

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 Construction Management

Implemented from the batch admitted in Academic Year 2022-23

VEERMATA JIJABAI TECHNOLOGICAL INSTITUTE
CIVIL AND ENVIRONMENTAL ENGINEERING DEPARTMENT

Scheme and Syllabus for

M.Tech. (Civil Engineering) with specialization in Construction Management)

2022- 2023

Programme Educational Objectives (PEOs)

PEO1	Develop advanced competencies in construction methodologies and their selection
PEO2	Develop entrepreneurial, managerial and leadership skills to perform as a professional construction manager
PEO3	Expand career potential of individuals through applied learning experiences and analytical skills using conventional and modern ICT tools in the area of construction and its management

Programme Outcomes (POs)

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 Construction Management.

PO5: An ability to use knowledge in planning, design, construction, commissioning, and operation & maintenance phases of Heavy engineering construction Infrastructure Projects

PO 6: Developing skills regarding quality, safety and legal aspects of Construction Projects

PO 7: An ability to engage in lifelong learning technological advances in Construction Industry and allied branches..

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

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

Scheme of Instructions and Evaluation

Semester I										
Scheme of Instruction						Scheme of Evaluation				
SN	Course Code	Course Title	L-T-P (Hours/Week)			Credit	TA	IST	ESE	ESE hours
1.	CECM5001S	Computational Methods	3	0	0	3	20	20	60	3
2.	CECM5011T	Advanced Project Management Principles & Practice	3	1	0	4	20	20	60	3
3.	CECM5012S	Advanced Materials & Construction Techniques	3	0	0	3	20	20	60	3
4	CECM5021T-24T	Programme Elective course I	3	1	0	4	20	20	60	3
5	CECM5031S-34S	Program Elective Course II	3	0	0	3	20	20	60	3
6	CECM5061S A-B	Open Elective1	3	0	0	3	20	20	60	3
7.	CECM5071L	Planning Scheduling and Estimation Lab	0	0	2	1	60% CIE		40	
8	CECM5072L	Construction Cost Engineering Lab	0	0	2	1	60% CIE		40	
9.	CECM5073L	Building Information modeling Lab	0	0	2	1	60% CIE		40	
10.	CECM5081L-A-D	Liberal Learning	0	0	2	1	100% CIE			
		Total	28			24				

Semester II										
Scheme of Instruction						Scheme of Evaluation				
SN	Course Code	Course Title	L-T-P (Hours/Week)			Credit	TA	IST	ESE	ESE hours
1.	CECM5002S	Research Methodology and IPR	3	0	0	3	20	20	60	3
2.	CECM5013T	Construction Resource Management	3	1	0	4	20	20	60	3
3.	CECM5014S	Construction Contract Management	3	0	0	3	20	20	60	3
4	CECM5041T-44T	Program Elective Course III	3	1	0	4	20	20	60	3
5	CECM5051S-54S	Program Elective Course IV	3	0	0	3	20	20	60	3
6	CECM5062S A-B	Open Elective 2	3	0	0	3	20	20	60	3
7	CECM5074L	Construction Project Management Lab	0	0	2	1	60% CIE		40	
8	CECM5075L	Rehabilitation of Structures Lab	0	0	2	1	60% CIE		40	
9	CECM5076L	Seminar on Special Topic	0	0	2	1	60% CIE		40	
10	CECM5082L-A-D	Liberal Learning	0	0	2	1	100% CIE			
		Total	28			24				

Abbreviations: **L**: Lecture, **T**: Tutorial, **P**: Practical, **TA**: Teacher Assessment / Term work Assessment, **IST**: In Semester Tests (comprise of average of two In semester tests), **ESE**: End Semester Written Examination, **CIE**: Continuous In-semester Evaluation

SEMESTER III							
SN	Course Code	Course Title		Credits	Evaluation pattern	Scheme of Evaluation (TA, IST, ESE)	ESE
1	CECM5091D	Skill based Project I		5	Graded evaluation by a committee of at least two examiners including supervisor (guide)	100% CIE	August End
2	CECM5092D	Skill based Project II		5	Graded evaluation by a committee of at least two examiners including supervisor (guide)	100% CIE	November end
3	CECM5101S	Self learning course I	1-0-0	1	Evaluation by course provider	100% CIE Or Credit Transfer	
4	CECM5201S to CECM5203S	Self learning course II	1-0-0	1	Evaluation by course provider	100% ESE of 3hrs Or Credit Transfer	
5	CECM5301S to CECM5304S	Non Credit course	2-0-0	0	Evaluation by course instructor	100% ESE of 3hrs Or Credit Transfer	
				12			
SEMESTER IV							
	CECM5093D	Skill based Project III		5	Graded evaluation by a committee of at least two examiners including supervisor (guide)	100% CIE	March end
	CECM5094D	Skill based Project IV		7	Graded evaluation by a committee of at least two examiners including supervisor (guide) and an external examiner	100% CIE	June end
				12			

List of Programme Elective Course I		
SN	Course Code	Program Elective Course
1	CECM5021T	Risk & Value Management
2	CECM5022T	Sustainable building construction
3	CECM5023T	EIA and Audit
4	CECM5024T	Environmental Management

List of Programme Elective Course II		
SN	Course Code	Program Elective Course
1	CECM5031S	Managerial Decision Making
2	CECM5032S	Energy conservation in facility design & construction
3	CECM5033S	Occupational Health & Safety management
4	CECM5034S	Construction Entrepreneurship

List of Programme Elective Course III		
SN	Course Code	Program Elective Course
1	CECM5041T	Integrated GIS & GPS in Infrastructure
2	CECM5042T	Water Resource management
3	CECM5043T	Construction management information systems
4	CECM5044T	Facilities management

List of Programme Elective Course IV		
SN	Course Code	Program Elective Course
	CECM5051S	Rehabilitation of Structures
1	CECM5052S	Quality Assurance on Construction Projects
2	CECM5053S	Pavement Management System
4	CECM5054S	International Construction Business

Open Elective 01

SN	Course Code	Interdisciplinary Open Elective 01
1	CECM5061S-A	Environmental Legislation and Management
2	CECM5061S-B	Sustainable Development

Open Elective 02

SN	Course Code	Interdisciplinary Open Elective 02
1	CECM5062S-A	Climate change and Carbon Neutrality
2	CECM5062S-B	Environment, Health and safety for Engineers

Liberal Learning Course Semester-I

SN	Course Code	Liberal Learning Course Semester-I
1	CECM5081L-A	Ancient Indian Civil Engineering
2	CECM5081L-B	Yoga and Stress Management
3	CECM5081L-C	Community Social Responsibility
4	CECM5081L-D	Development Engineering

Liberal Learning Course Semester-II

SN	Course Code	Liberal Learning Course Semester-II
1	CECM5082LA	Ancient Indian Civil Engineering
2	CECM5082LB	Yoga and Stress Management
3	CECM5082LC	Community Social Responsibility
4	CECM5082LD	Development Engineering

Self-Learning courses: Student should select self-learning courses from EDX, Couresra, MOOC, NPTEL, Swayam, Bentley , Professional Construction software's from government / private traing Institute such as NICMAR, PMI, NITIE or equivalent organization,

Self-Learning Courses

Self-Learning Course	Course Code	Course Title
Self-Learning Course –I	CECM5101S	Industry Internship
Self-Learning Course –II	CECM5201S	Python for Data Science
	CECM5202S	Design for internet of things
	CECM5203S	Block chain and its Applications

