VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
CBCS – M.TECH., ENVIRONMENTAL ENGINEERING SYLLABUS
FOR TEACHING – 2018-19

ADVANCED COMPUTATIONAL METHODS & OPTIMIZATION

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – I

Subject Code	18CEE11	IA Marks	40
Number of Lecture Hours/Week	04	Exam Marks	60
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to

1. Apply knowledge of statistics to environmental problems.
2. Understand the fundamentals of optimization, formulate the mathematical model and solve the models.
3. Apply the knowledge of numerical methods in solving algebraic, transcendental and partial differential equations.

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module -1		
Statistics: Frequency Distribution – Characteristics of Distributions: Central tendency and dispersion. methods of least square and regression, multiple regression, Solutions of regression analysis problems Analysis of Variance.	**12 Hours**	**L2,L3,L4**
Module -2		
Probability: Concept of probability, Random Variables, Binomial, Poisson and Normal distribution – applications, Chi-squared test, F test, t-test.	**8 Hours**	**L2,L3,L4**
Module -3		
Optimization: Concept, need, importance and applications related to environmental engineering, Single and multivariable optimization without and with constraints. Linear programming – standard form of problems, pivotal reduction of equations. Solutions of linear programming problems, Simplex method – single and two phase methods, Concept of Dual Linear Programming and conversion of primal to Dual.	**12 Hours**	**L2,L3,L4**

Module -4		
Non-Linear Programming: Numerical search methods non-linear problems-Dichotomous. Fibonacci and Golden section methods. Quadratic and cubic interpolation methods.	**8 Hours**	**L2,L3,L4**
Module -5		
Numerical Methods: Newton – Raphson method for solution of algebraic and transcendental equations, Numerical solutions of partial differential equations – finite difference, solution of elliptic, parabolic and hyperbolic equations.	**10 Hours**	**L2,L3,L4**

Course outcomes: After studying this course, students will be able to:

1. Analyze the environmental data and characterize with regression equations.
2. Select and apply the appropriate distribution to experimental/field data.
3. Able to apply optimization concepts to environmental problems.
4. Select suitable numerical methods to search the solution of nonlinear optimization equation.
5. Apply numerical methods to solve algebraic, transcendental and partial differential equations.

Program Objectives (as per NBA)

- *Engineering Knowledge.*
- *Problem Analysis.*
- *Interpretation of Data.*

Question paper pattern:

- The question paper will have ten questions, each full question carrying 12 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer Five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

Text Books:

1. Rao, S.S. (1996), “Optimization: Theory and applications”, Wiley Eastern Ltd. Publications.
2. Grewal. B.S., and Grewal. J.S., "Numerical methods in Engineering and Science", Khanna Publishers, 9th Edition, New Delhi.
3. Berthouex P M., and Brown L. C., “Statistics for Environmental Engineers”, Lishers Publications.

Reference Books:

1. Taha H.A., “Optimization Research”:An introduction, Pear son Prentice Hall, 8th Edition
2. Shanthakumar M.S., “Numerical Methods and Analysis”, Tata McGrawhill Pubs.
3. Levin R I., (2008), “Statistics for Management”, Pearson Education India.
4. Desai, C.S., and John F Abel ,(1972), “Introduction to the Finite Element Method: Numerical Method for Engineering Analysis” -Van Nostrand Reinhold, New York.

ADVANCED WATER TREATMENT TECHNOLOGY
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – I

Subject Code	18CEE12	IA Marks	40
Number of Lecture Hours/Week	04	Exam Marks	60
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Course Objectives:

This course will enable students to;

- Gain the Knowledge on Water and its significance, importance of its quality and Standards for usage.
- To understand about objectives of water treatment.
- Understand the Design and operation of Water Treatment Process.
- Understand about the Purification process like, Sedimentation, Coagulation, Filtration, Disinfection, Fluoridation & De-fluoridation and softening methodologies involved before supplying to Public.

Modules	**Teaching Hours**
Module -1	
Introduction–Objectives and necessity for Treatment of water. Sources of water and their characteristics. Micro-organisms in natural water purification system. Drinking water quality requirements as per BIS & WHO guidelines. Sources of Water Pollution, Diseases and Control. Public Health Significance. Flow Diagram on overall water supply Project. Unit diagrams and flow charts on Water Treatment System. Suitability of Intake Structures and types.	**10 Hours**
Module – 2	
Treatment Operations and Engineering Systems for Water Purification – Typical treatment for ground water containing Hardness and Turbid surface water contaminated with organisms. Water Aeration process, Importance and limitations. Gas Transfer two film model: Water in Air system and Air in water system. Estimation of Solubility of Air in water with Henry's Law. Significance of DO in Water. Principles of Sedimentation Process and Separation of Solids. Design Criteria and design of Sedimentation tank. Type-I and Type-II Settling pattern in the removal of Discrete particles.	**10 Hours**

Module – 3	
Coagulation and Flocculation Process – Theory of Coagulation and Principle. Types of Coagulants used and their characteristics, Chemical reaction with water. Alkalinity Coagulation relationship. Coagulant Aids, Chemical feeding devises. Determination of Optimum Coagulant Dosage. Numerical design problems on estimation of Coagulants.	**10 Hours**

Module – 4	
Water Treatment by Filtration Process – Theory of Filtration and basic Principles. Classification of Filters used in treatment of water. Filters washing Technique/back wash. Operational troubles and trouble shooting. Design criteria used and Design of Slow and Rapid Sand Filters required for water treatment plant.	**10 Hours**
Module – 5	
Water Disinfection Process – Disinfection methodologies and their suitability. Theory of Disinfection and characteristics of good disinfectant. Forms of Chlorination, Chemical reactions, Break point Chlorination. Measurement of Chlorine Demand and residual Chlorine. Estimation of quantity of Chlorine and Bleaching powder required for treatment of water. **Water Softening** - Hardness removal techniques, numerical problems on determination of Hardness in water sample and Studies on effects of hardness. Fluoridation and Defluoridation techniques in affected areas.	**10 Hours**

Course outcomes:

During this course, students will be trained :

- To understand the roll and importance of drinking water Quality and control of water borne diseases.
- Transmission of Various diseases in a Community.
- By knowing the Objectives and importance of treatment process, one can judge the standards of water before used and supplying to a community.
- To understand the Dynamics of Water Purification and type of treatment required with respect to water characteristics.
- Gaining the knowledge on water softening process and Fluoridation & Defluoridation techniques.

Question paper pattern:

- The question paper will have ten questions, each full question carrying 12 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer Five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

Text Books:

- Fair, G.M., Geyer J.C and Okun, (1969) "**Water and Waste water Engineering**" Vol II, John Wiley Publications.
- Weber W.J., (1975) "**Physico - Chemical Processes for Water Quality Control**".
- AWWA, (1971), "**Water Quality and Treatment** "McGraw Hill.
- CPHEEO Manual, (1991), "**Water Supply and Treatment",** GOI-Publications, New Delhi.

Reference Books:

- Peavy, H.S., Rowe and Tchobonoglous,G., (1985), **"Environmental Engineering**", McGraw Hill.
- Viessman Jr, Hammer J. M, Perez, E.M, and Chadik, P. A, **Water Supply and Pollution Control**, PHI Learning, New Delhi, 2009.
- Howard S. Peavy, Donald R. Rowe and George Tchobanoglous, **Environmental Engineering**, McGraw Hill., 1984

APPLIED ENVIRONMENTAL CHEMISTRY AND MICROBIOLOGY

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER– I

Subject Code	18CEE-13	IA Marks	*40*
Number of Lecture Hours/Week	04	Exam Marks	60
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Course objectives:

To train the engineers and researchers to know the basic composition of materials, technology for measurement of its concentration and technology for environmental conservation, and aspire to improve welfare and sustainability of our society by applying their chemical knowledge. Microbiology provides a general introduction to the diverse roles of microorganisms in natural and artificial environments.

