Teaching and Examination Syllabus of Bachelor of Technology (4th Year) in Civil Engineering

(As per NEP-2023)

Department of Civil Engineering

Sardar Vallabhbhai National Institute of Technology, Surat

Sr. No.	Subject	Code	Scheme L-T-P	Credits (Min.)	Notional hours of Learning (Approx.)
	Seventh Semester (4th year of UG)				
1	Construction Project Management (*)	CE401	3-1-0	4	70
2	Elective 7	CE4AA	3-X-X	3/4	55/70
3	Elective 8	CE4BB	3-X-X	3/4	55/70
4	Elective 9	CE4CC	3-X-X	3/4	55/70
5	Elective10	CE4DD	3-X-X	3/4	55/70
			Total	**16-20**	**350-410**
6	Minor/Honor(M/H#4)	CE4EE	3-X-X	3/4	55/70/85
	Eighth Semester (4th year of UG)				
1	Industrial Internship/Professional Experience (Mandatory)	CEP08	0-0-40	20	800 (20x40)
			Total	**20**	**800**

Electives Baskets

Sr. No.	Subject (L – T – P : 3 – X – X)	Scheme L-T- P	Credits	Code
	Seventh Semester (Elective-7)			
1	Construction Laws	3-1-0	4	CE431
2	Environmental Legislation and Impact Assessment	3-0-0	3	CE433
3	Geo-synthetic and Reinforced Soil Structure	3-1-0	4	CE435
4	Design of Pre-stressed Concrete Structures	3-1-0	4	CE437
5	Computer Aided Design of Structures	3-1-0	4	CE439
6	Transport Economics	3-1-0	4	CE441
7	Urban Economics and Sociology	3-1-0	4	CE443
8	Metro Construction Technology	3-1-0	4	CE445
	Seventh Semester (Elective-8)			
1	Building Information Modeling	3-0-2	4	CE447
2	Environmental Ethics, law and Policy	3-0-0	3	CE449
3	Introduction to Finite Element Method	3-1-0	4	CE451
4	Design of Bridge Structures	3-0-0	3	CE453
5	Repair and Maintenance of Structures	3-1-0	4	CE455
6	Planning and Development of Informal Sector	3-1-0	4	CE457
7	Flood Control and River Training Works	3-1-0	4	CE459
	Seventh Semester (Elective-9)			
1	Advanced Hydraulic Structures	3-1-0	4	CE461
2	Ground Improvement Techniques	3-1-0	4	CE463

Sr. No.	Subject (L – T – P : 3 – X – X)	Scheme L-T- P	Credits	Code
3	Earthquake Resistant Design of Structures	3-1-0	4	CE465
4	Non-linear Analysis of Frame Buildings	3-1-0	4	CE467
5	Urban Infrastructure Planning	3-1-0	4	CE469
6	Urban Transport Planning	3-0-0	3	CE471
	Seventh Semester (Elective-10)			
1	Construction Safety Management	3-1-0	4	CE473
2	Industrial Waste Management	3-0-0	3	CE475
3	Design of Advanced Concrete Structures	3-1-0	4	CE477
4	Computational Hydraulics	3-1-0	4	CE479
5	Urban Governance and Legislation	3-1-0	4	CE481
6	Stochastic Hydrology	3-1-0	4	CE483
7	GPS and applications	3-1-0	4	CE485

Seventh Semester (4th year of UG)
(Subjects)

CE 401Construction Project Management

L	T	P	C
3	1	0	4

1. Course Outcomes (COs)

At the end of the course the students will be able to:

CO1	Apply project management principles to manage heavy construction projects.
CO2	Develop and implement construction project planning, scheduling and control processes.
CO3	Assess project feasibility and conduct financial appraisals for heavy construction projects.
CO4	Evaluate and select appropriate construction equipment and estimate equipment-related costs.
CO5	Utilize advanced project management tools and techniques to optimize project outcomes.

2. Syllabus

- **CONSTRUCTION PROJECTS (06 Hours)**
  Concept of project and its features, characteristics of construction projects, project life cycle, lean construction, construction project management practice, functions and principles of management, organization of construction project, project categories, project planning & organization systems, heavy construction projects, project success strategies, construction industry in India.

- **PROJECT MANAGEMENT (15 Hours)**
  Work scope planning, project work breakdown structures, bar and milestone charts, network analysis fundamentals, network elements, network development, network development and analysis, PERT, CPM, precedence network analysis, line of balance, network updating, resource allocation and scheduling, levelling & smoothing, time–cost analysis, quality assurance and control, material and human resource management, construction safety management, disputes and resolution techniques, monitoring and control.

- **PROJECT FINANCE AND APPRAISAL (08 Hours)**
  Need & types of project appraisals, concepts of financial appraisal, finance source for heavy construction projects, methods of financing the heavy construction projects, major financing bodies, economic appraisal of project, Indian practice of investment appraisal, time value of money, analysis of risk, discounted and non-discounted cash flow methods, feasibility study.

- **CONSTRUCTION EQUIPMENT (10 Hours)**
  Classification of construction equipment, types & characteristics of heavy construction equipment, equipment capacities & costs, machine power, dozers, scrapers, excavators, trucks & hauling equipment, draglines & clamshells, pile driving equipment, selection of equipment, acquisition of equipment, time value of money for heavy construction equipment, depreciation.

- **ADVANCED PROJECT MANAGEMENT (06 Hours)**
  Earned value analysis, Project management information systems, IT applications in project management, project document management, cloud computing, cloud economics, project management software, web-based construction project management, building information modelling (BIM) for construction project management.

(Total Lectures: 45 hours)

3. Books Recommended

1. K N Jha, Construction Project Management: Theory and Practice, Pearson Education, New Delhi, 2015.
2. K K Chitkara, Construction Project Management: Planning, Scheduling & Controlling, 3rd Edition, Tata McGraw - Hill Publishing Co. Ltd., New Delhi, 2014.
3. P Chandra, Projects: Planning, Analysis, Selection, Financing, Implementation, and Review, Tata McGraw-Hill, New Delhi, 2009.
4. R L Peurifoy, Construction Planning, Equipment, and Methods, Tata McGraw-Hill, New Delhi, 2002.
5. F Harris and R McCaffer, Modern Construction Management, Seventh Edition, Blackwell Publishers, Oxford, 2013.
6. James Douglas and Bill Ransom, Understanding Building Failures, 4th Edition, Routledge, 2013.

4. Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	1	3	3	3	2	3	3	2
CO2	3	3	3	3	2	3	2	2	3	3	3	3
CO3	2	3	3	2	2	3	3	2	2	3	3	3
CO4	3	3	3	3	2	2	3	2	3	3	2	2
CO5	3	3	3	2	3	2	3	2	2	3	3	3

-Not related 1-Low 2-Moderate 3-High

5. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	3	3	3
CO2	3	3	3
CO3	3	3	3
CO4	3	3	3
CO5	2	3	3

-Not related 1-Low 2-Moderate 3-High

CORE ELECTIVE/ ELECTIVE 7

7th Semester- 4th Year UG

CE 431 Construction Laws

L	T	P	C
3	1	0	4

1. Course Outcomes (COs)

At the end of the course the students will be able to:

CO1	Assess legal and commercial framework of construction contracts.
CO2	Analyze claims for losses as per the Indian laws.
CO3	Demonstrate roles of the various Indian Acts in construction.
CO4	Apply different techniques of dispute resolution in projects.
CO5	Analyze international contracts.

2. Syllabus

- **LEGAL AND COMMERCIAL FRAMEWORK (03 Hours)**
  Introduction, the power of governments, agency regulation, statute law, application of law, contractor, subcontractor, consultant, supplier, government, funder, etc.

- **CONSTRUCTION CONTRACTS AND MANAGEMENT (08 Hours)**
  Contract specification, types of contract documents used for construction, selection of a contractor, standard of work, use of construction management contracts, allocation of risk in construction management, contents of construction management contracts.

- **CONTRACTORS CLAIMS FOR LOSS AND EXPENSES (06 Hours)**
  Contract claims and damages, grounds for claims, claims procedures, quantification of procedure, insurance, bonds and guarantees.

- **THE INDIAN CONTRACT ACT, 1872 (06 Hours)**
  Definition of a contract and its essentials, formation of a valid contract - offer and acceptance, consideration, capacity to contract, free consent, legality of object, discharge of a contract by performance, impossibility and frustration, breach, damages for breach of a contract, quasi contracts, special contracts contract of indemnity and guarantee, contract of bailment and pledge, contract of agency.

- **THE COMPANIES ACT, 1956 (06 Hours)**
  Nature and definition of a company, registration and incorporation, memorandum of association, articles of association, employee welfare, strategic human resource development; employment legislation, labor legislations: industrial dispute act, factories act, payment of wages act, workmen's compensation act. Important provisions of employees' state insurance act, payment of gratuity act, employees provident fund act.

- **THE BUILDING AND OTHER CONSTRUCTION ACT, 1996 (04 Hours)**
  Registration of establishment, registration of building workers, building and other construction workers welfare boards, conditions of service of building workers, safety and health measures, special provisions, penalties and provisions.

- **REAL ESTATE (REGULATION AND DEVELOPMENT) ACT, 2016 (04 Hours)**
  Introduction, registration of real estate project, functions and duties of promoter, rights and duties of allottee, real estate regulatory authority, real estate appellate tribunals, offences and penalties, agreement for sale between promoter and allottee.

- **DISPUTE RESOLUTION (04 Hours)**
  Background of dispute, the nature of construction dispute, the role of contractor, method of dispute resolution, arbitration, litigation, adjudication, alternative dispute resolution procedure.

- **INTERNATIONAL CONTRACTS (04 Hours)**
  Introduction to FIDIC, the necessity of FIDIC contract, contract administration and claims, risk, insurance and securities, remedies and dispute resolution.

(Total Lectures: 45 hours)

3. Books Recommended

1. J Coggins, T Davie, T Ears and P Evans, Understanding Construction Law, LexisNexis Butterworths, Chatswood, 2016.S Rowlinson, Construction Safety Management Systems, Routledge, London, 2004.
2. E Baker, B Mellors, S Chalmers and A Lavers, FIDIC Contracts Law and Practices, Routledge, Taylor & Francis Group, London, 2009.
3. J Bailey, Construction Law, Taylor and Francis Group, Oxford, 2011.
4. G Kelley, Construction Law: An Introduction for Engineers, Architects, and Contractors, John Wiley & Sons, New Jersey, 2012.
5. V Bhatt and P Vyas, Laws for Engineers (Contract, Arbitration, Evidence, Limitations), Second Edition, ProCare, New Delhi, 2015.

4. Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	2	1	3	2	3	1	2	3	1
CO2	1	1	1	3	3	3	2	3	2	2	3	2
CO3	1	3	1	1	1	3	2	3	2	2	2	1
CO4	3	3	3	2	2	3	2	3	2	2	3	2
CO5	1	3	1	2	1	3	1	3	1	1	2	3

-Not related 1-Low 2-Moderate 3-High

5. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	3	1	1
CO2	3	3	3
CO3	2	2	2
CO4	3	3	2
CO5	2	2	1

-Not related 1-Low 2-Moderate 3-High

CE433-Environmental Legislation and Impact Assessment

L	T	P	C
3	0	0	3

1. Course Outcomes(COs)

At the end of the course, the students will be able to:

CO1	Interpret and explain the objectives and scope of EIA.
CO2	Categorize the importance of environmental attributes.
CO3	Describe the legal provisions and statutory requirement of environmental clearance.
CO4	Calculate the identification and prediction of environmental impacts of new/expansion projects.
CO5	Formulate an EIA for any given project.

2. Syllabus

- **IMPACT ASSESSMENT: TYPES AND SIGNIFICANCE(03Hours)**
  Types of impacts, significant impacts, various impact assessments viz. health impact assessment, social impact assessment, disaster impact assessment, strategic environmental assessment.

- **EIA: INTRODUCTION &PLANNING(06Hours)**
  Evolution of EIA; EIA at project; regional and policy levels; EIA legislative and environmental clearance procedures in India; EIA Rules-1994 and subsequent amendments, Rapid and Comprehensive EIA.

- **EIA:METHODOLOGIES AND STRATEGIES(10 Hours)**
  Screening, baseline data collection, environmental inventory of physical, biological and socio-economic environment attributes, terms of reference, scoping, identification of impacts, rapid and comprehensive EIA, monitoring, analysis and report preparation in EIA, impact prediction tools / techniques such as adhocmethod, checklist method, development of environment management plan, post project monitoring.

- **PUBLICPARTICIPATION(06Hours)**
  Project Affected Persons, significance of public participation in EIA, methods of public consultation – Public Notice and Public Hearing, Resettlement and rehabilitation issues, Land Acquisition,Rehabilitation and Resettlement Act, 2013.

- **EIACASESTUDIES(10Hours)**
  Case studies / histories for different types of projects like metro rail project, nuclear power project, large hydro-electric power project, pharmaceutical industry, township and area development projects.