Mandatory Non Credit Course

	Course Code	Course Title
Mandatory Non Credit Course	CECM5301S	Constitutional Studies
	CECM5302S	Ethics in Engineering Practices
	CECM5303S	Engineering Economics
	CECM5304S	Disaster Management

Course Code	Course Title	L-T-P (Hours/Week)			Credit	TA	IST	ESE	ESE hours
		3	0	0					
CECM5001S	Computational Methods	3	0	0	3	20	20	60	3
Course Outcomes: CO1.To understand different mathematical modeling strategies to simulate civil engineering systems. CO2.To understand different computational techniques to analyze mathematical models CO3.To develop computational skills to solve problems in the field of civil engineering CO4.To develop ability to identify and define civil engineering problems, to gather data related to the problem, to select and implement the appropriate solution.									
Mathematical Model Model, Purpose of modeling, Types of model, Steps in modelling process - Problem definition, Purpose definition, Conceptualization, Selection 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)									
Interpolation and Extrapolation Langrange's Interpolation, Newton's Interpolation- Forward, Backward, Hermite Interpolation, Spline Interpolation - cubic, inverse interpolation, Extrapolation, Civil Engineering Application- elevation contour map, isohyetal map, Noise Map, etc.									
Numerical Differentiation and Numerical Integration Newton Raphson method, Modified Newton Raphson method and successive approximation method. Trapezoidal rule, Simpson's rule ($\frac{1}{3}$ rd, $\frac{3}{8}$ th), Gauss quadrature method 2-point, 3-point, Double integration- Trapezoidal rule, Simpson's rule ($\frac{1}{3}$ rd), Numerical solutions of ordinary differential equations: method of Euler, Taylor and Runge-Kutta procedures. Civil Engineering Application- Earthwork volume estimation , Estimation of pile capacity etc.									
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 Application- Population Forecasting Methods, Reduction Rate Parameters for design of Treatment Units, atmospheric dispersion of pollutant (Gaussian Dispersion Model) , Dispersion at sea outfall,etc 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, Elliptic equations Finite Element Method (limited to 1D elements):. Basic understanding of finite element method including elements types and their formulation, Civil Engineering Application- 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									
Optimization									

Concept of optimization, Linear programming , Civil Engineering, Environmental Engineering ,Water resources engineering, and Structural engineering Applications

References:

- Numerical Methods for scientific and engineering computation, M. K. Jain SRK Iyengar, R K Jain ,New Age International(P) Ltd. Fourth Edition 2003
- Engineering Optimization Theory and practice, SingiresuS.Rao, New Age International(P) Ltd. Third edition, 2004
- Fundamentals of Mathematical Statistics, Gupta.S.C. and Kapoor.V.K, Sultan Chand and Sons, 1978
- Numerical methods for Engineers, Chapra, S.C and Canale, R .P., Mcgraw hill Intl., 2012
- S.S. Sastry, Introductory methods in Numerical Analysis, Prentice Hall of India. Fourth Edition, 2005
- HammingR.W., Numerical Methods for Scientist and Engineers, McGraw Hill, 1998.
- ScarboroughJ. B., Numerical Mathematical Analysis, Oxford & IBH Publishing Co. Pvt. Ltd., 2000.
- JainK. K, IyengarS. R. K and JainR. K., Numerical Methods - Problem and Solutions, Wiley India Pvt. Ltd, 2001.
- Hayter A. J., Probability and Statistics, Duxbury, 2002.
- Mathews J. H. and FinkK.D., Numerical Methods using MATLAB, Pearson Education, 2004.

Course Code	Course Title	L-T-P (Hours/Week)			Credit	TA	IST	ESE	ESE hours
CECM5011T	Advanced Project Management Principles & Practice	3	1	0	4	20	20	60	3
<p>Course Outcomes:</p> <ol style="list-style-type: none"> 1. Able to understand fundamental principles of management and behavioral theories 2. Able to understand the policies of performing functions of management effectively and analyze what motivates employees and adopt appropriate motivation strategies 3. Able to implement management strategies in construction organizations 4. Able to prepare project plans, resolve resource conflicts & to understand time cost tradeoff principles 5. Able to interpret progress data, perform variance analysis and suggest control measures 6. Able to identify risks and safety issues on projects and to define risk and safety management policy and able to design information system for managing projects 									
<p>Introduction to Management Nature and Purpose, systems approach to Management Process, and emergence of management thought, contributions of Fredrick Taylor, Henry Fayol, Evolution of Management Thoughts – Pre-Scientific, Classical, Behavioral and Modern; Scientific Management, Project management: scope and framework, agencies involved, their relationships and scope</p>									
<p>Construction Management Need, nature of construction industry , scope and functions of construction management</p>									
<p>Project Planning Planning process , objectives , strategies and policies, making planning effective Plan development process, precedence diagrams with overlapping relationships, network analysis, master network and sub-nets, time scaled networks</p>									
<p>Resource scheduling Resource aggregation, allocation, concept of leveling and smoothing, line of balance, float factor, issues involved in multi project multi resource scheduling, time-cost tradeoff: simple and complex, crashing</p>									
<p>Organizing Nature and purpose, types of organizations, organizational behavior, informal organizations, organizational climate, group decision making , making organizing effective</p>									
<p>Staffing Nature and purpose, selection, performance appraisal, organizational development</p>									

Leading

Managing and human factor, motivation- theories of motivation, Leadership: Definition, Ingredients, Styles, Committees and Group Decision Making, team development, Communication: Purpose, Process of Communication, Barriers and Break Downs, Making Communication Effective

Project monitoring

Progress reporting, alarm reports, review meetings, updating plans

Controlling

Concept, planning -control relationship, Process of controlling, direct and indirect control, control techniques, control system framework, baselines, scope, time, cost & quality control systems, codification

Safety & Risk management

common causes of accidents, occupational health hazards, general measures to ensure safety and safe environment project risks, tools of assessment and methods of mitigation

Information systems

PMIS, integrated approach

Text books

- Chitkara K K, Construction Project Management, Tata McGraw Hill
- Harris R B, Precedence & arrow networking techniques for construction, John Wiley
- Barrie D.S. & Paulson B C, Professional Construction Management, McGraw Hill
- Antill J M & Woodhead R W, Critical Path Methods in Construction Practice, Wiley
- Harold Kerzner, Project management, CBS Publishers
- Koontz, O'Donnel & Wehrich, Management, McGraw Hill
- Dharwadkar P P, Management in Construction Industry, Oxford & IBH
- Luthans, Organization Behavior, McGraw Hill

References:

- Koontz, O'Donnel & Wehrich, Management, McGraw Hill
- Dharwadkar P P, Management in Construction Industry, Oxford & IBH
- Luthans, Organization Behavior, McGraw Hill
- King & Hudson, Construction Hazard and Safety Handbook, Butterworths
- P K Joy, Handbook of Construction Management
- James O'Brien, CPM in construction management, McGraw Hill

