

VEERMATA JIJABAI TECHNOLOGICAL INSTITUTE
(VJTI)
MATUNGA, MUMBAI 400 019

(Autonomous Institute affiliated to University of Mumbai)



Curriculum

(Scheme of Instruction & Evaluation and Course contents)

For

Two Year Postgraduate Programme Leading to
Master of Technology (M. Tech) Degree in
Civil Engineering with specialization in Environmental Engineering

Implemented from the batch admitted in Academic Year 2022-23

VEERMATA JIJABAI TECHNOLOGICAL INSTITUTE

(Autonomous Institute affiliated to University of Mumbai)

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For

Two Year Postgraduate Programme Leading to
Master of Technology (M. Tech)

In

Civil Engineering (with Specialization in Environmental Engineering)

Scheme and syllabus for M. Tech. in Civil engineering with specialization in Environmental Engineering

SN	Programme Educational Objectives (PEOs)
PEO 1	Develop advanced competencies in understanding basics of environmental engineering
PEO 2	Develop a competent environmental professional to manage and lead the environmental issues
PEO 3	Expand career potential of individuals through applied learning experiences and analytical skills in environmental engineering
PEO 4	Develop and hone up research and innovative approaches to solve environmental problems

Programme Outcomes (PO):

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

PO2: An ability to write and present a substantial technical report/document

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

PO 4: Ability to apply knowledge of fundamentals of science and engineering to environmental engineering.

PO5: An ability to use knowledge in planning, design, construction, commissioning, and operation & maintenance phases of environmental sanitation infrastructure

PO 6: Developing skills regarding quality, safety and legal aspects of environment.

PO 7: An ability to engage in lifelong learning technological advances in environmental engineering.

PO 8: An understanding of professional integrity and ethical responsibility.

PO 9: An ability to use the techniques, skills, and modern engineering tools and software necessary for environmental engineering practice and decision-making process.

VEERMATA JIJABAI TECHNOLOGICAL INSTITUTE
M. Tech Civil Engineering (With Specialization in Environmental Engineering)
Scheme of Instruction and Evaluation

SEMESTER I								
Scheme of Evaluation								
SN	Course Code	Course Title	L-T-P	Credits	TA	IST	ESE	ESE hours
1	CEEE5001S	Computational Methods	3-0-0	3	20	20	60	3
2	CEEE5011T	Environmental Chemistry and Microbiology	3-1-0	4	20	20	60	3
3	CEEE5012S	Hydraulics of Water & Wastewater	3-0-0	3	20	20	60	3
4	CEEE5021T-24T	Program Elective Course 1	3-1-0	4	20	20	60	3
5	CEEE5031S-34S	Program Elective Course 2	3-0-0	3	20	20	60	3
6	CEEE5061S A-B	Interdisciplinary Open Elective 1	3-0-0	3	20	20	60	3
7	CEEE5071L	Solid Waste and Env Microbiology Laboratory	0-0-2	1	60% CIE		40	-
8	CEEE5072L	Computer Application Lab	0-0-2	1	60% CIE		40	-
9	CEEE5073L	Air, Noise Pollution and Control Laboratory	0-0-2	1	60% CIE		40	-
10	CEEE5081L-A-D	Liberal Learning	0-0-2	1	100% CIE		-	-
			28	24				

SEMESTER II								
Scheme of Evaluation								
SN	Course Code	Course Title	L-T-P	Credits	TA	IST	ESE	ESE hours
1	CEEE5002S	Research Methodology & IPR	3-0-0	3	20	20	60	3
2	CEEE5013T	Advance Water & Wastewater Treatment	3-1-0	4	20	20	60	3
3	CEEE5014S	Solid and Hazardous Waste Management	3-0-0	3	20	20	60	3
4	CEEE5041T-44T	Program Elective Course 3	3-1-0	4	20	20	60	3
5	CEEE5051S-54S	Program Elective Course 4	3-0-0	3	20	20	60	3
6	CEEE5062S A-B	Interdisciplinary Open Elective 2	3-0-0	3	20	20	60	3
7	CEEE5074L	Water & Wastewater Laboratory	0-0-2	1	60% CIE		40	-
8	CEEE5075L	Env infrastructure design Lab	0-0-2	1	60% CIE		40	-
9	CEEE5076L	Seminar on Special Topic	0-0-2	1	60% CIE		40	-
10	CEEE5082L-A-D	Liberal Learning	0-0-2	1	100% CIE		-	-
			28	24				

SEMESTER III						
Scheme of Evaluation						
SN	Course Code	Course Title	L-T-P	Credits	Scheme of Evaluation	Semester
1	CEEE5091D	Skill based Project I	---	5	100 % CIE*	III
2	CEEE5092D	Skill based Project II	---	5	100 % CIE*	III
3	CEEE5101S	Self-learning course I	1-0-0	1	100 % CIE	III
4	CEEE5201S to CEEE5203S	Self-learning course II	1-0-0	1	100 % ESE of 3 Hours or credit Transfer	III
5	CEEE5301S to CEEE5304S	Mandatory Non Credit course	2-0-0	0	100 % ESE of 3 Hours or credit Transfer	III
				12		

SEMESTER IV						
Scheme of Evaluation						
SN	Course Code	Course Title	L-T-P	Credits	Evaluation pattern	Semester
1	CEEE5093D	Skill based Project III	---	5	100 % CIE*	IV
2	CEEE5094D	Skill based Project IV	---	7	100 % CIE**	IV
				12		

* Graded evaluation by a committee of at least two examiners including supervisor (guide)

** Graded evaluation by a committee of at least two examiners including supervisor (guide) and an external examiner

List of Program Elective I Course

SN	Course Code	Program Elective Course: I
1	CEEE5021T	Risk and Value Management
2	CEEE5022T	International Construction Business
3	CEEE5023T	Environmental Impact Assessment and Audit
4	CEEE5024T	Environmental Management

List of Program Elective II Course

SN	Course Code	Program Elective Course: II
1	CEEE5031S	Air, Noise Pollution and Control
2	CEEE5032S	Groundwater Hydrology and Contamination

3	CEEE5033S	Energy Conservation in Facility Design and Construction
4	CEEE5034S	Managerial Decision Making

List of Program Elective III Course

SN	Course Code	Program Elective Course: III
1	CEEE5041T	Industrial Wastewater Treatment
2	CEEE5042T	Operation and Maintenance of Treatment Facilities
3	CEEE5043T	Occupational Health & Safety management
4	CEEE5044T	Quality Assurance on Construction Projects

List of Program Elective IV Course

SN	Course Code	Program Elective Course: IV
1	CEEE5051S	Project management and financing
2	CEEE5052S	Rural Water Supply and Sanitation
3	CEEE5053S	Integrated GIS & GPS in Infrastructure
4	CEEE5054S	Water Resources Management

Interdisciplinary Open Elective 01

SN	Course Code	Interdisciplinary Open Elective 01
1	CEEE5061SA	Environmental Legislation and Management
2	CEEE5061SB	Sustainable Development

Interdisciplinary Open Elective 02

SN	Course Code	Interdisciplinary Open Elective 02
1	CEEE5062SA	Climate change and Carbon Neutrality
2	CEEE5062SB	Environment, Health and safety for Engineers

Liberal Learning Course Semester-I

SN	Course Code	Liberal Learning Course Semester-I
1	CEEE5081L-A	Ancient Indian Civil Engineering
2	CEEE5081L-B	Yoga and Stress Management
3	CEEE5081L-C	Community Social Responsibility
4	CEEE5081L-D	Development Engineering

Liberal Learning Course Semester-II

SN	Course Code	Liberal Learning Course Semester-II
1	CEEE5082L-A	Ancient Indian Civil Engineering
2	CEEE5082L-B	Yoga and Stress Management
3	CEEE5082L-C	Community Social Responsibility
4	CEEE5082L-D	Development Engineering

Self Learning Courses

Self Learning Course	Course Code	Course Title
Self-Learning Course –I	CEEE5101S	Industry Internship
Self-Learning Course –II	CEEE5201S	Python for Data Science
	CEEE5202S	Design for internet of things
	CEEE5203S	Block chain and its Applications

Mandatory Non Credit Course

	Course Code	Course Title
Mandatory Non Credit Course	CEEE5301S	Constitutional Studies
	CEEE5302S	Ethics in Engineering Practices
	CEEE5303S	Engineering Economics
	CEEE5304S	Disaster Management

Semester-I

Computational Methods								
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	IST	ESE	ESE hours
1	CEEE5001S	Computational Methods	3-0-0=3	3	20	20	60	3
<p>Course Outcome: After completion of course, student will be able to:</p> <p>CO1 identify the attributes and use them to model any phenomenon or situation in the field of civil engineering into a set of mathematical equations.</p> <p>CO2 identify the optimum methods and obtain the solution of various types of mathematical equations</p> <p>CO3 perform curve fitting into a data set and perform extrapolation and interpolation of data from a given data set.</p> <p>CO4 apply the principles of optimization to get optimal solutions to problems in civil engineering.</p>								
<p>Syllabus</p> <ol style="list-style-type: none"> <p>Mathematical Model Model, Purpose of modeling, Types of models, Steps in modeling process - Problem definition, Purpose definition, Conceptualization, Selection of computer code, Model design, Calibration, Validation. Errors in engineering calculations (sources of errors, significant digits, rounding off, propagation of maximum error, propagation of variance, bias & precision); statistical analysis of experimental data</p> <p>Interpolation and Extrapolation Lagrange's Interpolation, Newton's Interpolation- Forward, Backward, Hermite Interpolation, Spline Interpolation - cubic, inverse interpolation, Extrapolation, Civil Engineering Applications- elevation contour map, isohyetal map, Noise Map, etc.</p> <p>Numerical Differentiation and Numerical Integration Newton Raphson method, Modified Newton Raphson method and Successive approximation method. Trapezoidal rule, Simpson's rule (1/3 rd, 3/8 th), Gauss quadrature method 2-point, 3-point, Double integration- Trapezoidal rule, Simpson's rule (1/3 rd) Civil Engineering Applications- Earthwork volume estimation, Estimation of pile capacity, etc.</p> <p>Curve Fitting and Errors Curve fitting (Interpolation, function that fits given values - approximate and exact, find function where reaches min/max or a specific value, linear regression, higher order polynomial, Gaussian, quantifying errors in curve fitting) Civil Engineering Applications- Population Forecasting Methods, Reduction Rate Parameters for design of Treatment Units, Atmospheric dispersion of pollutant (Gaussian Dispersion Model) , Dispersion at sea outfall, etc. Linear regression, polynomial regression and multi-linear regression [using softwares like: Matlab, python or Minitab for curve fitting</p> <p>Finite difference and finite element method Finite Difference Method. Boundary value problems of exact differential equations limited to second order only, PDE's-Parabolic-explicit. Crank Nicholson method, Hyperbolic equations, and Elliptic equations. Finite Element Method (limited to 1D elements):. Basic understanding of finite element method including element types and their formulation, Civil Engineering Applications Groundwater modelling, Flood routing, Self-Purification of Streams (Streeter Phelps Equation) Finite element methods for simple beam and truss problem, 1 D consolidation problem, etc .</p> <p>Optimization Concept, need, importance and applications related to environmental engineering, Linear programming</p> 								

– standard form of problems, pivotal reduction of equations. Solutions of linear programming problems, Simplex method – single and two phase methods. Civil Engineering Applications - Environmental Engineering, Water resources engineering, Structural engineering.