- **NATIONALACTS&RULESFORENVIRONMENTALPROTECTION(10Hours)**
  IndianenvironmentallegislationandactssuchasWaterAct-1974,AirAct-1981,WildlifeProtectionAct- 1972, Forest Conservation Act-1980, Public Liability Insurance Act 1991, Environment Protection Act (EPA) – 1986; Various Rules under EPA-1986 such as Biomedical Waste Rules ~~1998~~ 2016, Coastal Regulation Zone-1999, Municipal Solid Waste rules, Hazardous Waste Rules-2016, Noise Regulation & Control Rules-2000, National Green Tribunal, NGT Act-2010, Case studies of landmark judgementsgiven by NGT and various Courts.

(TotalLectures:45Hours)

3. Books Recommended

1. Larry W.Canter, "Environmental Impact Assessment",TataMc Graw Hill Co,Singapore,1996.
2. Munn R.E., "Environmental Impact Assessment",JohnWiley&Sons, Toronto,1979
3. Suresh K.Dhameja,"Environmental Engineering and Management", S.K.Kataria&Sons, Delhi. 2004.
4. Relevant MoEF & CC Notificationsand CPCB Acts& Rules:

   Weblinks–1)https://cpcb.nic.in/index.php2)https://moef.gov.in/en/rules-and-regulations/environment-protection/3)https://cpcb.nic.in/general-standards/

4. Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	2	1	0	2	1	1	1	0	1	0
CO2	2	3	2	1	0	1	2	1	1	0	1	1
CO3	1	3	1	2	2	2	1	1	2	2	3	2
CO4	3	1	3	2	2	3	3	2	2	2	2	3
CO5	3	3	3	3	3	2	2	2	1	2	2	2

0-Not related 1-Low 2-Moderate 3-High

5. Mapping of COs and PSOs

	PSO1	**PSO2**	**PSO3**
CO1	2	1	3
CO2	2	1	2
CO3	1	1	1
CO4	3	2	3
CO5	3	3	3

0-Not related 1-Low 2-Moderate 3-High

CE 435 Geo-synthetics and Reinforced Soil Structures

L	T	P	C
3	1	0	4

1. Course Outcomes (COs)

At the end of the course the students will be able to:

CO1	Illustrate the principles of reinforced soil and its applications
CO2	Identify the types of Geosynthetics and their functions
CO3	Analyse the different engineering properties of Geosynthetic and recognize their applications for various civil engineering constructions
CO4	Design the mechanically stabilised earth wall as per the codal guidelines
CO5	Design the reinforced slope and footing

2. Syllabus

- **INTRODUCTION** **(03 Hours)**
  Historical background of reinforced soil, Principles of reinforced soil through Mohr circleanalysis

- **DIFFERENT TYPES OF GEOSYNTHETICS** **(05 Hours)**
  Types of geosynthetics like geotextiles, geogrids, geonets, geocells, geo-composites, their manufacturing methods

- **TESTING METHODS FOR GEOSYNTHETICS** **(05 Hours)**
  Techniques for testing of different index properties, strength properties, Apparent Opening Size, In-plane and cross-plane permeability tests, assessment of construction induced damage,extrapolation of long-term strength properties from short term tests.

- **REINFORCED SOIL RETAINING WALLS** **(12 Hours)**
  Different types of walls like wrap-around walls, full-height panel walls, discrete-facing panel walls, modular block walls. Design methods as per BS-8006 and FHWA methods Construction methods for reinforced soil retaining walls.

- **REINFORCED SOIL SLOPES** **(09 Hours)**
  Basal reinforcement for construction on soft clay soils, construction of steep slopes with reinforcement layers on competent soils, Different slope stability analysis methods like planarwedge method, bi-linear wedge method, circular slip methods. Erosion control on slopesusing geosynthetics.

- **APPLICATIONS IN FOUNDATIONS** **(05 Hours)**
  Binquet and Lee's approach for analysis of foundations with reinforcement layers.

- **PAVEMENT APPLICATION** **(06 Hours)**
  Geosynthetics for separation and reinforcement in flexible pavements, design by Giroud-Noiray approach, reflection cracking and control using geosynthetics. Use of geosynthetics for construction of heavy container yards and railway lines.

(Total Lectures: 45 hours)

3. Books Recommended

1. R M Koerner, Designing with Geosynthetics. Prentice Hall, New Jersey, 2012.
2. S Babu, An Introduction to Soil Reinforcement & Geosynthetics, Universities Press, India,2005.
3. J N Mandal, Geosynthetics Engineering: In Theory and Practice, Research Publishing, Singapore, 2018.
4. SK Shukla, An Introduction to Geosynthetic Engineering, CRC Press, Leiden, 2017.
5. S K Shukla, Yin JH. Fundamentals of Geosynthetic Engineering, CRC Press, Leiden, 2006.

4. Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	2	1	1	1	1	1	1	1	1	2
CO2	1	1	2	2	1	1	1	1	1	1	1	1
CO3	2	1	2	2	1	1	1	1	1	1	1	1
CO4	3	2	3	2	3	1	2	1	1	1	1	1
CO5	3	3	3	3	3	1	2	1	1	1	1	2

-Not related 1-Low 2-Moderate 3-High

5. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	3	1	1
CO2	1	1	1
CO3	2	2	2
CO4	2	2	2
CO5	3	3	3

-Not related 1-Low 2-Moderate 3-High

CE437 Design of Prestressed Concrete Structure

L	T	P	C
3	1	0	4

1. Course Outcomes (COs)

At the end of the course the students will be able to:

CO1	Comprehend the basic principles of prestressing
CO2	Apply knowledge of various prestressing systems in the field
CO3	Analyse the transfer of prestress in pre-tensioned and post-tensioned members
CO4	Design various pre stressed concrete sections
CO5	Design special prestressed concrete structural elements

2. Syllabus

- **INTRODUCTION (06 Hours)**
  Introduction to prestressed concrete- Concept of pre-stressing - Advantages of pre-stressing - Materials for prestressed concrete.

- **PRESTRESSING SYSTEMS (09 Hours)**
  Different pre stressing system - Analysis of pre stress and bending stresses -Various losses of pre-stress - Deflection of pre stressed concrete member.

- **TRANSFER OF PRESTRESS IN PRE-TENSIONED AND POST-TENSIONED MEMBERS (12 Hours)**
  Flexural strength of pre stressed concrete members - Transfer of pre stress in pre-tensioned members - Anchorage zone stresses in post-tensioned members- Limit state design criteria for Pre stressed concrete members.

- **DESIGN OF VARIOUS SECTIONS (06 Hours)**
  Design of pre stressed concrete sections - Design of pretension and post tensioned Flexural member - statically indeterminate Pre stressed Structures

- **DESIGN OF PIPE AND TANKS AND OTHER STRUCUTRES (12 Hours)**
  Prestressed concrete tanks - Pre stressed concrete slabs and grid-floors - Pre-stressed concrete bridges.

(Total Lectures: 45 hours)

3. Tutorial

Tutorial are in the form of theoretical assignments and numerical problems based on the syllabus, however, of practical significance.

4. Books Recommended

1. K. Raju, Pre-stressed Concrete, 6th Edition, Tata Mc Graw Hill, New Delhi, 2018.
2. P.Dayaratnam, Pre-stressed Concrete Structures, 7th Edition, Oxford & IBH Publication, New Delhi, 2017.
3. Dr. Praveen Nagarajan, Prestressed Concrete Design, 1st Edition, Pearson Education India, 2013.
4. L. Y. Lin, Design of Pre-stressed Concrete Structural, 3rd Edition, Asia Public House, New Delhi, 2010.
5. F. Leonhardt, Pre-stressed Concrete-Design &Construction, Welhelm Ernst and Sohn - Munich, 2007.

5. Mapping of COs and Pos

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	2	2	1	1	-	-	-	-	1
CO2	3	2	2	2	3	1	1	-	-	-	1	1
CO3	3	3	3	3	2	1	1	-	-	-	-	1
CO4	3	3	3	3	3	1	1	-	-	-	-	1
CO5	3	3	3	3	3	1	1	-	-	-	-	1

0-Not related 1-Low 2-Moderate 3-High

6. Mapping of COs and PSOs

	PSO1	**PSO2**	**PSO3**
CO1	3	2	2
CO2	3	2	2
CO3	3	3	2
CO4	3	3	2
CO5	3	3	2

0-Not related 1-Low 2-Moderate 3-High

CE 439-Computer Aided Design of Structures

L	T	P	C
3	1	0	4

1. Course Outcomes (COs)

At the end of the course the students will be able to:

CO1	Achieve Knowledge of Problem-solving skills using MATLAB, EXCEL / VBA
CO2	Explain structural design process and advantages of computer aided design.
CO3	Apply stiffness method for analysis of Truss, Beams, and Frames with special constructional aspects.
CO4	Apply numerical methods for solving structural engineering problems.
CO5	Understand modelling procedures for computer assisted structural analysis and designof RC high rise building structures usingstructural analysis software.

2. Syllabus

- **COMPUTER BASED STRUCTURAL ANALYSIS AND DESIGN: AN OVERVIEW (01 Hours)**

  Concept of Structural design process – Role of Computers in Structural Design process – Advantages of Computer Aided Design (CAD).

- **COMPUTER PROGRAMMING FOR STRUCTURAL ENGINEERS (10 Hours)**

  Introduction to MATLAB for engineers – Development of Computer Program for the Analysis of Beams – Design of slab, beam, column etc.

- **STIFFNESS METHOD FOR LINEAR ELASIC ANALYSIS (12 Hours)**

  Analysis of Trusses and Beams with emphasis on support settlement, skewness of support, internal hinge, temperature variation etc. using stiffness approach - Analysis of frames using stiffness approach.

- **INTRODUCTION TO COMPUTATIONAL TOOLS FOR STRUCUTRAL ENGINEERS (10 Hours)**

  Spreadsheet tool for engineers – Programming with Excel / VBA – Developing Spreadsheets for the design of structural elements - Developing spreadsheet tool for finding solution of linear simultaneous equations – Roots of Non-linear equations.

- **COMPUTER ASSISTED STRUCTURAL ANALYSIS AND DESIGN (12 Hours)**
  Modeling of Structural elements like truss – beam – frame and grid using structural design software – Introduction to integrated analysis and design process using structural design software packages. – Integrated analysis and design of building structures for gravity and late.

(Total Lectures: 45 hours)

3. Tutorial

1. Solving structural system like truss, beam, frame, and grid using stiffness method.
2. Developing MATLAB/C++ code and spreadsheet tool for solving nonlinear and simultaneous equations using numerical methods
3. Analysis and Design of RC building structure under lateral loading using software (MidasGen/ETABS/SAP/StaadPro etc)

(Total: 15 hours)

4. Books Recommended

4. G Ranzi and R Gilbert, Structural Analysis, Principles, Methods and Modelling, CRC Press, New York, 2015.
5. RC Hibbeler, Structural Analysis, 10th SI edition, Pearson education, 2020.
6. R S Esfandiari, Numerical Methods for engineering and scientists using MATLAB, 2nd edition, CRC Press, 2017.
7. D E Clough and S C Chapra, Spreadsheet Problem Solving and Programming for engineers and scientist, 1st edition, CRC Press, 2023.
8. V L Shah, Computer Aided Design in Reinforced Concrete Structures Publications, 2014.

5. Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	-	-	2	-	-	-	2	2	-	3
CO2	2	3	3	2	2	1	-	-	2	2	1	2
CO3	1	1	2	2	3	-	-	-	3	2	2	2
CO4	1	1	1	2	2	-	-	-	2	1	1	1
CO5	-	-	3	3	3	2	-	-	3	2	2	3

-Not related 1-Low 2-Moderate 3-High

5. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	2	3	2
CO2	2	2	2
CO3	2	2	2
CO4	1	1	1
CO5	3	3	2

-Not related 1-Low 2-Moderate 3-High

CE 441 TRANSPORT ECONOMICS

L	T	P	C
3	1	0	4

Course Outcomes(COs)

At the end of the course the students will be able to:

CO1	Estimate road user cost and time value of money.
CO2	Perform economic analysis of a transportation project.
CO3	Evaluate alternate transportation project proposals.
CO4	Carry out life-cycle cost analysis of transportation projects.
CO5	Analyze the risk involved in financing a highway project.

Syllabus

- **INTRODUCTION TOTRANSPORTATION ECONOMICS (10Hours)**
  Basic components of transport economics, review of engineering economics, elements of engineeringeconomics,andmicroeconomics,principlesofeconomicanalysis,Depreciationand Inflation, Consumerand SocialSurplus.

