VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
CBCS – M.TECH., ENVIRONMENTAL ENGINEERING
SYLLABUS FOR TEACHING – 2016-17

ADVANCED COMPUTATIONAL MEETHODS AND OPTIMIZATION

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

SEMESTER – I

Subject Code	**16CEE-11**	**IA Marks**	**20**
Number of Lecture Hours/Week	**04**	**Exam Marks**	**80**
Total Number of Lecture Hours	**50**	**Exam Hours**	**03**

CREDITS – 04

Course objectives:

To understand the fundamentals of applied optimization, develop competence in formulating optimization models and translating problem descriptions into mathematically solvable models. Learn systems techniques including linear programming, integer, stochastic, and dynamic programming.

Modules	**Teaching Hours**
Module -1 **Numerical Methods - Partial differential equations, Newton-Raphson method, Finite difference, finite element, method of characteristics, different methods, Successive over relaxation methods.**	**10 Hours**
Module -2	
Optimization – classification and importance in Environmental Studies. Single and multivariable optimization without and with constraints	**10 Hours**
Module -3	
Linear Programming – different methods, linear approximation of non-linear optimization.	**10 Hours**
Module -4	
Statistics - Significance Tests , Frequency Distribution, Characteristics of Distributions, Method of Least Squares and Regrssion, Multiple Regression	**10 Hours**
Module -5	
Probability – Concepts, Methods, Binomial, Poisson and Normal distribution, Risk and uncertainty analysis	**10 Hours**

Course outcomes:

On completion of this course, students are able to

1. **Understand systems analysis concepts and techniques applied to engineering problems**
2. **Effectively communicate systems methods and modeling results**
3. **Solve challenging engineering problems that involve constrained resource allocation.**

Question paper pattern:

The question paper will have ten questions.
Each full question consists of 16 marks.
There will be 2 full questions (with a maximum of four sub questions) from each module.
Each full question will have sub questions covering all the topics under a module.
The students will have to answer 5 full questions, selecting one full question from each module.

Reference Books:

1. **Rao. S.S." Optimization: Theory & Applications Techniques, Wiley Eastern Ltd New Delhi.**
2. **Taha H.A., "Optimization Research":An introduction, Pear son Prentice Hall, 8th Edition**
3. **Shanthakumar M.S., Numerical Methods and Analysis, Tata McGrawhill Pubs.**
4. **Ross S.M.,"Introduction to Probability and Statistics for Engineers and Scientists", John Wiley Publications.3rd Edition, Acedimic press**
5. **Stanton R.G –" Numerical methods for science and engineers".Prentice Hall, Trade Edition**
6. **Kreyszig Erwin " Advanced Engineering Mathematics", Wiley Eastern Publications.**
7. **Berthouex P M.,and Brown L. C., "Statistics for Environmental Engineers", Lishers publication,**

APPLIED ENVIRONMENTAL CHEMISTRY AND MICROBIOLOGY *[As per Choice Based Credit System (CBCS) scheme]* *SEMESTER – I*			
Subject Code	***16CEE-12***	***IA Marks***	***20***
Number of Lecture Hours/Week	**04**	**Exam Marks**	**80**
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 **Introduction: Importance of Environmental Chemistry, types of reactions, redox reactions, reaction kinetics.** **Electrochemistry and its applications. Physical and equilibrium chemistry–fundamentals and applications. Trace** **Contaminants and their analyses. pH – Principle, Measurement, Numerical Examples, Buffers and Buffer index.**	**10 Hours**
Module -2 **Colloidal Chemistry: Properties of colloids, colloidal dispersions, stability of colloids and applications.** **Applications of Organic Chemistry in Environmental Engineering.**	**10 Hours**
Module -3 **Colourimetry: Principles and applications. Applications of Analytical Chemistry – emission and absorption techniques.**	**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.**	**10 Hours**

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.**	

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 consists of 16 marks.
There will be 2 full questions (with a maximum of four sub questions) from each module.
Each full question will have sub questions covering all the topics under a module.
The students will have to answer 5 full questions, selecting one full question from each module.

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

ADVANCED WATER TREATMENT TECHNOLOGY

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

SEMESTER – I

Subject Code	**16CEE-13**	**IA Marks**	**20**
Number of Lecture Hours/Week	**04**	**Exam Marks**	**80**
Total Number of Lecture Hours	**50**	**Exam Hours**	**03**

CREDITS – 04

Course objectives:

The course is designed to train students in the practical aspects of operating and maintaining water treatment plants, emphasizing safe practices and procedures.

Modules	**Teaching Hours**
Module -1 **Introduction: Sources of water, necessity of treatment, Critical Water quality parameters, water quality guidelines and standards for various water uses.** **Unit operations: Principles and design of aeration systems – two film theory, water in air system, air in water system.** **Intake structures: Different types, design criteria**	**10 Hours**
Module -2 **Principles of sedimentation: Types of settling and settling equations, design criteria and design of settling tanks.** **Principle of Coagulation and Flocculation: types of coagulants, coagulant aids, coagulation theory, optimum dose of coagulant, design criteria and numerical examples.**	**10 Hours**
Module -3 **Filtration:Theory, types, hydraulics of filter bed, design criteria and design of filters, filter backwash, operational problems and trouble shooting.**	**10 Hours**
Module -4 **Adsorption Process: Types, factors affecting adsorption, kinetics and equilibrium – different isotherm equations and their applications**	**10 Hours**
Module -5 **Unit processes: disinfection – different types, disinfectants, factors affecting disinfection, methods of disinfection, chemistry of chlorination. Water Softening – Ions causing hardness, Langelier index, various methods. Fluoridation and defluoridation – Principles and design.** **Trace organic contaminants in water supplies and their removal.** **Bench Scale and Pilot Plant studies in water treatment. Rural Water Supply Systems.**	**10 Hours**

Course outcomes:

On completion of this course, students are able to

1. **Understand the principles and operation of water treatment systems**
2. **Appraise the suitability of the design of treatment plants and unit processes**
3. **Evaluate process operations and performance**
4. **Understand coagulation, flocculation, and sedimentation, filtration, and disinfection processes.**

Question paper pattern:
The question paper will have ten questions.
Each full question consists of 16 marks.
There will be 2 full questions (with a maximum of four sub questions) from each module.
Each full question will have sub questions covering all the topics under a module.
The students will have to answer 5 full questions, selecting one full question from each module.