References:

1. Numerical Methods for scientific and engineering computation, M. K. Jain SRK Iyengar, R K Jain, New Age International(P) Ltd. Fourth Edition 2003
2. Engineering Optimization Theory and Practice, Singiresu S.Rao, New Age international(P) Ltd. Third edition 2004
3. Fundamentals of Mathematical Statistics, Gupta.S.C. And Kapoor.V.K, Sultan Chand and Sons, 1978.
4. Numerical methods for Engineers, Chapra, S.C and Canale, R. P, McGraw hill Int.2012.

Environmental Chemistry & Microbiology								
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	IST	ESE	ESE hours
2.	CEEE5011T	Environmental Chemistry & Microbiology	3-1-0	4	20	20	60	3
<p>Course Outcome: After completion of course, student will be able to :</p> <p>CO1 develop an ability to identify and define environmental problems, gathering data related to the problem, selecting, and implementing the best treatment alternative.</p> <p>CO2 demonstrate acquired knowledge in planning, design, O & M of the treatment and pollution control facilities.</p> <p>CO3 apply basic and acquired knowledge in research and development.</p>								
<p>Syllabus</p> <ol style="list-style-type: none"> 1. Basic principles: Chemical equations, Types of chemical reactions, Stoichiometric calculations, Solutions, Chemical thermodynamics, Fundamentals of process kinetics, Gas laws, Ways of shifting chemical equilibria. Acid base equilibria: Equilibrium calculations, γ Alkalinity, Acidity, Buffers, Measurement of alkalinity. 2. Solubility equilibria: Solubility equilibrium for slightly soluble salts, Effect of other solutes on salt solubilities, Oxidation reduction equilibria: 3. Colloidal chemistry: Fundamentals, Coagulation, Mechanisms of coagulation, Effect of turbidity and alkalinity, Chemistry of coagulants. 4. Nuclear Chemistry: Basic concepts 5. Adsorption: Basic concepts, Factors affecting adsorption, Isotherm studies. 6. Ion exchange, Reverse Osmosis, fluoride removal, iron and manganese removal: Basic concepts of water and wastewater analysis: Basic concepts of quantitative analytical chemistry, Instrumental methods of analysis, Drinking water standards. 7. Life support system: Role of life science in environmental engineering as useful, nuisance causing and harmful organisms. The microorganism: Cell structure, eukaryotes, prokaryotes, viruses, their detection and quantification. 8. Nutrition and growth conditions: Temperature, pH, oxygen, nutritional requirements as selective agents for microbial population. Chemical composition of cell and nature of organic matter used by microorganisms. Metabolic classification of microorganisms: Phototrophs, Chemotrophs, application in environmental field. Enzyme function, classification, kinetics, inhibitors and inhibition. ATP formation: energy generation in cell. 9. Metabolism: Central pathways, aerobic, anaerobic, and fermentative metabolism of carbohydrates, proteins, lipids, nucleic acids and hydrocarbons, control of metabolic reactions. 10. Kinetics of biological growth, bacterial growth in terms of numbers and mass, growth curve, interpretation of curve, substrate limited growth, Monod's expression, substrate utilization and cell growth, effect of endogenous metabolism, effect of temperature, application of growth and substrate removal kinetics to biological treatment. 11. Microbiology and ecology of activated sludge process, trickling filters, oxidation ponds, aerobic and anaerobic digesters, anaerobic filters, UASB reactors, composting, vermiculture and other methods. Reduction of pathogens in treatment processes. Nuisance microorganisms: algae, fungi, 								

bacteria. Indicator microorganisms: bacteria, algae, protozoa

12. Water related and excreta related diseases: environmental classification, key concepts used in classification.

Recommended books and periodicals

1. Chemistry for environmental engineering - Sawyer & McCarty. McGraw Hill Publication, 2003
2. Process chemistry for water and wastewater treatment- Benefield, Judkins, Weand. Prentice Hall, Inc. N.J, Prentice-Hall, Englewood Cliffs, NJ, 1982.
3. Aquatic chemistry- Stumm and Morgan. Wiley-Inter-science, 3rd Edition, New York, 1996
4. Physico- chemical processes for water quality control-W. J. Weber Jr. Wiley-Inter-science, New York, 1972.
5. Standard methods for the examination of water and wastewater joint publication of APHA, AWWA and WEF, 22nd Edition, 2012
6. Microbiology for sanitary engineers – Ross E McKinney, York, McGraw Hill Publication
7. Microbiology for environmental scientists and engineers - A.F. Gaudy & E.T.Gaudy McGraw Hill Int. Book Co.
8. Ecological aspects of used-water treatment Vol. I, Vol. II and Vol. IV- Hawkes H.A. of Curds C.R.(Editors) Academic Press - London UK
9. Microbiology - Pelzar, Reid and Roger D. McGraw Hill
10. Basic ecology - E.P. Odum Philadelphia Saunders College Publishing

Hydraulics of Water and Wastewater								
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	IST	ESE	ESE Hours
3	CEEE5012S	Hydraulics of Water and Wastewater	3-0-0=3	3	20	20	60	3
<p>Course Outcome:</p> <p>After completion of course, student will be able to:</p> <p>CO1 Develop skills for identifying the most economical and technically feasible solution to conveying systems.</p> <p>CO2 Analyze and design storm drainage and sewerage systems.</p> <p>CO3 Apply basic knowledge to analyze, design and use of software for large pipe networks and analyze Water Hammer.</p>								
<p>Syllabus</p> <ol style="list-style-type: none"> Objectives of a public water supply, Design periods for water and wastewater structures, Population estimates, Estimate of water consumption and fluctuations in demand, Water Demand Surveys, Brief introduction of Hydrology of water resources - surface and ground water, Project Reports, Master Plans for water and sewerage project. Transmission of water: Types and materials of conduits, Hydraulic characteristics-size, capacity, number and shapes of conduits and their location, pumping of water, Types, design and selection of pumps, Economics of pump and pumping main selection, Water hammer, Water hammer controlling devices and their location on rising mains. Distribution of water: Pressure and capacity requirements of system, Provision for fire fighting, Field and office analysis of distribution networks, Hardy cross method, Optimization of network by various methods, Service storage and equalizing storage capacity requirements, Leak Detection survey, Water Audit, Domestic and Bulk Water Meter. Hydraulics of sewers: Open channel flow with special reference to sewers, Flow at sewer transitions, Measurement of flow in sewers, Patterns of sewerage systems, Estimate of wastewater flow, desired velocities in sewers and effect of flow variation. Rational method of estimating storm drainage, Intensity-duration-frequency relationship. Time of concentration and time of inlet, Lengths of side weirs and street inlets, Investigation, design and layouts of sanitary and storm water storage system, Maintenance of sewerage systems. Sewage pumping-selection of pumps, Capacity of wet wells and dry wells, Design of pumping station, Pumps in parallel and series, system head capacity curves, pump curves, economic diameter for force mains, present worth analysis. Household plumbing systems, Types and suitability of each system, fixture unit, Plumbing in high rise buildings, Design and pipe sizes for water and wastewater, Storage tanks and fixtures. Environmental design of plumbing for treatment plants; Advance materials for applications: Hydropolymer composites, high density polymer pipelines, fibre polymer composites Computer Applications 								
<p>Recommended books and journals etc.</p> <ol style="list-style-type: none"> Handbook of applied hydraulics - C.V. Davis. International Students' Edition McGraw Hill Book Co., New York. Water and Wastewater Engineering-Vol. I & II Fair, Geyer & Okun Wiley Toppan Co. Ltd. 1981, Tokyo. 								

3. CPHEEO Manual of sewerage and Sewage Treatment, 1993, Ministry of Urban Development.
4. CPHEEO Manual of Water Supply and Treatment, 1999, Ministry of Urban Development
5. Open Channel hydraulics, V.T. Chow – McGraw Hill New York
6. Engineering Hydrology- K. Subramanya. Third Edition, The Tata McGraw-Hill companies, New Delhi.
7. S. D. Chawathe, Manual on rainfall Analysis for Storm Water Drainage Systems, first Edition, 2011

Program Elective Course I: Risk & Value Management								
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	IST	ESE	ESE Hours
4	CEEE5021T	Risk & Value Management	3-1-0=4	4	20	20	60	3
<p>Course Outcomes After completion of course, student will be able to:</p> <ul style="list-style-type: none"> CO1. Conduct value management and risk analysis exercise. CO2. Predict life cycle costs. CO3. Identify and classify construction risks. CO4. Analyze appropriate risk response 								
<p>Syllabus</p> <ol style="list-style-type: none"> 1. Introduction: Definitions: Value, value engineering, value analysis, value management, Habits, Roadblocks & attitudes, and their relation to value engineering 2. Function Analysis: Function & its role in achieving value, function in terms of its cost & worth, Graphical function analysis, function analysis system technique 3. Creative thinking: creative people, creative processes, conducting creative session 4. Life cycle costing: purpose& implications, economic principles for life cycle costing, types of life cycle costs. 5. Energy: Energy resources & consumption, energy cost escalation, sources of energy supply, end use of energy, energy embodiment of construction materials, buildings, infrastructures facilities & energy systems, energy models, factors affecting energy consumption 6. Risks: risks in construction, risk management framework 7. Risk identification: sources of risk, risk classification, risk effects, common tools and techniques of identification. 8. Risk analysis: risk measurement, qualitative and quantitative techniques. 9. Risk response: risk management plan, risk retention, risk reduction, risk transfer, risk avoidance, attitudes towards risk. 10. Risks in construction projects: money, time and technical risks, contracts and risks, risks in the context of global project teams. 								
<p>Recommended books and journals etc.</p> <ol style="list-style-type: none"> 1. Value Engineering; L.W. Zimmerman, G.D. Hart, CBS Publishers and Distributors 2. Value Analysis in Design and Construction, O'Brien, JJ, McGraw Hill 3. Techniques of Value Analysis and Engineering; L.D. Miles; McGraw Hill 								

Programme Elective Course I: International Construction Business								
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	IST	ESE	ESE Hours
5	CEEE5022T	International Construction Business	3-1-0 = 4	4	20	20	60	3
<p>Course Outcomes: After completion of course, student will be able to:</p> <p>CO1 Demonstrate the knowledge of the business aspects for international construction CO2 Discuss theories of international trade CO3 Analyze Indian economic conditions and relate the same with international business of construction.</p>								
<p>Syllabus</p> <ol style="list-style-type: none"> 1. International economy International political system, economic system, multinationals, features of international trade & investment, national interest in international trade 2. International payments International monetary system, balance of international payments, transfer of international payments, foreign exchange rates and their determination 3. Theories of international trade 4. Developing countries in the world economy, international differences in technology, policy implications for host countries 5. Cultural environment of international business 6. Effect of culture, language, education, religion, value systems on business, impact on management styles in selected countries 7. Role of Indian construction industry in international business, role of foreign companies in Indian business, some case studies 								
<p>Recommended books and journals etc.</p> <ol style="list-style-type: none"> 1. International Business, Justin Paul, PHI 2. International business-Environment & Operations, Daniels, Radebaug & Sullivan, Pearson Publications 3. International business management, Bholanath Dutta, Excel Books, 4. International construction, Mark Mawhiney, Wiley-Blackwell 								

Programme Elective Course I : Environmental Impact Assessment and Audit								
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	IST	ESE	ESE hours
6	CEEE5023T	Environmental Impact Assessment and Audit	3-1-0=4	4	20	20	60	3
<p>Course Outcome: After completion of course, student will be able to :</p> <p>CO1. Describe EIA process and relate various government notifications.. CO2. Formulate the methodology for prediction and assessment of various impacts on environment CO3. Apply various methods of environmental audit.</p>								
<p>Syllabus</p> <ol style="list-style-type: none"> Fundamental Approach To EIA: History of EIA: Evolution Environmental Laws in World & India, Development of EIA in India, Environmental Clearance Procedure in India. Categorization of projects, Basic Concept of EIA: Introduction, Objective of EIA, Significances Systematic Approach for Using EIA: Introduction, Identification of Study Area, Classification of Environmental Parameters, Preparation of EIA Report, Screening ,Scoping Public consultation and appraisal Baseline Studies in EIA, Environmental Monitoring & Management Planning, Draft and Final EIA, Impact Analysis, Final EIA Report. Government of India Ministry of Environment and Forest Notification regarding Environmental clearance. List of projects requiring Environmental clearance, Application form, Composition of Expert Committee, Ecological sensitive places, Statutory Clearance required for projects along with EIA such as Forest/ Wildlife/ CRZ Clearance. EIA Methodologies: Introduction, Criteria for The Selection of EIA Methodology, EIA Methods: Adhoc Methods, Checklists Methods, Matrices Methods, Networks Methods, and Overlays Methods, Environmental Index Using Factor Analysis, Cost/Benefit Analysis, Predictive or Simulation Methods. Predictive Models for Impact Assessment. Environmental Impact Statement (EIS): Introduction, Basic Concepts behind EIS, Various Stages in EIS Production, Typical EIS Outline. Rapid EIA: Introduction, Procedure, Advantages and Limitation. Terms of References (TOR) for the Projects such as Coal sector, Hydropower , rivervalley , Highway Project, Building construction and town ship development projects etc. Prediction and assessment of impacts on soil and ground water environment: introduction, soils and ground water, methodology for the prediction and assessment of impacts on soil and groundwater. 								

