KERALA TECHNOLOGICAL UNIVERSITY

ERNAKULAM WEST CLUSTER

DRAFT

SCHEME AND SYLLABI

FOR

M. Tech. DEGREE PROGRAMME

IN

ENVIRONMENTAL ENGINEERING

(2015 ADMISSION ONWARDS)

SCHEME AND SYLLABI FOR M. Tech. DEGREE PROGRAMME IN ENVIRONMENTAL ENGINEERING

SEMESTER-I

Exam Slot	Course No:	Name	L-T - P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
A	06CE6013	Advanced Mathematics and Applied Statistics	3-0-0	50	50	3	3
B	06CE6023	Environmental Chemistry andMicrobiology	3-0-0	50	50	3	3
C	06CE6033	Principle and Design of Physico-Chemical Treatment	3-1-0	50	50	3	4
D	06CE6043	Environmental Impact Assessment	3-1-0	50	50	3	4
E	06CE6Y53	Elective I	3-1-0	50	50	3	4
F	06CE6063	Research methodology	1-1-0	100	0	0	2
G	06CE6073	Seminar I	0-0-2	100	0	0	2
H	06CE6083	Environmental Engineering Lab	0-0-2	100	0	0	1

Credits:23

Course No:	Elective I
06CE6153	GIS and Remote Sensing for Environmental Applications
06CE6253	Energy Management
06CE6353	Bioremediation Principles and Applications

SEMESTER-II

Exam Slot	Course No:	Name	L- T – P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
A	06CE6014	Principles And Design Of Biological Treatment Systems	3-1-0	50	50	3	4
B	06CE6024	Air Pollution Control Engineering	3-0-0	50	50	3	3
C	06CE6034	Environmental Systems Modeling	3-0-0	50	50	3	3
D	06CE6Y44	Elective II	3-0-0	50	50	3	3
E	06CE6Y54	Elective III	3-0-0	50	50	3	3
F	06CE6064	Mini Project	0-0-4	100	0	0	2
G	06CE6074	Environmental Computational Lab	0-0-2	100	0	0	1

Credits:19

Elective II		Elective III	
06CE6144	Solid and Hazardous Waste Management	06CE6154	Industrial Water Pollution Control
06CE6244	Environmental Geo-Technology	06CE6254	Fundamentals of Sustainable Development
06CE6344	Instrumental Methods In Environmental Engineering	06CE6354	Membrane Technology for Water And Wastewater Treatment

SEMESTER-III

Exam Slot	Course No:	Name	L- T – P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
A	06CE7Y13	Elective IV	3-0-0	50	50	3	3
B	06CE7Y23	Elective V	3-0-0	50	50	3	3
C	06CE7033	Seminar II	0-0-2	100	0	0	2
D	06CE7043	Project(Phase 1)	0-0-8	50	0	0	6

Credits: 14

Elective-IV		Elective-V	
06CE7113	Sustainable Water Resource Management	06CE7123	Environmental Hydrology
06CE7213	Environmental Economics	06CE7223	Environment, Health and Safety in Industries
06CE7313	Water Pollution Control And Stream Sanitation	06CE7323	Environmental Emergency Preparedness and Response

SEMESTER-IV

Exam Slot	Course No:	Name	L- T – P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
A	06CE7014	Project (Phase 2)	0-0-21	100	0	0	12

Credits: 12

Total Credits for all semesters: 68

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6013	Advanced Mathematics and Applied Statistics	3-0-0-3	2015
Pre-requisites	**B. Tech level Engineering Mathematics Course**		

Course Objectives

To instruct the students on

- The concept of solving ordinary and partial differential equations
- Fundamentals of data analysis
- Concept of probability distributions
- Various sampling techniques

Syllabus

Solution of Ordinary linear differential equations of nth order, Introduction to partial differential equations, Numerical methods for solving ordinary differential Finite difference method,Finite element method, Regression and correlation, Probability concepts, Fundamentals of data analysis, Sampling techniques and application in Environmental Engineering

Course Outcome

On completion of the course the students shall attain knowledge to apply statistics and advanced mathematical concepts in various modelling and data analysis problems of environmental engineering.

Textbooks

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Ed., John Wiley &Sons, 2005.
2. Gilbert Strang, Introduction to Linear Algebra, 4th Ed., Pub.: Society for Industrial and Applied Mathematics (SIAM), 2009

References

1. The Numerical Solution of Ordinary and Partial Differential
2. Equations Paperback –by Academic press January 1, 1988 by Granville Sewell(Author)
3. Numerical Methods In Engineering & Science (Programs In C, C++ And Introduction To MATLAB) EBook By Dr. B.S. Grewal – Khanna Publishers
4. Numerical methods in finite element analysis (Prentice-Hall civil engineering and engineering mechanics series)Hardcover – 1976 by K.J. Bathe (Author)

5. Advanced Engineering Mathematics by R. K Jain and S.R.K Iyengar – 4 thedition published by Narosa Publishing house PVT Ltd –New Delhi
6. Richard.A. Johnson: Miller and Freunds, Probability and Statistics for Engineers (6^{th} edition) Pearson.
7. Gupta.S.C. and Kapoor.V.K, Fundamentals of Mathematical Statistics, Sultan Chand and Sons, 1978.

Course Plan

Contents	Contact Hours	Sem. Exam Marks (%)
Module 1: Ordinary Differential Equations Ordinary differential equations: Solution of Ordinary linear differential equations of nth order, Solution of systems of first order linear differential equations, Power series methods for solutions of ordinary differential equations. Introduction to partial differential equations: Diffusion reaction problem, parabolic and elliptical equations.	**10**	**25**
Module II: Numerical Methods Numerical methods for solving ordinary differential equations -: Taylor method, implicit and explicit Euler's method, Trapezoidal method, Numerical solution of PDE s - ; Finite difference method implicit and explicit Euler's method, Solution of non-linear partial differential equations by method of characteristics. Accuracy, convergence and stability, Finite element method- variational and weighted residual formulations.	**12**	**25**
Module III: Probability Concepts Regression and correlation: Linear Regression and correlation, multiple correlation coefficient, standard error of estimate, curvilinear regression- Applications. Probability concepts-conditional probability and Bayes' theorem. Probability distributions, - BD, PD, ED and ND Fitting of the distributions – BD, PD and ND; Fundamentals of data analysis; Measurement uncertainty: Precision, error and accuracy;	**11**	**25**

Reproducibility/repeatability,; Types of Error, Normal error curve.		
Module IV: Sampling Techniques Sampling techniques: Simple random sampling, stratified sampling, systematic sampling, sample size determination- application in Environmental Engineering Applications: Experimental Design:Analysis of variance (i) Completely randomized designs (ii) Randomized block designs. Latin squares. Grecco Latin square design. Factorial experiments.	**9**	**25**
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6023	Environmental Chemistry and Microbiology	3-0-0-3	2015
Pre-requisites	Nil		

Course Objectives

To instruct the students on

- The principles and basic concepts of physical chemistry
- Techniques for the analysis of air, water and soil environment
- Fundamentals of microbiology
- Environmental applications of microbiology

Syllabus

Laws of physical chemistry- basic concept of chemical kinetics-Chemistry of Solutions, Behaviour of gases-Osmosis, adsorption, ionization, Analytical chemistry and instrumentation- Chemistry of water, soil and air-Microbiology of water, soil and air- water borne diseases and their causative organisms- bacteriological analysis of water and sewage-Applications of microbiology in Sanitary Engineering

Course Outcome

On completion of the course the students will be equipped with the essential concepts in chemistry and microbiology that are particularly valuable for environmental pollution monitoring and treatment.

Text Books

1. Clair N.Sawyer, PeryL.McCarty - Chemistry for Environmental Engineering (McGraw Hill)
2. G.W. Vanloon and S.J. Duffy “Environmental Chemistry – a global perspective, Oxford University Press, New York, 2000.

References

1. Chatwal and Anand – Instrumental methods of analysis (DhanpatRai)
2. Seinfeld and Pandis, Atmospheric Chemistry and Physics, Wiley Publ.
3. Tortora, G.J, B.R. Furke, and C.L. Case, “Microbiology – An Introduction” (4th Edition),Benjamin/Cummings Publ. Co., Inc., California, 1992.