Reference Books:

1. **Fair, G.M., Geyer J.C and Okun, Water and Waste water Engineering" Vol II, John Wiley Publications.**
2. **Weber W.J., "Physico - Chemical Processes for Water Quality Control".**
3. **APHA, AWWA, AAWF, "Water Quality and Treatment "McGraw Hill.**
4. **CPHEEO Manual on "Water Supply and Treatment", .available at Jain Book agency, C-9, Connaught place, New Delhi**
5. **Peavy, H.S., Rowe and Tchobonoglous,G., "Environmental Engineering", McGraw Hill**
6. **Raju, B.S.N., "Water Supply and Wastewater Engineering", Tata McGraw Hill Pvt Ltd., New Delhi.**
7. **World Health Organization, Geneva, Guidelines for Drinking Water Quality, Third Edition,**
   Volumes 1-3.

SOLID AND HAZARDOUS WASTE MANAGEMENT
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – I

Subject Code	**16CEE-14**	**IA Marks**	**20**
Number of Lecture Hours/Week	**04**	**Exam Marks**	**80**
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 solid 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 **Municipal Solid Waste Management: Legal and Organizational foundation: Definition of solid waste – waste generation technological society – major legislation, monitoring responsibilities, sources and types of solid waste – sampling and characterization – Determination of composition of MSW – storage and handling of solid waste – Future change s in waste composition.**	**10 Hours**
Module -2	
Collection and Transport of Solid Waste: **Collection of Solid Waste:Type of waste collection systems, analysis of collection system – alternative techniques for collection system. Separation and Processing and Transformation of Solid Waste: unit operations user for separation and processing, Materials Recovery facilities, Waste transformation through combustion and aerobic composting, anaerobic methods for materials recovery and treatment – Energy recovery – Incinerators** **Transfer and Transport: Need for transfer operation, transport means and methods, transfer station types and design requirements.**	**10 Hours**
Module -3	
Landfills : Site selection, design and operation, drainage and leachate collection systems – requirements and technical solution, designated waste landfill remediation – Integrated waste management facilities.	**10 Hours**
Module -4	
Hazardous Waste Management: Definition and identification of hazardous wastes-sources and characteristics – hazardous wastes in Municipal Waste – Hazardous waste regulations – minimization of Hazardous Waste-compatibility, handling and storage of hazardous waste-collection and transport, e- waste - sources, collection, treatment and reuse management.	**10 Hours**
Module -5	
Hazardous waste treatment and Design: Hazardous waste treatment technologies - Design and operation of facilities for physical, chemical and thermal treatment of hazardous waste –	**10 Hours**

Solidification, chemical fixation and encapsulation, incineration. Hazardous waste landfills: Site selection, design and operation – remediation of hazardous waste disposal sites. **Biomedical Waste management: Biomedical (Handling and Management) Rules 2008 ,sources, treatment and disposal**	

Course outcomes:
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 consists of 16 marks.
There will be 2 full questions (with a maximum of four sub questions) from each module.
Each full question will have sub questions covering all the topics under a module.
The students will have to answer 5 full questions, selecting one full question from each module.

Reference Books:

1. **Tchobanoglous G., Theissen H., and EIiassen R., "Solid Waste Engineering - Principles and Management Issues", McGraw Hill, New York.**
2. **Pavoni J.L., "Handbook of Solid Waste Disposal".**
3. **Mantell C.L.,, "Solid Waste Management", John Wiley.**
4. **CPHEEO, Manual on Municipal Solid waste management, Jain Book Agency, c-9, Connaught place, New Delhi**
5. **Sasikumar and Krishna S. G, Solid waste Management, PHI Learning Pvt Ltd, New Delhi**
6. **WHO Manual on Solid Waste Management.**
7. **Hazardous waste (management and handling) Rules, 2001**
8. **Biomedical (Handling and Management) Rules 2008**
9. **Charles A. Wentz; ""Hazardous Waste Management", McGraw Hill Publication, 1995.**

WATER RESOURCES ENGINEERING AND APPLIED HYDRAULICS

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

SEMESTER – I

Subject Code	**16CEE-151**	**IA Marks**	**20**
Number of Lecture Hours/Week	**04**	**Exam Marks**	**80**
Total Number of Lecture Hours	**40**	**Exam Hours**	**03**

CREDITS – 03

Course objectives:

The course is designed to deal with surface and groundwater, addressing both water quantity and quality, learning to understand human influences on the hydrological system, and apply tools, for the proper integration of hydrological knowledge and analysis in water resources planning and management.

Modules	**Teaching Hours**
Module -1 **Hydrology: Water resources of the world, India and Karnataka, National Water Policy, Hydrologic cycle, estimation of missing precipitation and rain gauge density.**	**08 Hours**
Module -2	
Hydrograph theory: Unit hydrograph-derivation, flow routing, low flow analysis. **Urban Hydrology - Run-off estimation – Design of Storm water Drains.**	**08 Hours**
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	**08 Hours**
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	**08 Hours**
Module -5	
Basics and applications of Remote Sensing: in water resources management, Hydraulic transients- flow through bends & constriction	**08 Hours**

Course outcomes:

On completion of this course, students are able to

1. **Understand theories and concepts in surface and subsurface hydrology, the physical, chemical and biological interactions between the hydrosphere, the lithosphere, the biosphere and the atmosphere**
2. **A thorough awareness of natural and human-induced variations of hydrological systems**
3. **Evaluate and analyze hydrological systems and processes at a wide range of scales in both space and time for the purpose of water resources assessment, natural hazard assessment and mitigation, and environmental planning and management.**

Question paper pattern:

The question paper will have ten questions.
Each full question consists of 16 marks.
There will be 2 full questions (with a maximum of four sub questions) from each module.
Each full question will have sub questions covering all the topics under a module.
The students will have to answer 5 full questions, selecting one full question from each module.

Reference Books:

1. **Raghunath H.M. "Advanced Hydrology", Wiley Eastern Ltd New Delhi**
2. **Subramanya K.S, "Advanced Hydrology".Tata Mc Graw Hill, New Delhi**
3. **David Keith Todd, "Ground Water Hydrology".2nd Edition John Wiley & Sons New Delhi**
4. **Sabins F.F., "Remote Sensing – Principles and Interpretations", W.H. Freeman & Co.**
5. **Anji Reddy, "Remote Sensing and GIS", B.S. Publications, Hyderabad.**
6. **Ven T. Chow, "Hand Book of Applied Hydrology", 1st Edition Mc Graw Hill Publications**
7. **Hammer M.J, and Mackichan K.A. "Hydrology and Quality of Water Resources", Newyork:Wiley.**
8. **John Permankian, "Water Hammer Analysis".**
9. **Linsley, Franzini, Freyberg, Tchobanoglous G. "Water Resources Engineering", TATA McGraw Hill Series.**
10. **Linsley, Kohler and Paulhes, "Hydrology for Engineers", McGraw Hill.**
11. **Mays L.W. , "Water Resources Engineering", John Wiley and Sons Publications**

RENEWABLE AND ALTERNATIVE FUELS

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

SEMESTER – I

Subject Code	**16CEE-152**	**IA Marks**	**20**
Number of Lecture Hours/Week	**03**	**Exam Marks**	**80**
Total Number of Lecture Hours	**40**	**Exam Hours**	**03**

CREDITS – 03

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**	**08 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**	**08 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.**	**08 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**	**08 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.	**08 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 consists of 16 marks.
There will be 2 full questions (with a maximum of four sub questions) from each module.
Each full question will have sub questions covering all the topics under a module.
The students will have to answer 5 full questions, selecting one full question from each module.