7. Prediction and Assessment of Impacts on Surface Water Environment: Introduction, Project Which Create Impact Concerns for the Surface-Water Environment, Systematic Methods For Evaluation of Impacts of Various,
8. Prediction and Assessment of Impacts on Biological Environment: Introduction, General Methodology for the Assessment of Impacts on Biological Environment, Systematic Approach for Evaluating Biological Impacts.
9. Prediction and assessment of impacts on the air environment: Introduction, a generalized approach for assessment of air pollution impact.
10. Prediction and assessment of impacts of noise on The environment: Introduction, Basic Information of Noise, Noise Measurement, Effects of Noise on People, Systematic Methodology for Assessing Environmental Impacts of Noise.
11. Prediction and Assessment of Impacts on the Socio-Economic Environment: Introduction, Social Assessment, Conceptual Frame Work for Socio Economic Assessment.
12. Environmental Audit: Aims & Objective, Types of audits, General audit methodology, Waste Audits and Pollution Prevention Assessments, Liability Audits and Site Assessment, Case Studies
13. Case studies on EIA for Industries and Infrastructure projects

Recommended books:

1. Environmental Impact Assessment, second edition, Larry W. Canter, McGraw-Hill International editions.
2. Environmental Impact Assessment, Lauren David P., Willy Interscience, New Jersey.
3. Environmental Impacts of Industrial & Mining activities, Lalit N. Patraik, Ashish Public house.
4. Anjaneyulu Y., Manickam Valli, "Environmental Impact Assessment Methodologies", CRC Press 2011
5. Impact of Mining on Environment, Trivedi R. K., Sinha M. P., Ashish Publication House.
6. Radioactive releases in the environment: Impact and Assessment, cooper, John R., Randle, Keith and other, 2003, John Wiley sons.
7. Environment, construction and sustainable development vol. 1, The Environmental Impact of Carpenter T. G., 2001, John Wiley & sons

Programme Elective Course I: Environmental Management								
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	IST	ESE	ESE Hours
7	CEEE5024T	Environmental Management	3-1-0=4	4	20	20	60	3
<p>Course Outcome: After completion of course, student will be able to:</p> <p>CO1 demonstrate the principles of environmental management to carryout policy analysis and prepare environment management plan.</p> <p>CO2 apply the environmental management practices for infrastructural projects.</p> <p>CO3 apply the tools and develop strategies to have an environmentally sustainable project.</p>								
<p>Syllabus</p> <ol style="list-style-type: none"> 1. Definition of Environmental Management, Principles of Environmental Management, Nature, Scope and Components of Environmental Management, Policies and Legal Aspect of Environmental Management 2. Overview of Environmental Impact Assessment (EIA), Need and Importance, Steps involved, Methods of EIA, Public Participation and Communication, Preparation and Review of Environmental Impact Assessment Report, Life Cycle Assessment as Environmental Management Tool. 3. Environmental Policy Analysis- Macro level and Micro level, Methods of Policy Analysis, steps involved, Environmental Management Plan (EMP), Components of EMP, Preparation of EMP, Case Study 4. Environmental Economics, Estimation of Costs and Benefits, Cost-Benefit Analysis. Interest Calculations, Present and future worth of Projects, Financial Aspects of Project, DPR and other feasibility Reports, Environmental Audit, Components of Audit, Preparation of Audit Report. Carbon neutrality and climate change in core courses; Discussion on methods/techniques for carbon savings, estimation of carbon saving, operational energy savings 5. Environmental Legislation, Air, Water and Environmental acts., Preventive and reactive strategies for environmental pollution control, Environmental organization for planning and implementation, sustainable development. 6. Organization for Environmental Management, Organizational Design, Institutionalization of Environmental management in India, Ministry of Environment and Forest, Central Pollution Control Boards, State Pollution Control Boards, Local Bodies, their scopes, Organizational and Functional issues, Related Issues in Environmental Management. 								
<p>Recommended books and journals etc.</p> <ol style="list-style-type: none"> 1. Primes on 'Environmental Management ', prof. P. Khanna, Multitech publications Co. New Delhi 2001. 2. Assessment and analysis of Environmental management, Shukla S. S., Shrivastva P. R. 1992, commonwealth publishers New Delhi 2003 3. Environmental Impact Assessment, second edition, Larry W. Canter, McGraw-Hill International editions. 4. Environmental Management by Rai R. K. et al Rawat Publications, New Delhi 1992. 5. Environmental Management Law and Administration, Diwan, Prag (Ed), vanity book international, New Delhi 1998. 6. Environmental Management in Petroleum industry, Walvi S. K., Agnihotri A. K., Wiley Eastern Ltd New Delhi 1992. 								

Programme Elective Course II: Air, Noise Pollution and Control								
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	IST	ESE	ESE Hours
8	CEEE5031S	Air, Noise Pollution and Control	3-0-0=3	3	20	20	60	3
<p>Course Outcome: After completion of course, student will be able to:</p> <p>CO1 analyze air and noise pollution related environmental issues.</p> <p>CO2 formulate the economical and technically feasible solutions to air and noise pollution problems.</p> <p>CO3 analyze and develop competency in use of various air modeling software and noise mapping software.</p> <p>CO4 apply the basic and advance air pollution knowledge in research and development.</p>								
<p>Syllabus</p> <ol style="list-style-type: none"> 1. Composition of dry ambient air, properties of air, Definition of air pollution, Classification of air pollutants, Units for classification of air pollutants, History of air pollution- global and national, Scope of problem-general, urban, rural, and specific. 2. Sources of air pollution: Natural and man-made, Major pollutants from different sources in Greater Mumbai area and other Indian cities, Emission factors. 3. Effect of air and noise pollution on human health, plants, animals, properties, and visibility, CoH, CoHb. 4. Meteorological aspects of air pollution-large scale wind circulation: geotropic wind, gradient wind, cyclone, anticyclone, planetary boundary layer, lapse rate, stability conditions, wind velocity profile, maximum mixing depth, topographic effects and plume patterns. 5. Plume dispersion, Gaussian model for predicting concentration downwind from a single source, line source, area source, Diffusion coefficients, Stability categories and graphs for dispersion estimates, Maximum ground level concentration, inversion effects, modification of model to predict particulate dispersion, Other mathematical models, Plume rise, Holland equation, ASME equations, Brigg's equation, other models for plume rise, Comparative evaluation of various models, Design of tall stacks. 6. Methods and instruments for sampling and analysis of air for stack and ambient air monitoring of gaseous and particulate pollutants, Theory of sampling, Isokinetic sampling, Continuous monitoring, particle size analysis and mass analysis, IS methods of sampling analysis 7. Government of India's air pollution Acts and laws, Indian standards - emission and air quality standards, Noise standards, Amendments in Acts, IS for various ambient air standards, emission standards for various industries. 8. Control devices: Principles, types, operations of each individual device. <ol style="list-style-type: none"> a. Hoods and ducts: Hood specification, hoods of simple geometry, complex hood design, duct design, ventilation by dilution, b. Settling chambers: Laminar flow, turbulent flow, economic sizing, dust removal, fractional and overall collection efficiency. c. Inertial devices: Cyclone flow, collection efficiency in laminar and turbulent flow, pressure drop and power requirement, economic sizing. d. Electrostatic precipitators: Collection efficiency, electric field, particle charging, effect of temperature and resistivity of dust on collection efficiency, Pressure drop and power requirement, Sizing and costing of ESPs, Practical design considerations. e. Particulate scrubbers: Interception and impaction, collection efficiencies, pressure drop, Design criteria, Cyclone scrubber, Venturi scrubber. f. Filters: Collection efficiency and pressure drop for packed filter bed and single layer filter, Bag filters and bag houses, Fabric filtration theory, design considerations, sizing and costing of fabric 								

filters.

- g. Absorption towers, Henry's law, mass transfer relations, equilibrium distribution curve, Pressure drop, Practical considerations of design.
- h. Incinerators for gaseous pollutants, Waste gas characterization, theoretical considerations, design considerations of thermal incinerators, Catalytic incinerators, Flammable mixtures and flares, pressure drop considerations, capital and annual operating costs, Other devices: Adsorption and condensation

9. Noise: Basic concept, measurement, various control methods.

References:

1. "Air pollution" by Henry C Perkins - McGraw Hill Publications
2. "Air Pollution" by Wark and Warner
3. "Air pollution control Guidebook for Management" Edited by A.T. Rossano
4. Environ-Science Service Dirn. ERA Inc.USA
5. Government of India's publication of laws related to air pollution. Maharashtra Pollution control Board's (MPCB) publication of standards IS relevant to air pollution monitoring definitions, standards etc.
6. "Environmental Engineers" Handbook vol. II 'Air pollution' by B.G. Liptak(ed.) Chilton book co. USA
7. Industrial Air Pollution Handbook by A Parker Tata McGraw Hill Publications Handbooks
8. "Environmental Engineers" Handbook Vol. II 'Air Pollution' by B. G. Liptak (ed.) Chilton Book Co.USA
9. Air Pollution Handbook by P.L. Magill and Others. McGraw Hill Publ. New York.
10. Industrial Air Pollution Handbook by A. Parker Tata McGraw Hill Publication Journals

