*

*CO5 : Interpret the stabilization of hazardous waste, storage, mechanism and its utilization by improved technique.*

## PERSPECTIVE IN GEOENVIRONMENTAL ENGINEERING

Scope in Geo-Environmental Engineering - role of soil in geo environmental applications- phase behaviour of soil - importance of hydrogeology- sources and type of soil contamination - case studies in soil failure. (9)

## CONTAMINANT TRANSPORT

Transport of contaminant in subsurface flow - advection, diffusion, dispersion - chemical process - biological process, sorption, desorption, precipitation, dissolution, oxidation, complexation, ion exchange, volatilization, biodegradation - characterization of contaminated sites - soil and rock data - hydrological and chemical data - analysis and evaluation - risk assessment - case studies. (9)

## REMEDICATION OF CONTAMINATED SITES

In-situ contaminant - vertical and horizontal barrier - surface cover - ground water pumping system on subsurface drain - soil remediation - soil vapour extraction, soil waste stabilization, solidification of soils, electro-kinetic remediation, soil heating, bio remediation, Phyto-remediation - ground water remediation - pump and treat , In-situ flushing, permeable reacting barrier, In-situ air sparing - case studies. (9)

## LANDFILLS AND SURFACE IMPOUNDMENTS

Source and characteristics of waste - site selection for landfills - components of landfills - liner system - soil, Geo-membrane, Geo-synthetic clay, Geo-composite liner system - leachate collection - final cover design - monitoring the geo liners in landfill. (9)

## STABILISATION OF WASTE

Hazardous waste control and storage system - stabilization/ solidification of wastes - micro and macro encapsulation - absorption, adsorption, precipitation- detoxification - mechanism stabilization - organic and inorganic stabilization - utilization of solid waste for soil improvement Case studies. (9)

Total : 45

## TEXT BOOK

1. Hari D. Sharma and Krishna R. Reddy, *Geo-Environmental Engineering - John Wiley and Sons, INC, USA, 2004.*

## REFERENCES

1. Daniel B.E, *Geotechnical Practice for waste disposal*, Chapman & Hall, London, 1993
2. Westlake, K., *Landfill Waste pollution and Control*, Albion Publishing Ltd., England, 1995.
3. Wentz, C.A., *Hazardous Waste Management*, McGraw Hill, Singapore, 1989.
4. *Proceedings of the International symposium of Environmental Geotechnology (Vol.I and II)*, Environmental Publishing Company, 1986 and 1989.
5. Ott, W.R., *Environmental Indices, Theory and Practice*, Ann Arbor, 1978.
6. Fried, J.J., *Ground Water Pollution*, Elsevier, 1975.
7. *ASTM Special Tech. Publication 874, Hydraulic Barrier in Soil and Rock*, 1985.
8. Lagrega, M.d., Buckingham, P.L., and Evans, J.C., *Hazardous Waste Management*, McGraw Hill, Inc. Singapore, 1994.

# 19MENE09 - TRANSPORT OF WATER AND WASTEWATER

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

CATEGORY : PROFESSIONAL CORE

## COURSE OUTCOMES

*At the end of the course, the student will be able to:*

*CO1 : Summarize fluid properties and flow measurement*

*CO2 : Design water transmission mains and water distribution system.*

*CO3 : Analyze storm water drainage and rainfall data*

*CO4 : Infer the role of pumps and pumping station in waste water transmission and conveyance*

*CO5 : Analyse troubleshooting options for water and sewage transmission using software application*

## GENERAL HYDRAULICS AND FLOW MEASUREMENT

Fluid properties, fluid flow, continuity principle, energy principle and momentum principle- Head loss - major loss and minor losses - Pumping of fluids - types of pumps, selection of pumps - cavitation in pumps - flow measurement - pipe flow, open channel flow. (9)

## WATER TRANSMISSION AND DISTRIBUTION

Need for transport of water and waste water - water transmission mains - water hammer analysis - pipe materials - pipe network-analysis, design of network & optimization - Laying and maintenance of pipelines - Pipe appurtenances - corrosion prevention - minimization of water losses and leak detection. (9)

## STORM WATER DRAINAGE

Combined and separate system, quantity estimation - rainfall data analysis - storm water drain design, rational method - storm water harvesting and roof water harvesting. (9)

## WASTEWATER COLLECTION AND CONVEYANCE

Planning factors - design of sanitary sewer, partial flow in sewer - Pumps and Pumping stations - sewer appurtenances - material, construction, inspection and maintenance of sewer, recent trends - Vacuum sewer system- conveyance of corrosive wastewaters. (9)

## SOFTWARE APPLICATIONS

Water distribution-Basics of LOOP 4.0, BRANCH and EPANET 2.0 - Sewer design - SEWER. (9)

Total : 45

## TEXT BOOKS

1. Modi, P.N. and Seth, S.M., "Hydraulics and Fluid Mechanics including Hydraulic Machines", 15thEdn. Standard Book House, Delhi, 2005.
2. Peavy, Rowe, Tchobanoglous, "Environmental Engineering", 5th Edn. McGraw Hill Publishers, New Delhi, 2017.
3. Birdie G.S and Birdie J.S "Water Supply and Sanitary Engineering" Dhatpat Rai Publishing Company New Delhi, 7th edition 2013.