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**

OCCUPATIONAL SAFETY AND HEALTH

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

SEMESTER – I

Subject Code	**16CEE-153**	**IA Marks**	**20**
Number of Lecture Hours/Week	**03**	**Exam Marks**	**80**
Total Number of Lecture Hours	**40**	**Exam Hours**	**03**

CREDITS – 03

Course objectives:

To identify risks, link to individual behaviors, evaluate precautions and preparations, identify correct processes and procedures, identify critical points, improve decision making.

Modules	**Teaching Hours**
Module -1 **Introduction: Occupational Safety and Health Act, Occupational Safety and Health Administration, Right to know Laws.** **Indian Acts – Labour Act, Factories Act, OSHA.**	**08 Hours**
Module -2	
Ergonomics: need, Task Analysis, Preventing Ergonomic Hazards, Ergonomics Programme. **Accident – Causation, investigation methods and different models.**	**08 Hours**
Module -3	
Occupational Hazard and Control: Hazard Analysis, Human Error and Fault Tree Analysis, Emergency Response. **Hazards and their control in different manufacturing and processing industries**	**08 Hours**
Module -4	
Fire Prevention and Protection: Types of Fire, Fire Development and its Severity, Effect, Extinguishing Fire, Electrical Safety, Product Safety	**08 Hours**
Module -5	
Occupational Health: Health and Safety Considerations, Personal Protective Equipment. Health problems in different types of industries – construction, textile, steel and food processing, pharmaceutical, occupationa Health and Safety considerations in Wastewater Treatment Plants.	**08 Hours**

Course outcomes:

On completion of this course, students are able to

1. **Contribute to the development and maintenance of a healthy and safe work environment**
2. **Interpret and apply legislative requirements, industry standards, and best practices in a variety of workplaces**
3. **Apply risk management principles to anticipate, identify, evaluate and control physical, chemical, biological and psychosocial hazards**
4. **Collect, manage, and interpret information and data to identify trends and issues in the workplace**
5. **Design, support, and evaluate health and safety programs and implement procedures using project management principles and processes appropriate to the task**
6. **Affect/manage change by advancing OH&S principles within management systems, cultures, practices, and priorities.**

Question paper pattern:
The question paper will have ten questions.
Each full question consists of 16 marks.
There will be 2 full questions (with a maximum of four sub questions) from each module.
Each full question will have sub questions covering all the topics under a module.
The students will have to answer 5 full questions, selecting one full question from each module.

Reference Books:

1. **Goetsch D.L., "Occupational Safety and Health for Technologists", Engineers and Managers",**
   Prentice Hall.
2. **Heinrich H.W., "Industrial Accident Prevention", McGraw Hill Publication , Newyork.**
3. **Colling D.A., "Industrial Safety Management and Technology", Prentice Hall, New Jersey.**
4. **Della D.E., and Giustina, "Safety and Environmental Management", Van Nostrand Reinhold**
   International Thomson Publishing Inc.
5. **CPHEEO, Manual on Sewerage and Sewage Treatment, M/s.Jain Book Agency, c-9, Connaught place, New Delhi.**
6. **National Safety Council and Associate (Data) Publishers Pvt. Ltd., "Industrial Safety and Pollution Control Handbook"**

REMOTE SENSING AND GIS IN ENVIRONMENTAL ENGINEERING

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

SEMESTER – I

Subject Code	**16CEE-154**	**IA Marks**	**20**
Number of Lecture Hours/Week	**03**	**Exam Marks**	**80**
Total Number of Lecture Hours	**40**	**Exam Hours**	**03**

CREDITS – 03

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.**	**08 Hours**
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**	**08 Hours**
Module -3 **INTRODUCTION TO GIS** **Data entry, storage and maintenances, Data output. Data analysis, Hardware and software**	**08 Hours**
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.**	**08Hours**
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**	**08 Hours**

Course outcomes:

On completion of this course, students are able to

1. **Develop a sound understanding of the nature, purpose and underlying principles of Remote Sensing.**
2. **Understand the range of available Remote Sensing technologies and be able to match these to particular kinds of scientific and management problem**
3. **Develop a critical awareness of the strengths and limitations of monitoring using Remote Sensing and the wider role of Remote Sensing in environmental modeling and monitoring.**

Question paper pattern:
The question paper will have ten questions.
Each full question consists of 16 marks.
There will be 2 full questions (with a maximum of four sub questions) from each module.
Each full question will have sub questions covering all the topics under a module.
The students will have to answer 5 full questions, selecting one full question from each module.

Reference Books:

1. **Lillies and T.M. and Kiefer, R.W., "Remote Sensing and Image Interpretation", John Wiley and Sons,**
2. **Burrough, P.A. and McDonnell, R.A., "Principles of Geographical Information Systems", Oxford University Press,**
3. **Lintz, J. and Simonet, "Remote Sensing of Environment", Addison Wesley Publishing Company,**
4. **Mishra H.C., "GIS Hand Book", GIS India, Shanthi Nivas, Hyderabad.**
5. **Syed R. Qasim , Edward M. Motley & Guang Zhu, "Water Works Engineering: Planning, Design And Operation", Eastern Economy Edition, PHI Learning Private Limited, New Delhi.**

COMPUTER APPLICATIONS LABORATORY

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

Subject Code	**16CEEL-16**	**IA Marks**	**20**
Number of Lecture Hours/Week	**03**	**Exam Marks**	**80**
Total Number of Lecture Hours	**40**	**Exam Hours**	**03**

CREDITS – 02

Writing programmes in C-language & Running for the following. — **40 Hours**

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, 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.**

ATMOSPHERIC ENVIRONMENTAL POLLUTION AND CONTROL

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

Subject Code	**16CEE-21**	**IA Marks**	**20**
Number of Lecture Hours/Week	**04**	**Exam Marks**	**80**
Total Number of Lecture Hours	**50**	**Exam Hours**	**03**

CREDITS – 04

Course objectives:

Introduction of major problems in indoor air pollution and control, regulations
Describe general air pollution problems, meteorological definitions, air transport equations and pollution control matters and devices.