Program Elective Course II: Ground Water Hydrology and Contamination								
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	IST	ESE	ESE Hours
9	CEEE5032S	Ground water hydrology and Contamination	3-0-0=3	3	20	20	60	3
<p>Course Outcome:</p> <p>After completion of course, student will be able to:</p> <p>CO1 discuss the geology and hydraulics of groundwater.</p> <p>CO2 formulate problems, generating and prioritizing a set of alternative solutions in ground water pollution control.</p> <p>CO3 explain economical and technically feasible solution for groundwater remediation.</p>								
<p>Syllabus:</p> <p>Ground water hydrology and Contamination</p> <ol style="list-style-type: none"> 1. Introduction: Hydrological Cycle; Water Budgets 2. Groundwater: Darcy's Law and Hydraulic Potential; The Steady-state Groundwater Flow Equation, Streamlines and Flow Nets, Regional Flow and Geologic Controls on Flow, Transient Flow, Aquifer Storage and Compressibility, Unconfined Flow, Groundwater Interaction with Streams and Lakes, Numerical Methods, Flow in Fractured Rock 3. Well Hydraulics: Thiem and Theis Equations, Pump Tests and Slug Tests 4. Groundwater Pollution Control <ul style="list-style-type: none"> • Fate of pollutants in the groundwater system • Pollutants (metals, VOCs, NAPL and DAPL) and Characteristics • Advection, dispersion, and diffusion • Sorption and desorption • Chemical reaction and precipitation • Biological activities 5. Methods of groundwater remediation 6. Case studies of groundwater remediation 								
<p>Recommended books</p> <ol style="list-style-type: none"> 1. Handbook of applied hydraulics - C.V. Davis. International Students' Edition McGraw Hill Book Co., New York. 2. Water and Wastewater Engineering-Vol. I &II Fair, Geyer & Okun Wiley Toppan Co. Ltd. Tokyo. 3. Engineering Hydrology- K. Subramanya. Third Edition, The Tata McGraw-Hill companies, New Delhi 4. Wastewater Engineering-Treatment, disposal, reuse Metcalf & Eddy 3rd ed. McGraw Hill 								

Programme Elective Course II: Energy conservation in Facility design & construction.								
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	IST	ESE	ESE Hours
10	CEEE5033S	Energy conservation in Facility design & construction	3-0-0=3	3	20	20	60	3
<p>Course Outcomes After completion of course, student will be able to:</p> <p>C01 analyze the energy requirements for buildings. C02 create a plan for energy efficient building and landscaping. C03 perform the thermal analysis and design energy efficient building for human comfort.</p>								
<p>Syllabus:</p> <p>1. Importance of Energy in City Planning Fundamentals of Energy-Energy production systems-Sustainable Urban development, Carbon Neutrality, Carbon Credits, Arnstein's Ladder of Citizen Participation, Solar City Programme of MNRE, Renewable Energy, Programmes introduced by BEE and EESL. Eco village concept initiated by Rural development department. Heat island effect, Heating, Ventilating and Air Conditioning-Solar Energy and conservation-Energy Economic Analysis-Energy Conservation And Audits-Domestic Energy Consumption-Savings-Primary Energy use in Buildings-Residential-Commercial-Institutional and Public Buildings</p> <p>2. Energy Conservation Thermal Analysis And Design For Human Comfort, Thermal comfort; Criteria and various parameters; Psychometric chart; Thermal indices, climate and comfort zones; Concept of sol-air temperature and its significance; Energy and resource conservation-Principles, Design of green buildings-rating systems-LEED Standards-GRIHA standards, Evaluation Tools for Building Energy-Embodied and Operating Energy-Peak demand-Comfort and Indoor Air Quality-Energy Efficient Design Strategies-Contextual factors-Heat Transmission In Buildings Surface co-efficient: air cavity, internal and external surfaces, overall thermal transmittance, wall and windows; Heat transfer due to ventilation/infiltration, internal heat transfer; Solar temperature; Decrement factor; Phase lag. Design of day lighting; Estimation of building loads: Steady state method, network method, numerical method, correlations; Computer packages for carrying out thermal design of buildings and predicting performance.</p> <p>3. Energy Efficiency Energy in Building Design-Energy Efficient and Environmental Friendly Building- Climate, Sunand solar radiation-Psychometrics-Passive Heating and Cooling Systems- Analysis of results- Identification of wastage-Priority of conservative measures-Maintenance of Energy Management - Calculation of instantaneous heat gain through building envelope; Calculation of solar radiation on buildings; building orientation; Introduction to design of shading devices; Overhangs; Factors that affect energy use in buildings; Ventilation and its significance; Air-conditioning systems; Energy conservation techniques in air-conditioning systems Application of wind, water and earth for cooling; Shading, paints and cavity walls for cooling; Roof radiation traps; Earth air-tunnel</p> <p>4. Energy Management Energy management concept in building, Bioclimatic classification of India; Passive concepts</p>								

appropriate for the various climatic zones in India; Typical design of selected buildings in various climatic zones; Thumb rules for design of buildings and building codes. Energy Efficient Landscape Design Modification of microclimatic through landscape element for energy conservation; Energy conservation through site selection, planning, and design, brownfield development; Energy Management of Electrical Equipment-Improvement of Power Factor-Management of Maximum Demand- Energy Savings -Applications-Facility Operation And Maintenance-Facility Modifications-Energy Recovery Dehumidifier- Water Heat Recovery-Steam Plants and Distribution Systems- Energy Savings In Pumps-Fans-Compressed air systems- Applications

Reference:

1. Moore F., " Environmental control systems ", McGraw Hill, Inc., 1994.
2. Brown, G.Z, Sun, " Wind and Light: Architectural design Strategies ", John Wiley & Sons., 1985.
3. Cook, J, " Award - Winning Passive Solar Design ", McGraw Hill, 1984

Program Elective Course II: Managerial Decision Making								
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	IST	ESE	ESE hours
11	CEEE5034S	Managerial Decision Making	3-0-0= 3	3	20	20	60	3
<p>Course Outcomes</p> <p>After completion of course, student will be able to:</p> <p>CO1. identify and formulate problems and identify suitable technique to solve the problem</p> <p>CO2. demonstrate use of optimization tools to make decisions.</p> <p>CO3. explain decision theories and issues involved in group decision making.</p>								
<p>Syllabus</p> <p>Management Decision Making</p> <p>Management decision making, art of modeling, systems approach, concept of optimization, attitudes of decision maker</p> <ol style="list-style-type: none"> 1. Linear programming LP formulation, solution by graphical method, simplex method, duality, sensitivity and parametric analysis, transportation model, assignment model, Integer programming - branch and bound algorithm 2. Network model Network definition, shortest route problem, maximal flow problem 3. Waiting Lines Basic structure of queuing models, M/M/1 model 4. Dynamic programming Formulation of model and recursive equations, and applications 5. Group decision making Behavior of a decision maker as an individual and in a group, compromise and consensus decision making 6. Decision theory and games Decisions under uncertainty and risk: decision trees, game theory 7. Simulation Monte Carlo method, applications 								
<p>Recommended books and journals etc.</p> <ol style="list-style-type: none"> 1. Shrivastava, Shenoy & Sharma, Quantitative Techniques for Managerial Decisions, Wiley 2. Taha Hamdy, Operations Research, An Introduction Rao S S, Optimization: Theory and applications 								

Open Elective Course 01: Environmental Legislation and Management								
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	IST	ESE	ESE hours
12	CEEE5061S A	Environmental Legislation and Management	3-0-0=3	3	20	20	60	3
<p>Course Outcomes: CO1. To elucidate the application of Environmental Management CO2. To demonstrate concepts of sustainability for environmental management CO3 : To analyze the need of environmental legislation. CO4 : To illustrate the application of National Environmental Protection Acts</p>								
<ol style="list-style-type: none"> 1. Definition of Environmental Management, Principles of Environmental Management, Nature, Scope and Components of Environmental Management, Policies and Legal Aspect of Environmental Management 2. Overview of Environmental Impact Assessment (EIA), Need and Importance, Steps involved, Methods of EIA, Public Participation and Communication, Preparation and Review of Environmental Impact Assessment Report, Life Cycle Assessment as Environmental Management Tool, Environmental Audit, Components of Audit, Preparation of Audit Reports. 3. Environmental Policy Analysis- Macro level and Micro level, Methods of Policy Analysis, steps involved, Environmental Management Plan (EMP), Components of EMP, Preparation of EMP, Case Study 4. Organization for Environmental Management, Organizational Design, Institutionalization of Environmental management in India, Ministry of Environment and Forest, Central Pollution Control Boards, State Pollution Control Boards, Local Bodies, their scopes, Organizational and Functional issues, Related Issues in Environmental Management. 5. Environmental Legislation -their need, historical background, national and international acts; Genesis of environmental acts – general procedure followed in changing a bill into an act; implementation of an act using judiciary, executive and legislative powers and their limitations. Environmental protection agency, air act, water act, water and sewerage Board’s Factory act, Municipal acts, acts dealing with hazardous and infectious wastes. Preventive and reactive strategies for environmental pollution control, sustainable development. 6. ISO: 14000 – its need, procedure to be followed to obtain ISO: 14000 certification, implications of ISO. 								
<p>Recommended books:</p> <ol style="list-style-type: none"> 1. Pollution législation – A.K. Mhaskar, M/s. Media Enviro, Pune 2. Environmental Audit – An overview, A. K. Mhaskar – M/s. Media Enviro, Pune. 3. Matter Hazardous Laws Explained. A. K. Mhaskar M/s. Media Enviro, Pune 4. Environmental impact assessment Larry W Canter McGraw Hill International Edition, New York 1996. 5. Environmental Impact Assessment, Lauren David P., Willy Interscience, New Jersey editions. 6. Primes on ‘Environmental Management’, Prof. P. Khanna, Multitech publications Co. New Delhi 2001. 7. Assessment and analysais of Environmental management, Shukla S. S., Shrivastva P. R. 1992, commonwealth publishers New Delhi 2003 								

Interdisciplinary Open Elective Course 01: Sustainable Development								
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	IST	ESE	ESE hours
13	CEEE5061SB	Sustainable Development	3-0-0=3	3	20	20	60	3
<p>Course Outcomes:</p> <p>After completion of course students will be able to CO1: Describe sustainable development, development processes and relate impact of various levels of development CO2: Formulate the methodology for assessment of sustainability of project using various indicators. CO3: Apply environmental legislations to various development processes and projects</p>								
<p>1 Development Goals and means of development, MDG's and SDG's sustainable development, Comparing levels of development, GDP, GNP, global development level 2 Industrialization and Post-industrialization era Major structural shifts, knowledge revolution, implications for development sustainability 3 Environmental episodes Ozone depletion, global warming, greenhouse effect, Bhopal gas tragedy etc 4 Pollutions Major sources, permissible standards and controls of urban air pollution, water pollution, Solid and hazardous waste disposals 5 Climate Change and the various industrial sectors The Risk of Global Climate Change, impact of CC & CN due to various industrial sectors 6 Environmental legislations Legislative provisions and measures towards sustainability 7 Indicators of Development Sustainability Composition of National wealth, Accumulation of National Wealth as an Indicator of Sustainable Development, Development Goals and Strategies, Gross happiness index, Millennium Development Goals, Role of National Development Policies, Life cycle assessment, Carbon foot print</p>								
<p>References Books:</p> <p>1 Tatyana P. Soubbotina, Beyond Economic Growth: An Introduction to Sustainable Development, World Bank Institute Learning Resources Series, 2Nd edition, 2004. (ISBN: 08213-5933-99) 2 P. P. Roger, F. J. Jalal and J. A. Boyd, An Introduction to Sustainable Development, Earthscan Publications, 2nd edition, 2008. (ISBN: 9781844075201/1844075206)</p>								
<p>Reference Books:</p> <p>1 T. Strange and A. Bayley, Sustainable Development: Linking Economy, Society, Environment, 2008. (ISBN: 9789264047785) 2 H. G. Brauch, Sustainable Development and Sustainability Transition Studies, Series: Springer Briefs in Environment, Security, Development and Peace, Series Ed. 3 G. Marletto, S. Franceschini, C. Ortolani and C. Sillig, Mapping Sustainability Transitions: Networks of Innovators, Techno-economic Competences and Political Discourses, Springer Briefs in Business, 2016. (ISBN: 9783319422725/9783319422749)</p>								