## REFERENCES

1. Merle potter, David C.Wiggert, "Fluid Mechanics", Schaum's Outline Series, McGraw- Hill Publications, New Delhi, 2008.
2. Bajwa, G.S. "Practical Handbook on Public Health Engineering", 3<sup>d</sup> Edition, Saurabh Publishers, New Delhi, 2011.
3. Streeter, V.L., "Fluid Mechanics", 9<sup>th</sup> Edition, McGraw-Hill Book Co.,2017.
4. "Manual on water supply and Treatment", CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 1999.
5. "Manual on Sewerage and Sewage Treatment", CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 1993.
6. Latest Manual on Sewerage and Sewage Treatment, CPHEEO, Ministry of Urban Development, GOI, New Delhi, 2013.

# 19MENE10 - ENVIRONMENTAL IMPACT ASSESSMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

CATEGORY : PROFESSIONAL ELECTIVE

## COURSE OUTCOMES

*At the end of the course, the student will be able to:*

*CO1 : Understand and analyse the various environmental impacts of the proposed projects*

*CO2 : Predict the magnitude of the impacts and provide appropriate solutions*

*CO3 : Propose proper mitigation measures to avoid environmental impacts*

*CO4 : Impart knowledge on the policies, legislations, and institutional frame work and enforcement mechanisms for environmental management in India.*

*CO5 : Possess knowledge on important process that control contaminant transport and tools that can be used in predicting and managing human health risks.*

## INTRODUCTION

Introduction to Environmental Impact Assessment - Evaluation of EIA in India - Organisation responsible for EIA - Scope and Objective of EIA - Environmental impact assessment notification, 1994 - Procedure for Environmental Clearance of Projects - List of projects requiring clearance - Application Form - Composition of expert committee - Public Hearing - Framework for Environmental Impact Assessment. (9)

## EIA METHODOLOGIES

Introduction - Criteria for selection of EIA methodology - EIA methods - Adhoc - Checklist - Matrices - Network - Overlays - Environmental Auditing - Cost Benefit Analysis - Assessment of Significance of Impact - Project alternation - Decision making - Preparation of EIA report - Environmental Impact Statements - Environmental Management Systems. (9)

## IMPACT AND RISK ASSESSMENT

Prediction and Assessment of Impacts -Soil and Ground Water - Surface Water - Air - Noise - Biological - Socio-economic and Human Health Environment - Environmental Risk Assessment - Steps in performing ERA - Risk-Cost-Benefit - Risk Ranking - Comparison of EIA and ERA. (9)

## CASE STUDIES

Case Studies on environmental Impact of a Project Development - Water, air, soil and solid waste - Physical Resources - Ecological resources - Human Use Values - Quality-of-life values - Project siting - Assessment of Impacts - Decision Making - Mitigation measures. (9)

## LEGISLATIVE PERSPECTIVES

Manufacture, storage, import and export of hazardous/micro-organism/genetically engineered organisms or cells rules, 1989, Coastal regulation zone notification, 1991 - NRBPT criteria - Criteria for registration of EIA Consultant organization - Code of Conduct for Consulting Organizations - list of Annexures. (9)

Total : 45

## TEXT BOOKS

1. Canter, L.W., "Environmental Impact Assessment", 2<sup>nd</sup> Edition, McGraw-Hill, New York, 1996.
2. Anjaneyulu, Y., Valli Manikam, "Environmental Impact Assessment Methodologies",BS Publications, 2007.

## REFERENCES

1. Rao, J.G., and Wotten, D.C., "Environmental Impact Analysis, Handbook", McGraw-Hill, 1980.
2. Cutter, S.L., *Environmental Risk and Hazards*, Prentice-Hall of India Pvt. Ltd., New Delhi, 1999.
3. Kolluru Rao, Bartell Steven, Pitblado R and Stricoff "Risk Assessment and Management Handbook", McGraw Hill Inc., New York, 1995.
4. Lawrence, D.P., *Environmental Impact Assessment - Practical solutions to recurrent problems*, Wiley-Interscience, New Jersey. 2003
5. Raghavan K. V. and Khan A A, *Methodologies in Hazard Identification and Risk Assessment, Manual by CLRI*, 1990.
6. Sam Mannan, *Lees' Loss Prevention in the Process Industries, Hazard Identification, Assessment and Control, 4<sup>th</sup> Edition*, Butterworth Heinemann, 2012.