- **TRANSPORT COSTS AND BENEFITS (10Hours)**
  Classification of Transportation Costs, Transportation User Costs, Impacts of Demand Elasticity and Induced Demand on User Costs, Cost Estimating Methods, Pavement Cost Analysis, Life Cycle Cost Analysis, Direct and Indirect Benefits, Vehicle Operation Cost (VOC): Components of VOC, Procedure for Assessing VOC, Factors Affecting VOC: Distance and Time Related Congestion Factors, VOC Estimation in Work Zones, VOC Estimation: IRC Practice, HDM-4 Road User Effects. Total Transportation Cost, Value of travel time savings, Value of Increased Comfort and Convenience – Accident Cost, Reduction in Maintenance Cost, Issues in Transportation Cost Estimation

- **ECONOMICEVALUATION TECHNIQUES (15Hours)**
  Generationandscreeningofprojectalternatives-Differentmethodsofeconomicanalysis:- Discounting and Non discounting criteria methods – NPV - IRR, Benefit/Cost analysis. Application economic theory in traffic assignment problem-Breakeven analysis,RoadUserCost Study (RUCS) models forcosts and benefits.

- **TRANSPORTATIONPROJECT APPRAISAL AND EVALUATION (10Hours)**
  Feasibilityandevaluation,cost,impactsandperformancelevels,evaluationofalternatives,analysis techniques,costbenefitanalysis,socialandfinancialbenefits,prioritizationofprojects,risk analysis, multi- criteria decision assessment, Life Cycle Cost Analysis(LCCA)of different pavement types,Role of Highway Development and Maintenance(HDM)infeasibility studies.

Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	3	3	1	2	1	2	1
CO2	3	3	3	2	3	3	3	-	1	1	1	1
CO3	3	3	3	2	3	3	3	2	3	2	2	1
CO4	3	3	3	1	3	3	3	1	1	1	1	1
CO5	2	3	2	2	3	3	3	-	1	1	1	1

0-Not related 1-Low 2-Moderate 3-High

Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	3	3	2
CO2	3	3	2
CO3	3	3	3
CO4	3	1	2
CO5	3	2	2

0-Not related 1-Low 2-Moderate 3-High

BOOKS RECMMENDED:

1. Ian G. Heggie (1972). Transport Engineering Economics. McGraw Hill, UK.
2. Winfrey R. (2013), Highway Economic Analysis, International Textbook Company (e-Book).
3. Banerjee A. and D. Mazumdar (1999). Fundamentals of Economic Principle and Problems. ABS Publishing House, New Delhi.
4. David H. and Brewer A. (2000). Transport: An Economics and Management Perspective. Oxford University Press, UK.
5. Sinha K.C. and Labi S. (2007). Transportation Decision Making: Principles of Project Evaluation and Programming. John Wiley & Sons, USA
6. James L. Riggs, David D. Bedworth and Sabah U. Randhawa (2009). Engineering Economics, Tata McGraw Hill, New Delhi.
7. Sarkar P K., and Maitri V. (2017). Economics in Highway and Transportation Planning, Standard Publisher, New Delhi, 2010.

REFERENCE CODES:

1. Indian Roads Congress (IRC) SP: 30 (2019). Manual on Economic Evaluation of Highway Projects in India

CE443 URBAN ECONOMICS AND SOCIOLOGY

L	T	P	C
3	1	0	4

1. Course Outcomes(COs)

At the end of the course, the students will be able to:

CO1	Understand the basics of urban economics and finance
CO2	Analyzing the public finance and project development cost
CO3	Predicting the economic growth and developing quality of life
CO4	Comprehending urban sociology and cultural aspects
CO5	Developing Socio-cultural aspects of community

2. Syllabus

- **URBAN ECONOMICS BASICS AND CONCEPTS: (10 Hours)**

  Introduction to the principles of economics. Importance of economics in Urban Development. Concepts of demand, supply, elasticity and consumer markets, revenue, Economies of scale, economic and social costs, production and factor market; price determination, cost-benefit analysis, public sector pricing; Determinants of national income, consumption, investment, inflation, unemployment, capital budgeting, risk and uncertainty, long-term investment planning. National plans appraisal and economic development in relation to urban development.

- **PUBLIC FINANCE: (08 Hours)**

  Introduction to the principles of public finance. Project development cost. land values, Economic base of cities, Industrial and other economic activity's location, Policies and Urban Development.

- **ECONOMIC GROWTH, DEVELOPMENT AND QUALITY OF LIFE: (07 Hours)**

  Human development index, poverty and income distribution, employment and livelihood; balanced versus unbalanced growth, public sector dominance; changing economic policies, implications on land. Relevant case studies.

- **URBAN SOCIOLOGY BASICS AND CONCEPTS: (12 Hours)**

  Socio-cultural profile of society and urban transformation; Tradition and modernity in the context of urban and rural settlements; Issues related to caste, age, sex, gender and marginalized groups; Displacement, resettlement and rehabilitation. Social problems of slums and Urban poor, urban and rural social transformation and their impact on social life, safety, security; Crimes in urban areas and their spatial planning implications, social structure and spatial planning.

- **ROLE OF SOCIO-CULTURAL ASPECTS: (08 Hours)**

  Growth patterns of city and neighborhood communities; Social planning and policy, community participation; Marginalization and inclusive planning, National Policy. Relevant case studies.

(TotalLectures:45Hours, Tutorial 15 Hours)

3. Books Recommended

1. O'sullivan, A. (2019). Urban Economics. New York: McGraw Hill Education.
2. Jones, C. (2021). Urban Economy: Real Estate Economy and Public Policy. London: Tailor & FrancisGroup.
3. Sondge, T. (2012). Urban Sociology in India. India: Chandralok Prakashan
4. Abrahamson, M. (2013). Urban Sociology: A Global Introduction. UK: Cambridge University Press.
5. MossL.(2001),'City and Country: An Interdisciplinary Collection',Wiley Blackwell

4. MappingofCOsandPOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	1	2	2	2	3	3	2	3	2
CO2	2	1	1	1	3	1	0	1	2	2	1	1
CO3	3	1	2	3	3	1	1	2	3	3	2	2
CO4	2	2	2	2	3	1	1	1	3	2	2	1
CO5	1	1	1	1	2	2	2	2	2	2	1	1

0-Notrelated 1-Low 2-Moderate 3-High

5. MappingofCOsandPSOs

	PSO1	PSO2	PSO3
CO1	3	2	3
CO2	3	2	3
CO3	3	3	3
CO4	3	2	2
CO5	3	2	3

0-Notrelated 1-Low 2-Moderate 3-High

CE 445 Metro Construction Technology

L	T	P	C
3	1	0	4

1. Course Outcomes (COs)

At the end of the course the students will be able to:

CO1	Analyse needs of metro construction project.
CO2	Prepare construction schedules and manage metro construction projects.
CO3	Illustrate underground construction and tunnel boring technology.
CO4	Design precast concrete and understand fundamentals of metro rail.
CO5	Demonstrate railway technology for metro projects.

2. Syllabus

- **METRO PROJECT FUNDAMENTALS (05 Hours)**
  Concept of rapid transit systems, requirements of rapid transit systems. types of rapid transit systems, concept of metro rail transit system, terminology of metro construction, advantages and disadvantages of metro, metro construction projects in India.

- **UNDERGROUND CONSTRUCTION (12 Hours)**
  Need for underground construction, fundamentals of underground constructions, planning for underground construction, site preparations, characteristics of soil and basics of geotechnical engineering, methods of underground construction, top-down constriction method, bottom-up construction method, safety during underground construction, workers health and safety provisions, regulations of underground construction.

- **TUNNEL CONSTRUCTION (12 Hours)**
  Fundamental and theories of tunnel construction, types of tunnels, different cross-sections of underground tunnels, methods of tunnel boring, tunnel boring machine (TBM), parts of TBM, working procedure of TBM, procedure of tunnel construction using TBM, stations construction during tunnels, removal and dumping of excavated materials.

- **PRECAST CONCTERE TECHNOLOGY (10 Hours)**
  Fundamentals of pre-cast concrete technology, Requirements of precast concrete elements in metro construction, Theories of formwork for precast concrete, curing of precast concrete, Admixtures and ingredients of precast concrete, Transportation off precast segments, Precast segments of tunnel, Precast bridge segments, Fundamentals of precast concrete bridge construction.

- **METRO RAIL** **(09 Hours)**
  Fundamentals of railway construction, terminology of railway and its components, Railway systems, Railway track construction, Components of railway track, Rail signaling, Introduction to electric supply for metro rail.

(Total Lectures: 45 hours)

3. Books Recommended

1. M Ramachandran, Metro Rail Projects in India: A Study in Project Planning, Oxford University Press, New Delhi, 2011.
2. R K Goel, B Singh and J Zhao, Underground Infrastructures: Planning, Design and Construction, Butterworth-Heinemann, Oxford, 2012.
3. S Chandra, Railway Engineering, Oxford University Press, New Delhi, 2008.
4. K S Elliott, Precast Concrete Structures, CRC Press, Boca Raton, 2016.
5. K N Jha, Construction Project Management: Theory and Practice, Pearson Education, New Delhi, 2015.

4. Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3	3	1	2	3	1	1	1	2	3
CO2	3	1	2	2	3	1	1	2	3	1	3	2
CO3	3	1	2	2	3	1	2	1	2	2	1	2
CO4	3	1	3	1	3	1	2	1	2	1	1	1
CO5	1	2	1	1	3	2	3	2	2	3	2	3

-Not related 1-Low 2-Moderate 3-High

5. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	3	1	2
CO2	3	3	2
CO3	2	2	3
CO4	2	3	3
CO5	3	2	3

-Not related 1-Low 2-Moderate 3-High

CORE ELECTIVE/ ELECTIVE 8

7th Semester- 4th Year UG

CE 447 Building Information Modelling

L	T	P	C
3	0	2	4

1. Course Outcomes (COs)

At the end of the course the students will be able to:

CO1	Apply concepts of BIM in traditional construction practice.
CO2	Prepare basic modelling of buildings.
CO3	Design advanced modelling of building components and elements.
CO4	Illustrate nD modelling in BIM.
CO5	Conduct advanced analysis on BIM models.

2. Syllabus

- **INTRODUCTION OF BIM (06 Hours)**
  Introduction to BIM process and integrated project delivery, nD modelling, BIM software systems and guidelines to choosing different BIM software systems.

- **BASIC MODELLING (09 Hours)**
  Introduction of modelling environment and tools, modelling approaches to producing plans, 3D models, views and sections of buildings, creating an initial sample of 3D BIM model using a BIM authoring software, modelling of building including basic and vital elements, production of plans, views and 3D models, annotations and preparations of sheets for printing and publishing.

- **ADVANCED MODELLING (06 Hours)**
  Personal protective equipment, emergency rescue equipment, safety aids, first aid health care, site hoardings, safety training on site, prevention and protection equipment for working on heights, modern scaffolding technology, advance technologies and computer applications in safety management.

- **nD MODELLING (08 Hours)**
  Introduction to safety training and education, need of safety training and education, importance of training and education, requirements of safety training and education, frequency of safety training, safety audit and inspection education, training of rules and acts of safety management, safety reporting training.

- **INTEROPERABILITY IN BIM (08 Hours)**
  Co Basics about interoperability, export formats and applications, exchange of information through IFC, COBie, BIM 360 Glue, mobile BIM.

- **ADVANCED BIM** **(06 Hours)**
  Co Basics about interoperability, export formats and applications, exchange of information through IFC, COBie, BIM 360 Glue, mobile BIM, Introduction: Sketch up, Blender for 3D, Rokoko Studio, Maximo- online, HTC vive pro served, bHaptics, Shimmer3 GSR+ unit, OpenAI, Consenys, etc,.

(Total Lectures: 45 hours)

3. Practical

1. Modelling: Exploring the user interface, working with Revit elements; creating a basic floor plan, working with grids and structural columns; adding and modifying walls, loading additional building components; importing and exporting using external files and linking files; creating advanced components, creating and modifying parametric families, viewing the building model, controlling object visibility, creating and modifying section and elevation views; developing the building model, creating and modifying floors, ceilings, roofs and curtain wall; detailing and drafting, duplicating views, creating elevations, creating section structural works, floor framing, working with roofs, working with structural steel frames; working with sloped beams, working with floor decks, working with foundation slabs and slabs, footings and grade beams, managing revisions, user interface and file organization.
2. Model Development: Exploring the user interface, working with NavisWorks elements and file organization; overriding transparency, colour, and object/model location; importing 3D files, how to import and append 3D model file; understanding NavisWorks file formats, object enablers; navigation, zooming, panning, walking around sectioning, moving objects, hiding layers and objects, establishing selection sets; viewpoints, establishing and organizing custom, viewpoints, publishing the model file and viewpoints, internal/in-house clash detection, 4D simulation.