Course Code	Course Title	L-T-P (Hours/Week)			Credit	TA	IST	ESE	ESE hours
		3	0	0					
CECM5012S	Advanced Materials & Construction Techniques	3	0	0	3	20	20	60	3
<p>Course Outcome:</p> <p>C01 Able to develop skills of choosing the appropriate construction technique for a particular construction project.</p> <p>C02 Able to develop skills of choosing the appropriate construction materials for a particular construction project.</p> <p>C03 Able to prepare method statements for large and heavy construction projects.</p> <p>C04 design formworks for infrastructure project</p> <p>C05 CO5. describe concept of intelligent buildings and 3D Modular Construction</p>									
<p>Method statement for large and heavy Engineering projects:</p> <p>Method statement for major activities like excavation, concreting, steel fabrication and erection for projects like earthen dams, tunnels, composite structure hydropower projects, nuclear power plant, refineries and other industrial projects like cooling tower, silos, and Chimney</p>									
<p>Concrete construction for heavy Engineering projects:</p> <p>Selection of equipments for batching , mixing, transporting, placing and compacting for various types of jobs, safety measures during concreting, special concretes and mortars, preplaced aggregate concrete, roller compacted concrete, Green Concrete, concreting under water, concreting in different weather condition.</p>									
<p>Prefabricated Construction:</p> <p>Planning for pre-casting, Prestressed Slab, 3D modular construction of Buildings,3D Printing in Construction, selection of equipment for fabrication, transport and erection, quality measures, safety measure during erection IoT based monitoring of Construction activity</p>									
<p>Steel Construction:</p> <p>Planning for field operation, selection of equipment and erection tools and methods of welding, tools and methods of cutting and joining, safety measures during fabrication and erection.</p>									
<p>Bridge Construction: Launching of bridges by incremental launching, using false work, and balanced cantilever construction method.</p>									
<p>Ground Improvement Techniques:-</p> <p>Soil distribution in India, Reclaimed Soils, selection for field compaction procedures, compaction quality control, stone column, sand drain, diaphragm wall, soil reinforcement, thermal methods, improving rock stability and quality.</p>									
<p>Formwork:- Requirement of formwork, loads carried by formwork, types of formwork such as timber formwork, Steel formwork, patent formwork, modular shuttering, slip forms, steel scaffolding.Stay in place formwork system</p>									
<p>Innovative Construction practice for Smart and Green Buildings:</p> <p>Intelligent Building: Historical Context, High technology: - Energy efficiency, life safety systems, Telecommunications systems, workplace automation and typical services.</p> <p>Simulation of construction process/activity in time ; Limitation during execution of construction; Use of robotics in construction industry</p> <p>Alternative Construction System: Glass Fiber Reinforced Gypsum Panel System,Precast Sandwich Panel Systems, Stainless Steel Reinforcement</p>									

Sustainable Road Construction: Sustainable and Durable Rigid and Flexible pavement Construction, Prestressed Concrete Road and Composite Roads, Ultra White Toppings

Construction Materials:

Study Of Advance Building Materials like, aluminum, glass, fabric, various types of finishes & treatments, Construction chemicals – sealants, engineering grouts, mortars , admixtures and adhesives

Aspects of eco-friendly materials; Geogrids, geotextiles, artificial turf; Industrial flooring- types and applications; Sunscreens films to reduce energy requirements;

Polymers in Civil Engineering-Structural Plastics And Composites- Polymer Membranes- Coatings-Adhesives, Non - Weathering Materials-Flooring And Facade Materials- Glazed Brick, Photo Catalytic Cement, Acid Etched Copper And Composite Fiber

Metals-Metals And Special Alloys Of Steel - Water Jet Cut Stainless Steel, Mill Slab Steel, Tension Rods Assemblies And Cast Iron, Heat Treatment In Steels, Tendons.

Smart and intelligent :Types & Differences between Smart and Intelligent Materials – Special features – Case studies showing the applications of smart & Intelligent Materials.

Case Studies for heavy Construction Projects

Reference Books:-

- Thomas Baron, Erection of steel structures
- Stubbs, handbook of heavy Construction
- Mahesh Verma, Construction Equipment and its planning & applications
- R.L. Purify & Ledbetter, Construction Equipment and planning , McGraw Hill
- Wadell, Concrete Construction Handbook
- Dr. P. Purushothamma Raj, Ground Improvement Techniques, Laxmi Publications
- Punnoswami, Bridge Construction
- Ashby, M.F. and Jones.D.R.H.H. “Engineering Materials 1: An introduction to Properties, applications and designs”, Elsevier Publications, 2005.
- Deucher, K.N, Korfiatis, G.P and Ezeldin, A.S, Materials for civil and Highway Engineers, Prentice Hall Inc., 1998.
- Mamlouk, M.S. and Zaniewski, J.P., Materials for Civil and Construction Engineers, Prentice Hall Inc., 1999.
- Alternate and Innovative Construction System for Housing, BMTPC, I.K.International Pvt Ltd. 2021
- Journals of Civil Engineering and Construction Engineering, National Building Code

Course Code	Course Title	L-T-P (Hours/Week)			Credit	TA	IST	ESE	ESE hours
		0	0	2					
CECM5071L	Planning, Scheduling and Estimation Lab	0	0	2	1	60% CIE	40		
<p>Course Outcomes:</p> <ol style="list-style-type: none"> 1. An ability to perform quantity and cost estimates of Civil Engineering Projects. 2. An ability to draft and prepare construction documents, such as specifications, bill of quantities, contracts and construction schedules. 3. Able to prepare plans and schedules using appropriate tools like bar chart, line of balance, time chainage chart, network etc and able to analyse networks using suitable software's / manually. 									
<p>The course shall include assignments to cover</p> <ul style="list-style-type: none"> - Preparation of plans for construction of a facility with different levels of detail, (broad and detailed ones) for use of persons at different levels in an organization - Demonstration of use of a software application to develop plans and develop schedules - Prepare detailed estimation of quantities and use of provisional sums, day works and contingencies in the estimate form architectural and working RCC drawings for a structure (Such as high rise buildings, flyovers, bridges, commercial structures, industrial structures may be considered). - Preparation of bill of quantities for structure. 									

Course Code	Course Title	L-T-P (Hours/Week)			Credit	TA	IST	ESE	ESE hours
		0	0	2					
CECM5072L	Construction Cost Engineering Lab	0	0	2	1	60% CIE	40		
Course Outcomes: CO1.Able to prepare quick and detailed cost estimates for civil engineering facilities CO2.Able to design information system for tracking cost data & monitor costs CO3.Able to present cost data and to draw inferences based on cost data CO4.To make decisions to organize finance and to control costs CO5.Prepare and submit bids in bidding process									
The laboratory shall include Assignments to cover									
Preparation of different types of estimates for construction of a facility based on available details Cost estimates: approximate and detailed Cost engineering for construction agencies, Cost accounting concepts Cost analysis table, network based cost control Proposals and bids preparation Construction financing, breakeven, profit and cash flow analysis									
Preparation of budgets and contracts Capital budgeting Contractor's cost control on various types of contracts Owner's cost control on various types of contracts									
Demonstration of use of a software application to monitor budgets and actual expenditure									
Text Books									
<ul style="list-style-type: none"> • Successful construction cost control, HiraAhuja, Wiley • Construction cost control, Roy Pilcher, Blackwell Publishers 									

Course Code	Course Title	L-T-P (Hours/Week)			Credit	TA	MST	ESE	ESE hours
CECM5073L	Building Information modeling Lab	0	0	2	1	60% CIE	40		
<p>Course Outcomes:</p> <p>CO1 Able to understand the modeling concept of building information</p> <p>CO2 Able to carry out the planning, design, construction and operation by using suitable BIM software for multi storey building</p>									
<p>Course Content:</p> <ol style="list-style-type: none"> 1. Introduction: Introduction to BIM, Introduction to Revit interface and function, Adding Elevations and Gridlines. 2. Creating Architectural and Structural Modeling 3. Using various libraries of Revit for MEP services and interior work 4. Modeling Output: Annotation and Tagging, Labeling and tagging, Dimensioning, Room tag, Creating door and windows schedule, Estimation 5. Creating Drawing Sheet 6. Introduction to other automation software - BIM 360, Grasshopper, Dynamo, Anylogic 									