# 19MENE11 - DESIGN OF ENVIRONMENTAL ENGINEERING STRUCTURES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

## COURSE OUTCOMES

*At the end of the course, the student will*

*CO1 : Apply the principle of limit state design for the structural design of water and waste water treatment plants.*

*CO2 : Develop structural design of concrete and steel pipes*

*CO3 : Analyse, apply and design the environmental engineering structures*

*CO4 : Design the special structures.*

*CO5 : Design underground water storage structures*

## INTRODUCTION AND DESIGN OF PIPES

Environmental Engineering structures - Introduction -Concept of elastic method, ultimate load method and limit state method - Advantages of Limit State method over other methods - Limit State philosophy as detailed in current IS Code. Structural design of Concrete, Prestressed Concrete, Steel and Cast-iron piping mains - anchorage for pipes - massive outfalls - Advances in the manufacture of pipe (9)

## DESIGN OF WATER RETAINING STRUCTURES

IS Codes for the design of water retaining structures - Design of concrete roofing systems - Cylindrical, Spherical and Conical shapes using membrane theory - Design of circular, rectangular, spherical and Intze type of tanks- Design of prestressed concrete cylindrical tank, Settling tanks, Clariflocculators, Filters (9)

## DESIGN OF WASTEWATER RETAINING STRUCTURES

Structural design of wastewater treatment units - Grit chamber, Parshall flume, Aeration tank, Anaerobic baffle reactor, Sludge digester, UASBR, Sludge thickener, Sludge drying beds. (9)

## STEEL STRUCTURES

Design of Square bunker and Storage structures - IS codal provisions - Design of cylindrical silo. Design of various types of foundation like isolated, combined and raft foundation for a Water tanks, Bunkers and Silo's. (9)

## SPECIAL STRUCTURES

Structural design of underground reservoirs and swimming pools, Intake towers - effect of earth pressure and uplift considerations - design of - Cyclone separator - Scrubber (9)

**TOTAL : 45**

## TEXT BOOKS

1. "Prestressed Concrete" by Krishna Raju, Tata McGraw Hill Publishing Co. 2<sup>nd</sup> Edition 1988.
2. "Reinforced Concrete" by N.C.Sinha & S.K.Roy - S.Chand and Co. 1985
3. Metcalf & Eddy, "Waste water Engineering, Treatment and Reuse", 3<sup>rd</sup> Edition, Tata McGraw - Hill Publishing Limited, New Delhi.

## REFERENCES

1. Ramaswamy, G.S., "Design and Construction of Concrete shell roofs", CBS Publishers, India, 1986.
2. Green, J.K. and Perkins, P.H., "Concrete liquid retaining structures", Applied Science Publishers, 1981.
3. Rajagopalan K., "Storage structures", Tata McGraw Hill, New Delhi, 1989. 6. Krishna Raju N., "Advanced Reinforced Concrete Design", CBS Publishers and Distributors, New Delhi, 1988.

# 19MENE12 - BIODEGRADATION AND BIOREMEDIATION TECHNIQUES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

CATEGORY : PROFESSIONAL ELECTIVE

## COURSE OUTCOMES

*At the end of the course, the student will be able to:*

*CO1 : Outline the types of biodegradation and analyze the role of microorganisms in the field of Environmental protection*

*CO2 : Impart sufficient scientific understanding of the current environmental tribulations and global concerns*

*CO3 : Understand the process of bioremediation, mechanisms, types, success stories and monitoring strategies*

*CO4 : Analyze specific bioremediation techniques*

*CO5 : Apply the concepts of bioremediation technology to heavy metal and oil spill pollution*

## BIODEGRADATION

Concepts - types of biodegradation processes - Metabolic basics of biodegradation - Types of enzymes that catalyse biological transformations substantial for nature and human beings - The microbiological processes, biological filtration, microbial interactions with pollutants - microorganisms as bio indicators and active actors in the field of environmental protection - types of fermentation. (9)

## APPLICATION AND CONTROL OF BIODEGRADATION

Control of biodegradation processes - usage of biodegradation in biotechnology, pharmaceutical, medical, agricultural production and protection - Possible usage of biological agents in wastewater treatment. (9)

## BIOREMEDIATION

Types of Bioremediation - Factors affecting Bioremediation .Bioremediation Mechanisms - Limitations of Bioremediations - Microbes for Bioremediation: Essential characteristics of Microbes for Bioremediation - Microbial adaptation for Adverse conditions - Microbes involved in Bioremediation - Metabolic process involved in bioremediation - Bioremediation Techniques: Insitu & Exsitu bioremediation techniques - Phytoremediation. (9)

## SPECIFIC BIOREMEDIATION TECHNOLOGIES

Application, specific advantages and disadvantages of specific bioremediation technologies - land farming, prepared beds, biopiles, composting, bioventing, biosparging, pump and treat method - constructed wet lands - use of bioreactors for bioremediation. (9)

## HEAVY METAL AND OIL SPILL BIOREMEDIATION

Heavy metal pollution & sources - Microbial interactions with heavy metals - resistance & tolerance; Microbial transformation; Accumulation and concentration of metals - Biosorption of heavy metals by microbial biomass and secondary metabolites - Biosurfactants, advantages of biosurfactants over chemical surfactants - Biotechnology and oil spills; Improved oil recovery. (9)

Total : 45

## TEXT BOOKS

1. Bruce E. Rittmann, Perry L. McCarty, "Environmental Biotechnology: Principles and Applications" McGraw-Hill, 2012.
2. Phillip L. Buckingham, Jeffrey C. Evans, "Hazardous Waste Management" Waveland Pr Inc; Reissue Edition 1, 2010.
3. S. K. Agarwal, "Environmental Biotechnology", APH Publishing, 2000.