Modules	**Teaching Hours**
Module -1 ImportanceofEnvironmentalChemistry as applied to the Environmental Engineering,typesof reactions, reversible and irreversible reaction,redoxreactions,reactionkinetics. Modes of expression for molarity, normality, molality, etc., Electrochemistryanditsapplications.Physicalandequilibrium chemistry– fundamentalsandapplications. pH–Principle,Measurement, NumericalExamples,BuffersandBufferindex.	**10 Hours**
Module -2	
ColloidalChemistry:Colloids – Types, properties and environmental significance. Colloidal dispersions in water, air and emulsions. Theory of colloids – double layer theory, zeta potential, destabilization of colloids (Schulze – Hardy rule) as applied to coagulation process. Absorption and adsorption process, adsorption isotherms	**10 Hours**
Module -3	
Instrumental methods of analysis: Lambert's and Beer's law. Colorimetry – estimation of iron and manganese in water samples. Methods of determining the trace organic and inorganic contaminants using emission and absorption technique	**10 Hours**
Module -4	
Water & wastewater analysis: Fluoridation, deflouridation, chlorination, BOD, DO, types and measurement of BOD, rate of BOD & theoretical oxygen removal, COD- determination & its application in wastewater treatment	**10 Hours**

Module -5	
Microbiology - Microorganisms of importance in air, water and soil environment Principles and applications of microscopy, microscopic flora and fauna of importance. Metabolism and metabolic pathways, Bioconcentration, Biomagnification and Bioaccumulation. Bacteria – Morphology, typical growth curve and generation time, Measurement Techniques – APC, MPN (Probability and Thomas methods), MFT. Monod's equation and its applications. Algae - orphology, classification and their importance. Fungi - Protozoa - morphology, classification and their importance. Enzymes - classification, kinetics – Michaelis - Menten equation, factors influencing enzyme reaction. Virology - Types, characteristics and enumeration methodology.	**10 Hours**

Course outcomes:

After studying this course, students will be able to:

1. Master a broad set of chemical knowledge concerning the fundamentals in the basic areas of the discipline (organic, inorganic, analytical, physical and biological chemistry).
2. Demonstrate that microorganisms have an indispensable role in the environment, including elemental cycles, biodegradation, etc.

Question paper pattern:

- The question paper will have ten questions, each full question carrying 12 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer Five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

Text Books

1. Pelczar M.J ,Chan ECS, Krieg, NR "Textbook of Microbiology" 5th edition Tata McGraw Hill Publishing Co. Ltd., New Delhi
2. McKinney R.E."Microbiology for Sanitary Engineers", Newyork McGraw Hill.
3. Sawyer C.N. and McCarty, P.L ., , "Chemistry for Environmental Engineering and Science", 5th Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.

Reference Books:

1. Gaudy and Gaudy, "Microbiology for Environmental Scientists and Engineers", McGraw Hill.
2. APHA, "Standard Methods for Examination of Water and Wastewater"; 21st Edition.
3. Stumn and Morgan, "Aquatic Chemistry", John Willey & Sons Newyork. Relevant Journals

SOLID WASTE ENGINEERING AND MANAGEMENT [As per Choice Based Credit System (CBCS) scheme] SEMESTER-1			
Subject Code	18CEE-14	IA Marks	40
Number of Lecture Hours/Week	04	Exam Marks	60
Total Number of Lecture Hours	50	Exam Hours	03
CREDITS – 04			
Course objectives:			
The student will have a thorough understanding of key functional elements in municipal solid waste management including waste minimization concepts. And also designing of engineered land fill sites for the disposal of0 wastes.			
Modules			**Teaching Hours**
Module – 1			
I**ntroduction :**Sources and engineering classification, characterization, generation and quantification; Objectives, principles, functional elements of solid waste management system – Regulatory aspects of solid waste management, major problems. Environmental implications of open dumping, Construction debris – management &handling, E-Waste Management, Rag pickers and their role.			10
Module – 2			
Waste Generation: Rate of generation, frequency, storage and refuse collection, physical and chemical composition, quantity of waste, engineering properties of waste, prediction, modelling concepts. **Collection, Segregation and Transport**: Handling and segregation of wastes at source, Collection (primary & secondary) and storage of municipal solid wastes, collection equipment, transfer stations, collection route optimization and economics, regional concepts. System dynamics			10
Module – 3			
Waste Minimization: 4R: reduce, recover, recycle and reuse, case study, guidelines **Treatment Methods :** Refuse processing technologies. Mechanical and thermal volume reduction. Biological and chemical techniques for energy and other resource recovery: composting, vermicomposting, vermigradation, fermentation. Incineration of solid wastes.			10
Module – 4			
Disposal Methods: Impacts of open dumping, site investigation and selection, sanitary land filling - Types, geotechnical considerations, design criteria and design, Liners - earthen, geo membrane, geo synthetics and geo textiles. **Operational aspects of MSW Landfills** : Daily cover, leachate disposal, Ground Water monitoring, leachate and gas collection systems			10

– Design, leachate treatment. Landfill Final Cap Design and Water Balance, Modelling (HELP – Hydraulic Evaluation of Landfill Performance), post-closure environmental monitoring; landfill remediation.	
Module – 5	
Recent Developments in Solid Wastes Reuse and Disposal : Power Generation, Blending with construction materials and Best Management Practices (BMP). Community based waste management, Waste as a Resource concept, Public private partnership (PPP) **Role of various organizations in Solid Waste Management :** Governmental, Non - Governmental, Citizen Forums.	10

Course outcomes.

Student will be able to

CO1: Identify improper practices of solid waste disposal and their environmental implications. Know the basic engineering principles of solid waste management

CO2: Describe the need for economics in collection and transportation of solid waste and clearly discuss various types of collection systems and analyse system dynamics

CO3: Understand the management concepts, define 4 R approach, apply PPP model and community involvement for effective management of solid waste

CO4: Develop a concise idea on various conventional and advanced treatment options for solid waste

CO5: Conceive the design aspects of engineered disposal options and apply the gained knowledge

Question Paper Pattern

- The question paper will have ten questions, each full question carrying 12 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer Five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

TEXT BOOKS

1. Tchobanoglous G., Theissen H., and EIiassen R., “Solid Waste Engineering Principles and Management Issues”, McGraw Hill, New York. Pavoni J.L., “Handbook of Solid Waste Disposal”.
2. Peavy, Rowe and Tchobanoglous, “Environmental Engineering”, McGraw Hill.
3. Mantell C.L., (1975), “Solid Waste Management”, John Wiley

REFERENCES

1. CPHEEO Manual on Solid Waste Management. WHO Manual on Solid Waste Management.
2. Vesiland A., “Solid Waste Engineering”, Thompson Books.
3. Flintoff F., (1976), “Management of Solid Wastes in Developing Countries”, WHO
4. Regional Publications, South East Asia, New Delhi

OCCUPATIONAL SAFETY AND HEALTH (OSHA)

(As per choice Based Credit System (CBCS) Scheme)

SEMESTER – I

Subject code	18CEE-15	IA Marks	40
Number of Lecture hours per week	04	Exam Marks	60
Total number of lecture hours.	50	Exam Hours	03

CREDITS – 03

Course Objectives

This course enables students to learn the basic principles of safety, OSH Acts and the national policy. It instills the knowledge on cause – effect relationships of accidents at the work places, need for ecorgonomics, hazard identification and control aspects, fire prevention and control. Work place health related issues are covered.

Modules	**Teaching Hours**
Module-1 **Introduction** – concept and scope of occupational safety and environmental health, basic requirements for healthy environment and environmental quality, human exposure and impact of environment factors on health. **Occupational Safety and Health** Occupational Health and Safety Administration- Laws governing OSHA and Right to know, National safety Law, types of diseases and their spread, Health Emergency.	10
Module – 2 **Ergonomics at work place** - Preventing ergonomic hazards, Ergonomic task analysis, Ergonomic standards, Ergonomic programs. **Occupational hazard and control –** Hazard analysis, Human error and fault tree analysis, Emergency response, Principles of Safety.	10
Module – 3 **Fire prevention and protection –** fire triangle, fire development and its severity, effect of enclosures, early detection of fire, classification of fire and fire extinguishers. **Electrical safety, Product safety -** safe handling of chemicals, safety procedures of nuclear installations.	10
Module – 4 **Accidents –** causation, investigstion, methods of acquiring accident facts, supervisory role in accident investigation. **Personal protective equipments –** types and advantages, effects of exposure and treatment for engineering industries, municipal solid waste. Environment management plans (EMP) for safety and sustainability.	10
Module – 5 **Occupational health and safety considerations.** Water and wastewater treatment plants, handling of chemicals and safety measures in water and wastewater treatment plants and labs, Construction material manufacturing industries like cement plants, RMC plants, precast	10

plants and construction sites. Policies, roles and responsibilities of workers, managers and supervisors	

Course Outcomes(COs)

CO1 - Gain knowledge on safety and health principles,OSHA and Right to know, National safety Law, types of diseases and their spread, Health Emergency.

CO2 - Develop the skills of understanding the ergonomics and address specific problems with appropriate strategies. Identify the problems related to the ergonomics and suggest remedial measures.

CO3 - Perform accident investigation and report preparation, describe the need for the product safety and acquire knowledge on various aspects of fire – types, prevention and protection.

CO4 - Perform basic accident investigation and report preparation. concept of Protective equipments and environmental management plan.

CO5 - Discuss health and safety considerations at different work places with a through understanding of PPE's. List the different types of diseases and recommend health emergency mechanism. Gain knowledge through some best management practices.