Solid waste and environmental Microbiology Laboratory							
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	IST	ESE
14	CEEE5071L	Solid waste and environmental Microbiology Laboratory	0-0-2=2	1	60 % CIE		40
<p>Course Outcomes:</p> <p>After completion of course, student will be able to:</p> <p>CO1 demonstrate acquired knowledge in O & M of treatment plants and in research.</p> <p>CO2 develop an ability to take samples, analyze and interpret the results.</p> <p>CO3 analyze and assess the accuracy and precision of the analytical results.</p> <p>Syllabus:</p> <p>Solid Waste</p> <ol style="list-style-type: none"> 1. Determination of Moisture Content 2. Determination of pH 3. Determination of Total Organic Content 4. Determination of Na & K <p>Microbiology</p> <ol style="list-style-type: none"> 1. Preparation of Nutrient Broth 2. Preparation of Nutrient Agar 3. Effects of pH on Growth of Microorganisms 4. Effects of Heavy Metals on Growth of Microorganisms 5. Effects of Radiation on Growth of Microorganisms 6. Effects of Temperature on Growth of Microorganisms 7. Effects of Osmotic Pressure on Growth of Microorganisms 8. Effects of Dyes on Growth of Microorganisms 9. Effects of Heat on Growth of Microorganisms 10. Isolation of Microorganisms 11. Determination of MPN 12. Standard Plate Count 13. Fermentation of Milk 14. Effect of Catalytic Action on Growth of Microorganisms 15. Effect of Antibiotics on Growth of Microorganisms 16. Types of Microscopes 17. Staining Technique 18. Phenol Coefficient <p>Recommended books</p> <ol style="list-style-type: none"> 1. Standard Methods for Examination of water and wastewater, Joint Publication of APHA, AWWA & WFF. 2. Chemistry for Environmental engineering, Sawyer & McCarty. 3. Solid Waste Management in developing countries by A. D. Bhide & B. B. Sundaresan, Indian National Scientific Documentation centre. 							

Computer Application Laboratory							
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	IST	ESE
15	CEEE5072L	Computer Application Laboratory	0-0-2=2	1	60% CIE		40
<p>Course Outcomes:</p> <p>After completion of course, student will be able to :</p> <p>CO1 Develop spreadsheets and database management systems. CO2 Acquire proficiency in using environmental software. CO3 Apply software to arrive at optimized solutions in design.</p>							
<p>Syllabus</p> <p>Study of Software for analysis & Design for water supply, Sewerage & GIS systems Such as loop, Branch, Sewer GEM, EPANET, Air pollution dispersion models such as Calpuff and aermod and application of Noise Mapping software.</p>							

Air, Noise Pollution and Control Laboratory							
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	IST	ESE
16	CEEE5073L	Air and Noise pollution Control Lab	0-0-2=2	1	60% CIE		40
<p>Course Outcome: After completion of course, student will be able to: CO1 analyze and interpret the results. CO2 calculate and apply the analytical results with accuracy and precision. CO3 develop and demonstrate skills for noise mapping. CO4 demonstrate the acquired knowledge in research.</p>							
<p>Syllabus</p> <ol style="list-style-type: none"> 1. Anderson Air Sampler 2. Ambient Air Monitoring using High volume Sampler 3. Anemometer 4. Velometer 5. Paper Tape Air Sampler & Paper Tape Densitometer 6. Stack Monitoring Unit 7. Dust Jar Apparatus 8. Measurement of Noise Levels and Leq. 9. Determination of Frequency Analysis of Noise 10. Measurement of Noise Dose 11. Industrial Bag Filter 12. Kitagawa Tubes 							
<p>Recommended books</p> <ol style="list-style-type: none"> 1. "Air Pollution Part A- Analysis" and "Part B- Prevention and Control" by J.O. Ledbetter Marcel Dekker Inc. New York. Publication 2. "Environmental Engineers" Handbook Vol. II 'Air Pollution' by B. G. Liptak (ed.) Chilton Book Co.USA 3. Industrial Hygiene and Toxicology by Patty 							

Semester II

Research Methodology and IPR								
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	IST	ESE	ESE hours
1	CEEE5002S	Research Methodology and IPR	3-1-0=4	4	20	20	60	3
<p>Course Outcomes</p> <p>After completion of course, student will be able to:</p> <p>CO1 critically evaluate current research.</p> <p>CO2 develop hypothesis and a research proposal</p> <p>CO3 design methods of data collection and to select appropriate tools for analysis</p> <p>CO4 illustrate method of communication of scientific results for peer review</p>								
<p>Syllabus</p> <ol style="list-style-type: none"> 1. Introduction: Meaning and purpose of research, objectives of research, types of research, significance of research, Research Approaches, Research Methods v/s Methodology, Research Process, Criteria of Good Research. Research and Scientific Methods 2. Research Problem: Steps in Research: Identification, selection, and formulation of research problem- Research Questions-Research design- Formulation of hypothesis- Review of literature. Definition, necessity, and techniques of defining research problem; Formulation of research problem; Objectives of research problem. 3. Research Design: Need and features of good research design. Types of Research Designs, Basic Principles of Experimental Designs; Design of experiments. 4. Data Collection: Primary and secondary data. Collection methods-Observation – Interview-Questionnaire-Schedule-Pretest-Pilot study –Experimental and case studies, Secondary data- Relevance, limitations, and cautions. 5. Sampling Design: Sampling theory-Types of sampling-Steps in sampling-Sampling and Non-sampling error-Sample size –Advantages and limitations of sampling. Census and Sample surveys, Different types of sample designs, characteristics of good sample design. Techniques of selecting a random sample. 6. Hypothesis Testing: Fundamentals and procedure of hypothesis testing flow diagram for hypothesis testing. Measurement in Research: Measurement scales – Tests of good measurement construction of Likert and Semantic Differential Scales-Source of errors in measurement- Scale validation. Parametric and non-parametric tests of hypothesis testing, non-parametric tests like Sign, Run Kruskal-Wallis test and Mann – Whitney test. Testing of significance of mean, proportion, variance, and correlation- Testing for significance of difference between means, proportions, variances, and correlation coefficients. Limitations of tests of hypothesis, One-way and two-way ANOVA – Latin Square tests for association and goodness of fit. 								

7. **Technical Paper and Report Writing:**

Basic concepts of paper writing and report writing, review of literature, Concepts of Bibliography and References, significance of report writing, steps of report writing, Types of Research reports, Methods of presentation of report.

8. **Structuring the Report:**

Types of reports, Contents, Styles of reporting, Steps in drafting reports, Chapter format, Pagination, Identification, using quotations, presenting footnotes – abbreviations, Presentation of tables and figures, Referencing, Documentation, Use and format of appendices- Indexing Editing and evaluating the final draft.

9. **Research ethics:**

Ethical Issues, Ethical Principles that govern Research, ethically valid Information Sources, Regulatory Compliance, IPR and IPR act

Recommended books and journals etc.

1. Research Methodology: R. Panneerselvam, Prentice Hall Publication ,2004
2. Research Methodology: Methods and Techniques by C. R. Kothari New Age International Publishing, second edition
3. Statistical Methods for Research Workers, Fisher R. A. Macmillan Pub Co, 1970

Advance Water & wastewater Treatment								
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	IST	ESE	ESE hours
2	CEEE5013T	Advance Water & wastewater Treatment	3-0-0=3	3	20	20	60	3
<p>Course Outcome: After completion of course, student will be able to:</p> <p>CO1 develop skills for effective planning of water supply and wastewater projects CO2 describe unit operations and unit processes in water and wastewater treatment. CO3 combine unit operations and unit processes together in a general flow scheme to meet specific treatment goals. CO4 develop design skills and optimizing techniques in water and wastewater treatment.</p>								
<p>Syllabus:</p> <ol style="list-style-type: none"> Standards for raw and treated waters. Surface waters, Effects of storage on water quality. Algae, Control measures, quality of underground waters. Nature and source of impurities. Requirements of water treatment facilities. Process design and hydraulic design. Unit operations, gravity systems, pumping systems. Design Period Fluctuations in demand. Useful concepts from water chemistry and biology. Intake structures. Principles of sedimentation and floatation. General equations for settling of discrete particulates. Theories of chemical coagulation, Nature of colloids, Zeta potential, coagulant, and their specificity. Theory of filtration. Preparations of filter sand Hydraulics of filtration through homogeneous and stratified beds. Performance of slow, rapid, high-rate multilayer and composite filters. Pressure filters. Diatomaceous earth filters. Micro-strainers, filterability index. Principles of disinfection. Factors effecting disinfection. Principles of aeration, Theories of adsorption, Adsorption Isotherms, Miscellaneous treatment: Methods of Iron and Manganese removal, Removal of taste and odour, Removal of colour, Fluoridation, Defluoridation, Arsenic Removal. Membrane Separation Techniques: Micro Filtration, Ultra Filtration, Nano Filtration and Reverse Osmosis. Electro dialysis, Theory of corrosion, and corrosion control. Sensor based technology for water and wastewater treatments; Application of SCADA i.e. Automation of water and waste water treatment; Fluctuations in quality and quantity of wastewater, Sampling, preservation of samples, C.O.D. , B.O.D. , Aerobic decomposition of organic material, Five day and ultimate values of oxygen demand. Population equivalent. Generalized B.O.D. formulations. Objectives of sewage treatment, unit operations, Process design and hydraulic design. Period of design, Pre-treatment, primary treatment and secondary treatment methods Percentage removal and overall efficiency. Physics, chemical and biological methods of treatment. Screening, Separation of grit. Principles of sedimentation applied to design of grit chambers. Primary, intermediate, and final clarification. Intermittent or continuous removal of sludge. Scum removal. Factors affecting performance. Sedimentation aided by chemicals. Principles of biological treatment of sewage, biological treatment in activated sludge process: Loading parameters, Sludge Volume Index, Process control, Aeration requirements and methods of Aerations, Activated sludge process modification. General considerations in disposal of sludge, Sludge pumping. Quantities, Characteristics, and behavior of 								

sludge. Disinfection of sewage effluents.

14. Natural Treatment Systems: Stabilization Pond, Design considerations in oxidation of stabilization pond, Natural and Constructed Wetlands, Wastewater Irrigation, Bioremediation

Recommended books, Journals etc.

1. Manual of Water Supply and Treatment Ministry of Urban Development
2. Design of water treatment plants. Dr. A. G. Bhole, Indian Water Works Association, Nagpur centre.
3. Wastewater Engineering-Treatment, disposal, reuse Metcalf & Eddy 4th Edition 2003. Tata McGraw Hill International Editions.
4. Water and Wastewater Engineering-Vol. II Fair, Geyer & Okun Wiley Toppan Co. Ltd. 1981, Tokyo.
5. CPHEEO Manual of sewerage and Sewage Treatment 1993. Ministry of Urban Development.
6. Wastewater Treatment for Pollution Control S. J. Arceivala Tata McGraw hill Publishing Co. Ltd. 3rd Edition, 2007, New Delhi.