Course Code	Course Title	L-T-P (Hours/Week)			Credit	TA	MST	ESE	ESE hours
CECM5081L-A-D	Liberal Learning	0	0	2	1	60% CIE	40		

Course Code	Elective 1 Course Title	L-T-P (Hours/Week)			Credit	TA	IST	ESE	ESE hours
		3	1	0					
CECM5021T	Risk & Value Management	3	1	0	4	20	20	60	3
Course Outcomes									
CO1.Able to conduct value management and risk analysis exercise									
CO2.Able to predict life cycle costs									
CO3.Able to gather requirements and generate alternatives to satisfy needs									
CO4.Able to determine appropriate risk response									
Value engineering introduction, definitions: Value, value engineering, value analysis, value management, Habits, Roadblocks & attitudes and their relation to value engineering									
Function Analysis :Function & its role in achieving value, function in terms of its cost & worth, Graphical function analysis, function analysis system technique									
Creative thinking: creative people, creative processes, conducting creative session									
Life cycle costing: purpose& implications, economic principles for life cycle costing, types of life cycle costs.									
Risks: risks in construction, risk management framework									
Risk identification: sources of risk, risk classification, risk effects, common tools and techniques of identification									
Risk analysis: risk measurement, qualitative and quantitative techniques									
Risk response: risk management plan, risk retention, risk reduction, risk transfer, risk avoidance, attitudes towards risk									
Risks in construction projects: money, time and technical risks, contracts and risks, risks in the context of global project teams									
An Integrated Approach to Value and Risk Management: Need of integration, The integrated process, timing, Project stages and study types, Critical success factor; A framework for introducing value and risk management into an organization									
References:									
<ul style="list-style-type: none"> • Value engineering, Larry Zimmerman, Glen Hart, VanNostrand Reinhold Co • Techniques of value analysis & engineering, Lawrence Miles, McGraw Hill book Co • Risk management & construction, R Flangan& G Norman, Wiley-Blackwell • Practical risk management in construction industry, Leslie Edwards, Thomas Telford • Value and Risk Management: A Guide to Best Practice; Michael Dallas MA (Cantab), MICE, FIVM, Wiley 									

Course Code	Elective 1 Course Title	L-T-P (Hours/Week)			Credit	TA	IST	ESE	ESE hours
		3	0	0					
CECM5031S	Managerial Decision Making	3	0	0	3	20	20	60	3
<p>Course Outcomes</p> <p>1.Able to identify and formulate problems and identify suitable technique to solve the problem</p> <p>2.Able to apply linear programming, network models, dynamic programming and simulation tools</p> <p>3.Able to understand decision theoriesand issues involved in group decision making</p>									
<p>Management Decision Making</p> <p>Management decision making, art of modeling, systems approach, concept of optimization, attitudes of decision maker</p>									
<p>Linear programming Problem</p> <p>LPPsformulation, solution of LPPsby graphical method, Solution of LPP bysimplex method: Concept of duality and solution of dual problems, Solution of LPP by dual simplex method and Sensitivity analysis, and parametric analysis, transportation model, assignment model, Integer programming - branch and bound algorithm</p>									
<p>Network model</p> <p>Network definition, shortest route problem, maximal flow problem</p>									
<p>Waiting Lines</p> <p>Basic structure of queuing modelsand characteristics, Expressions for M/M/1 model</p>									
<p>Dynamic programming</p> <p>Formulation of model and recursive equations, and applications</p>									
<p>Group decision making</p> <p>Behavior of a decision maker as an individual and in a group, compromise and consensus decision making techniques</p>									
<p>Decision theory and games</p> <p>Decisions under uncertainty and risk: Marginal Analysis , decision treesanalysis, game theory</p>									
<p>Simulationof Management Systems</p> <p>Simulation and Monte Carlo method, applications</p>									
<p>References:</p> <ul style="list-style-type: none"> • Shrivastava, Shenoy& Sharma, Quantitative Techniques for Managerial Decisions, Wiley • TahaHamdy, Operations Research, An Introduction <ul style="list-style-type: none"> • Rao S S, Optimization: Theory and applications 									

Programme Elective Course I : Environmental Impact Assessment and Audit								
SN	Course Code	Elective 1 Course Title	L-T-P (Hours/Week)	Credit	TA	IST	ESE	ESE hours
	CECM5023T	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> <p>1. 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,</p> <p>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.</p> <p>2. 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.</p> <p>3. Environmental Impact Statement (EIS): Introduction, Basic Concepts behind EIS, Various Stages in EIS Production, Typical EIS Outline.</p> <p>4. Rapid EIA: Introduction, Procedure, Advantages and Limitation.</p>								

5. Terms of References (TOR) for the Projects such as Coal sector, Hydropower ,rivervalley , Highway Project, Building construction and town ship development projects etc.
6. 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

SN	Course Code	Course Title	L-T-P (Hours/W eek)	Credi t	T A	IS T	ES E	ESE Hours
	CECM5024 T	Environmental Management	3-1-0=4	4	20	20	60	3

Course Outcome:

After completion of course, student will be able to:

- CO1** demonstrate the principles of environmental management to carryout policy analysis and prepare environment management plan.
- CO2** apply the environmental management practices for infrastructural projects.
- CO3** apply the tools and develop strategies to have an environmentally sustainable project.

Syllabus

Definition of Environmental Management, Principles of Environmental Management, Nature, Scope and Components of Environmental Management, Policies and Legal Aspect of Environmental Management

1. 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.
2. 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
3. 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.
4. Environmental Legislation, Air, Water and Environmental acts., Preventive and reactive strategies for environmental pollution control, Environmental organization for planning and implementation, sustainable development.
5. 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.

Recommended books and journals etc.

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.

Course Code	Course Title	L-T-P (Hours/Week)			Credit	TA	IST	ESE	ESE hours
CECM5022T	Sustainable building construction	3	0	0	3	20	20	60	3

Course Outcomes

1. Able to understand the various performance certifications techniques for sustainable construction of buildings
2. Able to know the national and international standard such as LEED, MEP for sustainable construction of buildings

Syllabus:

1. Introduction to Green Buildings: Definition of green buildings and sustainable development, typical features of green buildings, benefits of green buildings towards sustainable development. Green building rating systems – GRIHA, IGBC and LEED, overview of the criteria as per these rating systems. Green and Lean construction

Site selection and planning: Criteria for site selection, preservation of landscape, soil erosion control, minimizing urban heat island effect, maximize comfort by proper orientation of building facades, daylighting, ventilation, etc.

2. Water conservation and efficiency: Rainwater harvesting methods for roof & non-roof, reducing landscape-water demand by proper irrigation systems, water efficient plumbing systems, water metering, waste water treatment, recycle and reuse systems.

3. Energy Efficiency: Environmental impact of building constructions, Concepts of embodied energy, operational energy and life cycle energy. Methods to reduce operational energy, zero ozone depleting potential (ODP) materials, wind and solar energy harvesting, energy metering and monitoring, concept of net zero buildings. Orientation of building according to sun diagram to reduce energy requirements;

4. Materials & Resources: local building materials, natural and renewable materials, materials with recycled content, waste and salvaged materials, waste management, Circular economy

5. Indoor Environmental Quality: Daylighting, air ventilation, exhaust systems, low VOC paints, materials & adhesives, building acoustics.