## REFERENCES

1. *Martin Alexander, "Biodegradation & Bioremediation", Academic press, 1999.*
2. *Karrelly D., Chakrabarty K., Omen G.S, "Biotechnology and Biodegradation", Portfolio Pub. Co., 1990.*
3. *P. Rajendran, P. Guansekaran, "Microbial Bioremediation", Mjp Publishers, 2011.*
4. *Microbiology, M. J. Pelczer, E.C.S Chan (1993), McGraw Hill Education Private limited, New Delhi.*
5. *Bruce E. Rittmann, Eric Seagren, Brian A.Wrenn and Albert J.Valocchi, Chittaranjan Ray Lutgarde Raskin, "In-situ Bioremediation", Naves publication, U.S.A., 1991.*

# 19MENE13 - ENERGY MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

CATEGORY : PROFESSIONAL ELECTIVE

## COURSE OUTCOMES

At the end of the course, the student will be able to:

*CO1 : Realize the energy demand and understand the production and consumption of primary energy resources*

*CO2 : Understand the probable harvesting of various conventional and unconventional energy resources*

*CO3 : Effectively understand the energy conservation systems in urban regions*

*CO4 : Appropriately implement the energy audits and effective standards in conservation*

*CO5 : Comprehend the importance of energy saving and to express the relationship between cost and energy consumption*

## 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.

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)

Total : 45

## TEXT BOOKS

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, 2006.

## REFERENCES

1. Trivedi, P.K and Jorka, K.R., "Energy Management", Common Wealth Publication, New Delhi, 1998.
2. Gupta K., "Energy and Environment in India : A study of Energy Management", Gyan publishing House, Delhi, 2002
3. Mubeen, Abdul, "Energy and Environment", Anamaya Publishers, Delhi, 2004

# 19MENE14 - ENVIRONMENTAL ECONOMICS AND LEGISLATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

CATEGORY : PROFESSIONAL ELECTIVE

## COURSE OUTCOMES

*At the end of this course the students will be able to,*

*CO1 : Outline the environmental policies and legislation practicing in India and comparative views on International policies*

*CO2 : Summarize the circumstantial -based environmental policies*

*CO3 : Demonstrate the suitable functional skills in overall management of upcoming developmental projects*

*CO4 : Employ the appropriate and compatible environmental legislation by analysing the global environmental issues*

*CO5 : Interpret and comprehend the various roles and responsibilities of pollution control and environmental acts in India*

## 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)

Total : 45

## TEXT BOOK

1. Nick, H., Jaison, F.S. and Ben, W., "Environmental Economics in Theory and Practice", McMillan India Ltd., New Delhi, 1999.

## REFERENCES

1. John, W., "Sustainability and Environmental Economics", Addison Wesley Inc., Singapore, 1999.

2. Tiwari, H.N., "Environmental Law", Allahabad Law Agency, 2016.

3. Rosencrany, A., Divan, and Nable, M., "Environmental Law and Policy in India (Cases, Materials, and Statutes)", Tripathi Pub., Bombay, India, 1997.

# 19MENE15 - SUSTAINABLE DEVELOPMENT AND CLEANER PRODUCTION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

CATEGORY : PROFESSIONAL ELECTIVE

## COURSE OUTCOMES

*At the end of the course, the student will be able to:*

*CO1 : Appropriately understand the need-based sustainable development around the globe*

*CO2 : Understand the sustainable strategies for social improvement and economic growth.*

*CO3 : Analyse the legislation and policy in maintaining sustainable development.*

*CO4 : Apply the sustainable development principles during the planning of developmental activities*

*CO5 : Aware the National and International policies pertaining to environment quality and relevant standards*

## INTRODUCTION

History and emergence of Sustainable Development - Tiwari committee recommendation - sustainable development goals - Components and factors governing sustainable development - Environment and poverty -Industrial growth and resource depletion - Globalization and Environment - Action plan for implementing sustainable growth. (9)

## LEGAL ASPECTS IN SUSTAINABILITY

Major International Conventions and agreement on sustainability -Sustainability concepts through legal systems - principles - doctrines - case laws - Moral obligations and Operational guidelines. (9)

## SOCIO-ECONOMIC SUSTAINABLE DEVELOPMENT SYSTEMS

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

## AGENDA FOR FUTURE GLOBAL SUSTAINABLE DEVELOPMENT

Role of developed countries in the sustainable development of developing countries - Demographic dynamics and sustainability - Integrated approach for resource protection and management. Recent trends in Sustainable technological development - Cleaner production - Cleaner production Assessments. (9)

## LIFE CYCLE ASSESSMENT

Definition and necessity -Elements of LCA -Life cycle cost - -Eco labelling -Design for the environment -International environmental standards -ISO 14001 series -Environmental audit and environmental review (9)

Total : 45

## TEXT BOOKS

1. Bishop, P., "Pollution Prevention: Fundamentals and Practice", Wave Land Pr Inc.,Edn.,2014.
2. Kirkby, J.O., Keefe, P., and Timberlake, "Sustainable Development", Earthsean Pub., London, 2001

## REFERENCE

1. World Bank Group, "Pollution Prevention and Abatement Hand Books towards Cleaner Production", World Bank and UNEP, Washington, D.C., 1998.