Solid & Hazardous Waste Management								
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	IST	ESE	ESE hours
3	CEEE5014S	Solid & Hazardous Waste Management	3-0-0=3	3	20	20	60	3
<p>Course Outcome: After completion of course, student will be able to:</p> <p>CO1 design and optimize the techniques in Solid and Hazardous waste treatment. CO2 acquire knowledge on the specialized Solid and Hazardous waste treatment. CO3 formulate problems, gathering data related to the problem, generating and prioritizing a set of alternative solutions, and selecting as well as implementing the best alternative for Solid and Hazardous waste treatment.</p>								
<p>Syllabus</p> <ol style="list-style-type: none"> 1. Solid wastes - sources, types, composition, physical, chemical and biological properties of solid wastes, sources and types of hazardous and infectious wastes in municipal solid wastes. 2. Solid waste generation and collection, Handling, storage, processing, transportation 3. Disposal of solid wastes - materials separation and processing, thermal conversion, biological and chemical conversion, recycling of material in municipal solid wastes, Land filling, Composting, gas generation, closure of landfills. 4. Industrial solid wastes-composition, bio-degradable, non biodegradable hazardous, toxic solid wastes, methods of detoxification, disposal on land, disposal into water bodies. Agriculture solid waste management; Construction and demolition waste management 5. Legal aspects of municipal solid waste collection, conveyance, treatment, and disposal. 6. Hazardous wastes - origin, quantity, and quality parameters. 7. Treatment and disposal methods - Physico-chemical and biological. Stabilization and solidification, thermal methods, land disposal, site remediation. 								
<p>Recommended books and periodicals</p> <ol style="list-style-type: none"> 1. Integrated solid waste management. Tchobanoglous, Theissen and Vigil-McGraw Hill Book Co. 2. Hazardous waste management LaGrega, Buckingham & Evans. McGraw Hill Book Co. 3. Solid wastes - Engineering principles and management issues. Tchobanoglous, Theissen and Eliassen. McGraw Hill Book Co. 4. Solid waste management - Hagerty, Pavoni, Heer-Van Nostrand Reinhold Co., New York 5. Handbook of solid wastes disposal-Materials and Energy 6. Recovery-Paveni, Heer, Hagerty. Van Nostrand Reinhold Co. N. Y. 7. Infectious & Medical Waste Management by Peter A Reinhardt Judith G Gordo 								

Programme Elective Course 3: Industrial Wastewater Treatment								
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	IST	ESE	ESE hours
4	CEEE5041T	Industrial Wastewater Treatment	3-0-0=3	3	20	20	60	3
<p>Course Outcome: After completion of course, student will be able to:</p> <p>CO1 discuss processes in industries and pollution effects of industrial waste on environment. CO2 analyse unit operations and unit processes for treatment of wastewater and carry out treatability studies. CO3 formulate problems, gathering data related to the problem, and selecting the best alternative to reduce, recycle and treat industrial wastewater CO4 demonstrate industrial water budgeting, planning and performance studies for treatment plant</p>								
<p>Syllabus</p> <ol style="list-style-type: none"> 1. Stream sanitation. Different equations of self-purification, River standards, Effluent standards, Minimal national standards (MINAS). Sources and effects of various pollutants, Disposal of industrial wastes-on land, in creeks, in sea, in inland streams, into impoundments. 2. Importance of planning location of industries and industrial estates, Common effluent treatment plants, their economics and management. 3. Treatability Studies: - Bench Scale & Pilot scale, Preparation of Feasibility Reports. 4. Unit Operations and Processes: Color Removal, Oil and grease removal, Heavy Metal Removal, 5. Detailed considerations of wastes from industries such as Study of Manufacturing Process, Sources, Quality and Quantity of Wastewater, Pollution Effects, Volume and Strength reduction, Recovery of byproducts, reuse and recycle and treatment. Zero Liquid Discharge in Industries. Textile (Cotton, wool, rayon, synthetics), sugar, Pulp and paper, Distilleries, Oil refineries, Petrochemicals, Pharmaceuticals, dairy, food processing, soaps and detergents, mining, iron and steel, pickling, plating, galvanizing, tanning, slaughterhouse, fertilizers, pesticides, dyes and dye intermediates, radioactive wastes. 6. Industrial water budgeting from Environmental angle. 7. Performance study of Wastewater Treatment Plants. 								
<p>Recommended books & periodicals</p> <ol style="list-style-type: none"> 1. Rudolfs, W. Industrial Wastes-Their Disposal and treatment Reinhold Publ. Corporation. 2. Nemerow, N.D. Theories and practices of industrial waste treatment 3. Mahajan S.P. Pollution Control in Process Industries. 4. Eckenfelder, W.W. Jr. Industrial Water Pollution Control McGraw Hill Book Co. International edition. 5. Proceedings of Industrial Waste Conference-Purdue University. 6. Besselièvre, E.D. The treatment of industrial wastes - McGraw Hill Book Co. New York 7. A. D. Patwardhan, Industrial Wastewater Treatment, Prentice Hall of India Pvt Ltd, New Delhi, 2008 								

Programme Elective Course 3: Operation & Maintenance of Treatment facilities								
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	IST	ESE	ESE hours
5	CEEE5042T	Operation & Maintenance of Treatment facilities	3-0-0=3	3	20	20	60	3
<p>Course Outcome: After completion of course, student will be able to:</p> <p>CO1 plan, prepare and schedule daily operations and inspections. CO2 analyze and solve the operational problems. CO3 demonstrate preventive maintenance. CO4 develop skills of handling the emergency situations related to the failures and effective resource planning required for O & M.</p>								
<p>Syllabus</p> <ol style="list-style-type: none"> 1. Introduction Need of Operation & Maintenance, Basic principles, corrective and preventive maintenance, Requirement of successive operation, Limitations of O &M Operations, operation manuals, computer usage in O and M. 2. Operation & Maintenance of Water Treatment facilities Different Units of Water Treatment plant, Coagulation aided Sedimentation tanks, Filters, Chlorinators, Monitoring and operational problems and their trouble shooting, Check List, Record keeping, Operation & Maintenance of Appurtenances, Cleaning, and rehabilitation. 3. Operation & Maintenance of Pumping Machinery Introduction, Operation of pumps, Preventive maintenance, Maintenance of Pumping Station. Trouble Shooting, Safety Aspects. 4. Operation & Maintenance of wastewater facilities Different units of Wastewater plant, Inspection methods, Manual and mechanical, Sampling and analysis of wastewater, Cleaning and rehabilitation, Monitoring and operational problems and their trouble shooting, Building and other civil structure, Plant Control laboratory, Flow Measuring Devices 5. Operation & Maintenance planning Organizational structure, work planning, preparation and scheduling of daily operations and inspection of machinery, cost estimates. 								
<p>References:</p> <ol style="list-style-type: none"> 1. Design Operation Interaction at large wastewater treatment plants, International Association of Water pollution research. 2. All India Conference on operation and maintenance, pollution control equipment, the institute of energy management, Bombay. 3. CPHEEO Manual of Water Supply and Treatment, 1999, Ministry of Urban Development. 4. CPHEEO Manual of sewerage and Sewage Treatment, 1993, Ministry of Urban Development. 								

Programme Elective Course 3: Occupational Health & Safety Management								
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	IST	ESE	ESE hours
4	CEEE5043T	Occupational Health & safety Management	3-0-0=3	3	20	20	60	3
<p>Course Outcomes: CO1: To identify causes of work-related injuries, accidents, and ill health to workers in an organization. CO2: To describe methods for hazard prevention and reducing occupational health and safety risks. CO3: To describe the occupational health and safety legislations and related laws. CO4: To plan and implement training to create safe work environment.</p>								
<p>Syllabus:</p> <ol style="list-style-type: none"> 1. Hazards and causes of accidents: Definition: incident, accident, injury, dangerous occurrences, unsafe acts, unsafe conditions, hazards, errors, oversight, mistakes etc. 2. Work related ill health and diseases: Diseases caused by chemical agents, physical agents, and biological agents, Diseases by target organ systems: respiratory diseases, skin diseases, musculoskeletal disorders, mental and behavioral disorder, occupational cancer. 3. Management of accidents and Hazards: Accident prevention: theories/models of accident occurrences. Principles of accident prevention. Accident and financial implications. 4. Safety legislation and standards for construction works and industry, Organization for safety, site management, safety manual and check lists, safety officer, safety committee, safety training, safety audit. 5. Safety precautions and practices in various construction activities like excavation, concreting, scaffold erection and dismantle, concreting, steel erection and demolition of structures, case studies. 6. Occupational hazards and personal protection, equipment occupational safety, health and environment management system, bureau of Indian standards on safety and health: 14489-1998 and 15001-2000, ILO and EPA standards. 7. SAFETY, HEALTH, AND ENVIRONMENT (SHE) EDUCATION AND TRAINING: elements of training cycle, Assessment of needs. Techniques of training, design, and development of training program. Training methods and strategies types of training. Evaluation and review of training programs, Competence building technique (CBT) 								
<p>References:</p> <ol style="list-style-type: none"> 1. Safety and Health in Construction, International Labour Organization, 1992 2. Indian Standard on Codes of Practices for Occupational Safety & Health Auditing (IS 14489:1998) 3. Guidelines on occupational safety and health management systems, 2nd edition 2009, Juan Somavia, ILO Publications, ISBN 92-2-111634-4. 4. Construction Hazard & Safety handbook, R Hudson and R W King, Butterworths 								

Programme Elective Course 3: Quality Assurance on Construction Projects								
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	IST	ESE	ESE Hours
4	CEEE5044T	Quality Assurance on Construction Projects	3-0-0=3	3	20	20	60	3
<p>Course Outcome After completion of course, student will be able to:</p> <p>CO1 explain quality control concepts CO2 design system of record keeping for QA & audit. CO3 apply statistical tools for better quality control in construction projects</p>								
<p>Syllabus:</p> <ol style="list-style-type: none"> 1. Introduction: Quality basics and history, Quality advocates, Quality improvement 2. Concept of Total Quality Management; contributions of Deming, Juran, Crosby 3. Quality Improvement Techniques: Pareto Diagrams, Cause-Effect Diagrams, Scatter Diagrams, Run Charts, Cause and Effect Diagrams 4. Statistical Concepts: Definitions, Measures of Central Tendency, Measure of Dispersion, Concepts of Population and Samples, Normal Curves, Control Charts for Variables, Variation: Common vs. Special Causes Control Chart Techniques :X-bar and R chart Correlation. X-bar and S charts, Control Chart Interpretation and Analysis, Using Charts to Pinpoint Problems, Other Variable Control Charts, Individuals and Moving Range Charts, Moving Average and Moving Range Charts, Median and Range Charts 5. Fundamentals of Probability: Basic Concepts and Definitions, Discrete Probability Distributions, Continuous Probability Distributions, Control Charts for Attributes, Control Charts for Non-conforming Units, Control Charts for Counts of Non-conforming Units 6. Quality Costs: Quality Cost Measurement, Utilizing Quality Costs for Decision-Making, Quality of construction materials and workmanship: Specifications, how to define, standard documents and specifications therein, Evolving Standards, Benchmarking. 7. Quality Function Deployment: Design of Experiments, Quality Systems: ISO 9000, Six sigma, Certification Requirements, and Auditing. 								
<p>Reference books:</p> <ol style="list-style-type: none"> 1. Quality management in construction projects, A R Rumane, CRC Press 2. Management of quality in construction, Ashford, Routledge 3. Construction inspection handbook: total quality management, James O'Brien, Springer 								

Programme Elective Course 4: Project Management and Financing

SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	IST	ESE	ESE hours
5	CEEE5051S	Project Management and Financing	3-0-0=3	3	20	20	60	3

Course Outcomes

After completion of course, student will be able to:

CO1: Ability to study current market trends and choose projects.