Question paper pattern:

- The question paper will have ten questions, each full question carrying 12 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer Five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

TEXT BOOKS

1. Goetsch D.L., (1999), "Occupational Safety and Health for Technologists,
2. Engineers and Managers", Prentice Hall.
3. Heinrich H.W., (2007), "Industrial Accident Prevention - A Scientific Approach", McGraw
4. Book Co.

REFERENCES

1. Colling D.A., (1990), "Industrial Safety Management and Technology", Prentice Hall,
2. New Delhi.
3. Della D.E., and Giustina, (1996), "Safety and Environmental Management", Van
4. Nostrand Reinhold International Thomson Publishing Inc.
5. Biomedical Waste (Handling and Management) Rules
6. CPHEEO Manuals on Water Supply and Sewage Treatment.
7. National Safety Council and Associate (Data) Publishers Pvt. Ltd., (1991), "Industrial
8. Safety and Pollution Control Handbook"
9. Trevethick, R.A., ((1973), "Environmental and Industrial Health Hazards"- William
10. Heinemann Medical Books Ltd., London

ENVIRONMENTAL LABORATORY AND FIELD TEST

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – I

Subject Code	18CEEL-16	IA Marks	40
Number of Lecture Hours/Week	03	Exam Marks	60
Total Number of Lecture Hours	40	Exam Hours	03

CREDITS – 02

1. 1.Chemistry Laboratory practice: Sampling and characterization of water and wastewater by gravimetric, volumetric and colorimetric methods, Good laboratory practice – Analytical quality control 2. Sampling and analysis of ambient air Instrumental methods of analyses for particulates, PM10, PM2.5, HC, CO, NOx,SO_2, bio-aerosols, 3. Microbiology Laboratory : Bacteriological analysis of water, sewage, test for plate count – coli forms – fecal coli forms – E coli – M.P.N. and M.F. techniques. Techniques for studying aquatic organisms – identification of phytoplankton and zooplankton – bioassay study and biodegradation. 4. Solid Waste and leachate analyses:, for– Moisture content, organic content, pH, Sulphur, carbon, nitrogen and Trace metals. 5. Noise standards and measurements.	40 Hours

Reference Books:

1. Manual on water supply and Treatment, CPHEEO, Ministry of Urban Development, GoI,New Delhi, 1999.
2. "Manual on Sewerage and Sewage Treatment", CPHEEO, Ministry of Urban Development,GoI, New Delhi,
3. Software Package Manual on BRANCH, LOOP, SEWER – UNDP/UNEP.
4. WATPLANT and QUALOOP Softwares. – CPHEEO – Manual.
5. Relevant Software Manuals– USEPA
6. Wark.K, Warner G.F. and Davis W.T – Air Pollution its origin and control, Addison-Wesley,
7. Thomann R.V and Mueller J.A –. Principles of surface water quality modeling and control, Harper & Row Publishers,
8. Sincerio A.P.& Sincerio G.A., Environmental Engineering – A Design Approach Prentice Hall of India.
9. . "Standard Methods for the Examination of Water and Wastewater", 21th Edition, American Public Health Association, Washington. D.C . 2005

NOTE: 18RMI17- Research methodology and IPR sylabus is same for all streams and hence opined , this will be provided by joint board.

ADVANCED WASTEWATER TREATMENT ENGINEERING

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – II

Subject Code	18CEE-21	IA Marks	40
Number of Lecture Hours/Week	04	Exam Marks	60
Total Number Lecture Hours	50	Exam Hours	03

CREDITS – 04

Course objectives:

To provide a basic description and understanding of the principal unit processes used in the treatment of wastewater. This will include coverage of the scientific basis of each unit process, as well as the conventional approach to their engineering design. In the area of wastewater treatment the course will provide an understanding of the kinetic theory of biological growth and apply it to typical aerobic processes, and an appreciation of the purpose and practice of sludge treatment.

MODULES	Teaching hours
Module -1 **Domestic Wastewater -**characteristics, flow fluctuations, types of reactors and mass balance approach **Wastewater Treatment -**Flow Diagrams and Hydraulic Profile. **Kinetics of biological wastewater treatment syst**ems – biokinetic constants and their determination, batch and continuous system.	10 Hours
Module -2	
Design principles and design of unit operation systems - screen, equalization basin, grit chamber, primary settling tank.	10 Hours
Module -3	
Design Criteria and design of Biological processes – suspended and attached growth systems, conventional activated sludge process and its modifications. **Design principles** of trickling filter, bio-towers and rotating biological contactors.	10 Hours
Module -4	
Advanced Wastewater Treatment: Need and technologies used. Nitrification and Denitrification Processes, Phosphorous removal. Wastewater disinfection	10 Hours
Module -5	
Biological Sludge separation, conditioning and volume reduction Design of Sludge Processing units – secondary settling tank, slude thickeners and digesters– aerobic and anaerobic. **Wastewater treatment systems for small communities** – septic tanks, soak pits, two-pit latrines, eco-toilet.	10 Hours

Course outcomes:

On completion of this course, students are able to understand

1. A process flow sheet, concept of unit operations and biological units.
2. Appropriate treatment methods for municipal and certain industrial effluents.
3. Simple design equations for wastewater treatment plant.
4. The chemical and biological prociples behind unit processes used in wastewater treatment unit processes.
5. The management of residuals from water and wastewater treatment.

Question paper pattern:

- The question paper will have ten questions, each full question carrying 12 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module**.**

Text Books

1. Metcalf and Eddy Inc., , "Wastewater Engineering - Treatment and Reuse", 4th Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
2. Karia G.L., and Christian R.A., "Wastewater Treatment Concepts and Design Approach", Prentice Hall of India Pvt. Ltd., New Delhi.
3. Fair G.M., Geyer J.G and Okun, "Water-wastewater Engineering".

Reference Books:

1. Benefield R.D., and Randal C.W., , "Biological Process Design for Wastewater Treatment", Prentice Hall, Englewood Chiffs, New Jersey.
2. Ronand L., and Droste, ,"Theory and Practice of Water and Wastewater Treatment", John Wiley and Sons Inc.

ATMOSPHERIC ENVIRONMENTAL POLLUTION AND CONTROL [As per Choice Based Credit System (CBCS) scheme] SEMESTER II			
Subject Code	18CEE-22	IA Marks	40
Number of Lecture Hours/Week	04	Exam Marks	60
Total Number of Lecture Hours	50	Exam Hours	03
CREDITS – 04			
Course objectives:			
The course covers the air pollution sources, classification, effects, and measurement of air pollutants, standards, importance of meteorology in air pollutant dispersion, fate and transport of air pollutants using various mathematical tools, as well as air and noise pollution control technologies and regulations.			
Modules			**Teaching Hours**
Module - 1			
Introduction: Definition of Air Pollution, sources, characterization and classification of atmospheric pollutants, air pollution episodes. Effects of air pollutants on human health, vegetation, animals and materials and monuments. Composition and structure of the atmosphere;Visibility and other related atmospheric characteristics.			10
Module - 2			
Meteorology: Wind circulation, solar radiation, lapse rates, atmospheric stability conditions, wind velocity profile, Maximum Mixing Depth, Temperature Inversions, plume behaviour, Wind rose diagram, general characteristics of stack emissions, heat island effect. **Monitoring of particulate matter:** Respirable, non-respirable and nano - particulate matter. Monitoring of gaseous pollutants – CO, CO2, Hydrocarbons, SOX and NOX, photochemical oxidants. Monitoring equipment and sampling devices – stack sampling (Isokinetic sampling), air samplers, gas exhaust analyzer. Air Pollution Index.			10
Module - 3			
Pollutants' dispersion models: Point, line and areal sources models. Box model, Gaussian plume dispersion model – for point source (with and without reflection), Gaussian dispersion coefficient, Determination of ground level concentrations. Infinite line source Gaussian model. plume rise and effective stack height calculations.			10
Module - 4			
Air Pollution Control Equipment: Mechanisms, Control equipment for particulate matter – gravity settling chambers, centrifugal collectors, wet collectors, scrubbers, fabric filters, electrostatic precipitator (ESP) - Design principles and criteria with design **Control Equipment for gaseouspollutants** – adsorption, absorption, condensation and combustion. Design principles.			10
Module - 5			
Indoor Air Pollution : Sources, indoor air contaminants, effects and control. air changes per hour (ACH), IAQ Standards			10

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

Course outcomes (COs).

Student will be able to

CO1: Understand the importance of composition and structure of atmosphere, sources, classification, effects of air pollutants, and measurement of air pollutants, air pollution standards and control regulations.

CO2: Understand the basic concepts of various meteorological factors which influence the dispersion of air pollutants and to create wind rose diagram, Gain Knowledge about the monitoring of particulate matter.

CO3:. Prediction of dispersion of air pollutants using different models and to evaluate the plume rise using various model equations and get a fair knowledge on stack sampling.

CO4: Understand and analyze the basic mechanisms involved, working principlesand design aspects of various air pollution controlling equipment's through demonstration.