6. Innovation and design.

7. MEP systems such as ventilation, air conditioning, heating, electrical lighting and building control systems Facility management; Advance monitoring methods; Modern gadgets; Plumbing and electrical inputs

Reference book:

1. LEED Reference Guide – Green Building Design and Construction – 2009 edition Available from US Green Building Council

2. IGBC Green Homes Rating System, Version 2.0., Abridged reference guide, 2013, Indian Green Building Council Publishers.

GRIHA version 2015, GRIHA rating system, Green Rating for Integrated Habitat Assessment.

Course Code	Elective 2 Course Title	L-T-P			Credit	TA	IST	ESE	ESE hours
		(Hours/Week)							
CECM5032S	Energy conservation in facility design & construction	3	0	0	3	20	20	60	3

Course Outcomes:

- C01 Able to do analysis of energy requirements for buildings
- C02 Able to do the planning of energy efficient building and landscaping.
- C03 Able to perform the thermal analysis and design energy efficient building for human comfort

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-Energy Audit Report- Domestic Energy Consumption-Savings-Primary Energy use in Buildings-Residential-Commercial-Institutional and Public Buildings

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 daylighting; Estimation of building loads: Steady state method, network method, numerical method, correlations; Computer packages for carrying out thermal design of buildings and predicting performance.

Energy Efficiency

Energy in Building Design-Energy Efficient and Environmental Friendly Building- Climate, Sun and 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

Energy Management

Energy management concept in building, Bioclimatic classification of India; Passive concepts 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

References:

- Moore F., " Environmental control systems ", McGraw Hill, Inc., 1994.
- Brown, G.Z, Sun, " Wind and Light: Architectural design Strategies ", John Wiley & Sons., 1985.
- Cook, J, " Award - Winning Passive Solar Design ", McGraw Hill, 1984
- Fred S. Dublin and Chalmers G. Long Jr. "Energy Conservation in Buildings for Building Construction, Design and Operation", McGraw-Hill Inc., US, 1978

Course Code	Elective 2 Course Title	L-T-P (Hours/Week)			Credit	TA	IST	ESE	ESE hours
CECM5033S	Occupational Health & Safety Management	3	0	0	3	20	20	60	3

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.

Syllabus:

Unit 1: Hazards and causes of accidents: Definition: incident, accident, injury, dangerous occurrences, unsafe acts, unsafe conditions, hazards, errors, oversight, mistakes etc.

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.

Unit 2: Management of accidents and Hazards: Accident prevention: theories/models of accident occurrences. Principles of accident prevention. Accident and financial implications.

Unit 3: 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.

Unit 4: Safety precautions and practices in various construction activities like excavation, concreting, scaffold erection and dismantle, concreting, steel erection and demolition of structures, case studies.

Unit 5: 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.

Unit 6: 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)

References:

- Safety and Health in Construction, International Labour Organization, 1992
- Indian Standard on Codes of Practices for Occupational Safety & Health Auditing (IS 14489:1998)
- Guidelines on occupational safety and health management systems, 2nd edition 2009, Juan Somavia, ILO Publications, ISBN 92-2-111634-4.
- Construction Hazard & Safety handbook, 1985, R Hudson and R W King, Butterworths-Heinemann Publications, ISBN 10: 0408013478.

Course Code	Course Title	L-T-P (Hours/Week)			Credit	TA	IST	ESE	ESE hours
CECM5034S	Construction Entrepreneurship	3	0	0	3	20	20	60	3

Course outcome

- CO1 Able to prepare and evaluate contract bids
- CO2 Able to understand risks in construction business
- CO3 Able to maintain appropriate and necessary records

Course Content:

- 1. Indian construction industry:** Projects, Unique features of construction, project participants, methods of project execution
- 2. Construction economics:** Economic decision making, time value of money, evaluating alternatives, Investment criteria: Net present value, benefit cost ratio, internal rate of return.
- 3. Project organization:** Forms of business organization, structure of construction organization, organization for project management, management levels.
- 4. Construction contract and Bidding:** Types of contract, Contract document, Bidding process, Estimation of costs and bidding strategies, bid preparation, bidding models, General contract conditions (CPWD and FIDIC), sub-contracting, claims, disputes and project closure.
- 5. Planning and organizing construction site and resources:**
 - a. Site: site layout, developing site organization, record keeping at site
 - b. Manpower: planning, organizing, staffing, motivation
 - c. Materials: concepts of planning, procurement and inventory control
 - d. Equipment: basic concepts of planning and organizing,
- 6. Construction accounts:** Accounting process, revenue recognition, working capital needs, financing for working capital, Funds: cash flow, sources of funds
- 7. Risk Management, Health and Safety:** Risks in construction, Risk management process, insurance in construction, Health and Safety legislation.
- 8. Entrepreneurship:** Evolution of the concept, functions of an entrepreneur, concepts of entrepreneurship, stages in entrepreneurial process, different sources of finance for entrepreneurs, central and state level financial institutions. Micro, Small & Medium Enterprises (MSME): definition, characteristics, objectives, scope, role of MSME in economic development, advantages of MSME. Introduction to international entrepreneurship opportunities , entry into international business , exporting , direct foreign investment , venture capital
- 9. Laws applicable to construction activity**
- 10. Cost control and ERP systems; Reconciliation on the basis of as built drawing;**

Text Books:

- Jha K N, Construction Project Management, Pearson, 2011
- Chitkara K K, Construction Project Management, Tata McGraw Hill

Reference Books:

- Project Management for Construction - Fundamental Concepts for Owners, Engineers, Architects and Builders, Chris Hendrickson, World Wide Web Publication, 2000
- Barrie D.S. & Paulson B C, Professional Construction Management, McGraw Hill
- Bureau of Indian standards – IS 7272 (Part-1)- 1974 : Recommendations for labour output constant for building works
- Poornima M. Charantimath , Entrepreneurship Development and Small Business Enterprise, Dorling Kindersley (India) Pvt. Ltd

Course Code	Course Title	L-T-P (Hours/Week)			Credit	TA	IST	ESE	ESE hours
		3	0	0					
CECM5002S	Research Methodology and IPR	3	0	0	3	20	20	60	3
<p>Course Outcomes:</p> <p>CO1.Be able to conduct disciplined and ethical research under supervision</p> <p>CO2.Be able to critically evaluate current research and propose possible alternate directions for further work</p> <p>CO3.Be able to develop hypothesis and methodology for research</p> <p>CO4.Be able to communicate scientific results clearly for peer review</p> <p>CO5.Be able to explain various forms of the intellectual property, its relevance and protection</p>									
<p>Introduction:</p> <p>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</p>									
<p>Research Problem:</p> <p>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.</p>									
<p>Research Design:</p> <p>Need and features of good research design. Types of Research Designs, Basic Principles of Experimental Designs; Design of experiments.</p>									
<p>Data Collection:</p> <p>Primary and secondary data. Collection methods-Observation – Interview-Questionnaire-Schedule-Pretest-Pilot study –Experimental and case studies, Secondary data- Relevance, limitations and cautions.</p>									
<p>Sampling Design:</p> <p>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.</p>									
<p>Hypothesis Testing:</p> <p>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.</p> <p>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.</p>									

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: Content, Chapter format, Presentation of tables and figures, Referencing, Use and format of appendices- Indexing Editing and evaluating the final draft.

Research ethics:

Ethical Issues, Ethical Principles that govern Research, Ethically valid Information Sources, Regulatory Compliance.