4. Standard methods. APHA.

Course Plan

Contents	Contact Hours	Sem. Exam Marks (%)
Module I-Physical Chemistry Physical Chemistry- Introduction-solutions-representation of concentrations - vapour pressure, Dalton's law, Henry's law, Graham's law, Rault's law- Law of mass action - chemical equilibrium, Le-Chatelier's principle – basic concept of chemical kinetics,Chemistry of Solutions- molarity, molality, normality, solubility constant, Behaviour of gases- ideal gas equation Osmosis – Principle of solvent extraction – distribution coefficient, Electrodialysis, adsorption – Type of adsorption – Theory of ionization, pH and buffers – Henderson Hasselbalch's equation – Colloids and their classification, Properties and their stability – Colloidal dispersions – Zeta potential – destruction of colloids – basic method of coagulation, different colloidal dispersions.	**11**	**25**
Module II- Chemistry of Water, Soil and Air Principles of AAS, ICP, XRF, Chromatography- IC, HPLC, GC, TLC, Spectrophotometry, Flame photometer, SEM, TEM Chemistry of water and waste water – water pollution – pollutants in water – Water Quality requirement - Potable water standards - Wastewater Effluent standards principles of determination of water quality parameters like pH, alkalinity, BOD, COD, hardness, lethal doses of pollutants – sulphides, chlorides, Ca, Mg, and analysis of minerals Fe, Mn, Ca, Mg in water. Soil chemistry- Acid base and ion exchange reactions in Soil, salt affected Soil and its remediation. Degradation of food stuffs, Detergents, Pesticides and Hydrocarbons.	**11**	**25**

Air pollution chemistry- Carbon, nitrogen, sulfur cycles, PAN and photochemical smog, VOCs, secondary aerosol formation		
Module III-Introduction to Microbiology Introduction to microbiology - microorganism and their characteristics-classification. Characteristics of bacteria -observation of wet and stained preparation - Grams stain. Microbiology of water, wastewater, soil and air - water borne diseases and their causative organisms, bacteriological analysis of water and sewage, test for coliforms, their significance, bacteriological standards, MPN and membrane filter technique.	**10**	**25**
Module IV-Applications of Microbiology Applications of microbiology in Sanitary Engineering- Role of Aerobic and anaerobic organisms**.** Microbial production of industrial products, genetically modified organisms for environmental application, bioremediation, bio-energy conversion, Importance of sterilization, factors influencing sterilization, principles and methods	**10**	**25**
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6033	**Principle and Design of Physico-Chemical Treatment**	**3-1-0-4**	**2015**
Pre-requisites	**Nil**		

Course Objectives

To instruct the students on

- The concepts of physico-chemical treatment for water and waste water
- Design methodologies for water and waste water treatment plants based on physico-chemical principles
- Advances in the treatment technologies for water and waste water

Syllabus

Physical and chemical characteristics of water-Significance of physico-chemical treatment – Principles of Physical treatment - Design of Water Treatment Plants- Selection of Site for Water Treatment- Design of Wastewater Treatment Plants-sludge thickening- sludge drying beds. Design of industrial water and waste water treatment plants- adsorption, membrane separation, demineratlisation, electrolytic methods and solvent extraction

Course Outcome

This course will help the students develop thorough knowledge on the principles of physico-chemical treatment methods in environmental engineering and familiarize the design concepts for water and waste water treatment plants

Text Books

1. Metcalf and Eddy, Wastewater Engineering, Treatment and Reuse, Tata McGraw Hill,New Delhi, 2003.
2. Qasim, S.R., Motley, E.M. and Zhu.G. Water works Engineering – Planning, Design and Operation, Prentice Hall, New Delhi, 2002.

References

1. Metcalf and Eddy, Wastewater Engineering, Treatment and Reuse, Tata McGraw Hill,New Delhi, 2003.
2. Qasim, S.R., Motley, E.M. and Zhu.G. Water works Engineering – Planning, Design and Operation, Prentice Hall, New Delhi, 2002.
3. Hendricks, D. 'Water Treatment Unit Processes – Physical and Chemical' CRC Press, NewYork 2006
4. Weber, W.J. Physicochemical processes for water quality control, John Wiley and sons, Newyork, 1983.
5. Peavy, H.S., Rowe, D.R., Tchobanoglous, G. Environmental Engineering, McGraw Hills, New York 1985.
6. Lee, C.C. and Shun dar Lin, Handbook of Environmental Engineering Calculations, McGraw Hill, New York, 1999.

Course Plan

Contents	Contact Hours	Sem. Exam Marks (%)
Module I- Overview of Physical and Chemical Characteristics of Water Physical and chemical characteristics of water-Significance of physico-chemical treatment –Principles of Physical treatment - Screening,	**12**	**25**

Aeration, Mixing, Flocculation, Equalization, Sedimentation, Filtration - back washing-disinfection, Evaporation, Incineration, gas transfer – mass transfer coefficient.		
Module II- Design of Water Treatment Plants Design of Water Treatment Plants: Selection of Site for Water Treatment-Selection of Treatment – Design of municipal water treatment plant units – Screens-Aerators – chemical feeding – Flocculation – clarifier – tube settling – filters – Rapid sand filters slow sand filter, pressure filter, Dual media filter-disinfection.	**16**	**25**
Module III-Design of Wastewater Treatment Plants Design of Wastewater Treatment Plants: Design of municipal wastewater treatment units-screens-detritus tank-grit chamber, settling tanks-sludge thickening-sludge dewatering systems-sludge drying beds.	**12**	**25**
Module IV- Industrial Water and Waste Water Treatment Adsorption – Isotherms – Principles, kinetics &regeneration. Membrane separation-Reverse Osmosis, nano filtration, ultra-filtration and hyper filtration- electro dialysis-Distillation – stripping and crystallization Principles of Ion exchange, Electrolytic methods, Solvent extraction – advanced oxidation /reduction – Recent Advances. Design of Industrial Water Treatment Units– Design of softeners – Demineralisers –Reverse osmosis plants – flow charts – Layouts, Residue and rejects management. Design of Industrial Wastewater Treatment Units-Equalization-Neutralization-Chemical FeedingDevices-mixers-floatation units-oil skimmer- flow charts- Recent trends- case studies.	**16**	**25**
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6043	Environmental Impact Assessment	3-1-0-4	2015
Pre-requisites	Nil		

Course Objectives

To instruct the students on

- The basic concepts of EIA
- The EIA methodologies
- Environmental legislations in India
- Environmental Clearance procedure in India
- Environmental audit and management techniques
- Fundamental Concepts of Sustainable development

Syllabus

Rationale and historical development of EIA- Environmental clearance procedure- impact prediction, evaluation and mitigation- EIS preparation-Environmental management systems and audit- concept of sustainable development and life cycle assessment- energy, water, carbon and ecological footprints

Course Outcome

On completion of the course, students will be thorough with the procedures in India for getting environmental clearance. The course will train the students to prepare an EIA report. The course will also introduce the students to the concepts of environmental audit and sustainable development.

Text Books

1. Canter L.W., Environmental impact assessment, McGraw-Hill, 1997
2. Betty Bowers Marriott, Environmental Impact Assessment: A Practical Guide, McGraw-Hill Professional, 1997

References

1. Canter L.W., Environmental impact assessment, McGraw-Hill, 1997
2. Betty Bowers Marriott, Environmental Impact Assessment: A Practical Guide, McGraw-Hill Professional, 1997.
3. Peter Morris &RikiTherivel, Methods of Environmental Impact Assessment, Routledge, 2001.

4. Denver Tolliver, Highway Impact Assessment, Greenwood Publishing Group, 1993.
5. R. K. Jain, L. V. Urban, G. S. Stacey, H. E. Balbach, Environmental Assessment, McGraw-Hill Professional, 2001.
6. EIA 2006 notification, Govt.of India
7. Environmental Impact Assessment, 2003, Y.Anjaneyulu, B.S Publications

Course Plan

Contents	Contact Hours	Sem. Exam Marks (%)
Module 1: Introduction to EIA Concepts Environmental impact assessment (EIA), definitions and concepts, rationale and historical development of EIA, the role of EIA in relation to the planning and decision-making process,Initial environmental examination, environmental impact statement (EIS), environmental appraisal, organizational structure, status of EIA in India, Environmental legislations in India, EIA notifications, Rapid EIA and Comprehensive EIA	**12**	**25**
Module II: EIA Methodologies and Clearance Procedure Form-1, category of projects, EIA methodologies, Screening and scoping, checklist, matrix, network and overlay methodologies for impact identification, EIS format, baseline- description of the affected environment, Terms of Reference (ToR), Impact Prediction, Evaluation and Mitigation- air, noise and water environment, assessment of socio-economic impacts, assessment of ecological impacts, Public participation in EIA, techniques for conflict management and dispute resolution, EIA case studies for selected projects.	**16**	**25**
Module III: Environmental Audit, **Management and Monitoring** Environmental audit- Definitions and concepts, partial audit, compliance audit, methodologies and regulations,Qualities of Environmental Auditor, Contents of EA reports, Introduction to ISO and ISO 14000, case studies in ISO 14000, environmental management techniques, Environmental Monitoring Plan	**16**	**25**
Module IV: Sustainable Development Concept of Sustainable Development, CDM initiatives in India, Life	**12**	**25**

cycle assessment, procedures for LCA,Stages in LCA of a Product, Triple bottom line concept, design for environment, Energy, water, carbon and ecological footprints		
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6153	**GIS and Remote Sensing for Environmental Applications**	**3-1-0-4**	**2015**
Pre-requisites	**Nil**		

Course Objectives

To instruct the students on

- The basic concepts of satellite remote sensing
- Data analysis using Geographical Information Systems
- Application of RS & GIS to solve environmental problems

Syllabus

Physics of remote sensing-various types of platforms– types of sensors- different types of data products and their characteristics, basics of digital image processing-GIS Architecture– Type of data – Data structure –Spatial data modeling –Geospatial analysis

Course Outcome

The students will learn about satellite remote sensing data processing, Geographic Information System development and geospatial data analysis. Through this course, students will acquire enough knowledge for the application of RS & GIS to environmental monitoring and modeling problems.