4. Books Recommended

1. R Sacks, C Eastman, G Lee and P Teicholz, BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers and Contractors, Third Edition, John Wiley and Sons, Hoboken, 2018.
2. B Hardin and D McCool, BIM and Construction Management: Proven Tools, Methods, and Workflows, John Wiley and Sons, Hoboken, 2015.
3. W Kymmell, Building Information Modeling: Planning and Managing construction Projects with 4D CAD and Simulations: Planning and Managing Construction Projects with 4D CAD and Simulations, McGraw Hill Professional, New York, 2008.
4. B Kumar, A Practical Guide to Adopting BIM in Construction Projects, Whittles Publishing, Glasgow, 2015.
5. K Kensek and D Noble, Building Information Modeling: BIM in Current and Future Practice, John Wiley and Sons, Hoboken, 2014.

5. Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	3	1	2	1	1	1	2	1	2	3
CO2	2	1	3	1	3	1	2	1	2	1	3	3
CO3	2	2	3	1	3	2	3	1	3	1	3	3
CO4	2	1	2	2	3	2	3	1	2	3	3	3
CO5	3	1	2	3	3	1	3	1	3	1	3	3

-Not related 1-Low 2-Moderate 3-High

6. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	3	2	1
CO2	2	3	2
CO3	3	3	3
CO4	3	3	3
CO5	3	3	3

-Not related 1-Low 2-Moderate 3-High

CE449 Environmental Ethics, Law and Policy

L	T	P	C
3	0	0	3

1. Course Outcomes (COs)

At the end of the course the students will be able to:

CO1	Analyse local and global environmental impact issues.
CO2	Explain the significance of environmental ethics in today scenario.
CO3	Analyse different national environmental policy and guidelines.
CO4	Explain the concepts of environmental auditing, monitoring and reporting.
CO5	Evaluate important Indian and global environmental protection acts and protocols.

2. Syllabus

- **CURRENT PERSPECTIVES OF ENVIRONMENTAL PROTECTION (06 Hours)**
  Present perspectives on practical environmental issues; Current practices of environmental solutions through engineering, technology, legislation etc; Need for environmental ethics in today's scenario; Introduction to Environmental Ethics; Pollution - the scientific vs. philosophical view
- **ENVIRONMENTAL MANAGEMENT (09 Hours)**
  Moral Psychology, the environment and ethics; Religious and cultural views; ethics and law; Important Indian environmental legislation and acts such as Water Act-1974, Air Act-1981; Important rules under Environment Protection Act (EPA) – 1986 such as Biomedical Waste Rules-1998, EIA Rules-1994, Coastal Regulation Zone-1999, Municipal Solid waste rules, Hazardous Waste Rules-2008 etc.
- **ENVIRONMENTAL POLICY (10 Hours)**
  Sustainability and sustainable development; Environmental management plan; Disaster management; Environmental Audit; Life cycle assessment; National environmental policy; Beyond environmentalism and sustainability issues.
- **INTERNATIONAL ISSUES AND ETHICS AND LAWS (10 Hours)**
  Solution of international global and local issues through environmental ethics; Ethics & Social Responsibility; Global Ecology and the Shadow of Development; The Global Ecological Crisis; Holistic Environmental Ethics; Towards Global Justice and Planetary Health International environmental laws and protocols such as Stockholm Conference, Montreal Protocol, Rio Earth Summit, Kyoto Summit; Role of UN authorities in protection of global environment; Global environmental issues and environmental laws to control global warming, ozone depletion, acid rain, hazardous waste.
- **ENVIRONMENTAL POLICY (05 Hours)**
  National Environmental policy; environmental guidelines and regulations; environmental auditing, monitoring and reporting, environmental labeling studies by Central / State bodies; theory of corporate strategies; beyond environmentalism and sustainability issues.

(Total Lectures: 452 hours)

3. Books Recommended

1. G Singh, Environmental law in India, Macmillan India, New Delhi, 2005.
2. K Thakur, Environmental protection law and policy in India, Deep and Deep publishers, New Delhi, 1997.
3. Relevant MoEF Notifications and CPCB / GPCB Acts & Rules.
4. H Rolston, A New Environmental Ethics: The Next Millennium for Life on Earth, Routledge, London, 2011.
5. P Pojman and L P Pojman, Environmental Ethics, Cengage Learning, New York, 2011.

4. Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	3	3	2	3	3	3	3
CO2	3	3	3	2	2	3	2	1	3	3	3	2
CO3	3	3	2	2	1	3	2	3	3	3	3	3
CO4	3	3	1	1	1	3	3	3	3	2	1	3
CO5	3	3	2	2	2	3	3	2	3	3	3	3

0-Not related 1-Low 2-Moderate 3-High

5. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	1	0	3
CO2	1	0	3
CO3	2	1	2
CO4	2	1	3
CO5	3	2	3

0-Not related 1-Low 2-Moderate 3-High

CE 451 Introduction to Finite Element Method

L	T	P	C
3	1	0	4

1. Course Outcomes (COs)

At the end of the course the students will be able to:

CO1	Illustrate the basic concepts of finite element (FE) analysis
CO2	Identify and select the suitable element and mesh configuration to obtain converged solution
CO3	Develop the element characteristic equation and generation of global equation
CO4	Create 1D, 2D and 3D FE models of practical problems
CO5	Applying the FE analysis on actual problem to determine induced displacements, forces, stresses, and strains

2. Syllabus

- **INTRODUCTION** **(07 Hours)**
  Matrix algebra, Fundamentals of continuum mechanics, Stresses displacements and strains insoils, solids and structures, Constitutive relations.

- **ONE- AND TWO-DIMENSIONAL PROBLEMS** **(10 Hours)**
  Plane stress and strain, Interpolation functions, Shape functions (Lagrangian / Natural), Isoparametric elements – 1D and 2D, Numerical integration. Infinite elements, Joint elements, Assembly and Solution techniques, Convergence requirements, Patch test, Examples.

- **AXISYMMETRIC PROBLEMS** **(06 Hours)**
  Formulation and Examples

- **THREE-DIMENSIONAL PROBLEMS, CONSTITUTIVE MODELLING** **(08 Hours)**
  Formulation and Examples, Elastic, Elastic-plastic and Advanced constitutive models.

- **FINITE ELEMENTS IN CIVIL ENGINEERING** **(06 Hours)**
  Applications: Analysis of Shells, Trusses, Beams and Frames, Thin and thick plates, Dynamicconsiderations, In situ earth pressure, Construction and excavation sequences, Slope stability analysis (c-φ reduction), Seepage, Consolidation, Settlement analysis, Groundwater flow.

- **SOFTWARE BASED LEARNING** **(08 Hours)**
  Pre-processing and Post processing, Tutorials/Assignments, solving few examples using FE based software (StaadPro, SAP 2000, ABAQUS, PLAXIS, Geo Studio, etc.).

(Total Lectures: 45 hours)

3. Books Recommended

1. Zienkiewicz OC, Taylor RL and Zhu JZ, The Finite Element Method Its Basis and Fundamentals, Elsevier, Amsterdam, 2014.
2. Hutton DV, Fundamentals of Finite Element Analysis, McGraw-Hill, New Delhi, 2004.
3. Reddy JN, An Introduction to the Finite Element Method, McGraw-Hill, New Delhi, 2005.
4. Chandrupatla TR and Belegundu AD, Introduction to Finite Elements in Engineering, PearsonEducation, New Jersey, 2011.
5. Logan DL, A First Course in the Finite Element Method, Cengage-Learning, New Delhi,2007.

4. Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	2	2	-	-	1	2	2	2	1
CO2	2	2	1	2	2	1	1	1	2	2	2	1
CO3	2	2	2	2	2	1	1	1	2	2	2	1
CO4	3	3	2	3	3	1	1	1	3	3	2	2
CO5	3	3	3	3	3	2	1	1	3	3	3	2

-Not related 1-Low 2-Moderate 3-High

5. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	2	1	1
CO2	2	2	2
CO3	2	2	2
CO4	3	3	3
CO5	3	3	3

-Not related 1-Low 2-Moderate 3-High

CE453: Design of Bridge Structures

L	T	P	C
3	-	-	3

1. Course Outcomes (COs):

At the end of the course the students will be able to:

CO1	Demonstrate state-of-the-art practice including fundamental knowledge of relevant code specifications in bridge engineering.
CO2	Analyse and design the bridge components such as superstructures, substructures, bearings and deck joints.
CO3	Design short and medium span bridges using existing code of practice by taking into account the structural strength, serviceability and durability aspects.
CO4	Evaluate the special features of Prestressed concrete bridges, Balanced cantilever and Cable stayed bridges.
CO5	Analyse the bridge structures by various methods.

2.Syllabus:

Topics	Hours
• **INTRODUCTION TO BRIDGES -** Introduction to bridges - definition and basic forms - bridge hydraulic and scour- component of bridge- classification of bridges- introduce the importance of construction methods in design and vice versa- short history of bridge development- site selection and soil exploration for site importance of hydraulic factors in bridge design- general arrangement of drawing computation of discharge- linear waterway- economic span- Introduction to Indian Road Congress (IRC)- load distribution theory- bridge slab- effective width- introduction to methods as per national standard IRC- and international Federal Highway Administration (FHWA) and American Association of State Highway and Transportation Officials (AASHTO)- different types of bridges- impact factor- IRC Loads- wind load- centrifugal forces- economic span length- foundation for bridges- abutments. Introduction to relevant softwares.	**07**
• **DESIGN OF T BEAM AND DECK SLAB OF BRIDGES -** Standard and general features for road bridges (width of carriageway- clearance- load to be considered using IRC dead load- impact load- wind load- longitudinal forces- centrifugal forces- horizontal forces due to water current and Buoyancy effect- earth pressure- design of T beam bridges (up to three girders only) proportioning of components- constructability evaluations- QA/QC- plans-	**09**

specifications and estimates- analysis of slab using IRC Class AA tracked vehicle- structural design of slab- analysis of cross girder for dead load & IRC Class AA tracked vehicle- structural design of cross girder- analysis of main girder using Courbon's method- calculation of dead load BM and SF- calculation of live load B M & S F using IRC Class AA Tracked vehicle- structural design of main girder- Courbon's Method- Guyon- Massonet Method- Hendry Jaegar Method- Eccentric and Multiple concentric loads.

- **SUBSTRUCTURES AND SUPERSTRUCTURES -** Design of Piers and abutments- introduction to bridge bearings- hinges and expansion joints. (no design)- methods for bridge superstructure design- methods for bridge substructure design- bridge deck and appurtenant structures; bridge bearings and expansion joints- functions- types and selection of bearings- bearing materials- design of elastomeric bearings for different conditions- expansion joints- types of expansion joints **09**
- **PRESTRESSED CONCRETE BRIDGES -** Introduction to pre-stressed concrete bridges (design concept only)- determination of minimum section modulus- prestressing force and eccentricity (deviation not necessary)- substructures: analysis and design of abetment and pier detailing- drive equilibrium equations in Cartesian and cylindrical polar coordinates. **07**
- **BALANCED CANTILEVER BRIDGES -** Components of balance cantilever bridge. the outer beam, cantilevers and central beam. Suspended beam. Design of prestressed concrete sections – Design of pretension and post tensioned Flexural member statically indeterminatePrestressedStructures **06**
- **CABLE STAYED BRIDGES -** Cable bridge features, Components: Pylon's configurations, Deck girders, Anchorages, Cable stays- design principles- advantages- arrangement of stay cables, Types of towers, Linear analysis of cables and towers **07**

[Total Theory Hours: 45]

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3. References:

1. Krishna Raju N (2017) Design of Bridges. Oxford IBH Publication House- New Delhi.
2. Jagadeesh T R, Jayaram M A (2016) Design of Bridge Structures. PHI Learning Pvt Ltd- New Delhi.
3. Krishna Raju N (2006) Prestressed concrete. Tata Mc Graw Hil- new Delhi.
4. Dayaratnam P (2005) Prestressed concrete Structures. Oxford & IBH Publication- New Delhi

5. Ponnuswarmy S (2018) Bridge Engineering. Tata McGraw Hill- New Delhi.
6. Raina V K (2018) Concrete Bridge Practice-Analysis- Design and Economics. Tata McGraw-Hill- New Delhi.
7. Subramanian N (2008) Design of Steel Structures. Oxford Publications- New Delhi.
8. Raina V K. Concrete Bridges Practice – Analysis- Design and Economics. Shroff Publications
9. Vazirani V N, Ratwani M M, Aswani M G. Design of Concrete Bridges. Khanna Publishers
10. IRC: 112- 2011- IRC: 24-2001- IRC: SP: 13-2004- IRC: SF: 54-2000 Code of Practice for Concrete Road Bridges.
11. SAP2000- and CSI Bridge- Computers and Structures
12. Barker R, Puckett J. Design of Highway Bridges. Wiley Intercedence
13. AASHTO LRFD- Bridge Design Specifications- AASHTO
14. AASHTO LRFDUS-7 (2014). AASHTO LRFD Bridge Design Specifications – 7 th Edition
15. FHWA NHI-06-088 (2006). Soils and Foundations Reference Manual- Volumes I and II - downloadable free of charge at www.ncsconsultants.com/downloads
16. FHWA-HIF-12-003 (2012). Evaluating Scour at Bridges – 5th Edition- Hydraulic Engineering Circular (HEC) 18. HEC 18
17. FHWA-HIF-12-004 (2012). Stream Stability at Highway Structures – 4th Edition- Hydraulic Engineering Circular (HEC) 20. HEC 20
18. FHW- NHI-09-111 and -112 (2009). Bridge Scour and Stream Instability Countermeasures- Experience- Selection- and Design–Volumes 1 and 2 – 3rd Edition- Hydraulic Engineering Circular (HEC) 23. HEC 23
19. Guidelines for Establishing Scour and Freeboard for Bridges in Pima County- (2012) PCRFCD/PCDOT. Pima County Scour and Freeboard

4. Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	1	2	2	2	2	2	1	-	2
CO2	2	3	3	1	2	2	2	2	2	1	1	2
CO3	3	3	3	1	2	2	2	2	2	1	1	3
CO4	3	2	3	1	3	3	2	3	3	2	1	3
CO5	3	3	3	1	3	3	3	3	3	2	2	1

-Not related 1-Low 2-Moderate 3-High

5. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	3	3	3
CO2	3	3	2
CO3	3	3	3
CO4	3	2	3
CO5	3	3	2

-Not related 1-Low 2-Moderate 3-High

CE455 - Repair and Maintenance of Structures

L	T	P	C
3	1	0	4

1. Course Outcomes (COs)

At the end of the course the students will be able to:

CO1	Identify deterioration process and construction defect in structures
CO2	Illustrate the various distress and damages to concrete structures and understand the importance of maintenance of structures
CO3	Provide solution for different methods of repairs in concrete.
CO4	Identify repair materials for proper solutions of construction defects.
CO5	Apply suitable techniques for repair and rehabilitation of structures and to choose proper repair materials

2. Syllabus

MAINTENANCE AND REPAIR OF STRUCTURES (**09Hours)**

Need for maintenance and repairs, Inspection of structures for repairs and maintenance, methods for repairs, Material and methodology for repairs, cost of repair and maintenance, repair techniques for various structural elements, classification of maintenance works, surface deterioration, efflorescence causes, surface coating and painting, water proofing, varnishing, inspection and planning, budgeting and management

- **CAUSES FOR DISTRESS IN STRUCTURE (09 Hours)**
  Philosophy and definition, causes of failure, failure in ancient time and recent times - deficiency in design drag, material production, maintenance etc.- failure related problems; manmade and natural failure or damage; diagnosis of failure; change in appearance on an exposure, chemical deterioration, mechanical deterioration - cracking in buildings

- **PRINCIPLES OF MAINTENANCE (10 Hours)**
  Terminology of maintenance and repairs- objective - life expectancy of buildings – property inspection and report – maintenance budget estimate – health and safety requirement in maintenance – agencies causing deterioration - preventive and corrective maintenance - routine maintenance of buildings– maintenance problem and root causes. maintenance cost – specifications for maintenance work

- **MAINTENANCE OF BUILDINGS (09 Hours)**
  Effect of environmental elements on buildings – effect of chemical agents on buildings and building materials – damage by biological agents like plants, trees, algae, fungus, moss, insects etc. damp proofing of existing area – repair of water supply and sanitary system - type of repair materials, characteristics – common technique of building repair – surface preparation – specification of maintenance work – termite control – type of fire – fire protection and its effect on building.

- **PREVENTIVE MEASURES FOR DURABILITY OF STRUCTURES (08 Hours)**
  Proper selection and specification of materials, construction quality, quality assurance, the use of modern techniques for construction, proper design, better workmanship.

(Total Lectures: 45 hours)

3. Books Recommended

1. P C Varghese, Maintenance, Repair and Rehabilitation and Minor works of Buildings, PHI Learning Private Limited, New Delhi, 2023
2. T Kay, Assessment and Renovation of Concrete Structures (Concrete Design and Construction Series), Longman Scientific & Technical, 1992.
3. K S Rakshit, Construction Maintenance and Repair of Highway Bridge, M/s. New Central Book Agency (P) Ltd., New Delhi, 2008.
4. R N Raiker, Learning from failures, Deficiencies in Design, Construction and Service, New Bombay, India: R and D Centre, Structural Designers and Consultants, 1987.
5. J Bhattacharjee, Concrete Structures Repair, Rehabilitation and Retrofitting, CBS Publishers and Distributors, New Delhi, 2018.

4. Mapping of COs and POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	2	0	1	3	2	0	0	0	2	1
CO2	2	1	3	3	2	2	1	1	3	1	2	1
CO3	1	3	1	1	1	0	3	1	1	2	2	2
CO4	3	2	2	1	0	1	1	1	1	2	3	2
CO5	2	2	3	2	1	3	3	2	3	2	2	3

5. Mapping of COs and PSOs:

	PSO1	PSO2	PSO3
CO1	3	3	3
CO2	3	3	3
CO3	3	3	3
CO4	2	1	3
CO5	3	3	3

Note: - 0: Not related, 1: Slightly, 2: Moderately, 3: Substantially

CE 457 PLANNING AND DEVELOPMENT OF INFORMAL SECTOR

L	T	P	C
3	1	0	4

1. Course Outcomes (COs)

At the end of the course, the students will be able to:

CO1	Understand the urbanization and urban poor
CO2	Reviewing the Policies and acts related to the development of poor
CO3	Predicting the growth of informal and formal sectors and its trends
CO4	Analyzing the role of migration and economic growth
CO5	Developing economies and housing opportunities for the informal sector

2. Syllabus

- **URBANIZATION AND URBAN POVERTY: (08 Hours)**

  Formal and Informal economy challenges and opportunities, Economic linkages, interdependency and Economic flows of formal and informal sector, forward and backward linkages, Role of informal economy and informal sector in overall economic development, Socio-cultural and environment perspectives.

- **HOUSING FOR SLUMS: (12 Hours)**

  Housing policies for the urban poor, Housing demand and assessment, Role of migration, social housing projects and best practices, case studies and examples.

- **REVIEW OF POLICIES, ACTS AND PROGRAMMES: (06 Hours)**

  Review national and international scenario, innovation in the informal sector, survey techniques for socio- economic analysis and spatial analysis, measurement and assessment with projection of informal sector, Plan formulation and integration with spatial plans.

- **PLANNING FOR URBAN VILLAGE: (11 Hours)**

  Character of urban village, Problem and issue identification, Policies and guidelines for development and redevelopment, financial models and Governance structure

- **PLANNING OF POLICIES AND STATERGIES: (08 Hours)**

  Preparation of policies and strategies for informal setting for development, redevelopment, renewal or rejuvenation

(Total Lectures: 45 Hours, Tutorial: 15 Hours)

3. Books Recommended

1. Nurul, A. (2010). The Informal Sector in Asia. VDM Verlag.
2. Wiliams, C. and schneidar F. (2016). Measuring the Global Shadow Economy: The Prevalence of Informal Work and Labour. Edward Elgar Publisher
3. Mukhopadhyay I. (2022) Employment in the Informal Sector in India. Singapore: Springer
4. Barnes T. (2018). Informa Labour in India: Three Cities, Three Journeys. Routledge.
5. Mohsen. A (2021), 'Resilience of Imformal Areas in Megacities- Magnitude, Challenges and Policies: Strategic Environment' Springer Nature Switzerland

4. Mapping of Cos and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	1	2	2	2	3	3	2	3	2
CO2	2	1	1	1	3	1	0	1	2	2	1	1
CO3	3	1	2	3	3	1	1	2	3	3	2	2
CO4	2	2	2	2	3	1	1	1	3	2	2	1
CO5	1	1	1	1	2	2	2	2	2	2	1	1

0-Notrelated 1-Low 2-Moderate 3-High

5. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	3	2	3
CO2	3	2	3
CO3	3	3	3
CO4	3	2	2
CO5	3	2	3

0-Notrelated 1-Low 2-Moderate 3-High

CE 459	L	T	P	Credit
FLOOD CONTROL AND RIVER TRAINING WORKS	**3**	**1**	**0**	**4**

1. Course Outcomes (COs)

At the end of the Course the students will be able to:

CO1	Describe flood and use of different methods for its control including advanced Techniques.
CO2	Study of hydraulic geometry and variation in plan forms in alluvial rivers.
CO3	Importance of river training work including planning and design of related structures.
CO4	Recognize morphological behavior and modeling of alluvial river.
CO5	Collaborate flood control model in conjunction of river training works.

2. Syllabus

Flood Control and Its Assessment Types of Floods, Different methods of Flood Estimation and Control, structural and non-structural flood management strategies, Types and design of flood forecasting and protection systems, Comparison of levees with bypass channels and off stream storage, reservoir operation for flood control and management, Floods in major Indian river basins, flood damage estimation models	**(09 Hours)**
Morphology of Alluvial Rivers Alluvial streams and their hydraulic geometry, bed level variation of alluvial streams, various morphological parameters, river channel process and variation in plan form of alluvial streams, morphology of some Indian rivers.	**(10 Hours)**
River Training Work Concept of river training and river management, classification of river training work, various methods of river training, Guide lines for planning and design of river embankments (levees), planning, design, construction and maintenance of guide banks and groynes for alluvial rivers, Application of Geo-synthetics and other materials in river training works.	**(10 Hours)**
Morphological Modelling Concept of modelling for river morphology, Analytical models and Numerical models for morphological studies, Overview of software related to river morphology	**(05 Hours)**

Flood Mitigation Model using Soft Techniques Development of Flood inundation map, use of software required, Essential data, required, Process of development of Model, Inclusion of suggestions of river training structures like levee, channel enhancement, bypass channel etc. in flood mitigation model.	**(11 Hours)**
	[Total Hours: 45 hours]

3. References

1. Chow, V. T., Maidment, D. R., and Mays, L. W., "Applied Hydrology", McGraw Hill International editions, New Delhi, 2017.
2. Garde, R. J., and Ranga Raju, K. G. , "Mechanics of sediment transportation and alluvial stream problems", New age International (P) Limited, Publishers", New Delhi, 2000.
3. Garde, R. J., "River Morphology", New Age International Publishers, New Delhi, 2006
4. Mays, L. W., "Hydraulic Design Handbook", Mc Graw Hill Companies, New Delhi, 1999.
5. BIS 10751(1994), 12094 (2000), 12926 (1995), 8408 (1994)

4. Mapping of COs and POs

	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO-1	2	1	1	1	2	1	3	1	1	3	1	3
CO-2	2	1	1	1	2	2	3	1	1	2	1	2
CO-3	3	3	2	2	3	3	2	2	3	2	2	3
CO-4	2	2	2	1	3	2	1	3	1	1	2	3
CO-5	2	2	2	1	1	2	1	3	1	1	2	3

1-Low 2-Moderate 3-High

5. Mapping of COs and PSOs

	PSO-1	**PSO-2**	**PSO-3**
CO-1	1	2	3
CO-2	2	2	2
CO-3	1	1	2
CO-4	2	3	1
CO-5	3	1	1

1-Low 2-Moderate 3-High

CORE ELECTIVE/ ELECTIVE 9

7^{th} Semester- 4^{th} Year UG

CE 461 ADVANCED HYDRAULIC STRUCTURES	L	T	P	Credit
	3	1	0	4

1. Course Outcomes (COs)

At the end of the Course the students will be able to:

CO1	Plan the selection of dam site, reservoir capacity and reservoir operation.
CO2	Identify the methods of hydraulic structure design.
CO3	Design of hydraulic structures.
CO4	Analysis of weir and barrages, canal regulating structures.
CO5	Design and selection of cross drainage works and energy dissipaters**.**

2. Syllabus

Planning of Water Resources Project **(05 Hours)**

Planning and investigations of reservoir and dam sites, Choice of dams, preparation and protection of foundation and abutments, dam safety and hazard mitigation.

Gravity Dam **(10 Hours)**

Forces acting on solid gravity dam, modes of failures, stability analysis, elementary and practical profile of gravity dam, internal stresses and stress concentrations in gravity dam, joints, seals, keys in gravity dams.

Embankment Dam **(10 Hours)**

Classification of embankment dam, Homogeneous and zoned embankment dams, factors influencing design of embankment dams, criteria for safe design of embankment dam, steps in design of embankment dam, seepage analysis and its control through dam and its foundation, design considerations for rock fill dam, instrumentation.

Spillways and Energy Dissipaters **(08 Hours)**

Capacity of spillways, components and profile of different types of spillways, Non-conventional type of spillways, selection and design of energy dissipaters, spillway aerator.

Diversion Headwork **(07 Hours)**

Components of diversion head works and their functions, design of weirs and barrages on permeable foundations

Design of Canal and Canal Structure **(05 Hours)**

Canal regulation structures and design of cross drainage works, canal falls, operation and maintenance of canals.