Modules	**Teaching Hours**
Module -1 **Introduction: sources, effects on – ecosystems, characterization of atmospheric pollutants, air pollution episodes of environmental importance**	**10 Hours**
Module -2 **Meteorology - composition and structure of the atmosphere, wind circulation, solar radiation, lapse rates, atmospheric stability conditions, wind velocity profile, Maximum Mixing Depth (MMD), Temperature Inversions, Windrose diagram**	**10 Hours**
Module -3 **General characteristics of stack emissions, plume behaviour, heat island effect. Pollutants dispersion models – description and application of point, line and areal sources.** **Monitoring of particulate matter and gaseous pollutants – respirable, non-respirable and nano - particulate matter.** **CO, CO2, Hydrocarbons (HC), SOX and NOX, photochemical oxidants.**	**10 Hours**
Module -4 **Air Pollution Control equipment for particulate matter & gaseous pollutants – gravity settling chambers, centrifugal collectors, wet collectors, fabric filters, electrostaticprecipitator (ESP).** **– adsorption, absorption, scrubbers, condensation and combustion**	**10 Hours**
Module -5 **Indoor Air Pollution – sources, effects and control.** **Noise - sources, measurements, effects and occupational hazards. Standards, Noise mapping, Noise attenuation equations and methods, prediction equations, control measures, Legal aspects of noise**	**10 Hours**

Course outcomes:

On completion of this course, students are able to

1. **Identify anthropogenic sources and atmospheric effects to pollutions**
2. **Understand Regional, global pollution transport mechanisms**
3. **Appreciate development of transport equations and applications, stack**
4. **Learn theory and development of pollution control devices: Cyclone, electrostatic particle precipitator, packed towers, gravitational separator, bag house.**

Question paper pattern:
The question paper will have ten questions.
Each full question consists of 16 marks.
There will be 2 full questions (with a maximum of four sub questions) from each module.
Each full question will have sub questions covering all the topics under a module.
The students will have to answer 5 full questions, selecting one full question from each module.

Reference Books:

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

ECOLOGY AND ENVIRONMENTAL IMPACT ASSESSMENT

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

SEMESTER – II

Subject Code	**16CEE-22**	**IA Marks**	**20**
Number of Lecture Hours/Week	**04**	**Exam Marks**	**80**
Total Number of Lecture Hours	**50**	**Exam Hours**	**03**

CREDITS – 04

Course objectives:

The course introduces process of environmental impact assessment and policy decision making 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 **Ecology: Classification of Ecosystems, Structure and Function of Ecosystems, Energy flow in Ecosystems, Ecological Niche and succession, Bio-geo-chemical cycles, Ecological Pyramids.**	**10 Hours**
Module -2	
Aquatic and Terrestrial Ecosystems: Diversity and dominance Indices, Ecosystem Models. **Climate change and biodiversity** **Lake Ecosystem: Trophic levels, nutrient loading, nutrient enrichment, Leibig's Law, control of eutrophication.**	**10 Hours**
Module -3	
Environmental Impact Assessment: Definition, Objectives, Types – Rapid and Comprehensive EIA, EIS, FONSI. Step-by-step procedure for conducting EIA and Limitations of EIA, Prevention of Significant Deterioration (PSD) Programme. Carrying capacity concept	**10 Hours**
Module -4	
Attributes, Standards and Value functions:. Public participation in EIA. Environmental Management Plan (EMP) and Disaster Management Plan (DMP)	**10 Hours**
Module -5	
EIA Case Studies –Thermal Power Plant, Mining, Fertilizer, Construction Projects, Air port, Water and Wastewater Treatment Plants.	**10 Hours**

Course outcomes:

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**
4. **Appreciate the purpose and role of EIA in the decision-making process**
5. **Understand the strengths of EIA in regard to environmental management**
6. **Understand the technical and social/political limitations of EIA**

7. **Know the administration and procedures that apply in the student's jurisdiction**
8. **Understand the screening process**
9. **Understand the scoping process and how it is applied**
10. **Know the options for estimating environmental and social impacts**
11. **Know the format of an EIA Report (Environmental Impact Statement, or Environmental Statement)**
12. **Appreciate the factors that assist, and detract, from the usefulness of the EIA Report**
13. **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 consists of 16 marks.
There will be 2 full questions (with a maximum of four sub questions) from each module.
Each full question will have sub questions covering all the topics under a module.
The students will have to answer 5 full questions, selecting one full question from each module.

Reference Books:

1. **Kormondy, "Concepts of Ecology", Prentice Hall Publication, New Jersey.**
2. **Odum, "Fundamentals of Ecology", Adisson Co.**
3. **Krebs J., "Ecology - The Experimental Analysis of Distribution and Abundance", I Edition, Harper International.**
4. **Hall C.A.S., and Day J.W., "Ecosystem Modeling in Theory and Practice: An Introduction with Case Histories", John Willey.**
5. **Canter L., , "Environmental Impact Assessment", McGraw Hill.**

ADVANCED WASTEWATER TREATMENT ENGINEERING

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

SEMESTER – II

Subject Code	**16CEE-23**	**IA Marks**	**20**
Number of Lecture Hours/Week	**04**	**Exam Marks**	**80**
Total Number of 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 **Objectives of wastewater treatment: Characteristics, flow variations, types of reactors and reactors analysis.** **Wastewater Treatment Flow Diagrams and Hydraulic Profile.** **Kinetics of biological treatment systems: Biokinetic constants and their determination, batch and continuous systems.**	**10 Hours**
Module -2	
Theoretical principles and design: screens, equalization basin, grit chamber, primary and secondary settling tanks	**10 Hours**
Module -3	
Theoretical principles and design:Suspended growth system - conventional activated sludge process and its modifications. Attached growth system – trickling filter, bio-towers and rotating biological contactors. Principles and design of stabilization ponds	**10 Hours**
Module -4	
Advanced Wastewater Treatment: Need and technologies used. Nitrification and Denitrification Processes, **Phosphorous removal. Wastewater disinfection**	**10 Hours**
Module -5	
Sludge Processing: Separation - sludge thickeners, volume reduction, conditioning and digestion – aerobic and anaerobic. **Rural wastewater systems: Septic tanks, two-pit latrines, eco-toilet, soak pits.**	**10 Hours**