CO5: Understand the concept of Indoor Air Pollution and Noise Source and Control.

Question Paper Pattern

- The question paper will have ten questions, each full question carrying 12 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

TEXT BOOKS

1. C.S Rao., (2006), "Environmental pollution control engineering"- New age international publishers.
2. M. N Rao and H. V. N Rao.,(1999), "Air Pollution"- Tata McGraw-Hill Publishing Company Limited, New Delhi.
3. Wark, K., Warner, C.F., and Davis, W.T., (1998), "Air Pollution"- Its Origin and Control"- Harper & Row Publishers, New York.
4. Perkins, H.C ., (1980), "Air Pollution", McGraw Hill.

REFERENCES

1. Crawford, M., (1980)," Air Pollution Control Theory"- TATA McGraw Hill.
2. Howard S. Peavy, Donald R. Rowe and George Technobanoglous., (2017) "Environmental Engineering" – McGraw Hill International Publications.
3. Stern, A.C., Air Pollution, Vol I, II, III.
4. Stern, A. C., (1977), "Air Pollution : The Effects of Air Pollution" – 3rd- Edition, Academic Press
5. Sincero A.P andSincero, G.A. (1999), "Environmental Engineering - A Design Approach",Prentice Hall of India, New Delhi

INDUSTRIAL WASTEWATER TREATMENT

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – II

Subject Code	18CEE-23	IA Marks	40
Number of Lecture Hours/Week	04	Exam Marks	60
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Course objectives:

To provide an understanding of the mechanisms and processes used to treat waters that have been contaminated in some way by anthropogenic industrial or commercial activities prior to its release into the environment or its re-use. To understand various terms used in industrial wastewater treatment and to acquaint with different steps involved in treatment of industrial wastewater.

Modules	**Teaching Hours**
Module -1	
Effects of Industrial Wastes on sewerage system and sewage treatment plants and receiving water bodies. Effects of waste additions on physical and chemical properties of soil. Effluent standards and receiving water quality standards. Different aspects and choices of various disposal alternatives	10 Hours
Module -2	
Industrial Waste survey-Process flow charts, condition of waste stream. Material balance, Sampling – Grab, Composite and integrated samples. Continuous monitoring – pH, Conductivity, Biomonitoring	10 Hours
Module -3	
Pretreatment of Industrial Wastewater – Volume reduction, Strength reduction, Neutralization, Equalization and Proportion, Removal of Organic and inorganic dissolved solids. Bio-Remediation of contaminated soils	10 Hours
Module -4	
Wastewater Treatment in specific industries: Distrillery, Sugar, Pulp and paper, Cement, Textile, Dairy, Fertilizer, Pesticides, Pharmaceutical **Designof complete** treatment system & disposal for industries: Distillery, Diary, Textile, paper and pulp mill to meet P.C.B. norms.	10 Hours
Module -5	
Radio Active Wastes treatment- Low activity and high activity radiation, application of radio active techniques for wastewater treatment. Environmental Auditing: Introduction, Cost of Pollution, Environmental audit solutions, Financial and Managerial opportunities. Criminal and Regulatory liabilities	10 Hours

Course outcomes:

On completion of this course, students are able to

1. Learn physical/chemical/biological characteristics of and the evaluation technique for various industrial wastewater
2. Understand the theory, engineering application, and design technique for the industrial wastewater treatment unit processes.

Question paper pattern:

- The question paper will have ten questions, each full question carrying 12 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

Text Books:

1. Nemerow N.N., "Liquid Waste of industry theories, "Practices and Treatment. Addison Willey New York.
2. Rao and Dutta
3. Eckenfelder, "Industrial Water pollution Control"- McGraw hill Company, New Delhi American Chemical Society, Washington D.C. USA 7.Bioremediation books

Reference Books:

1. Azad N. S.,– "Industrial Wastewater Management Hand Book" McGraw Hill book Co., Newyork.
2. Ross R.D. "Industrial Waste Disposal", Reinhold Environmental Series – New York.
3. Dickinson" Practical Waste Treatment and Disposal Applied Science publication, London.
4. Mahajan," Pollution control in Process industries". TMH, New Delhi.

ENVIRONMENTAL GEO-TECHNOLOGY

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – II

Subject Code	18CEE-241	IA Marks	40
Number of Lecture Hours/Week	04	Exam Marks	60
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Course objectives:

- To identify the causes for soil pollution and behavior of the pollutants.
- To understand the current practice for waste disposal.
- To evaluate and remediate contaminated sites and monitor to bring natural attenuation

MODULES	**Teaching Hours**
Module -1 Soil- Pollutant Interaction: Introduction to geo environmental engineering – environmental cycle – sources, production and classification of waste – causes of soil pollution – factors governing soil-pollutant interaction-Physicochemical behavior and modelling -failures of foundations due to pollutants	10 Hours
Module -2	
Characterization, Stabilization and Disposal Safe disposal of waste – site selection for land fills – characterization of land fill sites – waste characterization –stability of land fills – current practice of waste disposal- passive contaminant system - Hazardous waste control and storage system – mechanism of stabilization - solidification of wastes – micro and macro encapsulation – absorption, adsorption, precipitation- detoxification — organic and inorganic stabilization	10 Hours
Module -3	
Transport of Contaminants: Contaminant transport in sub surface – advection – diffusion – dispersion – governing equations – contaminant transformation – sorption – biodegradation – ion exchange – precipitation – hydrological consideration in land fill design – ground water pollution – bearing capacity of compacted fills – pollution of aquifers by mixing of liquid waste – protecting aquifers.	10 Hours
Module - 4 Detection and Testing Methods Methodology- review of current soil testing concepts – Proposed approach for characterization and identification of contaminated ground soil for engineering purposes	10 Hours

Module -5	
Remediation of Contaminated Soils: Rational approach to evaluate and remediate contaminated sites – monitored natural attenuation – exsitu and insitu remediation – solidification, bio – remediation, incineration, soil washing, electro kinetics, soil heating, verification, bio venting – Ground water remediation – pump and treat, air sparging, reactive well- application of geo synthetics in solid waste management – rigid or flexible liners.	10 Hours

Course outcomes:

- On completion of this course, students are able to understand causes for soil pollution and behavior of the pollutants.
- Contaminants transport, detection and testing methods.
- Application of geo synthetics in solid waste management.

Question paper pattern:

- The question paper will have ten questions, each full question carrying 12 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

Text Books:

1. Daniel, B.E., Geotechnical practice for waste disposal, Chapman and Hall, London, 1993.
2. Fang, H.Y. Introduction to environmental Geotechnology, CRC press New York, 1997.

Reference Books:

1. Wentz, C.A., Hazardous Waste Management, McGraw Hill, Singapore, 1989.
2. Lagrega, M.d., Bukingham, P.L., and Evans, J.C., Hazardous Waste Management, McGraw Hill, Inc. Singapore, 1994.

RISK ASSESMENT AND HAZARDOUS WASTES MANAGEMENT [As per Choice Based Credit System (CBCS) scheme] SEMESTER II			
Subject Code	18CEE-242	IA Marks	40
Number of Lecture Hours/Week	04	Exam Marks	60
Total Number of Lecture Hours	50	Exam Hours	03
CREDITS – 04			
Course objectives:			
To provide detailed knowledge and skills in the management, treatment, disposal and recycling options for hazardous wastes, while focusing on key engineering and technical aspects involved. Understanding of the basic principles of waste and resource management will be supplemented, where appropriate, by practical problem-solving exercises in the context of civil engineering.			

Modules	**Teaching Hours**
Module - 1	
Risk – Importance, Identification, characterization, communication – Internal & External, Risk - Management Structure, management Cycle, Participation and Consultation **Ecological Health impact assessment**. Exposure assessment. risk factors. Sorption/ partitioning of organics, volatilization and structural / property activity relation.	10
Module - 2	
Risk factor calculation, impact identification – Risk Area, impact, Likelihood, consequences, Controls, Severity, risk score calculation; Toxicology and Risk Assessment: Toxic effects, Dose response assessment, Risk exposure assessment, Carcinogenesis, ecotoxicology, risk characterization.	10
Module - 3	
Hazard identification and Risk Assessment – HAZOP, HAZID, Risk Ranking Matrix, Process and Instrumentation Diagram, and importance of Standard operating procedures, Material safety and Data Sheets, Guidelines, case study **Emergency Preparedness**, Incident Investigation, Non Conformity, action and Preventive and Corrective Actions,Auditing.	10
Module - 4	
Hazardous Waste Management Sources, Classification, Impacts of Mismanagement, Problems in Developing Counties,and Regulations for Hazardous Waste Management **Hazardous Waste Characterization**, Designated Hazardous Wastes, Waste Minimization and Resource Recovery – Approaches, Development of a Waste Tracking System, Selection of waste Minimization Process, Case Studies.	10
Module - 5	
Biomedical Waste management: Biomedical (Handling and Management) Rules 2008 ,sources, treatment and disposal	10

Transportation of Hazardous Waste – requirements, regulations, containers and Labelling, bulk and non-bulk transport, Emergency Response, personal protective equipment. **Treatment & Disposal:** Physico-chemical, Chemical and Biological Treatment of hazardous waste, Thermal treatment - Incineration and pyrolysis	

Course outcomes (COs).