Review of codes of practice

[Total Hours: 45 Hours]

3. References:

1. USBR, Design of gravity dams, A Water Resources Technical Publication, Denver, Colorado, 1976.

2. Asawa, G. L., “Irrigation and water resources engineering”, New Age International Publishers, New Delhi, 2014.

3. Creager, W. P., Justin, J. D., and Hinds, J., “Engineering for dams”, Nemchand and Brothers, Roorkee, 1995.

4. Khatsuria, R. M., “Hydraulics of spillways and energy dissipaters”, CRC Press, 2005 (First Edition).

5. Novak, P., Moffat,A.I.B., Nalluri,C., Narayanan,R., “Hydraulic Structures”, CRC Press,2006 (Fourth Edition).

5. Mapping of COs and POs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	3	2	1	2	1	1	1	1	1	1	1	2
CO-2	3	2	1	2	1	1	1	1	1	1	1	1
CO-3	3	2	1	1	2	1	1	1	1	1	1	3
CO-4	3	2	1	1	2	2	2	2	2	1	1	1
CO-5	3	2	1	2	2	2	2	2	2	1	1	2

6. Mapping of COs and PSOs

	PSO-1	PSO-2	PSO-3
CO-1	3	2	1
CO-2	3	2	1
CO-3	3	2	1
CO-4	3	2	1
CO-5	3	2	1

CE 463 Ground Improvement Techniques

L	T	P	C
3	1	0	4

1. Course Outcomes (COs)

At the end of the course the students will be able to:

CO1	Illustrate the principle of ground improvement and identification of weak deposit
CO2	Identify the Geosynthetics and its application in Civil Engineering Project
CO3	Execute the ground improvement using stabilization and grouting technique
CO4	Design the ground improvement methods as per site requirements using national/international codal guidelines
CO5	Design of stone column and sand drain/PVD as per codal guidelines

2. Syllabus

- **INTRODUCTION** **(05 Hours)**
  Role of ground improvement in foundation engineering, Weak deposit, Classification of Ground Improvement Techniques, Principle of Ground Improvement, Factors affecting selection of Ground improvement Techniques.

- **HYDRAULIC MODIFICATION** **(08 Hours)**
  Methods of Dewatering, Design steps of Dewatering systems, Precompression and Vertical drain, Pre loading with sand drains. Radial consolidation combined vertical and radial consolidation.

- **IN-SITU DESIFICATION OF SOIL** **(10 Hours)**
  Dynamic compaction, Design of dynamic compaction by FHWA guidelines, Vibrotory compaction in sands, Vibroflotation, Blasting, Vibro compaction piles, Stone Columns, Methods of Installation of stone column, Design of stone column as per IS:15284.

- **EARTH REINFORCEMENT** **(12 Hours)**
  Geo-synthetics, Geo-synthetics applications of reinforced earth. Different types of walls like wrap-around walls, full-height panel walls, discrete-facing panel walls, modular block walls. Design methods as per ASD method, construction of steep slopes with reinforcement layers on competent soils.

- **GROUTING AND STABILIZATION** **(10 Hours)**
  Grouting principle and design, Suitability of methods of stabilization and Grouting, Suspension and solution grout, Injection methods, electrochemical stabilization, Stabilization with cement, lime and chemicals, stabilization of expansive clays.

(Total Lectures: 45 hours)

3. Books Recommended

1. J Han, Principles and Practice of Ground Improvement, John Wiley & Sons, New Jersey,2018.
2. M R Hausmann, Engineering Principles of Ground Modification, McGraw Hill PublishingCompany, New York, 2013.
3. K Kirsch, A Bell, Ground Improvement, CRC Press, Boca Raton, 2012.
4. S K Gulhati and M Datta, Geotechnical Engineering, Tata McGraw-Hill Education, NewDelhi, 2017.
5. S Mittal, An Introduction to Ground Improvement Engineering, Medtech, Delhi, 2013.
6. Design guidelines from IS code, FHWA, BS and other codal organizations.

4. Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	1	1	1	1	1	1	1	1	1
CO2	2	2	2	1	1	1	1	1	1	1	1	1
CO3	2	2	2	2	1	1	2	1	1	1	1	1
CO4	3	3	3	3	3	1	2	1	1	1	1	1
CO5	3	3	3	3	3	1	2	1	1	1	1	1

-Not related 1-Low 2-Moderate 3-High

5. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	1	1	1
CO2	2	1	2
CO3	2	1	2
CO4	3	3	2
CO5	3	3	2

-Not related 1-Low 2-Moderate 3-High

CE465 Earthquake Resistant Design of Structures

L	T	P	C
3	1	0	4

1. Course Outcomes (COs)

At the end of the course the students will be able to:

CO1	Describe the principles of engineering seismology
CO2	Calculate the lateral load distribution on RCC Building
CO3	Categorize the irregularities in buildings as per the clauses given in Codal Provisions
CO4	Analyse and Design earthquake resistant reinforced concrete buildings and water tank as per the Codal provision.
CO5	Deduce the concept of base-isolation and dampers in building

2. Syllabus

- **SEISMIC HAZARD ASSESSMENT (11 Hours)**
  Seismic Hazard Assessment: Engineering Seismology. Definitions, Introduction to Seismic hazard. Earthquake phenomenon, Seismo tectonics and seismic zoning of India-Earthquake monitoring and seismic instrumentation, Characteristics of strong Earthquake motion, Estimation of earthquake parameter, Micro zonation.

- **LATERAL LOAD ON BUILDINGS (11 Hours)**
  Lateral load on Buildings: Rigid diaphragm effect,Centre of mass and centre of stiffness, Torsional coupled and uncoupled systems, Distribution of lateral force for One storey and Multiple stories building

- **STRUCTURAL CONFIGURATION OF BUILDINGS (11 Hours)**
  Structural Configuration for earthquake resistant design, Concept of plan irregularities, soft storey, Torsion in buildings.Design provisions for these in IS-1893. The effect of infill masonry walls on frames. Modelling concepts of infill masonry walls. Behaviour of masonry building during earthquake, failure patterns.

- **CONCEPT OF EARTHQUAKE RESISTANCE DESIGN (12 Hours)**
  Concept of earthquake resistance design: Review of latest Indian seismic code IS 1893 (Part-1 & 2) and IS 4326 Provisions for buildings, Earthquake design philosophy. Analysis by seismic coefficient and response spectrum methods, IS 13920 Provisions for ductile detailing of RC building beams,

columns and joints. Earthquake analysis of elevated water tank, Model provisions for ground supported and elevated water tanks, impulsive and convective mass of water, Calculation of time period, Base shear, Base moments, Hydrodynamic pressure and sloshing wave height.

(Total Lectures: 45 hours, Tutorial :15 hours)

3. References:

1. Agrawal Pankaj &Shrinkhande Manish, Earthquake Resistant Design of Structures,1st Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2004
2. Pauley & Priestly, Seismic design of reinforced concrete and masonry buildings,John Wiley & Sons, 1992
3. Park Rand Paulay Y., Reinforced Concrete Structures, John Wiley & Sons, 1975.
4. Ghose S.K., Earthquake Resistance Design of Concrete Structures, SDCPI. R&DCenter, New Mumbai 73.
5. David J. Dowrick, Earthquake Resistant Design and Risk Reduction, 2nd Edition,John Wiley & Sons, 200

4. Tutorial:

The theoretical questions and numerical will be given as assignment to the students based on theory topics

5. Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	1	2	3	2	1	1	1	1
CO2	3	2	2	1	1	2	2	3	1	1	1	1
CO3	2	3	3	1	3	1	2	1	1	2	1	1
CO4	1	3	3	1	3	1	3	1	3	1	2	1
CO5	2	2	3	1	3	1	1	1	3	1	1	2

0-Not related 1-Low 2-Moderate 3-High

6. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	1	2	2
CO2	2	2	2
CO3	3	3	3
CO4	3	3	2
CO5	1	3	2

0-Not related 1-Low 2-Moderate 3-High

CE 467-Nonlinear Analysis of Frame Buildings

L	T	P	C
3	1	0	4

1. Course Outcomes (COs)

At the end of the course the students will be able to:

CO1	Evaluate the elastic behaviour of moment-resisting frame buildings using classical structural analysis
CO2	Detect the sources of geometric nonlinearity in frame buildings
CO3	Identify the sources of material nonlinearity in frame buildings
CO4	Predict the inelastic behaviour of moment-resisting frame buildings using nonlinear static analysis
CO5	Assess the performance of moment-resisting frame buildings using nonlinear static analysis

2. Syllabus

- **Introduction to Frame Buildings and Nonlinear Actions (03 Hours)**
  Structural Systems and Moment-Resisting Frames - Structural Actions - Sources of Nonlinearities in Frame Buildings.

- **Classical Structural Analysis (05 Hours)**
  Basis of Structural Analysis - Modelling, Loading, and Response - Principles of Structural Mechanics - Static and Kinematic Indeterminacy - Coordinate Frames - Slope Deflection Method - General Procedure for Linear Elastic Static Analysis - Special issues (Real Hinges, Specified Deformation at Supports, Flexible Restraints at Supports).

- **Geometric Nonlinear Static Analysis (13 Hours)**
  Effect of Axial Deformation on Bending - Effect of Bending on Axial Stiffness - Stability and Buckling - Solving Nonlinear Systems - General Procedure for Nonlinear Elastic Static Analysis - Special Issues (Small Strain and Large Deformation; Effective Length of Frame Members).

- **Material Nonlinear Static Analysis (13 Hours)**
  Stress-Strain Relations - Plastic Actions (Lumped Plasticity, Distributed Plasticity) - Inelasticity in Frames: Lumped Plasticity Approach - General Procedure for Nonlinear Inelastic Static Analysis.

- **Combined Geometric-Material Nonlinear Static Analysis (11 Hours)**
  General Procedure for Nonlinear Static Analysis including Geometric and Material Nonlinearity - Performance assessment of Frame Buildings using Nonlinear Static Analysis

(using ATC 40, FEMA 356 and FEMA 440) - Nonlinear Static Analysis of Frame Buildings using commercial software like SAP 2000 or Perform 3D.

(Total Lectures: 45 hours)

3. Tutorials

The students will be required to solve at least five examples and related theories from each topic as part of their assignment or tutorial. It helps to gain experience in conducting nonlinear analysis on various real-life problems applied in the field of structural engineering.

(Total Tutorials: 15 hours)

4. Books Recommended

1. Satyamoorthy,M., Nonlinear Analysis of Structures, CRC Press, Boca Raton, USA, 2017.
2. Levy,R., and Spillers,W.R., Analysis of Geometrically Nonlinear Structures, Chapman & Hall, New York, USA, 2010.
3. Kassimali,A., Matrix Analysis of Structures, Brooks/Cole Publishing Company, USA, 2011.
4. Ghali,A., and Neville,A.M., Structural Analysis – A unified Classical and Matrix Approach, E&FN Spon, London, UK, 2017.
5. Weaver,W., and Gere,J.M., Matrix Analysis of Framed Structures, CBS Publishers and Distributors, New Delhi, 2018.

5. Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	2	1	1	1	1	1	1	1
CO2	3	2	2	1	3	2	2	1	1	1	1	1
CO3	3	3	3	2	3	2	2	2	1	1	1	1
CO4	3	3	3	2	3	2	2	2	1	1	1	1
CO5	3	2	3	2	3	2	2	2	1	1	1	1

-Not related 1-Low 2-Moderate 3-High

6. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	3	1	3
CO2	3	1	3
CO3	3	1	3
CO4	3	1	3
CO5	3	1	3

-Not related 1-Low 2-Moderate 3-High

CE 469 URBAN INFRASTRUCTURE PLANNING

L	T	P	C
3	1	0	4

1. Course Outcomes(COs)

At the end of the course, the students will be able to

CO1	Understand Urban Infrastructure fundamentals with practical application.
CO2	Review different norms and guidelines of municipal infrastructure.
CO3	Adopt the most suitable management techniques for the better maintenance of infrastructure in future growth.
CO4	Identify different shortcomings and challenges in the current practices.
CO5	Explore modern techniques and technology in place of conventional methods.

2. Syllabus

- **URBAN INFRASTRUCTURE PLANNING (05 Hours)**

  Data required for provision & planning of Urban Infrastructure, Types, Significance, impact on urban form, norms and financial aspects, public, private, SPV and PPP models in infrastructure provisions, infrastructure policy.

- **NETWORKS AND SERVICES SYSTEMS (06 Hours)**

  Urban services overview, classification and significance, concepts and theories for design and operation, components, interrelationship, requirements of appropriate technology, cost recovery, gap analysis.

- **WATER SUPPLY NETWORK (06 Hours)**

  City & Household Network Scenario, Norms, National Water Policy, Water Rights: excess and underutilization of water, role of community in water provision, water harvesting, privatization of watersupply and its implications.