Text Books

1. Lillesand T.M. and Kiefer R.W., Remote sensing and Image Interpretation, Second Edition, John Wiley and Sons, 1987.
2. AnjiReddy, M. Remote Sensing and Geographical Information System, BSP Publications., 2001

References

1. Lillesand T.M. and Kiefer R.W., Remote sensing and Image Interpretation, Second Edition, John Wiley and Sons, 1987.

2. AnjiReddy, M. Remote Sensing and Geographical Information System, BSP Publications., 2001.
3. Chang, K (2005). Introduction to Geographic Information Systems, Tata McGraw Hills Edition, NewDelhi.
4. Manual of Remote Sensing, American Society of Photogrammetry and Remote Sensing, 1993.
5. Paul Curran P.J., Principles of Remote Sensing , ELBS, 1983.
6. Sabins F.F. Jr., Remote Sensing Principles and Interpretation, W.II. Freeman and Company, 1978.
7. Geo Information Systems – Applications of GIS and Related Spatial Information Technologies, ASTER Publication Co., Chestern (England), 1992.
8. Burrough P.A., Principles of GIS for Land Resources Assessment, Oxford Publication, 1980.
9. Jeffrey Star and John Estes, Geographical Information System – An Introduction, Prentice – Hall Inc., 1990.
10. Marble D.F., Galkhs H.W. and Pequest, Basic Readings in Geographic Information System, Sped System Ltd., New York, 1984.
11. Clarke, K.C. Parks B.O., and Crane M.P. (2006) Geographic Information systems and environmental modeling- PHI of India , New Delhi.

Course Plan

Contents	Contact Hours	Sem. Exam Marks (%)
Module I: Introduction to Remote Sensing Introduction to remote sensing – Electromagnetic spectrum – Physics of remote sensing – Effects of atmosphere – Atmospheric windows – Interaction of earth surface features with EMR – Spectral characteristics of vegetation, water, soil, etc. Various types of platforms– Airborne and space based platforms - Characteristics of different types of platforms – Characteristics of Remote Sensors –Multi spectral sensors – Multi Spectral Scanners – Microwave remote sensing- Factors affecting Microwave measurement- Radar wave bands- SLAR and SAR.	**13**	**25**
Module II: Introduction to Sensors	**13**	**25**

Sensors- Satellite system parameters- sensor parameters-spatial, spectral and radiometric resolution – False colour composite (FCC) – Multi spectral photographs – Thermal and microwave imaging system- Earth Resources satellite and Meteorological satellites Different types of data products and their characteristics –Basic principles of digital image processing – filtering, Retrieval Algorithms		
Module III: Introduction to GIS Geographic Information system – History and development of GIS – GIS definitions and Terminology -Architecture– System concepts – Coordinate systems – Standard GIS packages. Type of data – Spatial and non- spatial data – Data structure – Points – Lines – Polygon – Vector and raster – Files and data formats – Spatial data modeling –Raster GIS model and Vector GIS models.-GIS data file management and Database models	**14**	**25**
Module IV: Geospatial Data Analysis Data input and data editing-Input methods –GPS as data capture-data editing.Spatial analysis – Data retrieval – Query – Simple analysis – Record – Buffering and Overlay – Vector data analysis – Raster data analysis – Modeling in GIS – Digital elevation model – DTM Mini Project and Presentation	**16**	**25**
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6253	Energy Management	3-1-0-4	2015
Pre-requisites	Nil		

Course Objectives

To instruct the students on

- The basic principles of energy conservation
- Energy auditing
- Energy Management

Syllabus

Principles and Imperatives of Energy Conservation – non conventional energy sources – Energy Auditing- Concept of total Energy- Potential Areas for Conservation in Various Industries-Energy economics-life cycle costing

Course Outcome

Students will learn the basics of energy conservation, energy auditing and the economic benefits of energy management

Text Books

1. Trivedi, P R, Jolka K R, Energy Management, Commonwealth Publication, New Delhi, 1997.
2. Witte, Larry C, Industrial Energy Management & Utilization, Hemisphere Publishers, Washington, 1988.

References

1. Trivedi, P R, Jolka K R, Energy Management, Commonwealth Publication, New Delhi, 1997.
2. Witte, Larry C, Industrial Energy Management & Utilization, Hemisphere Publishers, Washington, 1988.
3. CB Smith, Energy Management Principles, Pergamon Press, New York, 3rd Edition, 2004.
4. Hamies, Energy Auditing and Conservation; Methods, Measurements, Management & Case Study, Hemisphere, Washington, 1980.

Course Plan

Contents	Contact Hours	Sem. Exam Marks (%)
Module I: Source of Energy	10	25

Energy Scenario – Principles and Imperatives of Energy Conservation – Various Sources – Alternative – non conventional energy sources – Alternative energy sources-wind-Solar energy – Energy Consumption Pattern – Resource Availability – Role of Energy Managers in Industries.		
Module II: Energy Auditing Energy Auditing:Energy Audit – Purpose, Methodology with respect to Process Industries – Power Plants, Boilers etc, - Characteristic Method Employed in Certain Energy Intensive Industries – Various Energy Conservation Measures in Steam System – Losses in Boiler, Methodology of Upgrading Boiler Performance; Energy Conservation in Pumps, Fans, Aerators Compressors, Air conditioning and refrigeration systems, Function, Necessity	**16**	**25**
Module III: Energy Conservation Energy Conservation:Total Energy Systems – Concept of total Energy – Advantages & Limitations – Total Energy System & Application – Potential & Economics of total Energy systems, water heat recovery. Potential Areas for Conservation in Various Industries – Energy Management Opportunities in Electrical Heating, Lighting System, Cable Selection – Energy Efficient Motors – Factors Involved in Determination of Motor Efficiency.	**16**	**25**
Module IV: Energy Economics Energy Economics**:** Importance of Energy Management, Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Life Cycle Costing, Carbon Credit. Applications:Case studies on Sugar Industry, Thermal Power Plant; Petrochemical Industries, Educational Institutions.	**14**	**25**
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6353	Bioremediation Principles and Applications	3-1-0-4	2015
Pre-requisites	**Nil**		

Course Objectives

To instruct the students on

- The basic principles of bioremediation
- Bioremediation systems and processes
- Management of bioremediation projects

Syllabus

Current bioremediation practices and applications-Factors influencing bioremediation-Applications of genetically engineered microorganisms for hazardous waste management-Microbial detoxification of specialty chemicals-Microbial cleaning of gases- in situ bioremediation- management of bioremediation project

Course Outcome

Students will learn the basics of bioremediation and its application in the field of environmental engineering.

Text Books

1. Maier, R.M., I.L. Pepper and C.P. Gerba, "Environmental Microbiology", Academic Press, NewYork, 1999.
2. Tortora, G.J, B.R. Furke, and C.L. Case, "Microbiology – An Introduction" (4th Edition),Benjamin/Cummings Publ. Co., Inc., California, 1992.

References

1. Maier, R.M., I.L. Pepper and C.P. Gerba, "Environmental Microbiology", Academic Press, NewYork, 1999.
2. Tortora, G.J, B.R. Furke, and C.L. Case, "Microbiology – An Introduction" (4th Edition),Benjamin/Cummings Publ. Co., Inc., California, 1992.
3. Baker, K.H. and D.S. Herson, Bioremediation, McGraw-Hill Inc., New York, 1994.
4. Chaudhury, G. R. "Biological degradation and Bioremediation of toxic chemicals', Dioscorides Press, Oregon, 1994.
5. Martin. A.M, "Biological degradation of wastes", Elsevier Applied Science, London, 1991.

6. Blaine Metting. F (Jr.,) Soil Microbiology Ecology, Marcel Dekker Inc., 1993.

Course Plan

Contents	Contact Hours	Sem. Exam Marks (%)
Module I Current bioremediation practices and applications, Microbial systems of bioremediation, Factors influencing bioremediation (Environmental, physical and chemical factors).	**10**	**25**
Module II Genetic response of microorganisms to the presence of pollutants (plasmid coded inducible degradative enzymes, Applications of genetically engineered microorganisms for hazardous waste management, microbial transformation reactions (aerobic and anaerobic biotransformation).	**15**	**25**
Module III Microbial detoxification of specialty chemicals (insecticides, herbicides, fungicides, polychlorinated biphenyls, heavy metals), Bioremediation systems and processes (solid, liquid and slurry phase remediation)	**16**	**25**
Module IV Microbial cleaning of gases (bio filtration and bio scrubbing), in situ bioremediation, laboratory scale bio treatability studies for bioremediation, management of bioremediation project	**15**	**25**
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6063	Research methodology	1-1-0-2	2015
Pre-requisites	**Nil**		

Course Objectives

To educate students on

- The research methodology
- Need for research design
- Execution of research
- Structure and composition of scientific report

Syllabus

Objectives and types of research- research methods vs methodology- Different types of research, Defining and formulating the research problem- Research design and execution- data collection and analysis- Structure and components of scientific reports- technical reports and thesis-Research ethics

Course Outcome

The students will be capable of formulate, design and execute research problems. They will be trained in writing scientific reports/papers and publishing their work in reputed journals.