On completion of this course, students are able to

1. Understand and apply the basic scientific and sustainability principles behind waste management, for solving practical waste management challenges
2. Understand the fundamental principles of existing and emerging technologies for the treatment of waste and recovery of value from waste
3. Appreciate the increasing importance of waste and resource management in achieving environmental sustainability.

Question Paper Pattern

- The question paper will have ten questions, each full question carrying 12 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

TEXT BOOKS

1. Lagrega M.D., Buckingham P.L., and Evans J.C., (1994), "Hazardous waste Management", McGraw Hill International Edition
2. Wentz C.A.,(1995),"Hazardous Waste Management", McGraw Hill International Edition

REFERENCES

1. Hazardous waste (management and handling) Rules, 2001
2. Biomedical (Handling and Management) Rules 2008
3. Charles A. Wentz; ""Hazardous Waste Management", McGraw Hill Publication, 1995.

ENVIRONMENTAL PLANNING AND MANAGEMENT

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – II

Subject Code	18CEE-243	IA Marks	40
Number of Lecture Hours/Week	04	Exam Marks	60
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Course objectives:

1. To introduce the basic knowledge of current environmental management systems applied in both public and private sectors. Class discussions will cover conventional development of ISO 14001 Environmental Management Systems (EMS) for various levels of organizations.
2. Possible extensions of internal and external environmental auditing, environmental label, and life cycle assessment can be made based on relevant Total Quality Environmental Management (TQEM) requirements.
3. Case studies emphasize enterprise strategic environmental management planning for organizations and their stakeholders, in the context of environmental regulatory, law and policy.
4. The topics are linked with ecoproduct evaluation, environmental performance evaluation, and green production planning to search for strategies compatible with ISO 14001- accreditation.

Modules	**Teaching Hours**
Module - 1	
Environment and Sustainable Development: Carrying capacity, relationship with quality of life, carrying capacity and resource utilization. Engineering Methodology in Planning and its Limitations: Carrying capacity based short and long term regional planning.	10
Module - 2	
Environmental Protection: Economic development and social welfare consideration in socio economic developmental policies and planning. Total cost of development and environmental protection cost. Case studies on Regional carrying capacity	10
Module - 3	
Engineering Economics: Value Engineering, Time Value of Money, Cash Flows, Budgeting and Accounting	10
Module - 4	
Environmental Economics: Introduction, economic tools for evaluation, Green GDP, Cleaner development mechanisms and their applications.	10
Module - 5	
Total Quality Management in environmental management and protection – ISO 9000, 14000 and 18000 series of standards. Environmental Audit – methods, procedure, reporting and case studies .	10

Course outcomes (COs).

On completion of this course, students have

1. A sound understanding of the principal environmental policy issues confronting managers in diverse geographical and culture situations
2. An awareness of the ethical and moral issues involved in seeking the wise and sustainable use of resources
3. A range of relevant practical skills, particularly in the fields of impact assessment, audit and law.

Question Paper Pattern

- The question paper will have ten questions, each full question carrying 12 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

TEXT BOOKS

1. Lohani B.N , "Environmental Quality Management",South Asian Publishers, New Delhi
2. Chanlett, "Environmental Protection", McGraw Hill Publication, Newyork.
3. Danoy G.E., and Warner R.F., "Planning and Design of Engineering Systems", Unwin Hyman Publications.

REFERENCES

1. MOEF, Government of India, "Carrying Capacity Based Developmental Planning Studies for the National Capital Region", 1995-96.
2. NEERI, Nagpur, Annual Reports 1995 & 1996.
3. UNEP / UNDP – "Environmental Sustainable Development".

WATER RESOURCES ENGINEERING AND APPLIED HYDRAULICS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – II

Subject Code	18CEE251	IA Marks	40
Number of Lecture Hours/Week	04	Exam Marks	60
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to

1. Understand the concept of hydrologic cycle and application of National Water Policy.
2. Use unit hydrograph theory in estimating the runoff and to design storm water drains.
3. Determine the quantity of flow in streams and understand the flow unsteadiness.
4. Quantify the groundwater flow and augment the ground water resources.
5. Understand the application of remote sensing and GIS in environmental engineering.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module -1		
Hydrology: Water resources of the world, India and Karnataka, National Water Policy, Hydrologic cycle, estimation of missing precipitation and rain gauge density.	**10 Hours**	**L2,L3,L4**
Module -2		
Hydrograph theory: Unit hydrograph-derivation, flow routing, low flow analysis. Urban Hydrology - Run-off estimation – Design of Storm water Drains.	**10 Hours**	**L2,L3,L4**
Module -3		
Unsteady Flow through Conduits: Water hammer analysis, Water hammer protection methods - surge tanks. **Flow Measurements:** – Area –Velocity method, Weir method, flumes, end-depth method & chemical and radioactive tracers method	**10 Hours**	**L2,L3,L4**

Module -4		
Groundwater: Basic equations of flow, confined and unconfined aquifers, sea water intrusion, artificial recharge, groundwater pollution, borewells - types & design principles, open wells – types, yield tests.	**10 Hours**	**L2,L3,L4**
Module -5		
Basics and applications of Remote Sensing and GIS: Concept of remote sensing and GIS, Sensors, Data types. Applications in water resources and environmental management	**10 Hours**	**L2,L3,L4**

Course outcomes:

After studying this course, students will be able to:

1. Understand the importance of hydrology and its components. Measure precipitation and analyze data.
2. Use unit hydrograph theory in estimating the peak discharge and design storm water drains in urban area.
3. Analyze the flow unsteadiness in pipes and compute the flow rate in the streams.
4. Estimate the quantity of ground water and select appropriate method of augmenting the ground water resources.
5. Identify the use of remote sensing and GIS concepts in various applications of water resources and environmental engineering.

Question paper pattern:

- The question paper will have ten questions, each full question carrying 20 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer Five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

Text Books:

1. K. Subramanya, “Engineering Hydrology”, Tata McGraw Hill Publishers, New Delhi.
2. K. Todd, “Ground Water Hydrology”, Wiley and Sons, New Delhi.
3. Basudeb Bhatta, “Remote sensing and GIS”, Oxford University Press, 2011.

Reference Books:

1. Raghunath H.M. “Advanced Hydrology”, Wiley Eastern Ltd New Delhi.
2. Ven T. Chow, “Hand Book of Applied Hydrology”, 1st Edition Mc Graw Hill Publications.
3. Lillesand, Kiefer, Chipman, “Remote Sensing and Image Interpretation”, Wiley, 2011.

ECOLOGY [As per Choice Based Credit System (CBCS) scheme] SEMESTER II			
Subject Code	18CEE-252	IA Marks	40
Number of Lecture Hours/Week	04	Exam Marks	60
Total Number of Lecture Hours	50	Exam Hours	03
CREDITS – 04			
Course objectives:			
The course introduces both ecology for environmental engineers. It explains different ecosystems and their interactions through symbiotic and synergic relationships, reviews ecological indices and modes. It describes trophic levels of lakes, influence of nutrient loading and control measures for eutrophication.			
Modules			**Teaching Hours**
Module - 1			
Ecology: Classification of Ecosystems, Structure and Function of Ecosystems, Energy flow in Ecosystems, Ecological Niche and succession, Bio-geo-chemical cycles, Ecological Pyramids.			10
Module - 2			
Aquatic and TerrestrialEcosystems: Diversity and dominance Indices, Ecosystem Models. Lake Ecosystem: Trophic levels, nutrient loading, nutrient enrichment, Leibig's Law, control of eutrophication.			10
Module - 3			
Systems ecology and ecosystems modelling. biodoversity and ecological perspective - human benifits, threats, conservation preservation and protection			10
Module - 4			
Ecosystem Modelling			10
Module - 5			
Environmental Education and Information: Goals, Objectives and guiding principles of Environmental educations. Environmental educational Programs; Environmental Education in India			10
Course outcomes (COs). On completion of this course, students are able to **1.** Develop an appreciation of the modern scope of scientific inquiry in the field of Ecology **2.** Become familiar with the variety of ways that organisms interact with both the physical and the biological environment			

3. Develop an understanding of the differences in the structure and function of different types of ecosystems

Question Paper Pattern

- The question paper will have ten questions, each full question carrying 12 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

TEXT BOOKS

1. Kormondy, "Concepts of Ecology", Prentice Hall Publication, New Jersey.
2. Odum, "Fundamentals of Ecology", Adisson Co.