INTELLECTUAL PROPERTY RIGHTS

Nature of Intellectual Property: The concept of IPR, Evolution and development of concept of IPR, IPR development process, Common rules of IPR practices, Types and Features of IPR Agreement: Patents, Designs, Trade Mark and Copyright. Patents – objectives and benefits of patent, Concept, features of patent. Process of Patenting and Development: Types of patent application, process E-filing, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents. New Developments in intellectual property rights

Reference Books:

- Research Methodology: R. Panneerselvam, Prentice Hall Publication ,2004
- Research Methodology: Methods and Techniques by C. R. Kothari New Age International Publishing, second edition
- Statistical Methods for Research Workers , Fisher R. A. Macmillan Pub Co, 1970
- Design and Analysis of Experiments, Montgomery D.C. John Wiley, 2001
- Robert P. Merges, Peter S. Menell, Mark A. Lemley, “ Intellectual Property in New Technological Age”, 2016.
- David Hunt, Long Nguyen, Matthew Rodgers, “Patent searching: tools & techniques”, Wiley, 2007.
- The Institute of Company Secretaries of India, Statutory body under an Act of parliament, “Professional Programme Intellectual Property Rights, Law and practice”, September 2013.

Course Code	Course Title	L-T-P (Hours/Week)			Credit	TA	IST	ESE	ESE hours
		3	1	0					
CECM5013T	Construction Resource Management	3	1	0	4	20	20	60	3
Course outcomes: C01 Able to prepare inventory analysis and make material purchase decisions. C02 Able to plan and monitor for equipments and material requirements and use. C03 Able to manage Human resources effectively and efficiently.									
Human Resources Management Staffing, recruiting, orientation and training, performance evaluating, merit rating Labour Management: Strikes and lockouts, collective bargaining, grievances and grievance settling procedure, labour welfare									
Equipment Management Mechanization on construction projects, selection of major and minor equipment, production estimating, sizing and matching of equipment Sources of construction equipment: purchase, rent and lease, old and new equipment Economics of equipment, useful / economic life of equipment, equipment operation and service, maintenance, depreciation, obsolescence and replacement Equipment management systems, organizations, record keeping, training to operators									
Materials Management Importance, estimation of materials, Classification and codification, ABC analysis Purchase function: legal aspects of purchase, inventory control, concept of EOQ Stores management, , minimizing wastage Material management systems, Organizations, record keeping									
References: Varma Mahesh, Construction Equipment, its Planning & Application, Metropolitan & Co Gopalkrishnan, Materials Management Nunnally, Managing construction equipment, Prentice Hall									

Course Code	Course Title	L-T-P (Hours/Week)			Credit	TA	MST	ESE	ESE hours
CECM5014S	Construction Contract Management	3	0	0	3	20	20	60	3

Course Outcomes

- CO1 Able to understand legal issues faced by the construction agencies.
CO2 Able to analyze trade union problems, workers' problems in view of legal provisions.
CO3 Able to analyze the contract conditions and their impact on project execution.

Course Content

- 1. Introduction to Contract:** Definition and legal issues in contract, Essential requirement of a contract as per Indian Contract Act 1872, Characteristics of a good contract, Legal enforceability of contract, Breach & termination of contracts.
- 2. Forms of Entities, establishment and their liabilities:** Sole Proprietorship Firm, Partnership firm, Private Limited Company, Limited Company – listed and unlisted, Society and Trust.
- 3. Forms of contracts:** Lump sum contracts, Fixed price contracts, Percentage rate contracts, Cost plus contracts, Target contracts, Design-Build contracts, EPC, MES, FIDIC, PPP.
- 4. Bid and Tendering:** Introduction, Bidding Systems, Electronic Procurement (e-Procurement), Modes of Tendering, Preparing Bid Documents, Publication, Receipt and Opening of Bids, Evaluation of Bids and Award of Work, Execution and Monitoring of Works and Quality Assurance, RA Bill, Design Approvals, General conditions & special conditions, Time Monitoring, Financial Monitoring, Closure of Contract, Subcontracting, Liabilities of Joint Venture. Bid Security and Performance Security, Risk Management.
- 5. Contract administration:** Deviations and extras, claims and their management, Breach of Contract, disputes, care to be taken to avoid disputes and protect rights, dispute resolution methods, Arbitration and Reconciliation Act.
- 6. Laws applicable to construction activity:** Need and broad provisions of: Environment Laws, Heritage laws, Industrial Disputes Act, Workmen's Compensation Act, Employer's Liability Act, Payment of wages Act, Contract Labour Act, Minimum Wages Act, Inter-state Migrant workmen act and other acts introduced from time to time.

References:

- Patil B S, Legal Aspects of Building & Engineering Contracts
- Gajaria, Indian contract Act
- Fisk E R, Construction Project Administration, Wiley
- All referred bare Acts ,Model Concession Agreement , FIDIC Documents Standard contract documents used by various Government agencies

Course Code	Course Title	L-T-P (Hours/Week)			Credit	TA	IST	ESE	ESE hours
		0	0	2					
CECM5074L	Construction Project Management Lab	0	0	2	1		60% CIE	40	
<p>Course Outcome:</p> <ol style="list-style-type: none"> 1. Able to prepare list of activities, logical sequence and preparation of plans 2. Able to Prepare plans and schedules of construction activity using project management software 3. Use of software to develop applications on cash flow generation, resource planning etc. 									
<p>Laboratory work to include;</p> <ul style="list-style-type: none"> - Simulation to develop issues involved in bidding, bid evaluation, plan preparation, monitoring & control - Use of project management software to develop a plan with overlapping relationships. - Application of general purpose software for project management functions like: Cash Flow generation, Resource leveling, Updating of networks, Variance analysis etc. - Site Visits 									

Course Code	Course Title	L-T-P (Hours/Week)			Credit	TA	IST	ESE	ESE hours
		0	0	2					
CECM5075L	Rehabilitation of Structure Lab	0	0	2	1		60% CIE	40	
<p>Course Outcomes: Students will be able to :</p> <p>CO1: Inspect and evaluate damaged structures.</p> <p>CO2. Perform testing to assess the condition of the existing concrete structures.</p> <p>CO3. Implement the techniques for repairing of concrete structures.</p> <p>CO4: Prepare BOQ for repairs</p>									
<p>1)Prepare a report on: a. Causes of distress in structures b. Points to be taken care during inspection and evaluation of damaged structure</p> <p>2) Study of Various NDT tests like Rebound Hammer, Ultrasonic pulse velocity, Half-cell potentiometer, Carbonation, Core test etc. and performing the same on actual structural audit site/laboratory.</p> <p>3) Study the maintenance of a nearby building/civil structure being carried out and prepare a case study on it including distress mapping, causes of distress and repair methodology etc.</p> <p>4)Study the guide lines of the Municipal Corporation or R& B department, BIS standards etc regarding declaring buildings/structures unsafe for living/use and based on this identify buildings/structures if any in your locality.</p> <p>5) Prepare BOQ for a building proposed for repairs / rehabilitation / strengthening.</p> <p>6) Selection of repair materials for concrete.</p>									

Course Code	Course Title	L-T-P (Hours/Week)			Credit	TA	IST	ESE	ESE hours
		0	0	2					
CECM5076L	Seminar on Special Topic	0	0	2	2	60% CIE	40		
Course Outcomes: CO1.Able to understand content and to summarize published research articles CO2.Able to prepare a concise report and give presentation on specific topic									
Student is expected to study at least two research papers on arelevant topic published in referred journals. Student should prepare a summary report providing background information from the topic and the contents of the research papers. Student has to present the report in an open seminar. Student may also be required to visit a construction site, study ongoing construction activities, prepare a detail report and present the same in an open seminar.									