Text Books

1. Kothari C.R., Research Methodology, New Age International Publishing.
2. Panneerselvam R., Research Methodology, PHI Learning Pvt. Ltd.

References

1. Kothari C.R., Research Methodology, New Age International Publishing.
2. Panneerselvam R., Research Methodology, PHI Learning Pvt. Ltd.
3. Bhattacharyya D.K., Research Methodology, Excel Books India.
4. Sam Daniel P. and Aroma G. Sam, Research Methodology, Gyan Publishing House.

Course Plan

Contents	Contact Hours	Sem. Exam Marks (%)
Module I Objectives and types of research, research methods vs methodology;	**10**	**25**

Different types of research, Defining and formulating the research problem, selecting the problem, necessity of defining the problem, importance of literature review in defining a problem, Literature review - primary and secondary data/information sources, reviews, monographs, patents, discussion series, white papers, research databases like CMIE, BB, UNSD etc., critical literature review, identifying gap areas from literature review.		
Module II Research design and execution: Research design – basic principles, need of research design, features of good design, important concepts relating to research design, observation and facts, laws and theories, prediction and explanation, development of models.	**15**	**25**
Module III Execution of the research, data collection and analysis: Aspects of method validation, observationand collection of data, methods of data collection, different sampling methods,data analysis techniques of hypothesis testing, ANOVA, randomized block design (RBD) and completely randomized design (CRD).	**16**	**25**
Module IV Reporting and thesis writing: Structure and components of scientific reports, types of report,technical reports and thesis. Different steps in thesis writing, layout, structure and language of typical reports, bibliography, referencing and footnotes. Research ethics – ethical issues, ethical committees, Scholarly publishing –Journal Impact Factor, H-Index, design of research paper, citation and acknowledgement, plagiarism, reproducibility andaccountability	**15**	**25**
End Semester Exam		

Course No.	Course Name	L-T-P Credits	Year of Introduction
06CE6073	Seminar I	0-0-2-2	2015

Each student is required to present a technical paper on a subject approved by the department. The paper should be on a recent advancement/trend in the field of Environmental Engineering. He/she shall submit a report of the paper presented to the department.

Course No.	Course Name	L-T-P Credits	Year of Introduction
06CE6083	Environmental Engineering Lab	0-0-2-1	2015

Pre-requisites	Nil

Course Objectives

To educate students on the analysis of characteristics of water/wastewater samples

SYLLABUS

Physical Analysis– Determination of pH, electrical conductivity, Turbidity & Optimum Coagulant Dosage, Solids

Chemical analysis– determination of DO, Hardness, Chlorides, iron, Alkalinity and Suphates in water, BOD & COD Analysis of wastewater, phosphate and nitrate in wastewater

Estimation of Na, K and Ca by flame photometer

Evaluation of Optimum Coagulant dosage and Optimum Chlorine dosage in water treatment.

Biological analysis

Culture media preparation – solid and liquid media. Preparation, distribution and sterilization.

Inoculation, streaking, colony observation. Colony counting technique for bacteria.

Determination of total bacterial population by standard plate count technique.

Bacteriological examination of water. Multiple tube fermentation test – MPN technique for coliforms in water and sewage.

Analysis of Air pollutants: SPM and gaseous pollutant analysis- High Volume Sampling, Stack Sampling

Course Outcome

The students will be trained on the analysis techniques for monitoring water and air quality in the environment

References:

1. Standard methods for the examination of water and waste water, American public health association 1996, New York.
2. F.W. Fifield and P.J. Haines, Environmental Analytical Chemistry, Blackie Academic and professional, Glasgow, UK
3. Vogel's qualitative inorganic analysis, 7th edition
4. Guide manual: Water and Wastewater, CPCB Delhi, India
5. Guidelines for the measurement of ambient air pollutants, CPCB Delhi, India

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6014	Principles And Design of Biological Treatment Systems	3-1-0-4	2015
Pre-requisites	Nil		

Course Objectives

To instruct the students on

- Basic principles of biological treatment of waste water
- Design and operation of aerobic and anaerobic treatment systems

Syllabus

Aerobic and anaerobic treatment kinetics of biological growth – Aerobic treatment of waste water: Process fundamentals and design- Anaerobic treatment of wastewater: Process fundamentals and design- tertiary treatment-issues and remedies-cost benefit analysis

Course Outcome

Course will familiarize the students with collection and characterization of wastewater samples, their biological treatment and disposal and advanced wastewater treatment process and their applications. After completion of the course students will be capable to decide on an appropriate biological treatment system based on the problem they are dealing with.

Text Books

1. Arceivala, S.J., Wastewater Treatment for Pollution Control, TMH, New Delhi, Second Edition, 2000.
2. Manual on "Sewerage and Sewage Treatment" CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 1999.

References

1. Arceivala, S.J., Wastewater Treatment for Pollution Control, TMH, New Delhi, Second Edition, 2000.
2. Manual on "Sewerage and Sewage Treatment" CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 1999.
3. Metcalf & Eddy, INC, 'Wastewater Engineering – Treatment and Reuse, Fourth Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2003.
4. Qasim, S.R. Wastewater Treatment Plant, Planning, Design & Operation, Technomic Publications, New York, 1994.
5.Benefield and Randall- Biological treatment Process – Design for waste water treatment, Prentice Hall of India, New Delhi.
6.Hammer- Water and Waste Water Technology, John Wiley and Sons
7. Quano- Principles of Waste Water Treatment, Vol. I, Oxford and IBH

Course Plan

Contents	Contact Hours	Sem. Exam Marks (%)
Module I Objectives of biological treatment – significance – aerobic and anaerobic treatment kinetics of biological growth – Factors affecting growth – attached and suspended growth Determination of Kinetic coefficients for organics removal – Biodegradability assessment - selection of process reactors- Batch - continuous type – kinetics	**10**	**25**
Module II Aerobic treatment of waste water: Process fundamentals Methods of aeration –design considerations – Operational difficulties –	**16**	**25**

proprietary technologies Description, design and operation of aerobic treatment systems: Activated Sludge process- Trickling Filters- Bio tower, RBC, MBBR, Membrane biological reactors (MBR), Sequencing Batch Reactors (SBR).		
Module III Anaerobic treatment of wastewater: Process fundamentals-Standard, high rate and hybrid reactors. Description, design and operation of attached and suspended growth processes: Anaerobic filters-Expanded /fluidized bed reactors-Up flow anaerobic sludge blanket reactors (UASB) Anaerobic Suspended growth reactors: septic tank, Imhoff tank	**15**	**25**
Module IV Aerated lagoons, waste stabilization ponds – nutrient removal systems – Nitrification and Denitrification- Phosphorus removal- natural treatment systems, constructed wet land – disposal options – reclamation and reuse Sludge treatment and disposal- anaerobic digestion- design of anaerobic digestors Operational issues and remedies in biological treatment- Foaming in aeration tank, floating sludge in clarifier Cost benefit analysis of various treatment technologies	**15**	**25**
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6024	Air Pollution Control Engineering	3-0-0-3	2015
Pre-requisites	**Nil**		

Course Objectives

To instruct the students on

- Fundamentals of air pollution control
- Design and operation of various air pollution control devices

Syllabus

Air pollution sources and effects – standards and legislation in India-design of particulate pollution control devices-design of gaseous pollutant control devices-source correction methods-Vehicular pollution control- Indoor air quality monitoring and control

Course Outcome

Course will familiarize the students with technologies available for the control of air pollution. After successful completion of this course, student will be capable to decide and design an appropriate air pollution control system based on the problem at hand.

Text Books

1.C.S.Rao. Environmental Pollution Control Engineering, Wiley Eastern Ltd, Delhi

2.Stern A. Air pollution Control vols 1, 2, 3. Academic press, NewYork

References

1.C.S.Rao. Environmental Pollution Control Engineering, Wiley Eastern Ltd, Delhi

2.Stern A. Air pollution Control vols 1, 2, 3. Academic press, NewYork

3.Magill. P. L. Air pollution hand book McGraw -Hill.

4.DeNevers Air Pollution Control Engineering McGraw-Hill.