REFERENCES

1. Krebs J., "Ecology - The Experimental Analysis of Distribution and Abundance", I Edition, Harper International.
2. Hall C.A.S., and Day J.W., "Ecosystem Modeling in Theory and Practice: An Introduction with Case Histories", John Willey.
3. Verma P.S and Agarwal V.K 1998. Concept of Ecology, S. Chand and company Ltd.,

RENEWABLE AND ALTERNATIVE FUELS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – II

Subject Code	18CEE-253	IA Marks	40
Number of Lecture Hours/Week	03	Exam Marks	60
Total Number of Le+cture Hours	50	Exam Hours	03

CREDITS – 04

Course objectives:

1. To create awareness in students familiar about importance of alternative fuels.

2. To teach combustion and emission characteristics of various gaseous and liquid alternative flues.

3. To teach adaptability of engines to alternative fuels.

Modules	**Teaching Hours**
Module -1 Introduction to energy and resources – Renewable energy sources - Availability of solar energy – Sun-earth relationships - - Solar radiation measurement – Flat plate collectors – Solar water heating systems – Evacuated Tubular Concentrators - Solar air heating systems and applications – Concepts on solar drying, cooking, desalination, solar ponds and solar cooling - Passive heating and cooling of buildings – Basics of solar concentrators and types Solar thermal power generation	10 Hours
Module -2	
Biomass to energy conversion processes – Anaerobic digestion, process parameters, biogas composition, digester types, high rate anaerobic conversion systems – Alcohol from biomass – Biodiesel: preparation, characteristics and application - Biomass combustion and power generation – Briquetting – Gasification: Process, types of gasifiers, applications – Waste to energy technologies	10 Hours
Module -3	
Power in the wind - Types of wind mills – WEG components, Power curves and energy estimation– Indian wind potential. Small Hydro Power: Types, site identification, head and flow measurement, discharge curve, estimation of power potential and system components. Technologies for harnessing renewable energy sources like geothermal, wave, tidal and ocean thermal energy.	10 Hours

Module -4	
Fossil fuels and their availability - Potential alternative liquid and gaseous fuels - Merits and demerits of various alternative fuels - Engine requirements Methods of production - Properties - Blends of gasoline and alcohol - Performance in SI engines – Adaptability - Combustion and emission characteristics - Performance in CI engines - Emission characteristics - Properties of alcohol esters. Production and properties of CNG, LPG, hydrogen gas, biogas and producer gas - Performance and Storage, distribution and safety aspects	10 Hours
Module -5	
Various vegetables oils - Properties - Esterification - Performance and emission characteristics - Bio-diesel: Feed stock, characteristics, preparation (lab and commercial), storage, applications, environmental impacts, economics, policy.	10 Hours

Course outcomes:

On completion of this course, students are able to

1. Students to learn need for alternative fuels

2. Learn sources of various alternative flues

3. An understanding limitation of fossil fuels and combustion characteristics fuels

Question paper pattern:

- The question paper will have ten questions, each full question carrying 12 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

Text Books:

Reference Books:

1. Frank Kreith and D.Yogi Goswami (2007), Handbook of Energy Efficiency and Renewable Energy, CRC Press.
2. John Twidell and Tony Weir (2006), Renewable Energy Resources, 2nd Edition, Taylor & Francis, USA.
3. John A. Duffie and William A. Beckman (2006),
4. Solar Engineering of Thermal Process, 3rd Edition, John Wiley & Sons.
5. Gilbert M. Masters (2004), Renewable and Efficient Electric Power Systems, Wiley Interscience.
6. Osamu Hirao and Richard Pefley (1988), Present and Future Automotive Fuels, Wiley Interscience Publication, New York
7. Alcohols and Motor Fuels: Progress in Technology - Series No. 19 - SAE Publication USA C

ENVIRONMENTAL ENGINEERING LABORATORY- II

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – II

Subject Code	18CEEL-26	IA Marks	40
Number of Lecture Hours/Week	03	Exam Marks	60
Total Number of Lecture Hours		Exam Hours	03

CREDITS – 02

Writing programmes in C-language & Running for the following.

1. Design of wastewater Collection units – Sewer network analysis and design.
2. Design of wastewater treatment units – Septic tank, Screen, Grit chamber, Secondary settling tank,
3. ASP, Trickling filter, Waste stabilization pond, Oxidation ditch, Sludge digester, Sludge drying beds.
4. Design of Sanitary Landfill for Municipal Solid Waste Disposal with leachate & gas collection systems.
5. GIS Operations – Spatial Data Input, Data Management Display, Exploration analysis & GIS Modeling.
6. Air quality system: Gaussian Plume model for gaseous and particulate dispersion, effective stack height determination and particulate control devices design.

II. Running following application software packages:

- **a.** WAT PLANT and DOWATTS for treatment units.
- **b.** WADISO, BRANCH, LOOP, QUALOOP and EPANET for water Distribution system.
- **c.** RMAIN - water rising main design.
- **d.** SEWER – sewer network design.
- **e.** WRPLOT (USEPA) – Wind rose plot
- **f.** ISCST / ISCLT (USEPA) versions air quality predictions from industrial sources.
- **g.** CALINE (USEPA) versions model for air quality near Highways.

Reference Books:

1. Manual on water supply and Treatment, CPHEEO, Ministry of Urban Development, GoI,New Delhi, 1999.
2. CPHEEO "Manual on Sewerage and Sewage Treatment",, M/s. Jain Book Agency, C-9, Connaught place, New Delhi,
3. Software Package Manual on BRANCH, LOOP, SEWER – UNDP/UNEP.
4. WATPLANT and QUALOOP Softwares. – CPHEEO – Manual.
5. Relevant Software Manuals– USEPA
6. Wark.K, Warner G.F. and Davis W.T – Air Pollution its origin and control, AddisonWesley,
7. Thomann R.V and Mueller J.A)–. Principles of surface water quality modeling and control, Harper & Row Publishers,
8. Sincerio A.P.& Sincerio G.A.–, Environmental Engineering – A Design Approach Prentice Hall of India.

ENVIRONMENTAL IMPACT ASSESSMENT

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Subject Code	18CEE-31	IA Marks	40
Number of Lecture Hours/Week	04	Exam Marks	60
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Course objectives:

The course introduces process of environmental impact assessment and policy decisionmaking as required under the National Environmental Policy Act (NEPA) and the regulations of the Council of Environmental Quality (CEQ). Topics include identification of purpose and need for any actions affecting the environment, development of objectives and decision criteria, and various techniques for assessing impact and comparing alternatives for a given environmental intervention. The strengths and weaknesses of various approaches are evaluated with techniques that allow analysis of multiple objectives and conflicting uses of environmental resources. The goals of this course, in addition to gaining an understanding of the discipline of ecology, include developing and improving skills in scientific writing, basic mathematics,statistics, and in the use of computer spreadsheets

Modules	**Teaching Hours**
Module – 1	
Environmental Legislation: Introduction & need, Constitution of India, Environmental Jurisprudence, National Environmental Policy, Environmental Tribunal (Green Tribunal) Legal Framework, Legislative act, rules, regulations notification and amendments	10
Module – 2	
Indian Environmental Acts: Environment (Protection) Act, 1986, Air & Water Acts. Biomedical Waste (Managing and Handling) Rules, 2011, Recycle Plastics (Manufacturing and Usage) Rules, 1999, Water Act, 1974, Air Act, 1981, Forest Act, 1927, Environmental Tribunal Authority, 1995. Wild Life Protection Act, 1972, Biodiversity Rules, 2004	10
Module – 3	
Environmental Impact Assessment: Definition, Objectives, Types – Rapid and Comprehensive EIA, EIS, FONSI. Step-bystep procedure for conducting EIA and Limitations of EIA, Prevention of Significant Deterioration (PSD) Programme. Carrying capacity concept	10
Module – 4	
Attributes, Standards and Value functions: Public participation in EIA. Environmental Management Plan (EMP) and Disaster Management Plan (DMP)	10

Module – 5	
EIA Case Studies –Thermal Power Plant, Mining, Fertilizer, Construction Projects, Air port, Water and Wastewater Treatment Plants	10

Course outcomes (COs).

Student will be able to

1. Appreciate the purpose and role of EIA in the decision-making process
2. Understand the strengths of EIA in regard to environmental management
3. Understand the technical and social/political limitations of EIA
4. Know the administration and procedures that apply in the student's jurisdiction
5. Understand the screening process
6. Understand the scoping process and how it is applied
7. Know the options for estimating environmental and social impacts
8. Know the format of an EIA Report (Environmental Impact Statement, or Environmental Statement)
9. Appreciate the factors that assist, and detract, from the usefulness of the EIA Report
10. Understand the purpose of developing follow-up procedures, and the options for designing these procedures

Question Paper Pattern

- The question paper will have ten questions, each full question carrying 12 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

TEXT BOOKS

1. Anjaneyulu and Valli Manickam, (2010), "Environmental Impact Assessment Methodologies", BS Publications, Hyderabad
2. Canter L., "Environmental Impact Assessment", McGraw Hill.