## 19MCEO01 - DISASTER MANAGEMENT

L	T	P	C
3	0	0	3

### ASSESSMENT : THEORY

#### COURSE OUTCOMES

At the end of this course, the student will be able to

*CO1 : Identify natural and manmade disasters*

*CO2 : Explain in detail about causes and effects of natural and manmade disasters.*

*CO3 : Apply geospatial techniques (including GIS) that can enhance vulnerability assessments*

*CO4 : Identify and analyse the factors that give rise to differential vulnerabilities and levels of community resilience and suggest necessary mitigation plans*

*CO5 : Assess and manage these vulnerabilities through disaster planning and policy-making.*

#### NATURAL DISASTERS

Cyclones, Floods, Drought and Desertification - Earthquake, Tsunami, Landslides and Avalanche. (9)

#### MAN MADE DISASTERS

Chemical industrial hazards, major power breakdowns, traffic accidents, Fire, War, Atom bombs, Nuclear disaster- Forest Fire- Oil fire -accident in Mines. (9)

#### GEOSPATIAL TECHNOLOGY

Remote sensing, GIS and GPS applications in real time disaster monitoring, prevention and rehabilitation- disaster mapping. (9)

#### RISK ASSESSMENT AND MITIGATION

Hazards, Risks and Vulnerabilities - Disasters in India, Assessment of Disaster Vulnerability of a location and vulnerable groups- Preparedness and Mitigation measures for various Disasters- Mitigation through capacity building -Preparation of Disaster Management Plans. (9)

#### DISASTER MANAGEMENT

Legislative responsibilities of disaster management- Disaster management act 2005- post disaster recovery & rehabilitation, Relief & Logistics Management; disaster related infrastructure development- Post Disaster, Emergency Support Functions and their coordination mechanism - Role of Engineers in Disaster Management. (9)

Total : 45

#### TEXT BOOKS

1. *R.Subramanian" Disaster Management " Vikas Publishing House Pvt. Ltd, New Delhi, 110055, 2018.*
2. *Tushar Bhattacharya, "Disaster Science and Management", McGraw Hill India Education Pvt. Ltd., 2017.*

#### REFERENCES

1. *Disaster Management in India- A Status Report- Published by the National Disaster Management Institute, Ministry of Home Affairs, Govt. of India, 2004.*
2. *Murthy D. B. N., "Disaster Management: Text and Case Studies", Deep and Deep Publications (P) Ltd., New Delhi, 2007.*
3. *Sundar I. and Sezhayan T., "Disaster Management", Sarup and Sons, New Delhi, 2007.*
4. *Singhal J.P. "Disaster Management", Laxmi Publications, 2010.*
5. *Khanna B K, "All You Wanted To Know About Disasters", New India Publishing Agency, New Delhi, 2005.*
6. *Ramana Murthy, "Disaster Management", Dominant, New Delhi, 2004.*
7. *RajdeepDasgupta, "Disaster Management and Rehabilitation", Mittal Publishers, New Delhi, 2007.*

# 19MCEOE02 - ENERGY EFFICIENT BUILDINGS

L	T	P	C
3	0	0	3

## ASSESSMENT : THEORY

### COURSE OUTCOMES

At the end of the course the student will be able to:

*CO1 : Perform energy audits in any type of building and suggest the conservation measures.*

*CO2 : Identify energy efficient landscape and building envelopes*

*CO3 : Understand natural heating and cooling system for efficient buildings CO4:Acquire knowledge about heat transmission and estimation of building loads CO5: Integrate the renewable energy systems in the buildings*

### INTRODUCTION

Conventional versus Energy Efficient buildings - Historical perspective - Water - Energy - IAQ- requirement analysis - Future building design aspects - Criticality of resources and needs of modern living. (9)

### LANDSCAPE AND BUILDING ENVELOPES

Energy efficient Landscape design - Micro-climates - various methods - Shading, water bodies- Building envelope: Building materials, Envelope heat loss and heat gain and its evaluation, paints, Insulation, Design methods and tools. (9)

### HEATING, VENTILATION AND AIR-CONDITIONING

Natural Ventilation, Passive cooling and heating - Application of wind, water and earth for cooling, evaporative cooling, radiant cooling - Hybrid Methods - Energy Conservation measures, Thermal Storage integration in buildings. (9)

### HEAT TRANSMISSION IN BUILDINGS

**Surface co-efficient** : air cavity, internal and external surfaces, overall thermal transmittance, wall and windows; Heat transfer due to ventilation/infiltration, internal heat transfer; Sol-air temperature; Decrement factor; Phase lag. Design of day lighting; Estimation of building loads: Steady state method, network method, numerical method, correlations; Computer packages for carrying out thermal design of buildings and predicting performance. (9)

### PASSIVE COOLING & RENEWABLE ENERGY IN BUILDINGS

**Passive cooling concepts** : Evaporative cooling, radiative cooling; Application of wind, water and earth for cooling; Shading, paints and cavity walls for cooling; Roof radiation traps; Earth air tunnel. Introduction of renewable sources in buildings, solar water heating, small wind turbines, stand-alone PV systems, Hybrid system - Economics. (9)

Total : 45

### TEXT BOOKS

1. Krieder J. and Rabi A., "Heating and Cooling of buildings: Design for Efficiency", Mc Graw Hill, 1994.
2. Ursala Eicker, "Solar Technologies for buildings", Wiley publications, 2003.