5.Chhatwal G.R. Encyclopedia of Environmental Pollution and Control. Vol 1,2,3 Anmol Publications

Course Plan

Contents	Contact Hours	Sem. Exam Marks (%)
Module I Air pollution – Definition and concentrations, classification and properties of air pollutants, criteria air pollutants, emission sources, Air	**8**	**25**

pollution laws and standards in India, behaviour and fate of various air pollutants in atmosphere. Photochemical smog, Effects of air pollution on health, impact on vegetation and materials.		
Module II Particulate pollution control– PM characteristics- shape, size, composition, Particle size distribution- measurement methods, Inertial Impaction, electrical mobility- DMA, thermophoresis. Principle and design of particulate matter control devices- gravitational settling chambers, cyclone separators, baghouse filters, electrostatic precipitators, wet and dry scrubbers, thermophoretic separators Source correction methods-Industrial stack design	**13**	**25**
Module III Control of specific gaseous pollutants– Control of sulphur dioxide emission, desulphurisation of flue gases, Dry methods, wet scrubbing methods, control of nitrogen oxides, Modification of operating conditions, modification of design conditions, effluent gas treatment methods, Carbon monoxide control, control of hydrocarbons, mobile sources.	**13**	**25**
Module IV Vehicular pollution control in India- Technical and non technical measures- laws and policies, Indoor air pollution fundamentals- Indoor air quality standards, detection and control measures, air purifiers,biofilters	**8**	**25**
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6034	Environmental Systems Modeling	3-0-0-3	2015
Pre-requisites	Nil		

Course Objectives

To instruct the students on

- Basic concepts and application of mathematical modelling in environmental engineering
- Various models available in surface water, ground water and air quality

Syllabus

Role of mathematical models– Modeling concepts-surface water modelling-Streeter-Phelps models- dispersion modelling of air pollutants- receptor models for particulate matter-exposure models-ground water quality modelling- contaminant transport-sea water intrusion

Course Outcome

Course will familiarize the students with modelling techniques available for environmental applications. After successful completion of this course, student will be capable to model the pollution transport in the environment.

Text 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.

References

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. Seinfeld and Pandis, Atmospheric Chemistry and Physics, Wiley Publ.
4. Ralph A. Wurbs, Water Management Models – A Guide to Software, Prentice Hall. PTR, New Jersey, 1995.

5. Todd David Keith, Ground water Hydrology, Fourth edition, John Wiley and Sons, New York, 2004..
6. Randall J. Charbeneau, "Ground water Hydraulics and Pollutant transport "Prentice Hall, Upper Saddle River, 1999.

Course Plan

Contents	Contact Hours	Sem. Exam Marks (%)
Module I Modeling/Concept: Environmental management – Role of mathematical models;– kinds of mathematical models – model development and validation- model sensitivity – assessing model performance-effluent and stream standards; ambient air quality standards.	**7**	**25**
Module II Water Quality Modeling: Historical development of water quality models; rivers and streams water quality modeling – river hydrology-depth and velocity and flow – low flow analysis – dispersion and mixing – flow,– estuaries – estuarine transport, net estuarian flow, Lakes and impoundments –Models for dissolved oxygen; Streeter – Phelps models.	**12**	**25**
MODULE III Air Quality Modeling: Transport and dispersion of air pollutants – wind velocity, wind speed and turbulence; estimating concentrations from point sources –Dispersion Modeling- Gaussian Plume Model – determination of dispersion parameters, atmospheric stability; concentration variation with averaging time; Plumebehavior-plume rise modeling techniques, modeling for non-reactive pollutants, multiple sources, line sources and area sources, computer models. Receptor Models- Chemical Mass Balance (CMB) and Positive Matrix Factorization (PMF), Exposure modeling- BenMAP	**13**	**25**

MODULE IV Groundwater Quality Modeling: Mass transport of solutes, degradation of organic compounds, application of concepts to predict groundwater contaminant movement, seawater intrusion – basic concepts and modeling	**10**	**25**
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6144	Solid and Hazardous Waste Management	3-0-0-3	2015
Pre-requisites	**Nil**		

Course Objectives

To instruct the students on

- Different elements of land pollution
- Various hazardous wastes, their origin, characteristics and treatment

Syllabus

Waste generation in a technological society- major legislation- monitoring responsibilities- type of waste collection systems- unit operations used for separation and processing of Solid Waste- Hazardous waste management- Design and operation of facilities for physical, chemical and thermal treatment of hazardous waste

Text Books

1. George Tchobanoglous, Hilary Theisen and Samuel A, Vigil "Integrated Solid Waste Management, McGraw-Hill International edition, New York, 1993.
2. CPHEEO "Manual on Municipal Solid Waste Management, Central Public Health and Environmental Engineering Organisation, Government of India, New Delhi, 2000.

References

1. George Tchobanoglous, Hilary Theisen and Samuel A, Vigil "Integrated Solid Waste Management, McGraw-Hill International edition, New York, 1993.
2. CPHEEO "Manual on Municipal Solid Waste Management, Central Public Health and Environmental Engineering Organisation, Government of India, New Delhi, 2000.
3. Micheael D. LaGrega, Philip L Buckingham, Jeffrey C. E vans and Environmental Resources Management, Hazardous Waste Management, McGraw-Hill International edition, New York, 2001.
4. Vesilind P A, Worrell W and Reinhart, Solid Waste Engineering, Thomson Learning Inc., Singapore, 2002.
5. David H.F.Liu and B.G.Liptak, "Environmental Engineers' Handbook" Lewis Publishers, 1997.Gyan Publishing House.

Course Plan

Contents	Contact Hours	Sem. Exam

		Marks (%)
MODULE I Definition of solid waste-waste generation in a 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 Collection and transport of solid waste: Collection of Solid waste: type of waste collection systems, analysis of collection system- alternative techniques for collection system.	**9**	**25**
MODULE II Separation and Processing and Transformation of Solid Waste: unit operations used for separation and processing, Materials Recovery, Waste transformation through combustion and anaerobic composting, anaerobic methods for materials recovery and treatment- Recycling of plastic materials and metals. Energy recovery – Incinerators. Transfer and Transport: methods, transfer station types and design requirements. Landfills: Site selection, design and operation, drainage and leachate collection systems Integrated waste management facilities.	**12**	**25**
MODULE III 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.	**9**	**25**
MODULE IV Hazardous waste treatment and design: Hazardous waste treatment technologies – Design and operation of facilities for physical, chemical and thermal treatment of hazardous waste –Biomedical waste disposal. Solidification, chemical fixation and encapsulation, incineration. Hazardous waste landfills: Site selection, design and operation – remediation of hazardous waste disposal sites.	**12**	**25**
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6244	Environmental Geo-Technology	3-0-0-3	2015
Pre-requisites	**Nil**		

Course Objectives

To educate the students on

- Principles of Geo-technology
- Soil-contaminant interaction
- Transport of contaminants in sub surface
- Remediation in soil strata

Syllabus

Soil- Pollutant Interaction- mechanism of stabilization- failures of foundations due to pollutants -Contaminant transport in sub surface-landfill design considerations-remediation of contaminated soils-pollution of aquifers- application of geosynthetics

Course Outcome

Course will educate the student on the geotechnical practices of waste disposal and remediation of contaminated soil.

Text 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.

References

1. Fang, H.Y. Introduction to environmental Geotechnology, CRC press New York, 1997.

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

Course Plan

Contents	Contact Hours	Sem. Exam Marks (%)
MODULE I Soil- Pollutant Interaction:Introduction to geo environmental engineering – environmental cycle – sources, production and	**8**	**25**

classification of waste – causes of soil pollution – factors governing soil-pollutant interaction- Physico-chemical behavior and modeling - failures of foundations due to pollutants		
MODULE II Characterization, Stabilization and Disposal:Safe disposal of waste – site selection for landfills – characterization of land fill sites – waste characterization –stability of landfills – 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	**12**	**25**
MODULE III 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**	**25**
MODULE IV Detection and Testing Methods:Methodology- review of current soil testing concepts – Proposed approach for characterization and identification of contaminated ground soil for engineering purposes 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.	**12**	**25**
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6344	Instrumental Methods In Environmental Engineering	3-0-0-3	2015
Pre-requisites	**Nil**		

Course Objectives

To educate the students on

- The use of instrumental methods in environmental engineering
- Application of advanced instrumental methods for air and water quality analysis.

Syllabus

Instrumental methods in environmental engineering- analytical methods: chemical, instrumental and biological methods- Optical methods of analysis-dispersion and scattering-thermal conductivity method-radioactivity methods-sound absorption method-chromatography

Course Outcome

Course will educate the student on the advanced instrumental methods for air and water quality analysis.