Course outcomes:

On completion of this course, students are able to understand

1. **A process flow sheet.**
2. **Appropriate treatment methods for municipal and certain industrial effluents.**
3. **How water and wastewater treatment plants operate.**
4. **Simple design equations for water and wastewater treatment plant.**
5. **The chemical and biological prociples behind unit processes used in water and wastewater treatment unit processes.**
6. **The concept of a unit operation and a unit process.**

7. **The fundamental scientific processes underlying the design and operation of wastewater treatment plant.**
8. **The management of residuals from water and wastewater treatment.**
9. **The methods that are used for the design of a water and wastewater treatment plant.**

Question paper pattern:
The question paper will have ten questions.
Each full question consists of 16 marks.
There will be 2 full questions (with a maximum of four sub questions) from each module.
Each full question will have sub questions covering all the topics under a module.
The students will have to answer 5 full questions, selecting one full question from each module.

Reference Books:

1. **Benefield R.D., and Randal C.W., , "Biological Process Design for Wastewater Treatment", Prentice Hall, Englewood Chiffs, New Jersey.**
2. **Metcalf and Eddy Inc., , "Wastewater Engineering - Treatment and Reuse", 4th Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.**
3. **Karia G.L., and Christian R.A., "Wastewater Treatment Concepts and Design Approach", Prentice Hall of India Pvt. Ltd., New Delhi.**
4. **Ronand L., and Droste, ,"Theory and Practice of Water and Wastewater Treatment", John**
5. **Wiley and Sons Inc.**
6. **Fair G.M., Geyer J.G and Okun, "Water-wastewater Engineering".**
7. **Lee C.C., and Lin S.D., "Handbook of Environmental Engineering Calculations", McGraw Hill, New York.**

ENVIRONMENTAL GEO-TECHNOLOGY

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

SEMESTER – II

Subject Code	**16CEE-24**	**IA Marks**	**20**
Number of Lecture Hours/Week	**04**	**Exam Marks**	**80**
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-Physico-chemical 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 consists of 16 marks.** **There will be 2 full questions (with a maximum of four sub questions) from each module.** **Each full question will have sub questions covering all the topics under a module.** **The students will have to answer 5 full questions, selecting one full question from each module.**	
Reference Books: **1. Wentz, C.A., Hazardous Waste Management, McGraw Hill, Singapore, 1989.** **2. Daniel, B.E., Geotechnical practice for waste disposal, Chapman and Hall, London, 1993.** **3. Fang, H.Y. Introduction to environmental Geotechnology, CRC press New York, 1997.** **4. Lagrega, M.d., Bukingham, P.L., and Evans, J.C., Hazardous Waste Management, McGraw Hill, Inc. Singapore, 1994.**	

AIR AND WATER QUALITY MODELING

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

SEMESTER – II

Subject Code	**16CEE-251**	**IA Marks**	**20**
Number of Lecture Hours/Week	**03**	**Exam Marks**	**80**
Total Number of Lecture Hours	**40**	**Exam Hours**	**03**

CREDITS – 03

Course objectives:

To understand the concept of modeling for water and air quality management.

To assess model performance and sensitivity for water quality.

To ascertain the utilisation, computer models.

Modules	**Teaching Hours**
Module -1 **Modeling/Concept** **Water and air quality management – Role of mathematical models; systems approach – systems and models – kinds of mathematical models – model development and validation effluent and stream standards; ambient air quality standards.**	**08 Hours**
Module -2	
Surface Water Quality Modelling: **Historical development of water quality models; rivers and streams water quality modeling – river hydrology and flow – low flow analysis – dispersion and mixing – flow, depth and velocity – estuaries – estuarine transport, net estuarian flow, estuary dispersion coefficient; Lakes and impoundments – Water quality response to inputs; water quality modeling process – model sensitivity – assessing model performance; Models for dissolved oxygen, pathogens; Streeter – Phelps models.**	**08 Hours**
Module -3	
Air Quality Modelling: **Transport and dispersion of air pollutants – wind velocity, wind speed and turbulence; estimating concentrations from point sources – the Gaussian Equation – determination of dispersion parameters, atmospheric stability; dispersion instrumentation – Atmospheric traces; concentration variation with averaging time; Air pollution modeling and prediction – Plume rise modeling techniques, modeling for non-reactive pollutants, single source – short term impact, multiple sources and area sources, model performance and utilisation, computer models.**	**08 Hours**
Module -4	
Groundwater Quality Modelling: **Mass transport of solutes, degradation of organic compounds, application of concepts to predict groundwater contaminant movement, seawater intrusion – basic concepts and modelling**	**08 Hours**

Module -5

Computer Models: **Exposure to computer models for surface water quality, groundwater quality and air quality.**	**08 Hours**

Course outcomes:
On completion of this course, students are able to understand modeling concepts.
To development of model and validation of effluent and stream standards;
To achieve ambient air quality standards.

Question paper pattern:
The question paper will have ten questions.
Each full question consists of 16 marks.
There will be 2 full questions (with a maximum of four sub questions) from each module.
Each full question will have sub questions covering all the topics under a module.
The students will have to answer 5 full questions, selecting one full question from each module.

Reference Books:

1. **Steven C.Chapra, Surface Water Quality Modeling, The McGraw-Hill Companies, Inc., New York, 1997.**
2. **R.W.Boubel, D.L. Fox, D.B. Turner & A.C. Stern, Fundamentals of Air Pollution Academic Press, New York, 1994.**
3. **Ralph A. Wurbs, Water Management Models – A Guide to Software, Prentice Hall. PTR, New Jersey, 1995.**

ENVIRONMENTAL PLANNING AND MANAGEMENT

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

SEMESTER – II

Subject Code	**16CEE-252**	**IA Marks**	**20**
Number of Lecture Hours/Week	**03**	**Exam Marks**	**80**
Total Number of Lecture Hours	**40**	**Exam Hours**	**03**

CREDITS – 03

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.**	**08 Hours**
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**	**08 Hours**
Module -3	
Engineering Economics: Value Engineering, Time Value of Money, Cash Flows, Budgeting and Accounting	**08 Hours**
Module -4	
Environmental Economics: Introduction, economic tools for evaluation, Green GDP, Cleaner development mechanisms and their applications	**08Hours**
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	**08 Hours**

Course outcomes:

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 consists of 16 marks.
There will be 2 full questions (with a maximum of four sub questions) from each module.
Each full question will have sub questions covering all the topics under a module.
The students will have to answer 5 full questions, selecting one full question from each module.