REFERENCES

1. Jain R.K., Urban L.V., Stacey G.S., (1977), "Environmental Impact Analysis-A New Dimension in Decision Making", Van Nostrand Reinhold Co. 12

CLIMATE CHANGE AND GLOBALIZATION

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Subject Code	18CEE-321	IA Marks	40
Number of Lecture Hours/Week	04	Exam Marks	60
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Course objectives:

To provide an understanding of the factors responsible for climate change, the biological and sociological consequences of such changes; and the possible engineering, economic, and legal solutions to avoid more extreme perturbations.

Modules	**Teaching Hours**
Module – 1	
Energy Issues and Climate Change ,Warming Earth - Heat and principles of Thermodynamics,Alternate Energy Sources	10
Module – 2	
Green-House Effect as a Natural Phenomenon, Green House Gases GHGs) and their Emission Sources Quantificationof CO2 Emission, Global Warming Potential (GWP) of GHGs	10
Module – 3	
Modeling Climate change, Ozone layer depletion and its control,Impacts of climate change: Global and India, Temperature Rise, Sea Level rise, Coastal Erosion and landslides, Coastal Flooding, Wetlands and Estuaries loss Impact of ocean current on global climate, EL-NINO & LA-NINA effects	10
Module – 4	
Kyoto Protocol: Importance, Significance and its role in Climate Change Carbon Trading - Mechanisms , Various Models (European, Indian) Global and Indian Scenario	10
Module – 5	
Cleaner Development Mechanisms: Various Projects related to CO2 Emission Reduction, Alternatives of Carbon Sequestration: Conventional and non conventional techniques , Role of Countries and Citizens in Containing Global Warming	10

Course outcomes (COs).

On completion of this course, students are able to

1. Measure climate factors and how they change
2. Understand connections between global warming and human activities
3. Identify effects of climate change on biodiversity and ecosystems in different biomes and aquatic systems
4. Model possible scenarios for future climate change

5. Achieve possible ways to deal with climate change.

Question Paper Pattern

- The question paper will have ten questions, each full question carrying 12 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

TEXT BOOKS

1. Corell R.W., and Anderson P.A., (Eds.), "Global Environmental Change", SpringlerVerlog Publishers.
2. Frame B., Medury Y., and Joshi Y., (Eds.), "Global Climate Change: Science, Impact and Responses".
3. Wyman R.L., (Ed.), "Global Climate Change and Life on Earth", Chapman and Hall Publications.
4. Farmer G.T and Cook J., "Climate change science: A Modern Synthesis", Springer

REFERENCES

1. Barry R.G., and Chorley R.L., "Atmosphere, Weather and Climate", 4th Edition, ELBS Publication.
2. Bolin B., (Ed.), "Carbon Cycle Modelling", John Wiley and Sons Publications.
3. Francis D., "Global Warming: The Science and Climate Change", Oxford University Press.
4. Linden E.,, "The Winds of Change: Climate, Weather and the Destruction of Civilizations", Simon and Schuster Publications.
5. Mintzer I.M., (Ed.), "Confronting Climate Change, Risks, Implications and Responses", Cambridge University Press.
6. Srivatsava A.K., "Global Warming", APH Publications.
7. Yadav, Chander and Bhan, "Global Warming: India's Response and Strategy", RPH Publications.

NATURAL RESOURCES CONSERVATION AND MANAGEMENT [As per Choice Based Credit System (CBCS) scheme] SEMESTER – III			
Subject Code	18CEE-322	IA Marks	40
Number of Lecture Hours/Week	03	Exam Marks	60
Total Number of Lecture Hours	40	Exam Hours	03
CREDITS – 04			
Course objectives:			
The course describes natural resources and their significance for life existence with an emphasis on Sustainable Development. It deliberates in depth on the various conservation techniques to be adopted. The course also enriches the student with possible legislative measures and management options for effective and efficient management of available natural resources for human consumption and societal development.			
Modules			**Teaching Hours**
Module – 1			
Introduction to Sustainable Development Need, importance and role of Environmental Engineers **Renewable and Non-renewable Resources** Resources - Appraisal, problem, classes, renewable resources flow, destruction versus conservation			10
Module – 2			
Forest Resources Ecological and economic significance, types and management, forest resources of the world and India, deforestation and its impact and solution **Water Resources** Worldwide supply, renewal and distribution, water resources of India, Managing water resources, Environmental Impact of large dams, River water disputes, water pollution problems			10
Module – 3			
Mineral Resources Sources, exhaustibility, Exploration and uses, Environmental impacts and solutions **Food Resources** World food production and problems, agri production, live stock production, modern agri practices, use of pesticides and fertilizers – environmental impact, environmental limits of increasing food production, sustainable agriculture			10
Module – 4			
Energy Resources Energy resources, world energy demand, Indian resources, renewable, alternate / non-conventional energy resources – solar, tidal, wind, geothermal, hydel, hydrogen, biomass , nuclear, wave (ocean)			10

Module – 5	
Land Resources Land as a resource, soil – types and degradation, soil conservation	10

Course outcomes (COs).

Student will be able to

1. Introduce the concept of sustainable development. Discuss the role of Environmental Engineers in sustainable development and conservation of natural resources

2. Differentiate between biotic and abiotic, renewable and non – renewable resources of nature. Describe the flow of resources and resource use problems.

3.Describe the importance of forest, water and mineral resources, their deterioration and effective conservation and management practices.

4.Explain the significance of food, energy and land resources and identify the possible pollution sources and their effective management to conserve these resources.

5. Apply the knowledge of legal frame work and management concepts through host of acts and regulations for natural resources conservation and management.

Question Paper Pattern

- The question paper will have ten questions, each full question carrying 12 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

TEXT BOOKS

1. Anjaneyulu Y., (2004), “Introduction to Environmental Science”, B.S. Publications, Hyderabad
2. Misra S.P. and Pandey S.N., (2008), “Essential Environmental Studies”, Ane Book Publishers, New Delhi

REFERENCES

1. Asthana D.K and Meera asthana (2005), "Environment-Problems and solutions" S. Chand and company Ltd., New Delhi
2. Suresh K. Dhameja (2007), "Environmental Studies" Kataria and sons, Delhi

NON – POINT SOURCES OF POLLUTION AND MANAGEMENT [As per Choice Based Credit System (CBCS) scheme] SEMESTER – III			
Subject Code	18CEE-323	IA Marks	40
Number of Lecture Hours/Week	03	Exam Marks	60
Total Number of Lecture Hours	40	Exam Hours	03
CREDITS – 04			
Course objectives:			
To provide an understanding to protect the quality of water resources from the adverse effects of nonpoint source (NPS) water pollution. Types of regulated point sources include wastewater treatment facilities, municipal storm water systems, and concentrated animal feeding operations. NPS pollution occurring from rainfall flows off the land, roads, buildings, and other features of the landscape are discussed in the modules.			
Modules			**Teaching Hours**
Module – 1			
Introduction: Non-point Pollution, Problem, definitions, magnitude of Non-point Pollution, Non-point Pollution Control Laws, Waste Assimilative Capacity and Stream Standards Pollution From the Atmosphere: Atmospheric Inputs – fall out, radionuclides Rainfall, General Hydraulics system model, Lumped Overland flow routing of the precipitation excess, River routing by Muskingum Method			10
Module – 2			
Groundwater Pollution: Sources of Groundwater Contamination, Groundwater Movement. Pollution from impervious urban areas: Introduction Deposition and Accumulation of Pollutants on Impervious Surfaces Removal of Solids from street Surfaces, Porous Pavement			10
Module – 3			
Non point Pollution Simulation Models: Basic Concepts, Nonpoint Pollution Simulation Models- SWAT MODEL			10
Module – 4			
Land use and non-point pollution: Effects , Comparative Assessment of Pollution Impact from land use, agricultural runoff, mining area runoff, Effect of hydrologic Modifications Management Practices of Non-point pollution control: Introduction, Source Control Measures Collection Control and Reduction of Delivery			10
Module – 5			
Planning for Nonpoint Pullution Control: Introduction, Water Quality Planning Process, Selection of Best Management Practices for Non Point Source Pollution Control – detention ponds, exfiltration and infiltration trenches, vegetative swales.			10

Course outcomes (COs).