Course Code	Course Title	L-T-P (Hours/Week)			Credit	TA	MST	ESE	ESE hours
CECM5082L-A-D	Liberal Learning	0	0	2	1	60% CIE	40		

Course Code	Elective 3 Course Title	L-T-P (Hours/Week)			Credit	TA	IST	ESE	ESE hours
		3	1	0					
CECM5041T	Integrated GIS & GPS in Infrastructure	3	1	0	4	20	20	60	3
Course Outcomes: CO1. Able to analyze spatially referenced data using scientific method to address an inquiry based study CO2. Able to acquire and create spatial data from satellite imagery, printed maps, online sources, &GPS CO3. Able to develop spatial and temporal models for presentation, analysis and decision-making CO4. To achieve competency in the use of the GIS software packages CO5. Able to design and execute a workflow GIS techniques appropriate to an applied field									
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, Web based GIS database, Drone based digital mapping, Augmented reality									
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., 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.									
Civil Infrastructure Management: Introduction, Infrastructure Life Cycle, Challenges of Infrastructure Management, meeting the challenges, Infrastructure Management services tier, GIS based civil Infrastructure management.									
Case Studies: <ol style="list-style-type: none"> i. GIS based management approach for Transportation Infrastructure Construction ii. Application of GIS in Transportation iii. GIS based applications in Airfield Infrastructure system management and maintenance iv. Developing Enterprise GIS based data repositories for Municipal Infrastructure asset management v. GIS based decision support system for optimal renewal planning of sewers vi. GIS based integrated infrastructure Management vii. GIS based technologies for watershed management viii. Single frequency GPS for Bridge deflection monitoring : progress and results ix. Monitoring of rigid structures using GPS and RTS – Experiment x. Real- time bridge health monitoring for management xi. Deformation studies of Koyana Dam, Western India using GPS. xii. GIS based Land record management 									
Reference Books:- <ul style="list-style-type: none"> • Handbook on transportation Engineering , The McGraw – Hill Publication • Concepts and Techniques of Geographical Information System, Lo C.P. Yeung A K W, Prentice Hall India • Introduction to Geographical Information System, Kang-tsung Chang, Tata McGraw Hill • International and National Journals on GIS and GPS 									

Course Code	Course Title	L-T-P (Hours/Week)			Credit	TA	IST	ESE	ESE hours
		3	1	0					
CECM5042T	Water Resource management	3	1	0	4	20	20	60	3
Course Outcomes:									
CO1. Skill of choosing the correct management techniques for water resources.									
CO2. Ability to identify and define problems, gather data, generate and prioritize a set of alternative solutions, and select and implement the best alternative.									
CO3. Ability to apply the principles of remote sensing and GIS to the water resources for management.									
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.									
2. Watershed Management techniques: Rain water harvesting, On-site and off-site management structures for soil and water conservation. Community Watershed Management									
3. 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									
4. 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.									
5. 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.									
6. Water Resources Management: Erosion control and watershed development: their benefit towards conservation of national water wealth. Rain water 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.									
7. 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									
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 									

Course Code	Elective 3 Course Title	L-T-P (Hours/Week)			Credit	TA	IST	ESE	ESE hours
		3	1	0					
CECM5043T	Construction management information systems	3	1	0	4	20	20	60	3
Course Outcomes: CO1. Able to manage the Information Systems Resources. CO2. Able to establish organizational foundations of Information Systems. CO3. Able to develop and administer Database based information systems									
Different tools and component of MIS Decision making and information requirements analysis Manual systems versus computerized systems									
System Approach and Design Design, development and implementation of system									
Process Automation Need and tool, Automation of construction engineering & management functions									
Simulation 3D visualization of construction processes									
Data acquisition system Different techniques and tool sensor Mobile and modern day communication techniques									
Economic Analysis Different method and tool for financial planning of project , monitoring project . Budget allocation and other techniques									
References: <ul style="list-style-type: none"> • Management information Systems, S Sadgopalan, PHE Learning • Management information system for the Construction industry, D E Douglas, University of Arkansas 									

Course Code	Elective 3 Course Title	L-T-P (Hours/Week)			Credit	TA	IST	ESE	ESE hours
		3	1	0					
CECM5044T	Facilities management	3	1	0	4	20	20	60	3
Course Outcomes:									
C01 Able to understand issues involved in facilities management									
C02 Able to prepare facilities management plan									
C03 Able to carry out facility performance audit.									
Types, mechanisms and analyses of deterioration of concrete and steel structures, approaches and means of damage assessment, assessing structural stability and integrity of existing structures, development of sound strategy for repair and restoration. Protection and repair materials, techniques, design and economic aspects.									
Introduction to build facility management Need, functional planning, workspace ecology, worker productivity, space planning, needs analysis									
Property maintenance Maintenance planning, support services, obsolescence and refurbishment, outsourcing									
Facility performance audit Premises audit, health & safety, whole life assessment.									
Financial aspects Budgets, budgetary control depreciation.									
Disaster recovery plans: Maintenance concepts, Understanding RISK, Risk-Based Maintenance, the methodology, Developing a risk-based maintenance strategy, Typical inspection and maintenance tasks for utilities									
MIS for facility management									
References:									
<ul style="list-style-type: none"> • Strategic management of built facility; Craig Langston & Rima Lauge Kristensen; Butterworth, Heinemann • Facilities Management - Theory & Practice; E & F N Sons • Total Facilities Management; Atkins & Book; Blackwell Science 									

Course Code	Electives 4 Course Title	L-T-P (Hours/Week)			Credit	TA	IST	ESE	ESE hours
		3	0	0					
CECM5051S	Rehabilitation of Structures	3	0	0	3	20	20	60	3
.Course Outcomes: CO1. Able to identify various types of distress in concrete structures. CO2. Able to identify the effects due to climate, temperature, chemicals, wear and erosion on structures. CO3. Able to make recommendations regarding appropriate materials and techniques for repairs									
Infrastructure management: Need and concept, expected performance, survey and evaluation of distresses, inspection checklists, organization for rehabilitation, policies, funding									
Concept of infrastructure upkeep									
Buildings: Post occupancy evaluation of buildings, deformation and common defects in buildings, restoration & rehabilitation measures									
Pipelines (water/ sewage/ air/ gas): Purpose and methods of evaluation, evaluation of physical condition, methods of rehabilitation									
Pavements (roadways / runways): Evaluation and performance surveys, distress evaluation, methods of resurfacing, overlays, restoring and rehabilitation, up-gradation and maintenance of permanent way									
Bridges: Inspection and reporting methods, rehabilitation measures									
Case studies of Repairs and rehabilitations of various structures									
Text Books: 1. Denison Campbell, Allen and Harold Roper, "Concrete Structures, Materials, Maintenance and Repair", Longman Scientific and Technical UK, 1991. 2. Allen R.T. & Edwards S.C, Repair of Concrete Structures, Blakie and Sons, UK, 1987									
References: <ul style="list-style-type: none"> • Published books in the relevant areas to be supplemented by latest journal articles and papers, seminar and conference proceedings, in-house publications, monographs etc. • CPWD and Indian Buildings Congress, Hand book on Seismic Retrofit of Buildings, Narosa Publishers, 2008. • Shetty M.S., "Concrete Technology - Theory and Practice", S. Chand and Company, 2008 									