### REFERENCE

1. Guide book for National Certification Examination for Energy Managers and Energy Auditors (Could be downloaded from [www.energymanagertraining.com](http://www.energymanagertraining.com))

# 19MCMOE01- LANDSCAPE AND ARCHITECTURE

L	T	P	C
3	0	0	3

## ASSESSMENT : THEORY

### COURSE OUTCOMES

- CO1 : Present architectural designs associated with spaces, mass, visual and emotional effects and design components.*
- CO2 : Familiarize students with various elements landscape architecture and the principle of landscape design.*
- CO3 : Provide an overview of ecological balance and impacts of human activities and stress the need for environmental protection and landscape consideration.*
- CO4 : Develop and strengthen the competency in dealing with the analytic, artistic and technical aspects of designing open spaces at different scales.*

### OVERVIEW OF ARCHITECTURE

Definition of architecture - Introduction to architecture - Elements of architecture - - Need and fulfillment - Architecture design - An analysis - Integration of aesthetic and function - Mass and space, visual and emotional effects of geometric forms and their derivatives - Space - Form - Composition - Dimension - Proportion, scale, Balance, Rhythm, Symmetry, Hierarchy, Pattern and axis with building examples - Concept development. (9)

### ELEMENTS IN LANDSCAPE DESIGN

Ecology, ecological balance - Hard and soft landscape elements; Plant materials - Classification, Characteristics, use and application in landscape design; Water and landform. (9)

### GARDEN DESIGN

Landscape and garden design in history - Japanese, Italian Renaissance and Moghul gardens in India, Study of notable examples, spatial development in landscape design. (9)

### SITE PLANNING

Organization of spaces - Circulation, built form and open spaces, site planning and micro climate, site planning of neighborhood parks, children's play area and campus development. (9)

### LANDSCAPING OF FUNCTIONAL AREAS

Urban open spaces and principles of urban landscape; Street landscaping; Landscape design for waterfront areas and functional areas in urban centers; Green roofs and walls. (9)

Total : 45

### TEXT BOOKS

1. Michael Laurie, "An Introduction to Landscape Architecture", Elsevier, 1986
2. Geoffrey and Susan Jellicoe, "The Landscape of man", Thames and Hudson, 1987
3. Van Meiss, "Elements of Architecture", Van Nostrand Publications, London 1986

### REFERENCES

1. Ching, Francis D. K. Architecture-form, Space, & Order. Hoboken, NJ: John Wiley & Sons, 2007. Print.
2. TSS for Landscape Architecture, Mc Graw Hill Inc., 1995
3. Grant W Reid, Form concept, form in landscape design, Van Nostrand Reinhold Company, 1993

## 19MENOE01- CLIMATE CHANGE AND ADAPTATION

L	T	P	C
3	0	0	3

### ASSESSMENT : THEORY

#### COURSE OUTCOMES

At the end of the course, the student will be able to:

*CO1 : Understand earth's climate system and the concept of global warming*

*CO2 : Infer the causes for climate change on the earth's surface*

*CO3 : Comprehend the impact of climate change on society*

*CO4 : Apply the various climate change adaptation and mitigation measures*

*CO5 : Evaluate the role of clean technology in climate change adaptation*

#### EARTH'S CLIMATE SYSTEM

Introduction - weather and climate - Climate in the spotlight-The Earth's Climate Machine - Climate Classification - Global wind systems - Trade Wind Systems - Trade Winds and the Hadley Cell - Cloud formation and Monsoon Rains - Storms, Hurricanes and Tornado - The Hydrological Cycle - Global Ocean Circulation - El Nino - LA Nino effect - Solar Radiation - The Earth's Natural Green House Effect - Green House Gases and Global Warming (9)

#### OBSERVED CHANGES AND ITS CAUSES

Observation of Climate Change - Changes in pattern of temperature, precipitation and sea level rise - Observed effects of Climate Changes - Drivers of Climate Change - Climate Sensitivity and Feedbacks - The Montreal Protocol - UNFCCC - IPCC - Evidences of Changes in Climate and Environment - on a Global Scale and in India - Climate Change modeling. (9)

#### IMPACTS OF CLIMATE CHANGE

Impacts of Climate Change on various sectors - Agriculture, Forestry and Ecosystem - Water resources - Human Health - Industry, Settlement and Society - Methods and Scenarios - Projected Impacts for different regions - Uncertainties in the Projected Impacts of Climate Change - Risk of irreversible changes. (9)