- **SEWERAGE NETWORK (06 Hours)**

  City & Household Network Scenario, Norms, Sewerage drainage, refuse collection, storage, recycling and disposal, minimum basic needs, formulation of objectives, norms and standards both for space allocation and quality control, Storm water Network.

- **SANITATION AND SOLID WASTE MANAGEMENT (06 Hours)**

  Types, Generation, collection system, transfer station location, Segregation, transportation, disposal, siteselection, Effect of population density, Impact of Urban land use, Bio-medical waste and disposal, Policies and programs in the provision of sanitation at various level, Low-Cost Sanitation, city sanitationplan and state sanitation strategies, cost recovery in solid waste.

- **ELECTRICITY & COMMUNICATION NETWORK (06 Hours)**

  Planning for electrification, Current scenario, services and space standards of Transformers spacestandards for electricity networks, Space station Location, Street lighting requirements, Communication network requirement.

- **SOCIAL INFRASTRUCTURE** **(10 Hours)**

  Health and Education hierarchy, norms and location. Energy distribution, fire protection: requirements, norms and standards, planning provision, milk distribution system, Recreation & Open Space Planning inSocial Infrastructure.

(Total Lectures:45Hours, Tutorial: 15 Hours)

3. Books Recommended

1. National Institute of Urban Affairs (2005). Status of water supply, sanitation, and solid wastemanagement in the urban area.
2. Yigitcanlar, T. (2010). Sustainable urban and regional infrastructure development: technologies,application, and management. IGI Global publishing company.
3. CPHEEO (2013). CPHEEO Manual on Sewerage and Sewage Treatment Systems.
4. CPHEEO (2016).CPHEEO Manual on Municipal Solid Waste Management.
5. CPHEEO (2019).CPHEEO Manual on Storm Water Drainage System

4. Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	1	2	2	2	3	3	2	3	2
CO2	2	1	1	1	3	1	0	1	2	2	1	1
CO3	3	1	2	3	3	1	1	2	3	3	2	2
CO4	2	2	2	2	3	1	1	1	3	2	2	1
CO5	1	1	1	1	2	2	2	2	2	2	1	1

0-Not related 1-Low 2-Moderate 3-High

5. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	3	2	3
CO2	3	2	3
CO3	3	3	3
CO4	3	2	2
CO5	3	2	3

0-Not related 1-Low 2-Moderate 3-High

CE 471 Urban Transport Planning

L	T	P	C
3	0	0	3

Course Outcomes (COs)

At the end of the course the students will be able to:

CO1	Paraphrase urbanization process and its impact on travel demand
CO2	Explain the urban transport planning process and specify transport planning surveys for the given problem
CO3	Perform trip generation and distribution analysis for a given study area
CO4	Apply mode share models and carry out traffic assignment for a given study area
CO5	Apply land use transport model and estimate fleet size and capacity for suitable urban transit system

1. Syllabus

- **URBANISATION PROCESS** **(03 Hours)**
  Urban growth mechanism- Urban morphology - Urbanization & travel demand - Urban development planning policy- NUTP - Urban transport projects - Urban transport problems in India.

- **URBAN TRANSPORT PLANNING PROCESS** **(04 Hours)**
  Urban travel patterns - Study area delineation- Zoning - Planning surveys - Urban activity system- Sustainable urban transport - Systems approach.

- **TRAVEL DEMAND ESTIMATE** **(04 Hours)**
  Trip based and activity based approach - Four stage travel demand modelling - Data needs and outputs - Quick response techniques - Survey designs.

- **TRIP GENERATION** **(04 Hours)**
  Productions & Attractions - Influential Factors Trip rate analysis -Category analysis- Simple & Multiple linear regression models FHWA method.

- **TRIP DISTRIBUTION** **(06 Hours)**
  Interchange matrix Growth factor methods Synthetic Methods Calibration of Gravity model.

- **MODAL SPLIT** **(06 Hours)**
  Influential factors FHWA Procedure Diversion curves & surfaces- Discrete choice models, Concept, Types, BL, MNL & HL models.

- **TRIP ASSIGNMENT** **(06 Hours)**
  Trip Assignment Procedure Diversion curves- BPR model - All or Nothing assignment - Multipath assignment - Capacity restraint assignment User equilibrium and system equilibrium approach - Stochastic assignment approach.

- **LAND USE TRANSPORT SYSTEM** **(06 Hours)**
  Urban system components - Urban spatial structure Accessibility - Location theory - Land use models - Land use transport models, Lowry & Garin Lowry models.

- **URBAN PUBLIC TRANSPORTATION** **(06 Hours)**
  Urban growth and public transport needs - transit mode classifications - transit characteristics - fleet size and capacity estimation, goods/logistic transportation.

(Total Lectures: 45 hours)

2. Books Recommended

1. B G Hutchinson, Principles of Urban Transportation System Planning, Mc-Graw Hill, 1974
2. J D Ortuzar and L G Willumsen, Modeling Transport, John Wiley & Sons,4th Edition, 2011.
3. Khisty, C. Jotio, and B. Kent Lall. 2002. Transportation Engineering an Introduction.
4. P Chakroborty and N Das, Principles of Transportation Engineering, PHI, New Delhi, 2003.
5. P Sarkar, V Maitry and G J Joshi, Transportation Planning Principles, Practices & Policies, PHI, New Delhi, 2014.

3. Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	1	3	2	0	2	2	2	3	2	1
CO2	2	3	3	1	1	2	3	1	2	1	1	2
CO3	3	2	3	3	3	1	2	0	1	2	1	2
CO4	2	1	1	1	3	0	0	0	0	0	0	1
CO5	2	2	3	1	2	1	2	0	0	1	0	1

-Not related 1-Low 2-Moderate 3-High

4. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	1	2	3
CO2	2	3	3
CO3	2	1	1
CO4	2	1	1
CO5	3	3	2

-Not related 1-Low 2-Moderate 3-High

CORE ELECTIVE/ ELECTIVE 10

7^{th} Semester- 4^{th} Year UG

CE 473 Construction Safety Management

L	T	P	C
3	1	0	4

1. Course Outcomes (COs)

At the end of the course the students will be able to:

CO1	Understand the negligence in safety management in the construction industry.
CO2	Establish safety management in your organization, and incorporate safety audit reviews in your workplace.
CO3	Assess safety risks and hazards associated with construction.
CO4	Apply safety culture, and behaviour to improve safety performance.
CO5	Communicate safe work practices, and responsibilities with all concerned stakeholders.

2. Syllabus

- **EVOLUTION OF SAFETY MANAGEMENT (06 Hours)**
  Overview of construction site safety status, construction fatalities across the globe, terminologies related to safety management, safety management systems, fatalities and injuries in construction industry, estimate of fatalities in Indian construction industry.

- **PREVENTION OF ACCIDENTS (10 Hours)**
  Accident costs, components, computation of direct cost elements, ratio of direct to indirect cost studies, accident causation theories, Heinrich's Domino theory, chain of events theory, distractions theory, accident prevention program, prevention through design, toolbox talks, hazard recognition, safe operating procedure, work permits, preventive maintenance programs, personal protective equipment.

- **HAZARD IDENTIFICATION AND RISK ASSESSMENT (10 Hours)**
  Identification of hazards, risk identification, risk evaluation and risk ranking, risk transfer, safety control measures, risk estimate: quantitative and qualitative, ergonomic assessment methods, cognitive assessment methods, construction job safety analysis, *A Priori* risk estimates, assessment of ergonomics work system, Task Demand Assessment method, job hazard analysis.

- **SAFETY INVESTIGATION AND MITIGATION (09 Hours)**
  Safety audit system, principles of auditing, types of audits, accident investigation and analysis methods, ARCTM model for accident investigation, fault tree analysis failure, modes and effect analysis, hazard and operability study, CPR basics –theory & demonstration, demonstration of portable fire extinguishers, Safety Legislation: Acts and Codes.

- **SAFETY AND HEALTH MANAGEMENT (10 Hours)**

Safety principles and system, safety practice tools, behaviour-based safety management, safety culture and performance measurement, reactive indicators, proactive indicators, contractor's safety performance evaluation framework, responsibilities of stakeholders, organization-specific responsibility of owner/employer/client, project manager, safety head, safety supervisor, site engineer, employees/workers, policies for an effective safety and health management program, safety inspection, safety manual, accident investigation reporting, safety budget and incentives, safety in demolition operations, traffic work zone safety,

(Total Lectures: 45 hours)

3. Books Recommended

1. K N Jha, D A Patel and A Singh, Construction Safety Management, Pearson, Noida, 2022.
2. S Rowlinson, Construction Safety Management Systems, Routledge, London, 2004.
3. H Lingard and S M Rowlinson, Occupational Health and Safety in Construction Project Management, Routledge, Oxford, 2004.
4. C D Reese and J V Eidson, Handbook of OSHA Construction Safety and Health, CRC Press, New York, 2006.
5. A Griffith and T Howarth, Construction Health and Safety Management, Routledge, London, 2014.

4. Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3	1	1	3	2	3	1	3	3	2
CO2	1	2	3	1	2	3	2	3	3	3	3	3
CO3	3	3	3	3	3	3	2	3	2	2	3	2
CO4	2	2	3	2	3	3	2	3	1	3	3	2
CO5	1	2	3	2	3	3	2	3	3	3	3	3

-Not related 1-Low 2-Moderate 3-High

5. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	3	3	2
CO2	3	3	2
CO3	2	3	2
CO4	2	3	2
CO5	2	3	2

-Not related 1-Low 2-Moderate 3-High

CE475 Industrial Waste Management

L	T	P	C
3	0	0	3

1. Course Outcomes (COs)

At the end of the course the students will be able to:

CO1	Explain industrial wastewater with its impact on environment
CO2	Analyse the quality and quantity of waste generated from by different industrial manufacturing processes
CO3	Analyse industrial pollution prevention by applying advance treatment
CO4	Analyse wastewater management by advance treatment system
CO5	Explain handling of different industrial wastewater with 3R concept

2. Syllabus

- **INTRODUCTION (10 Hours)**
  Sources of wastes – Industrial and domestic – Nature and characteristics of wastewater – Industrial wastewater and environmental impacts – Regulatory requirements for treatment of industrial wastewater– Quality and quantity of industrial wastes –Evaluation of pollution prevention – physical, chemical and biological process. Prevention Vs Control of Industrial Pollution – Benefits and Barriers.

- **INDUSTRIAL POLLUTION PREVENTION (10 Hours)**
  Waste minimization – Source reduction Techniques – waste volume reduction- Waste strength reduction – Neutralization – Removal of suspended and colloidal solids – Removal of inorganic and dissolved solids – reduction of wastewater at point source.

- **ADVANCE WASTEWATER MANAGEMENT (10 Hours)**
  Waste Audit – Mass Balance - Toxicity of industrial effluents and Bioassay tests - Individual and common effluent treatment plants – Zero effluent discharge systems – Wastewater quality requirements for its reuse. Quantification and characteristics of Sludge – Thickening, conditioning, digestion, dewatering and sludge disposal.

- **CASESTUDIES (15 Hours)**
  Industrial manufacturing process description– source of wastewater-Wastewater, characteristics– effect of wastewater on receiving water and sewers –waste treatment flow sheet for Textiles, Tanneries, Pulp and paper, Pharmaceuticals, Sugar.

(Total Lectures: 45 hours)

3. Books Recommended

1. P G Smith and J S Scott, Dictionary of Water and Waste Management - Heinemann, Linacre House, Oxford 2005.
2. S N Barton, Industrial Waste: Management, Assessment and Environmental Issues; Nova Science Publishers, New York, 2016.
3. A D Patwardhan, Industrial Waste Water Treatment. PHI Learning, New Delhi, 2008.
4. N L Nemerow, Industrial Waste Treatment, Elsevier Butterworth- Heinemann, USA, 2007.
5. M N Rao and A K Datta, Waste Water Treatment, Oxford & IBH Publishing, New Delhi, 2017.

4. Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	1	1	2	2	1	1	0	2	1
CO2	2	2	3	1	1	1	1	1	1	1	1	1
CO3	2	3	3	3	3	2	2	3	3	2	1	2
CO4	3	1	3	3	3	2	2	3	2	2	2	1
CO5	2	1	1	1	2	1	1	1	1	1	2	1

0-Not related 1-Low 2-Moderate 3-High

5. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	1	1	2
CO2	1	2	2
CO3	3	3	2
CO4	3	2	2
CO5	2	2	2

0-Not related 1-Low 2-Moderate 3-High

CE477 Design of Advanced Concrete Structures

L	T	P	C
3	1	0	4

1. Course Outcomes (COs)

At the end of the course the students will be able to:

CO1	Comprehend material-strengths, structural-response and design procedures to design various structural forms.
CO2	Design and detail combined footings in accordance to relevant code provisions.
CO3	Apply advanced tools and techniques in design procedures of water tanks.
CO4	Analyze the design and detailing procedures of retaining wall.
CO5	Evaluate types, behavior and design procedure of shear wall.