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

TRANSPORT PROCESSES AND MODELING OF AQUATIC SYSTEMS
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – II

Subject Code	**16CEE-253**	**IA Marks**	**20**
Number of Lecture Hours/Week	**03**	**Exam Marks**	**80**
Total Number of Lecture Hours	**40**	**Exam Hours**	**03**

CREDITS – 03

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	**08 Hours**
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	
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	**08Hours**
Module -3	
1-D Oxygen balance models: Streeter-Phelps equation, critical point method. Calibration and verification of 1-D oxygen model. Error measures.	**08 Hours**
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	**08 Hours**
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 Hours**

Course outcomes:

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 consists of 16 marks.
There will be 2 full questions (with a maximum of four sub questions) from each module.
Each full question will have sub questions covering all the topics under a module.
The students will have to answer 5 full questions, selecting one full question from each module.

Reference Books:

1. **Rich L.G., "Environmental Systems Engineering", McGraw Hill.**
2. **Thomann R.V., and Mueller J.A., "Principles of Water Quality Management and Control", Harper & Row Publications.**
3. **Schnoor J.L., "Environmental Modelling – Fate and Transport of Pollutants in Water, Air and Soil", John Wiley and Sons.**
4. **Thomann R.V., "Systems Approach to Water Quality Management", McGraw Hill.**
5. **Lee C.C., and Lin S.D., "Handbook of Environmental Engineering Calculations", McGraw Hill, New York.**

GLOBAL WARMING AND CLIMATE CHANGE

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

SEMESTER – II

Subject Code	**16CEE-254**	**IA Marks**	**20**
Number of Lecture Hours/Week	**03**	**Exam Marks**	**80**
Total Number of Lecture Hours	**40**	**Exam Hours**	**03**

CREDITS – 03

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 , Alternate Energy Sources**	**08 Hours**
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**	**08 Hours**
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**	**08 Hours**
Module -4 **Kyoto Protocol: Importance, Significance and its role in Climate Change Carbon Trading - Mechanisms , Various Models (European, Indian) Global and Indian Scenario**	**08 Hours**
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**	**08 Hours**

Course outcomes:

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 consists of 16 marks.
There will be 2 full questions (with a maximum of four sub questions) from each module.
Each full question will have sub questions covering all the topics under a module.
The students will have to answer 5 full questions, selecting one full question from each module.

Reference Books:

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. **Corell R.W., and Anderson P.A., (Eds.), "Global Environmental Change", Springler Verlog Publishers.**
4. **Francis D., "Global Warming: The Science and Climate Change", Oxford University Press.**
5. **Frame B., Medury Y., and Joshi Y., (Eds.), "Global Climate Change: Science, Impact and Responses".**
6. **Linden E.,, "The Winds of Change: Climate, Weather and the Destruction of Civilizations", Simon and Schuster Publications.**
7. **Mintzer I.M., (Ed.), "Confronting Climate Change, Risks, Implications and Responses", Cambridge University Press.**
8. **Srivatsava A.K., "Global Warming", APH Publications.**
9. **Wyman R.L., (Ed.), "Global Climate Change and Life on Earth", Chapman and Hall Publications.**
10. **Yadav, Chander and Bhan, "Global Warming: India's Response and Strategy", RPH Publications.**

ENVIRONMENTAL LABORATORY AND FIELD TEST
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – II

Subject Code	**16CEEL-26**	**IA Marks**	**20**
Number of Lecture Hours/Week	**03**	**Exam Marks**	**80**
Total Number of Lecture Hours	**40**	**Exam Hours**	**03**

CREDITS – 02

1.Chemistry Laboratory practice: Sampling and characterization of water and wastewater by gravimetric, volumetric and colorimetric methods – Sampling and analysis of ambient air for SPM, SO_2, Oxides of nitrogen – Good laboratory practice – Analytical quality control **2. 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.Air pollutants, Solid Waste and leachate analyses: Instrumental methods of analyses for particulates, PM10, PM2.5, HC, CO, NOx, SO_2, bio-aerosols,** **Leachate tests for solid wastes – 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**

INDUSTRIAL WASTEWATER TREATMENT

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

Subject Code	**16CEE-41**	**IA Marks**	**20**
Number of Lecture Hours/Week	**04**	**Exam Marks**	**80**
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.** **Wastewater Treatment in specific industries: Distrillery, Sugar, Pulp and paper, Cement, Textile, Dairy, Fertilizer, Pesticides, Pharmaceutical**	**10 Hours**
Module -4 **Design of complete treatment system & disposal for industries: Distillery, Diary, Textile, paper and pulp mill to meet P.C.B. norms.** **Radio Active Wastes treatment- Low activity and high activity radiation, application of radio active techniques for wastewater treatment. Bio-Remediation of contaminated soils**	**10 Hours**
Module -5 **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 consists of 16 marks.
There will be 2 full questions (with a maximum of four sub questions) from each module.
Each full question will have sub questions covering all the topics under a module.
The students will have to answer 5 full questions, selecting one full question from each module.

Reference Books:

1. **Nemerow N.N., "Liquid Waste of industry theories, "Practices and Treatment. Addison Willey New York.**
2. **Azad N. S.,– "Industrial Wastewater Management Hand Book" McGraw Hill book Co., Newyork.**
3. **Ross R.D. "Industrial Waste Disposal", Reinhold Environmental Series – New York.**
4. **Dickinson" Practical Waste Treatment and Disposal Applied Science publication, London.**
5. **Mahajan," Pollution control in Process industries". TMH, New Delhi.**
6. **Eckenfelder, "Industrial Water pollution Control"- McGraw hill Company, New Delhi American Chemical Society, Washington D.C. USA**
7. **Bioremediation books**

ADVANCED ATMOSPHERIC ENVIRONMENTAL ENGINEERING

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

SEMESTER – IV

Subject Code	**16CEE-421**	**IA Marks**	**20**
Number of Lecture Hours/Week	**03**	**Exam Marks**	**80**
Total Number of Lecture Hours	**40**	**Exam Hours**	**03**

CREDITS – 03

Course objectives:

Course introduces Atmospheric Processes and Chemical Reactions, Characteristics of atmospheric boundary layer and its depth. It enlightens students on Urban Air Quality Simulation Modeling and its inherent problems, dispersion of Heavy Gases, design of Industrial Ventilation Systems.