#### CLIMATE CHANGE ADAPTATION AND MITIGATION MEASURES

Adaptation Strategy/options in various sectors - Water - Agriculture - Infrastructure and Settlement including coastal zones. Human Health - Tourism - Transport - Energy - Key Mitigation Technologies and practices - Energy supply - Transport - Buildings - Industry - Agriculture - Forestry - Carbon sequestration - Carbon Capture and Storage (CCS) - Waste (MSW & Biowaste, Biomedical, Industrial waste - International and Regional co-operation. (9)

#### CLEAN TECHNOLOGY AND ENERGY

Clean Development Mechanism - Carbon Trading - Examples of future Clean Technology - Biodiesel - Natural Compost - Eco-friendly Plastic - Alternate Energy - Hydrogen - Bio-fuels - Solar Energy - Wind - Hydroelectric Power. (9)

Total : 45

#### TEXT BOOKS

1. Dash Sushil Kumar, "Climate Change - An Indian Perspective", Cambridge University Press India Pvt. Ltd, 2007.
2. IPCC Fifth Assessment Report.
3. Jan C. van Dam, Impacts of "Climate Change and Climate Variability on Hydrological Regimes", IHE, The Netherlands, October,2009.

## REFERENCES

1. Anil Maranda, *Climate Change and Sustainable Development: Prospects for Developing Countries*, Routledge, 2002.
2. Al core "inconvenient truth" - a Global Warming, video form, Documentary, May 2006.
3. Heal, G. M., *Interpreting Sustainability*, in *Sustainability: Dynamics and Uncertainty*, Kluwer Academic Publ., 1998.
4. Jepma, C.J., and Munasinghe, M., *Climate Change Policy - Facts, Issues and Analysis*, Cambridge University Press, 1998.
5. Munasinghe, M., *Sustainable Energy Development: Issues and Policy in Energy, Environment and Economy: Asian Perspective*, Kleindorfer P. R. et. al (ed.), Edward Elgar, 1996.

# 19MCOC01 - PRACTICAL GEOTECHNICAL ENGINEERING

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

## COURSE OUTCOMES

*At the end of this laboratory, the students will be able to*

*CO1 : Plan and conduct appropriate soil exploration method based on site condition.*

*CO2 : Classify soils based on their index properties*

*CO3 : Understand strength and settlement characteristics of soils.*

*CO4 : Compute Safe Bearing Capacity of soils and select appropriate foundations.*

## LIST OF EXPERIMENTS

1. Soil Exploration and Site Characterization. (3)
2. Assessment of Index Properties of Soil. (3)
3. Assessment of Flow and Consolidation Properties of Soil. (3)
4. Assessment of Shear Strength Parameters of Soil. (3)
5. Assessment of Bearing Capacity of Soil. (3)

## REFERENCES

1. "Soil Engineering Laboratory Instruction Manual", Published by the Department of Civil Engineering. CIT, Coimbatore, 2008.
2. Head, K.H, "Manual of Soil Laboratory Testing (Vol-1 to 3)", John Wiley & Sons, Chichester, 1998.
3. Lambe T.W., "Soil Testing for Engineers", John Wiley & Sons, New York, 1990.
4. IS Code of Practice 2720 - Indian Standard Code of Practice for Methods of Tests for soil.
5. Saibaba Reddy, E. and Rama Sastri, K., "Measurement of Engineering Properties of Soils", New Age International, 2002.

# 19MCOC02 - GREEN BUILDINGS

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

## COURSE OUTCOMES

At the end of the course the student will be able to:

CO1 : Acquire knowledge about energy impact in buildings

CO2 : Identify different energy analysis method and standards

CO3 : Understand energy quality management in buildings.

## INTRODUCTION

Life Cycle impacts of materials and products - sustainable design concepts - strategies of design for the Environment -The sun-earth relationship and the energy balance on the earth's surface, climate, wind - Solar radiation and solar temperature - Sun shading and solar radiation on surfaces - Energy impact on the shape and orientation of buildings - Thermal properties of building materials. (5)

## ENERGY EFFICIENT BUILDINGS

Passive cooling and day lighting - Active solar and photovoltaic- Building energy analysis methods- Building energy simulation- Building energy efficiency standards- Lighting system design- Lighting economics and aesthetics- Impacts of lighting efficiency - Energy audit and energy targeting- Technological options for energy management. (5)

## INDOOR ENVIRONMENTAL QUALITY MANAGEMENT

Psychometry- Comfort conditions- Thermal comfort- Ventilation and air quality-Air conditioning requirement- Visual perception- Illumination requirement-Auditory requirement- Energy management options- Air conditioning systems- Energy conservation in pumps- Fans and blowers- Refrigerating machines - Heat rejection equipment- Energy efficient motors- Insulation. (5)

Total : 15

## TEXTBOOKS

1. Kibert, C. "Sustainable Construction: Green Building Design and Delivery", John Wiley & Sons, 2016
2. Edward G Pita, "An Energy Approach- Air-conditioning Principles and Systems", Pearson Education, 2018

## REFERENCES

1. Colin Porteous, "The New Eco-Architecture", Spon Press, 2002.
2. Energy Conservation Building Codes: [www.bee-india.nic.in](http://www.bee-india.nic.in)
3. Lever More G J, "Building Energy Management Systems", E and FN Spon, London, 2000.
4. Ganesan T P, "Energy Conservation in Buildings", ISTE Professional Center, Chennai, 1999.
5. John Littler and Randall Thomas, "Design with Energy: The Conservation and Use of Energy in Buildings", Cambridge University Press, 1984.