Text Books

1. Sawyer and McCarty-Chemistry for environmental engineering, McGraw Hill
2. Kemmer-The NALCO Water Handbook, McGraw Hill

References

1. Galen Wood Ewing - Instrumental methods of chemical analysis, McGraw Hill
2. Howard A. Strobel, William R. Heineman: Chemical instrumentation: a systematic approach, Wiley

Course Plan

Contents	Contact Hours	Sem. Exam Marks (%)
MODULE I Instrumental methods in environmental engineering, analytical methods, chemical, instrumental and biological methods. Analytical instruments and process instruments, sensors, body of the instrument,	**9**	**25**

read out, accuracy, precision, sensibility, range, resolution. Transducers, measurement of nonelectrical quantities like pressure, temperature, displacement, velocity, acceleration etc. strain gauge and its applications, use of microprocessors in instrumentation.		
MODULE II Potentiometer: pH meter, ion selective electrodes, redox potential. Polarographic analysis, photometry, DO meter, conductivity, colourimetry and its applications. Optical methods of analysis: absorption and emission methods, visible spectrum photometer, U.V. Spectrometer, infrared spectrometer, flame photometer, atomic absorption spectrophotometer. X-ray diffraction method, mass spectrometer, methods using microscopy, refractrometric method.	**12**	**25**
MODULE III Dispersion and scattering: turbidimetry and nephelometry, fluorimetry. Thermal conductivity method , radioactivity methods, sound absorption method.	**8**	**25**
MODULE IV Chromatography: general principles and specific techniques-thin layer, column, liquid, high performance, ion etc. Air and water pollution control instrumentation, computer aided analysis, process instrumentation and control in lab and pilot experiments. Process Control Instrumentation: basic design concepts for air ,water and waste water treatment process instrumentation	**13**	**25**
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6154	Industrial Water Pollution Control	3-0-0-3	2015
Pre-requisites	Nil		

Course Objectives

To educate the students on

- different elements of water pollution and methods of treatment
- various industrial processes and the origin, characteristics and treatment of waste water generated

Syllabus

Effects of industrial waste on sewage treatment plants and stream- Study of some typical problem caused by industrial pollution in India-reduction of strength and volume of industrial waste-Joint treatment of industrial waste and domestic sewage-characteristics of waste, waste management and treatment methods for selected industries

Course Outcome

Course will educate the student on varioustreatment methods for different types of industrial waste water

Text Books

1. N.L. Nemerrow(1963) –Theories and practices of Industrial Waste Treatment, Addison Wesley Publishing.

2. C.F. Gurnham –Principles of Industrial Waste Treatment,John Wiley and Sons, Inc., New York. 1955.

References

1. N.L. Nemerrow(1963) –Theories and practices of Industrial Waste Treatment, Addison Wesley Publishing.

2. C.F. Gurnham –Principles of Industrial Waste Treatment,John Wiley and Sons, Inc., New York. 1955.

3. M.N. Rao and Datta, A.K,(1979) – Waste Water Treatment-Rational Methods of Design and Industrial Practices,Bombay: Oxford and IBH Publication

4. Berne F. (1995),Industrial Waste Treatment, Gulf Publishing

Course Plan

Contents	Contact Hours	Sem. Exam Marks (%)
MODULE I Damages caused by industrial pollution- Effects of industrial waste on stream- Effects of industrial waste on sewage treatment plants- Study of some typical problem caused by industrial pollution in India – Need for environment impact assessment for major industries.	**10**	**25**
MODULE II Volume reduction of industrial waste- strength reduction of industrial waste- neutralization- equalization and proportioning Joint treatment of raw industrial waste with domestic sewage- Joint treatment of partially treated industrial waste with domestic sewage – Discharge of treated waste to municipal sewers- Stream protection measures.	**10**	**25**
MODULE III Industrial manufacturing process, Characteristics of waste, waste management and treatment methods in the following industries -Textile mills, Dairy plant, Canneries, Tanneries, Distilleries, Fishing industry, Sugar mills , Pulp and paper mills and Rubber industry.	**11**	**25**
MODULE IV Industrial manufacturing process, Characteristics of waste, waste management and treatment methods in the following industries - Metal plating industry, Oil refineries, Petrochemicals, Fertilizer plant, steam and nuclear power plants.	**11**	**25**
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6254	Fundamentals of Sustainable Development	3-0-0-3	2015
Pre-requisites	**Nil**		

Course Objectives

To make the students aware on

- the principles of sustainable development
- sustainability aspects in different fields of development
- recent trends in sustainability development

Syllabus

Principles of Sustainable Development- Induction of sustainability concepts through legal systems-Sustainable Development and International Contribution- Socio economic Sustainable Development Systems- Role of developed countries in the sustainable development of developing countries- Recent trends in Sustainable technological development.

Course Outcome

Course will educate the student on various aspects of sustainable development.

Text Books

1. Kirkby, J., O' Keefe, P. and Timberlake, Sustainable Development, Earthscan Publication, London,1996.
2. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998.

References

1. Kirkby, J., O' Keefe, P. and Timberlake, Sustainable Development, Earthscan Publication, London,1996.
2. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998.
3. Bowers, J., Sustainability and Environmental Economics – an alternative text, Longman, London, 1997

Course Plan

Contents	Contact Hours	Sem. Exam Marks (%)

MODULE I Principles of Sustainable Development: History and emergence of the concept of Sustainable Development – Definitions – Environmental issues and crisis – Resource degradation – green house gases – desertification – social insecurity – Industrialization – Globalization and Environment.	**10**	**25**
MODULE II Indians Judiciary System & Sustainable Development: Judicial System in India – Induction of sustainability concepts through legal systems – concepts – principles – doctrines – case laws. Sustainable Development and International Contribution: Components of sustainability – Complexity of growth and equity – International Summits – Conventions – Agreements – Transboundary issues – Action plan for implementing sustainable development – Moral obligations and Operational guidelines	**11**	**25**
MODULE III Socio-economic Sustainable Development Systems: Socio-economic policies for sustainable development – Strategies for implementing eco-development programmes – Sustainable development through trade – Economic growth – Carrying Capacity – Public participation.	**10**	**25**
MODULE IV Agenda for Future Global Sustainable Development: Role of developed countries in the sustainable development of developing countries – Demographic dynamics and sustainability – Integrated approach for resource protection and management. Recent trends in Sustainable technological development.	**11**	**25**
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6354	Membrane Technology for Water And Wastewater Treatment	3-0-0-3	2015
Pre-requisites	**Nil**		

Course Objectives

To instruct the students on

- the membrane processes and systems
- Design of membrane systems
- Maintenance issues and economics of membrane systems

Syllabus

Theory of Membrane separation -Types and choice of membranes- Membrane processes and systems-design aspects- economics- Membrane bioreactors principles and design- Pretreatment Systems- Membrane fouling issues and remedies -Zero Liquid effluent discharge Plants.

Course Outcome

Course will educate the student on the advancements in the field of membrane technology for the treatment of water and wastewater

Text Books

1. Mulder, M., Basic Principle of Membrane Technology, Kluwer Academic Publishers, 1996
2. Water Environment Federation (WEF), Membrane Systems for Wastewater Treatment, McGraw-Hill, USA, 2005

References

1. Mulder, M., Basic Principle of Membrane Technology, Kluwer Academic Publishers, 1996
2. Water Environment Federation (WEF), Membrane Systems for Wastewater Treatment, McGraw-Hill, USA, 2005
3. Simon Judd, MBR Book – Principles and application of MBR in water and wastewater treatment, Elservier, 2006
4. Jorgen Wagner, Membrane Filtration handbook, Practical Tips and Hints, Second Edition, Revision2, Osmonics Inc., 2001
5. Noble, R.D. and Stern, S.A., Membrane Separations Technology: Principles and Applications, Elservier, 1995

Course Plan

Contents	Contact Hours	Sem. Exam Marks(%)
MODULE I Solid Liquid separation systems - Filtration systems - Theory of Membrane separation – mass Transport Characteristics Cross Flow filtration - Membrane Filtration - Types and choice of membranes, porous, non porous, symmetric and asymmetric – Plate and Frame, spiral wound and hollow fibre membranes – Liquid Membranes	**10**	**25**
MODULE II Membrane Processes And Systems: Microfiltration – Ultra filtration- Nano Filtration – Reverse Osmosis – Electro dialysis - Pervaporation – Membrane manufactures – Membrane Module/Element designs – Membrane System components – Design of Membrane systems - pump types and Pump selection – Plant operations – Economics of Membrane systems.	**11**	**25**
MODULE III Membrane Bioreactors: Introduction and Historical Perspective of MBRs, Biotreatment Fundamentals, Biomass Separation MBR Principles, Fouling and Fouling Control, MBR Design Principles, Design Assignment, Alternative MBR Configurations, Commercial Technologies, Case Studies.	**10**	**25**
MODULE IV Pretreatment Systems: Membrane Fouling – Pretreatment methods and strategies – monitoring of Pretreatment – Langlier Index, Silt Density Index, Chemical cleaning ,Biofoulant control. Case Studies :Case studies on the design of membrane based water and wastewater treatment systems – zero Liquid effluent discharge Plants.	**11**	**25**
End Semester Exam		

Course No.	Course Name	L-T-P Credits	Year of Introduction
06CE6064	**Mini Project**	**0-0-4-2**	**2015**

SYLLABUS

Each student is required to carry out a mini project on a subject approved by the department. He/she shall submit a report and a conference paper on the mini project to the department.