Modules	**Teaching Hours**
Module -1 **Atmospheric Processes and Chemical Reactions: Definition of terms aerosols, particle, photolysis, gas to particle conversion, condensation, evaporation, dissolution, sublimation, specific heat, conduction, radiation. Mechanical turbulence, forced convection, advection, equation of state, first law of thermodynamics. Reaction Rates (Gas Phase Species) Atmospheric gases and their molecular structures, chemical reactions and photo processes, reaction rates, reaction rate coefficients, sets of reactions, stiff systems**	**08 Hours**
Module -2	
Atmospheric Boundary Layer: Characteristics of atmospheric boundary layer-boundary layer depth, mean velocity power-law profile, Log-Log velocity profile, spectral description of turbulence, turbulence intensity, Reynolds stress parameter, spectral density function, integral length scale, inertial sub range and small scales. Turbulent fluxes of momentum, turbulent fluxes of energy and water vapour, friction velocity, surface roughness lengths, bulk aerodynamic equations for eddy diffusion, monin-obukhov similarity theory, eddy diffusion above the surface layer, ground surface temperature and moisture.	**08 Hours**
Module -3	
Urban Air Quality Simulation Modeling: General need, alternative approaches, basic model applications, general composition of models, Numerical modeling approaches-Gaussian diffusion models, physical basis of the mass conservation approach, mathematical foundation of the mass conservation approach.	**08 Hours**
Module -4	
Inherent problem in air quality simulation modeling: Boundary conditions, spatial resolution and compatibility with available data. Transportation related modeling-street canyon models, highway models, airport models. Air quality simulation models for Quasi-Inert pollutants-sulfur dioxide and particulate models, carbon monoxide models. Air quality simulation models for photochemical pollutants-background, features of photochemical air quality	**08 Hours**

simulation models, model evaluation, model validation. **Dispersion of Heavy Gases: Introduction, characteristics of heavy gas flow, introduction to numerical modeling of heavy gas dispersion, requirements for physical models (non-dimensional parameters, choice of scaling variables).**	
Module -5	
Mobile Sources of Pollution: Introduction, emission standards for automobiles, Gasoline, origin exhaust emissions from gasoline engines, crankcase and evaporative emissions, alternative fuels and their utilization. **Indoor Air Pollution: Introduction, the IAQ problem, diagnosis and remediation of IAQ problems, the interdisciplinary approaches. Industrial hygiene and its application to IAQ, industrial hygiene methodology. Indoor air quality and industrial hygiene, sampling, analysis and interpretation. Industrial hygiene methodology, architectural and construction aspects.** **Design of Industrial Ventilation Systems: Introduction, ventilation by dilution, hood specifications, hoods of simple geometry, experimental velocity contours, complex hood design, duct design, fan selection and performance.**	**08 Hours**

Course outcomes:

On completion of this course, students are able to

1. **Understand Atmospheric Processes and Chemical Reactions**
2. **Effectively utilize knowledge of design on Industrial Ventilation Systems**
3. **Learn Urban Air Quality Simulation Modeling**

Question paper pattern:

The question paper will have ten questions.
Each full question consists of 16 marks.
There will be 2 full questions (with a maximum of four sub questions) from each module.
Each full question will have sub questions covering all the topics under a module.
The students will have to answer 5 full questions, selecting one full question from each module.

Reference Books:

1. **Jacobson. Z. A., Fundamental of Atmospheric modeling, Cambridge University Press, Cambridge.**
2. **Warren B. Johnson et. al. , Air Pollution, Arthur C. Stern, third edition, Volume I, Academic Press, New York, .**
3. **Krogstad and Jacobsen, Dispersion of heavy gases, in encyclopedia of environmental control technologies, edited by Cheremioinoff, Volume-2, Rulf publishing company, Houston.**
4. **Crawford Martin, "Air pollution control theory", Tata McGraw- Hill publishing company Ltd. New Delhi, .**
5. **Stull B. Roland, Boundary Layer Meteorology, Kluwer Academic Publishers, .**
6. **Snyder H. William, "Guideline for fluid modeling of atmospheric diffusion", U.S. Environmental Protection Agency research Triangle Park, NC 27711.**
7. **Wark K., Warner C.F., and Davis. W.T., Air Pollution, "its origin and control", Third Edition, Harper and Row Publication.**
8. **Steve M. Hays, Ronald V. Gobbell & Nicholas R. Ganick, "Indoor Air Quality"- Tata McGraw- Hill.**

TOXICOLOGY & ENVIRONMENTAL RISK ASSESSMENT

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

SEMESTER – IV

Subject Code	**16CEE-422**	**IA Marks**	**20**
Number of Lecture Hours/Week	**03**	**Exam Marks**	**80**
Total Number of Lecture Hours	**40**	**Exam Hours**	**03**

CREDITS – 03

Course objectives:

1. **This course introduces the principles; mechanistic and management about the environmental toxicology.**
2. **This course comprises :Introduction Environmental toxicology, Toxic-kinetic, Carcinogenic compound, Developmental toxicology, Environmental hormone, Pesticides, Heavy metal, Dioxin, Polychorinated biphenyls (PCBs), Polyaromtic hydrocarbons (PAHs).**

Modules	**Teaching Hours**
Module -1 **Introduction to toxicology:** **Significance, Applications, & Importance**	**08 Hours**
Module -2	
Introduction to risk assessment: **Assessment methods, Human exposure assessment, characterization of health risks. LD50 & LC50 concentrations**	**08 Hours**
Module -3	
Toxicology: **Exposure, toxic effects, dose response relationships, carcinogens and non-carcinogens.**	**08 Hours**
Module -4	
Toxicology & Epidemiology: **Public health & Risk assessment, Epidemiology & its importance**	**08 Hours**
Module -5	
Hazard identification, exposure and toxicity assessment, Risk characterization, risk communication, **Ecological risk assessment – Monte Carlo methods, case studies.**	**08 Hours**

Course outcomes:

On completion of this course, students are able to

1. **Understand various risk assessment methods**
2. **Identify the significance and applications of toxicology**
3. **Learn Ecological risk assessment methods**

Question paper pattern:

The question paper will have ten questions.
Each full question consists of 16 marks.
There will be 2 full questions (with a maximum of four sub questions) from each module.
Each full question will have sub questions covering all the topics under a module.
The students will have to answer 5 full questions, selecting one full question from each module.