## 19MCOC03- GEO INFORMATICS LABORATORY

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

### COURSE OUTCOMES

*CO1 : The students will be able to carry out remote sensing and GIS applications of various industrial needs.*

*CO2 : The students will be able to demonstrate the various environmental change detections.*

*CO3 : The students will be able to be instrumental for decision support system.*

### GIS INTRODUCTION

Exploring - GIS functions - features - layers - map scale - connecting to folder - reordering of layers - symbolize layer - identify features - using of identify tool - hyperlink tool - zoom pan tools - map document saving (5)

### GIS MAP

Layer attribute table - feature attribute relationship- creating map layout - making map layout in reverse - pinning down geographic data (5)

### GEOGRAPHY STUDY

Vector and raster data - geographic data work with item description - query based on attributes and locations - analyze data using buffer and overlay - applying gis analysis process (5)

Total : 15

### TEXT BOOKS

1. *Floyd F.Sabins, J.R., WH, "Remote Sensing Principles Interpretation", Freeman and Company and Francis Company, France, 1996.*
2. *Lillesand, Thomas.M and Raiph W.Kiefer, "Remote Sensing and Image Interpretation", John Wiley Sons, 2002.*

### REFERENCE S

1. *Burrough.P.A., "Principles of GIS for Land Resources Assesment, Oxford Publication, 1998.*
2. *Thomas.M.Lillesand and Ralph.W.Kiefer, Remote Sensing and Image Interpretation, John Wiley and Sons, Inc, 2003.*

# 19MCOC04 - SUSTAINABLE ARCHITECTURE

L	T	P	C
1	0	0	1

## ASSESSMENT : THEORY

### COURSE OUTCOMES

At the end of the course, the student will be able to:

*CO1 : Understand the concept of sustainable architecture.*

*CO2 : Analyze Impact and perform energy audit for the building*

*CO3 : Apply the various water and waste management sustainable methodology.*

### SUSTAINABLE CONCEPTS - PEOPLE, ENVIRONMENT AND BUILDING

Introduction -sustainable development goals- Components and factors governing sustainable development- Relationship between people and environment, impact of people on environment and vice versa, extent of the energy and environmental crises facing the world, Need for implementing energy efficiency on an international, national and individual basis in the context of the building industry & environmental issues. Introduction to Indoor environment - spatial environment, Thermal environment, visual environment, sonic environment and olfactory environment. (5)

### ENERGY AUDIT & ENVIRONMENTAL IMPACT ASSESSMENT

General Aspects of Energy Management & Energy Audit. Energy Efficiency in Thermal Utilities and Energy Efficiency in Electrical Utilities , Energy Performance Assessment for building envelope, fenestration and embodied energy.- Introduction and components such as physical, biological and socio-economical of Environmental impact assessment (EIA) in India based on the Environmental Protection Act (EPA), 1986 , Ministry of Environment and Forest (MoEF) January 1994 for Environmental Clearance (EC) known as EIA Notification, 1994 (5)

### WASTE UTILIZATION & MANAGEMENT, WATER AND BUILT FORMS

The primary goal is to provide a comprehensive understanding of waste management from an environmental public health perspective. Sustainable techniques in municipal solid waste management. Recycling and Reuse. Energy development and Management of urban waste services.- water demand, growing water misuse, pollution, threat to environment, social implications, sustainability of water recourses, ground water management, issues related to urban water supply. (5)

Total : 15

### TEXT BOOKS

1. *Jacqueline Hoyer, Wolfgang Dickhaut, Lukas Kronawitter, Björn Weber "Water Sensitive Urban Design": Principles and Inspirations for Sustainable Storm water Management in the City of theFuture, ISBN 978-3-86859-106-4 03. 2011.*
2. *S. BrySarte, "Sustainable Infrastructure The Guide to Green Engineering and Design", Publisher: Wiley, ISBN: 978-0470453612, September 2010.*

### REFERENCES

1. *Baker Nick and Steamers Koen, "Energy and Environment in Architecture", E & FN Spon, London, 1999.*
2. *Goulding, John, R., Lewis, Owen, J., and Steemers, Theo, C, "Energy in Architecture", Bastford Ltd., London, 1986.*
3. *Givoni, B., "Man, Climate and Architecture", Elsevier, Amsterdam, 1986*
4. *MoncefKrtati, "Energy Audit of Building Systems: an Engineering approach" CRC Press, LLC, Florida 2000.*