CO2: Ability to prepare project feasibility report

CO3: To understand the roles and responsibility of project manager

Syllabus

- Project Management Concepts:** Concept and characteristics of a Project, Types of project, project life cycle. Objectives of Project management, Nature and scope of project management, challenges and problems of project management, Role of project manager.
- Project Identification and Formation:** Generation and screening of project ideas, Project identification, Identification of investment opportunities, Projects screening, project feasibility study [market, technical, financial, economic and ecological], Project selection, Project formulation, Stages in project formulation, Project report preparation, Project clearance procedure, Planning Commission's guidelines for project formulation.
- Project Implementation, Monitoring and Control:** Monitor and assess project performance, Basic Scheduling concepts: Resource levelling, Resource allocation, Setting a base line, Project management information system, quality management tools and techniques.
- Project Financing:** Introduction, Project Finance Market, Role of Advisors in Project Finance, Valuing the Project, and Project Cash Flow Analysis, NPV, IRR, Probability Index Method, Accounting Rate of Return Method, Payback Period method.
- Project Risk Assessment:** Project Finance and Commercial Risks, Project Finance and Macroeconomic Risks, Regulatory and Political Risks, Risk Mitigation Methodologies for Projects, Sensitivity analysis, scenario analysis, break-even analysis.

Recommended books and journals etc.

- Project Management Institute A Guide to the Project Management Body of Knowledge PMBOK Guide (Sixth Edition), Sept 2017
- James C.Van Horne, Fundamentals of Financial Management, Person Education 2004
- Clifford F Gray, Erik W Larson, "Project Management-The Managerial Process",
- Financial Management by I M Pandey, Vikas Publishing House

Programme Elective Course 4: Rural Water Supply & Sanitation								
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	IST	ESE	ESE hours
5	CEEE5052S	Rural water supply & sanitation.	3-0-0=3	3	20	20	60	3
<p>Course Outcome: After completion of course, student will be able to:</p> <p>CO1 formulate issues of rural water supply and sanitation. CO2 acquire skills and understanding about the development of these projects with cost effective implementation and, operation & maintenance. CO3 develop an ability of effective resource planning for rural environmental projects</p>								
<p>Syllabus</p> <ol style="list-style-type: none"> 1. Concept of environment and scope of sanitation in rural areas. Magnitude of problems of rural water supply and sanitation. Population to be covered, difficulties. National policy. 2. Planning of water supply system: Design population and demand loads. Various approaches of planning of water supply schemes in rural areas. 3. Selection and Development of preferred sources of water: springs, Wells, infiltration wells, radial wells and infiltration galleries, collection of raw water from surface source. Specific practices and problems encountered in rural water supply, Rainwater Harvesting, Groundwater Recharge. 4. Specific Problem in rural water supply and Treatment: Source Sustainability, Slippage, Water Quality, Operation and Maintenance. Low cost treatment, appropriate technology for water supply and sanitation. 5. Improved methods and compact systems of treatment: Brief Details of multi-bottom settlers (MBS), diatomaceous earth filter, cloth filter, slow sand filter, chlorine diffusion cartridges. Water supply during fair, festival and emergencies. 6. Treatment and Disposal of Waste-water/sullage: 7. Community latrines: Different types and location of latrines, various methods of collection and disposal of night soil. 8. Simple wastewater treatment units and systems in rural areas such as stabilization ponds, septic tanks, Imhoff tank, soak pit etc. Disposal of wastewater soak pits and trenches. 9. Disposal of Solid Wastes. Composting, land filling, incineration, rural health. Other specific issues and problems encountered in rural sanitation 10. Biogas plants: Definition, Objective, Methodology and Construction, operation and Maintenance, Economic analysis, Benefits, Shortcoming 								
<p>Recommended books:</p> <ol style="list-style-type: none"> 1. Rural Water Supply in developing countries, international development research center. 2. Water supply for rural areas and small communities, Publication W. H. O. Geneva, 1959. 3. Rural water supply and sanitation, Wright Forest b., second Edition, Wiley Eastern New Delhi 1956. 4. Low-cost wastewater treatment technology, Trivedi R. K., Kaul S., ABD publications, Japan 2001. 								

Program Elective Course 4: Integrated GIS & GPS in infrastructure								
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	IST	ESE	ESE hours
5	CEEE5053S	Integrated GIS & GPS in infrastructure	3-0-0=3	3	20	20	60	3
<p>Course Outcomes: After completion of course, student will be able to:</p> <ul style="list-style-type: none"> CO1. describe Spatial and non-spatial database of geographic information system. CO2. acquire and create spatial data from satellite imagery, printed maps, online sources, &GPS. CO3. develop spatial and thematic models for presentation, analysis and decision-making. CO4. use the GPS, GIS software packages. CO5. integrate GPS- GIS techniques for problem solving of construction projects. 								
<p>Syllabus</p> <ol style="list-style-type: none"> 1. Geographical Information System (GIS): Information systems, spatial and non- spatial information, geographical concept and terminology, advantages of GIS, Basic component of GIS, Commercially available GIS hardware and Software Field data, statistical data, maps, aerial Photographs, satellite data, points , lines, and areas features, vector and raster data, data entry through keyboard, digitizer and scanners, preprocessing of data rectification and registration , interpolation techniques 2. Global Positioning System (G.P.S) G.P.S. Segments: Spaces Segment, Control Segment, User Segment, Features of G.P.S. Satellites, Principle of Operation, Surveying with G.P.S.: Methods of observations, Absolute Positioning, Relative Positioning, differential G.P.S. and Kinematics of G.P.S., G.P.S. Receivers: Navigational Receivers, Surveying Receivers, Geodetic Receivers, Computation of Co- ordinates:- Transformation from Global to Local Datum , Geodetic Coordinates to map co- ordinates , G.P.S. Heights and mean sea level Heights, Applications of G.P.S. 3. Civil Infrastructure Management: Introduction, Infrastructure Life Cycle, Challenges of Infrastructure Management, meeting the challenges, Infrastructure Management services tier, GIS based civil Infrastructure management. 4. Case Studies: <ol style="list-style-type: none"> a. GIS based management approach for Transportation Infrastructure Construction b. Application of GIS in Transportation c. GIS based applications in Airfield Infrastructure system management and maintenance d. Developing Enterprise GIS based data repositories for Municipal Infrastructure asset management e. GIS based decision support system for optimal renewal planning of sewers f. GIS based integrated infrastructure Management g. GIS based technologies for watershed management h. Single frequency GPS for Bridge deflection monitoring: progress and results i. Monitoring of rigid structures using GPS and RTS – Experiment j. Real- time bridge health monitoring for management k. Deformation studies of Koyna Dam, Western India using GPS. 								

Recommended books and journals etc.

1. Handbook on transportation Engineering, The McGraw – Hill Publication
2. Concepts and Techniques of Geographical Information System, Lo C.P.Yeung A K W, Prentice Hall India
3. Introduction to Geographical Information System, Kang-tsung Chang, Tata McGraw Hill
4. International and National Journals on GIS and GPS

Program Elective Course 4: Water Resource Management									
Course Code	Course Title	L-T-P (Hours/Week)			Credit	TA	IST	ESE	ESE hours
CEEE5054S	Water Resource Management	3	0	0	3	20	20	60	3
Course Outcomes:									
<p>CO1. Skill of choosing the correct management techniques for water resources.</p> <p>CO2. Ability to identify and define problems, gather data, generate and prioritize a set of alternative solutions, and select and implement the best alternative.</p> <p>CO3. Ability to apply the principles of remote sensing and GIS to the water resources for management.</p>									
<p>1. Water resources System and planning: System Components, Planning and management, Concept of a system, Advantages and limitations of systems approach. Watershed- Watershed-element and types, Watershed hydrology, Hydrological cycle, Precipitation, water losses, Runoff, Rainfall-Runoff analysis, Watershed problem. Water resources planning, Modeling of Water Resources Systems, Simulation and optimization, Economics in water resources, Challenges in water sector.</p>									
<p>2. Measurement and Processing of Data: Measurement and Processing of Rainfall Data , Stream flow Data , Meteorological Data, Water Quality Data, Ground Water and Other Data Acquisition and management of spatial data Hydrological databases and Dissemination of Data Statistical Analysis of Data : Regression, Correlation and Data Generation</p>									
<p>3. Watershed Management techniques: Rain water harvesting, On-site and off-site management structures for soil and water conservation. Community Watershed Management</p>									
<p>4. Surface flow modeling techniques: Hydrological and hydraulics flow model, Reservoir routing, channel routing, general operation of flood forecasting, forecasting methods adopted in India, forecasting by unit hydrograph method, Numerical modeling</p>									
<p>5. Subsurface flow modeling techniques: yield, transmissibility, Darcy's law, Dupuit's theory of unconfined flow, steady flow towards fully penetrating wells in case of confined and unconfined aquifers, Numerical modeling.</p>									
<p>6. Linear Programming and Dynamic Programming Applications, Economics in water resources, Modeling of water resources systems, Constrained and unconstrained optimization, Linear programming with applications to reservoir sizing, reservoir operation, Dynamic programming with applications to water allocation, capacity expansion, reservoir operation.</p>									
<p>7. Water Resources Management: Erosion control and watershed development: their benefit towards conservation of national water wealth. Rainwater harnessing and recharge of ground water: role of society and people's participation for sustainable water resource development. Mitigation strategies for flood damage: structural and non-structural measures.</p>									
Recommended books:									
<ul style="list-style-type: none"> • Engineering Hydrology- K. Subramanya. Third Edition, The Tata McGraw-Hill companies, New Delhi. • Water Resource Engineering by Ralph A Wurbs and Wesley P James, PHI Learning Private Ltd, New Delhi, 2009 • Varshney, Gupta & Gupta, Theory and Design of Irrigation Structures, Nem Chand & Bros • Punmia B C & Pande B B lal, irrigation Engineering and Waterpower Engineering, 									

Laxmi Publications

- Elementary Hydrology, V.P. Singh, Prentice Hall of India Pvt. Ltd. , New Delhi-110 001,1994

Interdisciplinary Open Elective Course 02: Climate Change and Carbon Neutrality								
SN	Course Code	Course Title	L-T-P (Hours / Week)	Credit	TA	IST	ESE	ESE hours
6	CEEE5062SA	Climate change and Carbon Neutrality	3-0-0=3	3	20	20	60	3
<p>Course Outcome:</p> <ol style="list-style-type: none"> 1. An ability to identify and analyze earth's atmosphere and air pollution related environmental issues. 2. Be able to identify the key principles, causes and consequences of climate change 3. Developing competency in use of various air modeling software and carbon footprints. 4. Ability to use the signs, future projections, impacts of carbon in research and development. 								
<p>Syllabus</p> <ol style="list-style-type: none"> 1. Composition of dry ambient air, properties of air, Definition of air pollution, Classification of air pollutants, Units for classification of air pollutants, History of air pollution- global and national, Scope of problem-general, urban, rural, and specific. Sources of air pollution: Natural and man-made, Major pollutants from different sources in Greater Mumbai area and other Indian cities, Emission factors. 2. Meteorological aspects of air pollution-large scale wind circulation: geotropic wind, gradient wind, cyclone, anticyclone, planetary boundary layer, lapse rate, stability conditions, wind velocity profile, maximum mixing depth 3. Introduction – Climate, The earth's natural greenhouse effect, radiative balance, importance of water. Effect of Climate change on human health, plants, animals, properties 4. Green house gases, role of Carbon dioxide and other GHG gases, their emissions. Different concerns of developed and developing part of the world, The earth's Carbon reservoir, biogeochemistry, Carbon cycling; Global Ocean circulations – introduction and overview; Introduction to Climate change-advances in computer modeling 5. Climate Change Agreements: Understanding the evolution of the climate agreements, UNFCCC, Kyoto protocol, the defining agreements of Paris and COP; The pledges of COP26, Future scenarios of climate action. 6. Carbon neutrality, Carbon net zero emissions, Scope I, II & III emissions, Carbon Footprints. 								
<p>Reference Books:</p> <ol style="list-style-type: none"> 1. "Air pollution" by Henry C Perkins - McGraw Hill Publications 2. "Air Pollution" by Wark and Warner 3. Climate and Eco-systems, David Schimel, Princeton University Press, 2013 4. Climate Crisis: An Introductory Guide to Climate Change; David Archer & Stefan Rahmstorf ; Cambridge University Press; 2001 5. Global Warming and Climate Change; Grover Velma.I; Science Publishers; 2008 6. UNFCCC (2008). Compendium on Methods and Tools to Evaluate Impacts of, and Vulnerability and Adaptation to, Climate Change. Available at https://unfccc.int/files/adaptation/nairobi_workprogramme/compendium_on_methods_tools/application/pdf/20080307_compendium_m_t_complete.pdf 7. UNFCCC (2006). UNFCCC Handbook. Available at https://unfccc.int/resource/docs/publications/handbook.pdf 8. UNFCCC & UNEP (2002). Climate Change Information Kit. Available at https://unfccc.int/resource/iuckit/cckit2001en.pdf 9. Atmospheric Chemistry and Physics: from Air Pollution to Climate Change, John Wiley, New York, 1998 								