Reference Books:

1. **LaGrega M.D., Buckingham P.L. and Evans J.C., "Hazardous Waste Management"- McGraw Hill, New York**
2. **David G.M, and Haner N.B., "An Applied Approach to Epidemiology and Toxicology for Engineers" – Instructor's Resource Guide, US Department of Health Education and Welfare.**
3. **World Health Organization Report," Recommended Health Based Limits in Occupational Exposure to Heavy Metals"**
4. **Kamrin S. E., "A text book on Primer on Toxicology Principles & Applications" Lewis Publishers.**
5. **Kalos M.H., and Whitloc P.A, Monte Carlo Methods, Vol. 1, Basics, Wiley Publications.**
6. **Fan A.M & Chang L.W, , "Toxilogy & Risk Assessment- Principles, Methods & Applications", Informa Health Care pubs.**
7. **Price F.T, Nancy Lane, Briq K.V, , "Environmental Toxiology & Risks Assessment – Recent Advancement in Environmental Fate & Transport ", ASTM International**
8. **Landis W.G., Ming-Ho Yu, "Introduction to Environmental Toxicology - Impacts of Chemicals upon Ecological Systems", CRC Press**

NON – POINT SOURCES OF POLLUTION AND MANAGEMENT

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

SEMESTER – IV

Subject Code	**16CEE-423**	**IA Marks**	**20**
Number of Lecture Hours/Week	**03**	**Exam Marks**	**80**
Total Number of Lecture Hours	**40**	**Exam Hours**	**03**

CREDITS – 03

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, rainfall, Overland routing of the precipitation excess, interflow ground water flow**	**08 Hours**
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**	**08 Hours**
Module -3	
Non point Pollution Simulation Models: Basic Concepts Brief Description available Nonpoint Pollution Simulation Models	**08 Hours**
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**	**08 Hours**
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.	**08 Hours**

Course outcomes:

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 consists of 16 marks.
There will be 2 full questions (with a maximum of four sub questions) from each module.
Each full question will have sub questions covering all the topics under a module.
The students will have to answer 5 full questions, selecting one full question from each module.

Reference Books:

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**

ENVIRONMENTAL LEGAL ASPECTS AND POLICY GUIDELINES

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

Subject Code	**16CEE-424**	**IA Marks**	**20**
Number of Lecture Hours/Week	**03**	**Exam Marks**	**80**
Total Number of Lecture Hours	**40**	**Exam Hours**	**03**

CREDITS – 03

Course objectives:

This course takes a hybrid approach to teaching environmental law. This course aims to:

1. **Provide an overview of some of the major environmental statutes in India**
2. **Address the variety of regulatory tools and concepts that can be used to prevent environmental harm, focusing on the proper match between regulatory tool and environmental harm; and**
3. **Discuss the role of other disciplines (e.g., science) and alternative means (e.g., public awareness) to facilitate changes in environmental policy.**

Modules	**Teaching Hours**
MODULE 1: Environment Definitions and Acts **Environment definition in Indian law- Different environmental protection legislations- History of Environmental protection in India - Provisions in Indian Penal Code for Environmental protection-The constitutions of India – Union list- State list – Concurrent list - Panchayats and Municipalities role.**	**08 Hours**
MODULE 2: Water (prevention & control of Pollution) Act & Air (prevention & control of Pollution) Act **Water pollution – definition – Water (Conservation and protection) Act 1974 – Objectives of Water Act – Legislation to control water pollution – Functions of CPCB and SPCB - Local bodies role – Water (prevention & control of pollution) Act 1974 as amended by Amendment Act 1988. Water (prevention and control of pollution) Rules 1975 - Water (prevention & control of Pollution) Cess Act 1977 as amended by Amendment Act 1987 and relevant notifications - Tolerance limits for effluents discharge and drinking water - Constitution and Resources management and pollution control – Air (prevention & control of Pollution) Act 1981-Sections of Air (prevention & control of Pollution) Act 19, 20, 21, 22-Penalties - Ambient air quality standards-Noise and the Laws**	**08 Hours**
MODULE 3: Environmental (Protection) Act 1986 **Environment and pollution - definition as per Environmental law- General powers of Central and state Government under EPA- Important Notification in EPA 1986- The Indian Forest Act 1927- Forest Conservation Act 1980 - Wild Life (Protection) Act - Constitution of Pollution Control Boards - Powers, functions, Accounts, Audit etc. – Equitable remedies for pollution control**	**08 Hours**

MODULE 4: Municipal Solid Waste Management Rules **Solid waste management – Hazardous Wastes (Handling and Management) Rules 1998-Bio-medical Wastes (Handling and Management) Rules 1998-Recyclled plastics (Manufacture and Usage) Rules, 1999-Municipal Solid Waste Management Act 2003-Rules - E.I.A and Public Hearing- Eco-labeling-Eco Mark**	**08Hours**
MODULE 5: Coastal Regulation Zone Notification and Green Benches **Coastal Regulation Zone - definition-Importance of coral reef-Regulation activities in CRZ - The Biological Diversity Act 2002-Bio diversity Rules 2004-The Intellectual Property Rights (IPR)-National Environment Appellate Authority –Environmental Tribunal and Green Benches - Some Important cases on Environment - International Conventions - Protocols for protection of the Environment**	**08Hours**

Course Outcomes:

On completion of this course, students will be able to:

1. **Analyze contrasting environmental regulatory methods and conceptual approaches including the common law, health and technology based statutes, and informational and economic approaches.**
2. **Evaluate the economic and ethical assumptions and justifications when choosing any regulatory approach such as cost-benefit analysis, environmental justice, and the tradeoff between environmental protection and public welfare.**
3. **Assess the lawfulness of administrative agency and private action towards the environment by application of the relevant environmental statute or agency regulation.**
4. **Explain the role of the Central and state judiciaries, as well as state legislatures and agencies, in formulating and implementing environmental policy.**
5. **Interpret environmental statutes and case law.**
6. **Formulate both legal and non-legal strategies to assist future clients in solving problems that implicate environmental law and policy.**

Question paper pattern:
The question paper will have ten questions.
Each full question consists of 16 marks.
There will be 2 full questions (with a maximum of four sub questions) from each module.
Each full question will have sub questions covering all the topics under a module.
The students will have to answer 5 full questions, selecting one full question from each module.

Reference Books:

1. **Constitutional Law of India – J.N. Pandey 1997 (31st Edn.) Central Law Agency Allahabad.**
2. **Administrative Law U.P.D. Kesari 1998. Universal Book Trade Delhi.**
3. **Environmental Law H.N. Tiwari, Allahabad Law. Agency 1997.**
4. **Environmental, A., Divan and Noble M. Environmental Law and Policy in India (cases, Materials and Statutes) 1991 Tripathi Bombay.**
5. **Environmental Policy. Forest Policy. Bare Acts – Government Gazette Notification.**
6. **Environmental Laws of India-C.P.R. Environmental Education Centre.**