Course No.	Course Name	L-T-P Credits	Year of Introduction
06CE6074	Environmental Computational Lab	0-0-2-2	2015

Course Objectives

To give students an exposure to latest and relevantsoftware tools forenvironmental applications

SYLLABUS

MODFLOW– Subsurface flow and ground water contaminant transport modeling

ISC AERMOD– Air pollution modeling

EPA NET-Distribution network modeling

BIOWIN- Design of waste water treatment plants

MATLAB- Fundamentals and programming for solving environmental problems

FLUENT- Computational Fluid Dynamics applications

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE7113	Sustainable Water Resource Management	3-0-0-3	2015
Pre-requisites	**Nil**		

Course Objectives

to make the students aware on

- the sustainability principles for water management
- water shed management practices
- inter-basin transfers
- water audit and footprints
- National and state water policies
- Role of PPP in water sector

Syllabus

Sustainability principles for water management- Sustainable water resource indicators- National and state water policies-watershed management practices- Social Aspects of Watershed Management : Community participation- Inter basin transfer of water- Storm water and flood management-virtual water trade- water audit- footprints-Public private partnership in water management

Course Outcome

Student will be introduced to sustainability principles for water management, various aspects of water shed management, river basin transfers, eco restoration approach, storm water management techniques, concepts of water auditing and water foot printing and role of PPP in India's water sector

Text Books

1. Negi S S, Integrated watershed Management, Oriental Enterprises, 2001
2. Jeffrey Sturman, G. E. Ho, Kuruvilla Mathew, 2004. Water Auditing and Water Conservation, WA Publishing

References

1. Robin Clarke, Jannet King, 2004. The atlas of water: mapping the world's most critical resource, Earthscan
2. Paul Simon, 2003. Tapped out: the coming world crisis in water and what we can do about it. Welcome Rain
3. Frederick R. Troeh, J. Arthur Hobbs, Roy L. Donahue, 2003. Soil and Water

Conservation for Productivity and Environmental Protection Prentice Hall Rs. 5986

4. Joseph P. Quinlan, SumantraSen, Kiran Nanda, 2014. Thirsty Nation, Random House India.

Course Plan

Contents	Contact Hours	Sem. Exam Marks (%)
MODULE I Concepts of 'blue', 'green', 'grey' and 'black' water , Basic concepts of sustainable development – Dublin conference and Earth Summit – Sustainability principles for water management- Sustainable water resource indicators-National and state water policies: their highlights and limitations – Need of water policies at local level. Basic Concept of watershed, introduction to watershed management practices in Arid and Semiarid Regions, Case studies, system concept for watershed modeling, overall description of different hydrologic processes, modeling of rainfall -runoff process, subsurface flows and groundwater flow. Social Aspects of Watershed Management : Community participation, Private sector participation, Institutional issues, Socio-economy, Integrated development, Water legislation and implementations, Case studies.	**12**	**25**
MODULE II River basin approach –Inter-basin transfer of water–Water cycle – soil and biomass as regulators of water cycle – Eco-restoration and ecosystem regeneration approach – Rainwater Harvesting and artificial recharge.	**9**	**25**
MODULE III Storm Water and Flood Management : Storm water management, design of drainage system, flood routing through channels and reservoir, flood control and reservoir operation, case studies on flood damage.	**10**	**25**

Drought Management : Drought assessment and classification, drought analysis techniques, drought mitigation planning. Water Conservation and Recycling : Perspective on recycle and reuse, Waste water reclamation.		
MODULE IV Water balance-Instruments for demand management (economic, regulatory, institutional, etc.)-Virtual water trade for achieving global water security- Concept of water footprints, Water Auditing Public-Private Partnership in Water Management -Private sector involvement in water resources management: PPP objectives, PPP options, PPP processes, PPP experiences through case studies Recent trends in Sustainable technological development.	**11**	**25**
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE7213	Environmental Economics	3-0-0-3	2015
Pre-requisites	**Nil**		

Course Objectives

The goal of this course is to orient students with topics in environmental economics, the analytical techniques that policy makers adopt and the general problem solving skills.

Syllabus

Economy- Environment Interaction, Material Balance Principle, entropy law, Environmental Kuznet's curve hypothesis- Pigouvian v/s Coasian solution-competitive market structures and optimal extraction policy- resource scarcity indicators -growth functions and growth rate; economic models of fisheries-economics of optimal harvest cycles of forests- economics of biodiversity

Course Outcome

Student will be able to analyse basic environmental issues with economic methods and tools at the end of the course

Text Books

1. Singh, K. and A. Shishodia (2007), Environmental Economics: Theory and Applications, Sage Publications, New Delhi.
2. Bhattacharya, R.N. (2001), Environmental Economics- An Indian Perspective, Oxford University Press, Delhi

References

1. Hanley, N., J.F. Shogren and B. White, Environmental Economics: In theory and practice, Oxford University Press, 2006
2. Dasgupta, P.S and G.M. Heal, Economic Theory and Exhaustible Resources, University Press, 1979

Course Plan

Contents	Contact Hours	Sem. Exam Marks (%)
MODULE I	**9**	**25**

Economy- Environment Interaction, Material Balance Principle, entropy law, market failure, property rights; Open, closed and common access resources; resource economics- environmental economics- ecological economics: Characteristics and synergy		
MODULE II Relation between development and environmental stress; Environmental Kuznet's curve hypothesis- theory and empirical evidence;various approaches to environmental accounting	**9**	**25**
MODULE III Pigouvian solution; Buchnan's theory; Coase's theorem and its critique; Pigouvian v/s Coasian solution; Hotelling's rule; Hartwick's rule; competitive market structures and optimal extraction policy; monopoly, oligopoly, cartel and other market structures-optimal extraction policy; uncertainty and the rate of resource extraction; resource scarcity- indicators, evidence and critique	**12**	**25**
MODULE IV Characteristics of renewable resources- growth functions and growth rate; economic models of fisheries, economics of optimal harvest cycles of forests; extinction of species, economics of biodiversity	**12**	**25**
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE7313	Water Pollution Control And Stream Sanitation	3-0-0-3	2015
Pre-requisites	**Nil**		

Course Objectives

To make the students aware about the sources of surface water pollution, their control and stream quality standards

Syllabus

sources of stream pollution-types of waste products-location and management of waste loads-Organic self purification-Streeter Phelp's equation-Critical deficit-problems-Microbial purification-Rational stream sanitation practices- Purification in estuaries- Impacts of river developments waste assimilation capacity, socio-economic sector -detrimental and beneficial effects-Legal measures in river protection.

Course Outcome

Student will be introduced to environmental issues of pollution on surface water bodies, their management and rational stream sanitation practices

Text Books

1. Phelps E.B, Stream Sanitation, John Wiley and Sons, Inc, New York N..,1944

2.Applied stream sanitation, Clarence J. Velz John Wiley & Sons, Incorporated, 1984

References

1. Phelps E.B, Stream Sanitation, John Wiley and Sons, Inc, New York N..,1944

2.Applied stream sanitation, Clarence J. Velz John Wiley & Sons, Incorporated, 1984

3. P. K. Goel,1997, Water pollution, causes, effects and control, New Age International Ltd., New Delhi.

4.Todd D. K,1980, Groundwater hydrology, 2nd edition, John Wiley and Sons New York

Course Plan

Contents	Contact Hours	Sem. Exam Marks (%)

MODULE I Introduction-importance of water sources-socio-economic importance-sources of pollution-types of waste-waste products of man's activities-sources of stream pollution-types of waste products-location and management of waste loads-projecting waste loadings. Water quality and stream quality standards	**9**	**25**
MODULE II Eutrophication-organic pollution-oil pollution-radioactive pollution-marine pollution-thermal pollution-pesticide pollution-heavy metal pollution Organic self-purification-quantitative definition-reoxygenation-oxygen balance and stream dissolved oxygen profile-oxygen sag curve-Streeter Phelp's equation-Critical deficit-problems Microbial purification-pathogenic microorganisms of sewage origin-indices of contamination-enumeration-percapita contribution-seasonal variations-death rate survival in the stream environment	**10**	**25**
MODULE III Classification of streams-natural self-purification process-disposal of wastewater- Rational stream sanitation practices-dual objectives of stream sanitation practices-the science and art of applied stream sanitation-stream survey-types of stream survey-execution of stream surveys Purification in estuaries- self-purification in estuaries-tides and currents- distribution of waste loads by tidal translation-sea water intrusion-waste assimilation capacity of estuaries-bacterial contamination-stable wastes	**11**	**25**
MODULE IV Impacts of river developments waste assimilation capacity, socio-economic sector -detrimental and beneficial effects-hydroelectric power-navigation works-flood control works-irrigation and other	**12**	**25**

diversions Case Studies for river cleaning program (Ganga & Pampa action Plan). Legal measures in river protection.		
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE7123	**Environmental Hydrology**	**3-0-0-3**	**2015**
Pre-requisites	**Nil**		

Course Objectives

to make the students aware on

- Surface hydrology and run off calculations
- Well hydraulics
- Ground water hydrology
- Basin management concepts

Syllabus

Fundamentals of surface and ground water hydrology- frequency analysis- Hydrograph- vertical distribution of ground water, types of aquifers-Well hydraulics-Design of open well - well development- Concept of basin management-Geophysical exploration techniques- recharging

Course Outcome

Student will be educated on surface and ground water hydrology, well hydraulics and basin management concepts.

Text Books

1. Singh, V.P. Elementary Hydrology. Prentice Hall of India, New Delhi, 1994.
2. Chow , V.T., D.R. Maidment and L.W. Mays, Applied Hydrology, McGraw Hill Book company, Singapore, 1988.