2. Syllabus

- **DESIGN OF COMBINED FOOTING (12 Hours)**
  Introduction - Types of combined footings - Rectangular pad footing - Rectangular strap footing - Strip footing -Trapezoidal Footing

- **LIMIT STATE DESIGN OF WATER TANK (13 Hours)**
  Classification of water tank - Codal provisions - Design of circular and rectangular ground supported water tanks - Design of circular and rectangular underground water tanks

- **DESIGN OF RETAINING WALL (12 Hours)**
  Introduction - Types of Retaining wall - behavior and application of retaining wall - Loads on retaining wall - stability criteria - design of cantilever retaining wall - design of counter fort retaining wall.

- **DESIGN OF RC SHEAR WALL (07 Hours)**
  Introduction - Types of shear wall - Behavior of shear wall - Design procedure of shear wall Detailing of shear wall.

(Total Lectures: 45 hours, Tutorials: 15 hours)

3. Tutorial

The theoretical questions and numerical will be given as assignment to the students based on theory topics

4. Books Recommended

1. S U Pillai and D Menon, Reinforced Concrete Design, 3rd edition, Tata Mc Graw Hill Publication Ltd, New Delhi. 2009.
2. H J Shah, Reinforced Concrete, Vol. I and II, Charotar Publishing House, Anand, 2007.

3. A V Varghese, Advanced Reinforced Concrete, Varghese, Prentice Hall of India. New Delhi, 2005.
4. M L Gambhir, Fundamentals of Reinforced Concrete Design, Prentice Hall of India, New Delhi, 2006.
5. N Subramanian, Design of Reinforced Concrete Structures, Oxford University Press, New Delhi, 2013.

5. Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	2	1	-	-	-	-	-	-
CO2	3	2	3	2	1	2	1	-	-	-	-	-
CO3	2	3	3	2	2	-	1	-	1	-	-	-
CO4	3	3	2	3	2	-	1	-	1	-	-	-
CO5	3	2	2	1	2	-	1	-	-	-	-	-

-Not related 1-Low 2-Moderate 3-High

6. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	3	1	3
CO2	3	1	3
CO3	2	1	3
CO4	3	1	3
CO5	3	1	3

-Not related 1-Low 2-Moderate 3-High

CE479 COMPUTATIONAL HYDRAULICS

L	T	P	Credit
3	1	0	4

1. Course Outcomes (COs)

At the end of the Course the students will be able to:

CO1	Recall concepts of fluid motion
CO2	Derive and apply appropriate flood wave routing models
CO3	Solve partial differential equations using numerical methods
CO4	Apply numerical methods for flood waves, flow through saturated porous media and closed conduit flows
CO5	Solve the real-world problems related to water flow

2. Syllabus

BASIC CONCEPTS OF FLUID MOTION **(11 Hours)**

Basic Concepts – Lagrangian and Eulerian methods of describing fluid motion, acceleration and deformation of fluid elements, Laws governing fluid motion, continuity, Euler's equation, Energy equation, Saint Venant equation, classification of partial differential equations.

NUMERICAL TECHNIQUES FOR SOLUTION OF PARTIAL DIFFERENTIAL EQUATION **(18 Hours)**

Review of linear algebra, solution of simultaneous linear algebraic equations-matrix inversion, solvers-direct methods, elimination methods, ill conditioned systems, Gauss-Seidel method, successive over relaxation method, Finite difference method, Finite element method, Finite volume method.

ENGINEERING APPLICATIONS **(16 Hours)**

Application to water resources problems in open channel flows, Pressure Flow, ground water flows, and unsaturated flows through porous media.

[Total Hours: 45 Hours, Tutorial: 15 hours]

3. References

1. Gerald, C.F., and Wheatley, P.O., "Applied Numerical Analysis", Pearson Education India, 2007 (Seventh Edition)
2. Choudhary, M. H., "Open Channel Flows", Springer, 2007 (Second Edition).
3. Abbott, M. B., "Computational Hydraulics", Pitman Publishing House, 1979.
4. Cunge, J. A., Holly, F. M., Verway, A., "Practical Aspects of Computational River Hydraulics", Pitman Publishing House, 1980.

5. Pinder, G., and Gray, W. G., “Finite Element Simulation in Surface and Subsurface Hydrology”, Academic Press, New York, 1997.
6. Hoffman, D. H., “Numerical Methods for Engineers and Scientists”, CRC Press, Boca Raton, 2001 (Second Edition)

4. Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	1	1	1	2	1	1	1	1	1	1
CO2	2	3	2	2	2	1	2	2	1	1	2	2
CO3	2	1	2	2	3	1	2	2	2	1	2	2
CO4	3	2	3	3	3	2	3	3	3	1	3	2
CO5	3	3	3	3	3	2	3	3	3	1	3	3

1-Low 2-Moderate 3-High

5. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	1	1	2
CO2	2	2	1
CO3	2	2	1
CO4	3	3	3
CO5	3	3	3

1-Low 2-Moderate 3-High

CE481 URBAN GOVERNANCE AND LEGISLATION

L	T	P	C
3	1	0	4

1. Course Outcomes(COs)

At the end of the course, the students will be able to:

CO1	Classify Indian System of urban governance, organization structure and planning legislation.
CO2	Understand finance systems of ULB's and role of state and central government.
CO3	Review of constitutional amendments and their relevance to planning and plan implementation.
CO4	Identify ULB's role, functions for citizens including public administration.
CO5	Formulate and design scenarios for ULB's in context of governance, finance and administration.

2. Syllabus

- **OVERVIEW OF URBAN GOVERNANCE (06 Hours)**

  Definition, concepts, components, government and governance, hierarchy and structure, forms of governance, Indian Constitution, Planning Legislation-Acts and Amendments.

- **INDIAN SYSTEM OF URBAN GOVERNMENT (10 Hours)**

  Salient Features of Local Government System in India-historical overview; Commissions & Committees;Council of State ministers; All India Council of Mayors; Centre-State-Local Relationships, 73^{th} & 74^{th} Constitution Amendment Act, E-governance and M-governance.

- **URBAN LOCAL GOVERNANCE AND PARTICIPATORY PROCESSES (15 Hours)**

  Role of Municipal bodies, City/Urban development authority in urban development, its background, functions, powers, organizational structure, achievement and limitation, case studies, ULB interface withNGO's, other agencies. stakeholders' participation, roles and responsibilities, access to government by various stakeholders.

- **URBAN FINANCE (14 Hours)**

  Central and State; Taxation, Property Tax Administration – Valuation Assessment, Collection, Budget, Municipal Accounting, Municipal Audit – Concepts, Settlement of Audit Objectives. Urban fiscal reforms, municipal finance and urban inclusion, Sources of revenues and application of money; Equities; Loans; Debt financing; Municipal Bonds, land and non-land-based sources.

(Total Lectures: 45Hours, Tutorial:15 Hours)

3. References

1. Mathur,O.P. and George,P.(2006).State Finance Commissions and Urban Fiscal Decentralization in India .NIPFP.
2. Ministry of Finance.(2011).Report of 13th Finance Commission Government of India. NewDelhi.
3. Jayal,N.G.PrakashA.and SharmaP.K.(2006).Local Governance in India: Decentralization and Beyond .Oxford University Press, New Delhi.
4. Baud,I.S.A.,and Wit,J.de.(2008).New Forms of Urban Governance in India :Shifts ,Models, Networks and Contestations Sage, New Delhi.
5. Sharma A.K.(2004).Bureaucracy and Decentralization, Mittal, New Delhi.

4. Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	1	2	2	2	3	3	2	3	2
CO2	2	1	1	1	3	1	0	1	2	2	1	1
CO3	3	1	2	3	3	1	1	2	3	3	2	2
CO4	2	2	2	2	3	1	1	1	3	2	2	1
CO5	1	1	1	1	2	2	2	2	2	2	1	1

0-Notrelated 1-Low 2-Moderate 3-High

5. Mapping of Cos and PSOs

	PSO1	PSO2	PSO3
CO1	3	2	3
CO2	3	2	3
CO3	3	3	3
CO4	3	2	2
CO5	3	2	3

0-Notrelated 1-Low 2-Moderate 3-High

CE 483 Stochastic Hydrology

L	T	P	C
3	1	0	4

1. Course Outcomes (COs)

At the end of the course the students will be able to:

CO1	Apply knowledge of stochastic hydrology.
CO2	Appraise basic concepts of probability theory
CO3	Elaborate various types of time series analyses
CO4	Explain various types of stochastic models
CO5	Fit probability distribution to hydrologic data

2. Syllabus

- **INTRODUCTION**
  (02Hours)
  Stochastic hydrology – Applications of stochastic hydrology.

- **FUNDAMENTALS OF STATISTICS (10 Hours)**
  Concept of probability – Discrete and continuous variables – Probability distributions including fitting to hydrological data.

- **TIME SERIES ANALYSIS (08 Hours)**
  Definitions and classification of time series – Stochastic processes – Components of time series – Trend analysis – Periodicity – Auto-correlation and spectral analysis – Frequency analysis.

- **STOCHASTIC MODELS (13 Hours)**
  Univariate models: classification of models – univariate annual models with normal and other distributions – univariate annual models obeying Hurst's law – univariate seasonal models. Multivariate models: multisite annual models – multisite AR models for seasonal flows – MA models – ARIMA models – non-stationary processes.

- **CASE STUDIES (12 Hours)**
  Examples related to fitting probability distributions – Trend analysis – Spectral analysis – Stochastic models in hydrologic forecasting.

[Total Lectures: 45 hours]

3. Books Recommended

1. N T Kottegoda, Stochastic Water Resources Technology, The Macmillan Press Ltd., 1980.
2. V P Singh, Handbook of Applied Hydrology, Second Edition, McGraw-Hill, New York, 2016.
3. V Yevjevich, Stochastic Processes in Hydrology, Water Resources Publications, Fort Collins, Colorado, 1972.
4. C T Hann, Statistical Methods in Hydrology, Wiley–Blackwell, 2002 (Second Edition).
5. R T Clarke, Mathematical Models in Hydrology, FAO, 1973.

4. Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	2	1	1	1	1	1	1	1	1	1
CO2	1	1	2	1	1	1	1	1	1	1	1	1
CO3	1	1	2	2	2	2	2	1	2	2	2	2
CO4	1	1	2	2	2	2	2	1	2	2	2	2
CO5	3	2	3	2	2	2	2	1	2	2	2	2

1-Low 2-Moderate 3-High

5. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	1	1	1
CO2	1	1	1
CO3	1	1	1
CO4	1	1	1
CO5	3	2	3

1-Low 2-Moderate 3-High

CE 485 GPS and Applications

L	T	P	Credit
3	1	0	04

1. Course Outcomes (COs)

At the end of the course the students will be able to:

CO1	Describe GPS and geodesy
CO2	Explain different positioning modes
CO3	Analyze different errors
CO4	Integrate GPS with other technologies
CO5	Solve complex civil engineering applications using GPS

2. Syllabus

Global Positioning System **(07 Hours)**
History - Segments of GPS system - GPS receivers and its components –GPS signals

Datum, Coordinate Systems and Map Projections **(07 Hours)**
Geodesy - Earth surface - Datum – Co-ordinate systems - Projection systems

Positioning Modes **(07 Hours)**
Absolute positioning - Relative positioning - Differential GPS –Real Time Kinematic GPS

Errors and Corrections **(06 Hours)**
Types of errors - Accuracy and precision - Basic statistical concept – Satellite Geometry

GPS and Information Technology **(09 Hours)**
GPS-GIS integration–Other types of integrations - GPS and Remote Sensing - Web based development - GPS software

Applications of GPS **(09 Hours)**
General applications - Engineering applications - Special applications - Innovative applications - 3D modelling- Case studies

(Total Lecture Hours: 45)

3. Books Recommended

1. NK Agrawal, Essentials of GPS, Spatial Network, Hydrabad, 2006.
2. A Leick, LRapoport and DTatarnikov, GPS Satellite Surveying, John Wiley and Sons, 2015.
3. MNKulkarni, Proceedings of CEP Training Course on The Global Positioning System and its Applications, IIT Bombay, Mumbai, 2003.
4. A E Rabbany, Introduction to GPS, Artech House, Boston, 2002.
5. G S Rao, Global Navigation satellite Systems, Tata McGraw Hill, New Delhi, 2010.

4. Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	2	2	2	3	3	3	-	-	-	1
CO2	1	2	2	-	-	-	3	3	2	2	3	1
CO3	2	2	2	2	3	3	3	-	-	1	1	1
CO4	3	1	1	1	2	2	-	-	2	2	3	3
CO5	2	2	1	1	1	-	-	2	3	3	-	1

0-Notrelated 1-Low 2-Moderate 3-High

5. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	3	1	1
CO2	1	2	2
CO3	2	1	2
CO4	3	3	1
CO5	1	3	2

0-Notrelated 1-Low 2-Moderate 3-High