Interdisciplinary Open Elective Course 02: Environment, Health and safety for Engineers								
SN	Course Code	Course Title	L-T-P (Hours / Week)	Credit	TA	IST	ESE	ESE hours
6	CEEE5 062SB	Environment, Health and safety for Engineers	3-0-0=3	3	20	20	60	3
<p>Course Outcome:</p> <ol style="list-style-type: none"> 1. An ability to identify and analyze Environment, Health and safety issues. 2. Be able to identify the key principles, causes and consequences of Health and safety issues 3. Developing competency in overcoming risk and accidents related to work places. 4. Ability to use the signs, future projections, impacts of workplace hazards; 								
<p>Syllabus</p> <ol style="list-style-type: none"> 1. Safety and Health Management: Occupational Health Hazards, Promoting Safety, Safety and Health training, Stress and Safety. Safety Psychology, Safety information system, Ergonomics - Introduction, Definition, Objectives, Advantages. Ergonomics Hazards - Musculoskeletal Disorders and Cumulative Trauma Disorders. iii. Importance of Industrial safety. 2. Radiation and Industrial Hazards: Types and effects of radiation on human body, Measurement and detection of radiation intensity. Effects of radiation on human body, Measurement – disposal of radioactive waste, Control of radiation, Indian Standards. ii. Different air pollutants in industries, Effect of different gases and particulate matter, acid fumes, smoke, fog on human health, Industrial Hygiene & Health Unit 3. Electrical Hazards and Hazards in Construction Industry: Safe limits of amperages, voltages, distance from lines, etc., Joints and connections, Overload and Short circuit protection, Earthing standards and earth fault protection , Protection against voltage fluctuations, Effects of shock on human body Hazards 4. Fire and other Hazards: General causes and classification of fire, Detection of fire, extinguishing methods, firefighting installations with and without water. Machine guards and its types, automation. High pressure hazards, safety, emptying, inspecting, repairing, hydraulic and non-destructive testing, hazards and control in mines. 5. Safety at workplace: 6. Safe use of machines and tools: Safety in the use of: Grinding, CNC’s computer numeric control, Shearing, Bending, Milling, Boring, Shaping Safe use of hand tools: 7. Plant design and Housekeeping: Plant layout, design and safe distance, Ventilation and heat stress, Significance of ventilation, Natural ventilation, Mechanical ventilation Air conditioning , National Building code part VIII and Building service, 8. Industrial Lighting: Purpose of lighting, Uses of good illumination, recommended optimum standards of illumination, Design of lighting installation, Standards for lighting and color. Testing and Maintenance of ventilation systems. Vibration and Noise: Vibration- effects, Measurement & control, Activities related to vibrations, its impact on human health, Sources. Industrial Noise- sources & its control, effects of noise on man, Measurement and evaluation of noise, Silencers, Practical aspects of control of noise. Audiometry, hearing conservation programmes. 9. Accident prevention techniques: Principles of accidents prevention: Definition: Incident, accident, injury, dangerous occurrences, unsafe acts, unsafe conditions, hazards, error, oversight, mistakes, etc. Accident Prevention : Theories of accident occurrences, Principles of accident prevention, Accident and Financial implications, Hazard identification and analysis. 								
<p>Reference Books:</p> <ol style="list-style-type: none"> 1. The Factories Act with amendments 1987, Govt. of India Publications DGFASLI, Mumbai 2. Grimaldi and Simonds , Safety Management, AITBS Publishers , New Delhi (2001) 3. Industrial Safety –National Safety Council of India ISHET. 								

Design of Environmental Infrastructure							
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	IST	ESE
7	CEEE5075L	Design of Environmental Infrastructure	0-0-2=2	1	60 % CIE		40
		<p>Course Outcome: After completion of course, student will be able to:</p> <p>CO1 Design & plan water and wastewater projects. CO2 Basic design elements of Water, Wastewater, and solid waste infrastructure. CO3 develop design skills and related software understanding about env infrastructure.</p>					
		<p>Syllabus</p> <p>Basic design elements about the environmental infrastructures as water, wastewater, and solid waste management highlighting Design elements of various types of pumping systems. Design Period Fluctuations in demand. Mathematical model of the unit processes., Reuse of water and conservation of water in industry, corrosion, and corrosion control economics, Measurement of sewage flow. Economics. Sludge pumping. Quantities, Wastewater Reuse: Industry, Agriculture, Augmentation of Public water supplies.</p>					
		<p>Recommended books:</p> <ol style="list-style-type: none"> 1. Water and Wastewater Engineering- Vol.II Fair, Geyer & Okun Wiley Toppan Co. Ltd. 1981, Tokyo. 2. Manual of Water Supply and Treatment Ministry of Urban Development 3. Design of water treatment plants. Dr. A. G. Bhole, Indian Water Works Association, Nagpur centre. 4. Wastewater Engineering-Treatment, disposal, reuse Metcalf & Eddy 4th Edition 2003. Tata McGraw Hill International Editions. 5. CPHEEO Manual of sewerage and Sewage Treatment 1993. Ministry of Urban Development. 					

Technical Seminar							
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	IST	ESE hours
8	CEEE5076L	Seminar on Special Topic	0-0-4=4	2		60% CIE	40
<p>Course Outcome:</p> <p>After completion of course, student will be able to:</p> <p>CO1 develop a skill of reading and understanding the research paper and, summarizing it with optimum words..</p> <p>CO2 develop a presentation skill.</p> <p>CO3 point out the need for lifelong learning</p>							
<p>Technical Seminar</p> <p>Students are required to select at least two research papers as a particular topic published in referred journal on the said topic. Students are expected to study and understand the contents and prepare a summary report about the contents of the papers and will present a seminar.</p>							
<p>Recommended books and journals etc.</p> <p>Any National and International Journal of Impact Factor 1.5 and above</p> <ol style="list-style-type: none"> 1. Journal of Institute of Engineers 2. Journal of Indian Water Works Association 3. Journal of Environmental Health and Management 4. Journal of Environmental Engineering and Science 							

Water and Wastewater Laboratory							
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	IST	ESE
9	CEEE5074L	Water and Wastewater Laboratory	0-0-2=2	1	60%	CIE	40
<p>Course Outcome: After completion of course, student will be able to :</p> <p>CO1 develop an ability to take samples, analyze and interpret the results of water and wastewater samples.</p> <p>CO2 apply the acquired knowledge in planning, design, O & M of the treatment and pollution control facilities.</p> <p>CO3 analyze and assess the accuracy and precision of the analytical results.</p> <p>CO4 demonstrate the acquired knowledge in research</p>							
<p>Water:</p> <ol style="list-style-type: none"> 1. Determination of Alkalinity 2. Determination of Hardness 3. Determination of Chlorides 4. Determination of Solids 5. Determination of Residual Chlorine 6. Determination of pH 7. Determination of Turbidity 8. Determination of NO₃⁻ 9. Determination of Phosphates 10. Determination of Sulphates 11. Determination of Dissolved Oxygen 12. Determination of BOD 13. Determination of COD <p>Wastewater</p> <ol style="list-style-type: none"> 1. Determination of SVI 2. Determination of Detergents 3. Determination of Oil & Grease 4. Determination of Volatile Acids 5. Determination of Optimum Dose of Alum Using Jar Test Apparatus 6. Determination of Metals- Iron 7. Determination of Metals- Chromium 8. Determination of Metals- Manganese 9. Determination of Metals- Zinc 10. Filter Sand: <ol style="list-style-type: none"> A) Determination of Specific Gravity B) Determination of Acid Solubility C) Determination of Ignition Loss D) Determination of Friability Loss E) Determination of Sieve Analysis 							

Sampling and Analysis of water and Wastewater

1. Study of standard procedure for collection of samples of water, Sewage & industrial wastes.
2. Methods for determination of sample size.
3. Methods of testing hypothesis and drawing interferences.
4. Determining physical, chemical and biological properties of the sample

Recommended Books:

1. Standard Methods for examination of water & wastewater, Joint Publication of APHA, AWWA & WEF.
2. Chemistry for environmental Engineering: Sawyer & McCarty

Semester III

Self-learning course I : Industry Internship								
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	IST	ESE	ESE hours
1	CEEE5101S	Industry Internship	1-0-0=1	1			100% CIE	
<p>Syllabus:</p> <p>It is mandatory to each student to undergo the Industrial Internship of 4 week to 6 week or 06 site visits during vacation after Sem - II on Environmental Engineering Projects and its evaluation during Sem - III: During internship required to work with environmental consultant firms/company on various projects related to environmental issues for 4 to 6 week. Or 4-6 site visits.</p> <p>The student is expected to learn the following during site visit:</p> <ol style="list-style-type: none"> 1) To visit and understand the Site conditions 2) Characterisation of parameters required for design of treatment facility 3) To understand the design of treatment facility with respect to various criteria 4) To monitor the performance of the treatment facility 5) Testing of quality parameters at site <p>To understand the troubles caused in the treatment facility and its remedial measures</p>								

Self-learning course II								
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	IST	ESE	ESE hours
1	CEEE5201-203S	1. Python for data Science 2. Design for internet of things; 3. Block chain and its Applications	1-0-0=1	1	--	--	100	3
<p>Syllabus:</p> <p>All above listed courses are available on NPTEL- SWAYAM platform. Student can select anyone of the course out of above listed courses provided that the course is available and offered in a given time frame of the appearing semester. Also student can discuss with Class Mentor/Head of Department/ Faculty and select any other appropriate course available on online platform which could be offered in a given time frame of the appearing semester</p>								

Mandatory Non Credit Course								
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	IST	ESE	ESE hours
1	CEEE5301-304S	1. Constitutional Studies; 2. Ethics in Engineering Practices; 3. Engineering Economics; 4. Disaster Management	2-0-0=1	Non Credit	--	--	100	3
<p>Syllabus:</p> <p>All above listed courses are available on NPTEL- SWAYAM platform. Student can select anyone of the course out of above listed courses provided that the course is available and offered in a given time frame of the appearing semester. Also student can discuss with Class Mentor/Head of Department/ Faculty and select any other appropriate course available on online platform which could be offered in a given time frame of the appearing semester</p>								