Course Code	Course Title	L-T-P (Hours/Week)			Credit	TA	IST	ESE	ESE hours
		3	0	0					
CECM5052S	Quality Assurance on Construction Projects	3	0	0	3	20	20	60	3
Course Outcomes:									
C01 Able to apply quality control concepts for improving the quality of construction									
C02 Able to maintain the records of quality assurance processes and audits.									
C03 Able to use statistical tools for better quality control in construction projects.									
Introduction:Quality basics and history, Quality advocates, Quality improvement									
Concept of Total Quality Management;contributions of Deming, Juran, Crosby									
Quality Improvement Techniques :Pareto Diagrams, Cause-Effect Diagrams, Scatter Diagrams, Run Charts, Cause and Effect Diagrams									
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 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									
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									
Quality Function Deployment : Design of Experiments, Quality Systems: ISO 9000, Six sigma, Certification Requirements, and Auditing									
References:									
<ul style="list-style-type: none"> • Quality management in construction projects, A R Rumane, CRC Press • Management of quality in construction, Ashford, Routledge • Construction inspection handbook: total quality management, James O'Brien, Springer 									

Course Code	Course Title	L-T-P (Hours/Week)			Credit	TA	IST	ESE	ESE hours
		3	0	0					
CECM5053S	Pavement Management System	3	0	0	3	20	20	60	3
Course outcomes: C01 Skills in selecting appropriate maintenance operations / alternatives of pavements. C02 Able to plan and design pavement management system. C03 Able to design new as well as overlay on exiting flexible and rigid pavements C04 Able to carry out the cost-benefit analysis of pavements projects.									
Pavement distresses Distresses in flexible/rigid pavements causes & remedies. Visual Surface distress survey procedures and techniques. Serviceability Indicators for roads, Measurement of Serviceability Indicators using various equipments like Bump Indicator, Skid tester, Distress surveys & Benkelman Beam Functional evaluation of pavements: Serviceability Concepts, Visual Rating, Pavement Serviceability Index, Roughness Measurements, Skid Resistance, Roughness, and Safety Aspects. Inventory System									
Maintenance operations/alternatives Classification of maintenance operations: Routine, Periodic, Special. Common types of maintenance: Potholes, Cracked surface, Ruts & undulations, Resurfacing, Interface treatments, Bituminous Thin Surface Courses: Seal Coat, Surface Dressing, Premixed carpet, Mixed seal surfacing, Micro asphalt concrete (MAC) , Bituminous Surface Courses: Semi-Dense Bituminous Concrete, Bituminous Concrete, and Bitumen Mastic. Road maintenance in high rainfall areas. Choice of materials. Modified bitumen & geo-fabrics. Maintenance alternatives including recycling									
Pavement Management System (PMS) Components of PMS and their Activities, Major Steps in Implementing PMS, Inputs, Design, Construction and Maintenance, Rehabilitation and Feedback Systems									
Pavement Structural Design and Economic Analysis									
Emerging Technology in Pavement Management Systems									
References: <ul style="list-style-type: none"> - IRC 58-2001, Guidelines for the design of rigid pavements for highways - Specifications for rural road, Indian Road Congress - Rural roads manual, Indian Road Congress - Guidelines for the design of flexible pavements, Indian Road Congress - IRC 81-1997, Guidelines for strengthening of flexible road pavements using Benkalman beam deflection technique 									

Course Code	Course Title	L-T-P (Hours/Week)			Credit	TA	IST	ESE	ESE hours
CECM5054S	International Construction Business	3	0	0	3	20	20	60	3

Course Outcomes

- CO1 Able to understand the business aspects for international construction business
CO2 Able to know the cultural environment of international business.
CO3 Able to assess the nations on different parameters and determine feasibility of entering into the international business of construction.

Course Content:

1. **International economy:** International political system, multinationals economic system, features of international trade & investment, national interest in international trade, differences in culture ethics in international business
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:** Developing countries in the world economy, international differences in technology, policy implications for host countries
4. **The Strategy and Structure of International Business:** The strategy of international business, the organization of international business entry Strategy and Strategic Alliances
5. Role of Indian construction industry in international business, role of foreign companies in Indian business, some case studies, Introduction to international entrepreneurship opportunities, entry into international business , exporting , direct foreign investment , venture capital
6. Cultural aspects of communication in international establishments/companies; Communication and relationship; Global chain management; Matrix orientation, transparency; Performance management

References:

- International Business, Justin Paul, PHI
- International business-Environment & Operations, Daniels, Radebaug& Sullivan, Pearson Publications
- International business management, BholanathDutta, Excel Books
- International construction, Mark Mawhiney, Wiley-Blackwell

Open Elective 1 Course								
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	IST	ESE	ESE hours
1	CECM5061S-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 analysis of Environmental management, Shukla S. S., Shrivastva P. R. 1992, commonwealthpublishers 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
2	CECM5061S-B	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</p> <p>CO1: Describe sustainable development, development processes and relate impact of various levels of development</p> <p>CO2: Formulate the methodology for assessment of sustainability of project using various indicators.</p> <p>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</p> <p>2 Industrialization and Post-industrialization era Major structural shifts, knowledge revolution, implications for development sustainability</p> <p>3 Environmental episodes Ozone depletion, global warming, greenhouse effect, Bhopal gas tragedy etc</p> <p>4 Pollutions Major sources, permissible standards and controls of urban air pollution, water pollution, Solid and hazardous waste disposals</p> <p>5 Climate Change and the various industrial sectors The Risk of Global Climate Change, impact of CC & CN due to various industrial sectors</p> <p>6 Environmental legislations Legislative provisions and measures towards sustainability</p> <p>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)</p> <p>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)</p> <p>2 H. G. Brauch, Sustainable Development and Sustainability Transition Studies, Series: Springer Briefs in Environment, Security, Development and Peace, Series Ed.</p> <p>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>								

Open Elective 2 Course :								
SN	Course Code	Course Title	L-T-P (Hours / Week)	Credit	TA	IST	ESE	ESE hours
1	CECM5062S- A	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/ckit2001en.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								
S N	Course Code	Course Title	L-T-P (Hours / Week)	Credit	TA	IST	ESE	ESE hours
2	CECM5062S- B	Environment, Health and safety for Engineers	3-0-0=3	3	20	20	60	3
Course Outcome:								
<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; 								
Syllabus								
<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, extinguishing48 methods, fire fighting 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. 								
Reference Books:								
<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. 								

SEMESTER - III

CECM5101S 100% CIE	Self learning course I : Industry Internship:
	<p>It is mandatory to each student will undergo the Industrial Internship of 4 week to 6 week or 06 site visits report during vacation after Sem -II on Civil Engineering Project and its evaluation during Sem - III:</p> <p>The student is expected to learn the following :</p> <ol style="list-style-type: none"> 1) Office/ Site Documents, working Drawings, Tendering and Billing Process 2) Preparation and Monitoring Bar chart , Activity Network diagram to understood activities of ongoing construction sites 3) Construction Site Safety and Health practices ,Quality Parameters of construction materials and Techniques 4) Onhand practice on Construction / Project management software's And other equivalent activity

Self-learning course II								
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	IST	ESE	ESE hours
1	CECM5201-203S	<ol style="list-style-type: none"> 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								
S N	Course Code	Course Title	L-T-P (Hours/Week)	Credit	T A	IST	ES E	ESE hours
1	CECM530 1-304S	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 any one 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>								