References

1. McCuen, R. H. Hydrologic analysis and design, Prentice Hall, Eaglewood Cliffs, New Jersey, 1989.
2. Subramanya, K. Engineering Hydrology, Tata Mcgraw Hill, Newdelhi,1994

3. Raghunath H.M..-Hydrology H.M Wiley Eastern Ltd Newdelhi,1985
4. Raghunath H.M..- Groundwater , New Age International, 2007
5. Tood D. K.-Ground water hydrology, Wiley Eastern
6. Duggal and Soni, Elements of Water Resources Engineering, New Age International, 1996
7. Garg S.P, Ground water and tube wells, Oxford &IBH, New Delhi, 1982.
8. Chapra, S.C and Canale, R .P. Numerical methods for Engineers, Mcgraw hill Int.1990. McGraw Hill,Inc. Singapore, 1994.

Course Plan

Contents	Contact Hours	Sem. Exam Marks (%)
MODULE I Fundamental hydrology-Hydrological cycle-components of hydrologic cycle – Rainfall- atmospheric circulation –types and forms of precipitation-Rainfall data and its processing- frequency analysis-probability distribution and its application hydrology.-IDF Curves and DAD curves and its derivation and uses. Water losses-Infiltration-Hortans' and Green Ampt model runoff-Indices. Hydrograph-components- base flow separation- unit hydrograph- S and synthetic hydrograph.	**11**	**25**
MODULE II Vertical distribution of ground water, types of aquifers, storage coefficients, Darcy's law, permeability, determination of hydraulic conductivity Well hydraulics- steady radial flow to a well, unsteady radial flow in confined, unconfined and leaky aquifers, multiple well systems, specific capacity	**10**	**25**
MODULE III Open wells – Design of open well –yield test.- Methods of construction-dug wells. Tube wells –design-screened wells-gravel	**11**	**25**

packed wells-selection of screen size-yield of a well-Well loss-determination of well loss by step pumping method. Well development-testing wells for yield-failure of tube wells. Cavity wells and Infiltration galleries		
MODULE IV Concept of basin management, pollution of ground water, salt water intrusion in aquifers, Ghyben- Herzberg relation, Geophysical exploration techniques, artificial recharge of ground water	**10**	**25**
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE7223	Environment, Health and Safety in Industries	3-0-0-3	2015
Pre-requisites	**Nil**		

Course Objectives

To educate students about the importance of work place safety and various measures to prevent occupational health hazards

Syllabus

Occupational Health and Hygiene-Exposure pathways - Advantages and limitations of environmental monitoring and occupational exposure limits-control methods and reduction strategies -Workplace safety and safety systems-Control methods to eliminate or reduce the risks - Techniques of environmental safety-Requirements and benefits of the provision of information, instruction, training and supervision.

Course Outcome

Student will be educated on the techniques for environmental safety at work place and various control methods and reduction strategies for occupational hazards

Text Book

1. Environmental and Health and Safety Management by Nicholas P. Cheremisinoff and Madelyn L.Graffia, William Andrew Inc. NY, 1995
2. The Facility Manager's Guide to Environmental Health and Safety by Brian Gallant, Government Inst Publ., 2007.

References

1. Effective Environmental, Health, and Safety Management Using the Team Approach by Bill Taylor, Culinary and Hospitality Industry Publications Services 2005.

Course Plan

Contents	Contact Hours	Sem. Exam Marks (%)

MODULE I Need for developing Environment, Health and Safety systems in work places. Status and relationship of Acts, Regulations and Codes of Practice. Role of trade union safety representatives. International initiatives. Ergonomics and work place.	**8**	**25**
MODULE II Occupational Health and Hygiene: Definition of the term occupational health and hygiene. Categories of health hazards. Exposure pathways and human responses to hazardous and toxic substances. Advantages and limitations of environmental monitoring and occupational exposure limits. Role of personal protective equipment and the selection criteria. Effects on humans, control methods and reduction strategies for noise, radiation and excessive stress.	**12**	**25**
MODULE III Workplace Safety and Safety Systems: Features of the satisfactory design of work premises HVAC, ventilation. Safe installation and use of electrical supplies. Fire safety and first aid provision. Significance of human factors in the establishment and effectiveness of safe systems. Safe systems of work for manual handling operations. Control methods to eliminate or reduce the risks arising from the use of work equipment. Requirements for the safe use of display screen equipment. Procedures and precautionary measures necessary when handling hazardous substances. Contingency arrangements for events of serious and imminent danger.	**11**	**25**
MODULE IV Techniques of Environmental Safety: Functions and techniques of risk assessment, inspections and audits. Investigation of accidents-Principles of quality management systems in health and safety management. Relationship between quality manuals, safety policies and written risk assessments. Records and other documentation required by an organisation for health and safety. Industry specific EHS issues. Requirements and benefits of the provision of information, instruction, training and supervision. Factors to be considered in the development of	**11**	**25**

effective training programmes. Principles and methods of effective training. Feedback and evaluation mechanism.		

End Semester Exam

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE7323	Environmental Emergency Preparedness and Response	3-0-0-3	2015
Pre-requisites	**Nil**		

Course Objectives

To educate students about the concepts of environmental emergencies risk assessment preparation of contingency plans and familiarise National and International systems for emergency reponse.

Syllabus

Type of Environmental Emergencies -Economic cost of environmental emergencies- Assessment of risk from industrial activities - Environmental vulnerability to natural disasters -Preparing Contingency Plans-National and International Systems for Environmental Emergency Response

Course Outcome

Student will be familiar with national and international systems for emergency response and will be capable of assessing the risk and preparing contingency plans.

Text Books

1.Emergency Response Planning, Paul Erikson, Elsevier BH

2.Manual on Oil Pollution and Contingency Planning: International Maritime Organisation

References

1.Tollys Handbook of Disaster and Emergency Management, Tony Moore, Raj Lakha, Routledge

2.Guidelines for Environmental Assessment following Chemical Emergencies, Joseph A. Bishop, Joint UNEP/OCHA Environment Unit

3.Guidelines for Environmental Emergencies, UNEP/OCHA Joint Environment Unit

Course Plan

Contents	Contact Hours	Sem. Exam Marks (%)
MODULE I Environmental Emergencies: Nature of the Hazards:Type of Environmental Emergencies – oil spills, industrial accidents, forest fires – Natural disasters and environmental emergencies – Major environmental emergencies in recent history - Environmental impact of disasters - Economic cost of environmental emergencies	**11**	**25**
MODULE II Risk Assessment:Assessment of risk from industrial activities – Transportation Risk Assessment (Road, Rail, Air and Shipping) – Storage of hazardous and flammable goods) – Environmental vulnerability to natural disasters (coastlines, forests, wetlands, lakes, lagoons)- Dam Safety Assessment – Vulnerability Assessment of Communities – Modelling of Oil Spills and Air Pollution - Long Term Risks from Environmental Contamination	**10**	**25**
MODULE III Preparing Contingency Plans:Risk Minimisation – Precautionary Principle and ALARP principle – Organisation for Contingency Planning – Incident Command System – Training of Personnel – Mock Drills and Exercise- Internal Communication during emergencies – External Communication (community and media)	**11**	**25**
MODULE IV National and International Systems for Environmental Emergency Response:Fire and Safety Department – Disaster Management Authority – National Disaster Response Force – Oil Spill Response – UN Disaster Assessment and Coordination Systems	**10**	**25**
End Semester Exam		

Course No.	Course Name	L-T-P Credits	Year of Introduction
06CE7033	Seminar II	0-0-2-2	2015

Each student is required to present a technical paper on a subject approved by the department. The paper should be on a recent advancement/trend in the field of Environmental Engineering. He/she shall submit a report of the paper presented to the department.

Course No.	Course Name	L-T-P Credits	Year of Introduction
06CE7043	Project(Phase 1)	0-0-8-6	2015

The thesis (Phase-I) shall consist of research work done by the candidate or a comprehensive and critical review of any recent development in the subject or a detailed report of project work consisting of experimentation/numerical work, design and or development work that the candidate has executed.

In Phase-I of the thesis it is expected that the student should decide a topic of thesis, which is useful in the field or practical life. It is expected that students should refer national and international journals, proceedings of national and international seminars. Emphasis should be given to the introduction to the topic, literature review, and scope of the proposed work along with some preliminary work / experimentation carried out on the thesis topic.

Student should submit Phase-I thesis report in two copies covering the content discussed above and highlighting the features of work to be carried out in part-I of the thesis. Student should follow standard practice of thesis writing.

The candidate will deliver a talk on the topic and the assessment will be made on the basis of the term work and talks there on by a panel of internal examiners one of

which will be the internal guide. These examiners should give suggestions in writing to the student to be incorporated in thesis work Phase-II.

Course No.	Course Name	L-T-P Credits	Year of Introduction
06CE7014	**Project (Phase 2)**	**0-0-21-12**	**2015**

In the fourth semester the student has to continue the thesis work and present the report. At the end of successfully finishing the work he / she has to submit a detailed report and has to present for a viva–voce.

The work carried out should lead to a publication in a National / International Conference. They should submit the paper before the evaluation of the thesis and specific weightage will be given to accepted papers in reputed conferences.