On completion of this course, students are able to

1. Utilize Simulation Models for tracing nonpoint source pollution
2. Develop management solutions for nonpoint source pollution control
3. Select best management solutions for nonpoint source pollution control

Question Paper Pattern

- The question paper will have ten questions, each full question carrying 12 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

TEXT BOOKS AND REFERENCES:

1. Novotny V., and Chesters G., " Hand Book of Non-point Pollution, Sources and Management", Van Nostrand Reinhold Environmental Engineering Series, New York.
2. Pavoni J L, (Ed) "Hand Book of Water Quality Management Planning", Van Nostrand Reinhold, Environmental Engineering Series.New York
3. Pluarg, Pollution from Land Use Activities Reference Group Novotny V and Chesters G, , "Hand Book of Non-point Pollution, Sources and Management", Van Nostrand Reinhold Company

REMOTE SENSING AND GIS IN ENVIRONMENTAL ENGINEERING

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER III

Subject Code	18CEE-331	IA Marks	40
Number of Lecture Hours/Week	04	Exam Marks	60
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Course objectives:

1. It is aimed at students looking to gain a sound appreciation of the principles and practice of Remote Sensing and how to use it to help address important societal monitoring requirements and science questions.
2. It develops a strong interdisciplinary understanding of critical perspective on Remote Sensing and its role in monitoring the environment.
3. It provides understanding of how Remote Sensing data can be combined with and used in wider environmental modeling.

Modules	Teaching Hours
Module - 1	
FUNDAMENTALS OF REMOTE SENSING Definition, Physics of Remote Sensing, Electromagnetic Radiation and its interactions with atmosphere, Spectral reflectance of earth features, Resolution SpectralSpatial, Temporal and Radiometric.	10
Module - 2	
PLATFORMS SENSORS AND IMAGE PROCESSING Aerial Photographs, Active and passive sensors, Data products, Various satelites in orbit and their sensors. Image Processing – Visual and digital image, Interpretation, Interpretation keys, Methodology, Training sets, Ground truth verification, Image analysis, Image enhancement, Rectification, Classification methods, Users accuracy, Producers accuracy and overall accuracy.	10
Module - 3	
INTRODUCTION TO GIS Data entry, storage and maintenances, Data output. Data analysis, Hardware and software	10
Module - 4	
Applicaions of remotely sensed data for identifying solid waste disposal, forest fire mapping, EIA studies etc. Environmental degradation assessment using RS and GIS.	10
Module - 5	
Optimal routing of solid waste using GIS – Case study, Environmental siting of industries and zoning atlas development, Remodeling of water distribution system using GIS	10

Question Paper Pattern

- The question paper will have ten questions, each full question carrying 12 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

TEXT BOOKS

1. Lilliesand T.M, Kiefer R.W and Chipman J.W., "Remote Sensing and Image Interpretation", John Wiley and Sons, 6th Edition.
2. Goa, J. "Digital Analysis of Remotely Sensed Imagery", McGrill Publishers.
3. Burrough, P.A. and McDonnell, R.A., "Principles of Geographical Information Systems", Oxford University Press,
4. Chang K.T, "Introduction to Geographic information system", McGraw hill Education Pvt Ltd., 4th edition

REFERENCES

1. Bonham-carter, G.F. Geographic information system for Geo scintists: Modelling with GIS, Pergamon,
2. Lintz, J. and Simonet, "Remote Sensing of Environment", Addison Wesley Publishing Company,
3. Mishra H.C., “GIS Hand Book”, GIS India, Shanthi Nivas, Hyderabad.
4. Syed R. Qasim , Edward M. Motley & Guang Zhu, “Water Works Engineering: Planning, Design And Operation”, Eastern Economy Edition, PHI Learning Private Limited, New Delhi.

TRANSPORT PROCESSES AND MODELING OF AQUATIC SYSTEMS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Subject Code	18CEE-332	IA Marks	40
Number of Lecture Hours/Week	04	Exam Marks	60
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Course objectives:

1. To make students learn evaluation and control techniques of water quality management in streams, lakes, and estuaries.
2. Mathematical analyses of patterns of water movement and their relation to water quality.
3. Fate and transport of contaminants in natural aquatic systems, design and management of environmental and water resource systems,

Modules	**Teaching Hours**
Module – 1	
Introduction: Modelling: Introduction, applications in environmental management. Physical phenomena – advection, diffusion, dispersion, Fick's laws of diffusion and convective - diffusion equations for turbulent & shear flow regimes	10
Module – 2	
Steady-state water quality modeling: Models for conservative and non-conservative substances. Data collection and analysis - specialized water quality surveys,estimation of decay and reareation rates	10
Module – 3	
1-D Oxygen balance models: Streeter-Phelps equation,critical point method. Calibration and verification of 1-D oxygen model. Error measures.	10
Module – 4	
Mixing zones in rivers: Types of outfalls and mixing regimes. Steady-state 2-D analysis. Field study methodology. Parameter estimation – lateral mixing co-efficient - critical point method – simple numerical problems. Dissolved oxygen models for lakes under completely mixed and stratified conditions	10
Module – 5	
Eutrophication models: Simplified nutrient loading models for rivers and lakes. Ocean disposal of wastewater: Siting and design of outfalls. Ground water quality modeling concepts: Formulation 1-D & 2-D models with decay and retardation for instantaneous sources, plume delineation studies	10

Course outcomes (COs).

On completion of this course, students are able to understand

1. Contaminant transport and fate
2. Ecological and human effects assessment
3. Environmental decision criteria
4. Monitoring strategies
5. Environmental exposure assessment

Development of pollutant transport, fate and persistence models; model parameter estimation.

Question Paper Pattern

- The question paper will have ten questions, each full question carrying 12 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

TEXT BOOKS

1. Rich L.G., "Environmental Systems Engineering", McGraw Hill.
2. Schnoor J.L., "Environmental Modelling – Fate and Transport of Pollutants in Water, Air and Soil", John Wiley and Sons.

REFERENCES

1. Thomann R.V., and Mueller J.A., "Principles of Water Quality Management and Control", Harper & Row Publications.
2. Thomann R.V., "Systems Approach to Water Quality Management", McGraw Hill.
3. Lee C.C., and Lin S.D., "Handbook of Environmental Engineering Calculations", McGraw Hill, New York

OPERATION AND MAINTENANCE OF ENVIRONMENTAL FACILITY

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Subject Code	18CEE-333	IA Marks	40
Number of Lecture Hours/Week	03	Exam Marks	60
Total Number of Lecture Hours	40	Exam Hours	03

CREDITS – 04

Course objectives:

The course encompasses the aspects of operation and maintenance of Environmental facilities. It highlights the operational problems and suggests the control, preventive and corrective measures.

Modules	**Teaching Hours**
Module – 1	
Operation & Maintenance Planning - Organizational Structure, Work Planning, Preparation and Scheduling, Cost Estimates.	10
Module – 2	
Data Base of Facilities for O&M – Detailed Plans, Drawings, Operation Manuals, Record keeping, standard operating procedure and Computer Applications in O&M and SCADA.	10
Module – 3	
O&M of Water Treatment and Supply and Facilities, Operational Problems and Corrective Measures in Different Units of Treatment. Water Distribution Network	10
Module – 4	
O&M of Wastewater Collection and Treatment Facilities, Operational Problems and Corrective Measures in Different Units of Treatment, sewer network system. O & M of Industrial wastewater systems.	10
Module – 5	
O&M of Air Pollution Control Facilities, Operational Problems and Corrective Measures in Different Units of Treatment.	10

Course outcomes (COs).

Student will be able to

- Know the need, types, basic principles, organizational structure, work planning and scheduling and cost estimates of O&M
- Explain the importance of drawings, plans, record keeping. Recognize the need for operational manual and SOP. Discuss the advantages and limitations of SCADA based control systems
- Identify and list the operational problems in water treatment and supply facilities. Apply preventive and corrective maintenance measures
- Describe the operational problems in wastewater collection and treatment facilities. Enumerate the remedial measures. Explain the problems and control measures in Industrial

wastewater treatment facilities

- Identify and discuss the troubles in air pollution control systems and suggest the preventive and control measures

Question Paper Pattern

- The question paper will have ten questions, each full question carrying 12 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer five full questions selecting one full question from each module. If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

TEXT BOOKS

1. Hammer M.J., and Hammer Jr. M.J., (2008), "Water and Wastewater Technology", Prentice Hall of India Pvt. Ltd., New Delhi.
2. Metcalf and Eddy Inc., (2003), "Wastewater Engineering - Treatment and Reuse", 4th Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.

REFERENCES

1. Training Manual on O&M for Municipal Staff, Asian Development Bank Project, Government of Karnataka.
2. CPHEEO Manual., (1991) "Water Supply & Treatment", GOI Publication.
3. CPHEEO Manual., (1995) on Sewerage & Sewerage Treatment, GOI Publication,.
4. National Safety Council and Associate (Data) Publishers Pvt. Ltd., (1991), "Industrial Safety and Pollution Control Handbook"