

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

(Autonomous Institute affiliated to University of Mumbai)



Curriculum
(Scheme of Instruction & Evaluation and Course contents)
(Revision 2018)

For
Final Year
of
Four Year Undergraduate Programme Leading to
Bachelor of Technology (B. Tech) Degree in Civil Engineering

Implemented from the batch admitted in First year, 2018-19

VEERMATA JIJABAI TECHNOLOGICAL INSTITUTE (VJTI)

(Autonomous Institute affiliated to University of Mumbai)

Curriculum

(Scheme of Instruction & Evaluation and Course contents)

For

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Four Year Undergraduate Programme Leading to
Bachelor of Technology (B. Tech)

In

Civil Engineering

Programme Educational Objectives (PEO)

1. Develop a professional to pursue career as a Civil Engineer with adequate technical knowledge and skills while using modern tools for problem solving and exhibiting qualities of communication, team membership, and leadership.
2. Develop ability to practice ethically focusing on social relevance, environmental sustainability, optimal solutions and safety of stakeholders.
3. Develop abilities of lifelong learning to continuously strive to enhance decision making abilities to investigate, design and develop complex facilities.

Programme Outcomes (PO)

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Programme Specific Outcomes (PSO)

1. Able to analyze various Civil Engineering structures and systems by using basic and advanced technologies.
2. Able to design civil engineering facilities and their elements and also use of modern software tools for the same.
3. Able to plan, monitor and supervise construction activities to complete civil engineering facilities satisfactorily.
4. Able to practice as construction professional through ethical practice while focusing on sustainability and economy.

VeermataJijabaiTechnological Institute (VJTI)
B.Tech. Civil Engineering
Scheme of Instruction and Evaluation

SEMESTER VII

Scheme of Instruction					Scheme of Evaluation					
SN	CourseCode	Course Title	L	T	P	Credits	TA	MST	ESE	ESE hour
1	R4SE4001T	Design of Steel Structures	3	0	0	3	20	20	60	3
	R4SE4001P	Design of Steel Structures Laboratory	0	0	2	1	60		40	
2	R4CE4002T	Water and Wastewater Engineering	3	0	0	3	20	20	60	3
	R4CE4002P	Water and Wastewater Engineering Laboratory	0	0	2	1	60		40	
3	R4CE4001S	Transportation Engineering	2	1	0	3	20	20	60	3
4	R4CE4004L	Development Engineering Laboratory	0	0	2	1	60		40	
5	PE2	Professional Elective 2	3	0	0	3	20	20	60	3
6	OE2	Open Elective 2	3	0	0	3	20	20	60	3
7	R4CE490D	Project –I	0	0	4	2	60		40	
8	R4CE4003L	Industry Internship	0	0	4	2	60		40	
		TOTAL	14	1	13	22				
		Total contact hours		28						

Abbreviations: **L**: Lecture, **T**: Tutorial, **P**: Practical, **TA**: Teacher Assessment / Term work Assessment, **MST**: Mid Semester Test (One Mid Semester Test), **ESE**: End Semester Written Examination, **CIE**: Continuous In-semester Evaluation

VeermataJijabai Technological Institute (VJTI)
B.TechCivil Engineering
Scheme of Instruction andEvaluation

SEMESTER VIII

Scheme of Instruction						Scheme of Evaluation				
SN	CourseCode	Course Title	L	T	P	Credits	TA	MST	ESE	ESE hours
1	R4CE4006T	Construction Management	3	0	0	3	20	20	60	3
	R4CE4006P	Construction Management Laboratory	0	0	2	1	60		40	
2	R4CE4005S	Construction Entrepreneurship	3	1	0	4	20	20	60	3
3	R4SE4003L	Structural Design Laboratory	0	0	2	1	60		40	
4	PE3	Professional Elective 3	3	0	0	3	20	20	60	3
5	PE4	Professional Elective 4	3	0	0	3	20	20	60	3
6	R4CE4902D	Project –II	0	0	8	4	60		40	
		TOTAL	12	1	12	19				
		Total contact hours		25						

Abbreviations: **L**: Lecture, **T**: Tutorial, **P**: Practical, **TA**: Teacher Assessment / Term workAssessment, **MST**: Mid Semester Test (One Mid Semester Test), **ESE**: EndSemester Written Examination, **CIE**: Continuous In-semester Evaluation.

List of Electives:

Semester VII: Professional Elective II

SN	Course Code	Course Title
1	R4CE4101S	Terrain Data Analysis
2	R4CE4102S	Environmental Management
3	R4CE4103S	Water Resources System Planning & Management
4	R4CE4104S	Rehabilitation of Buildings
5	R4CE4105S	Advanced construction Techniques
6	R4SE4101S	Introduction to Nonlinear Analysis
7	R4SE4102S	Soil Dynamics and Machine Foundation
8	R4SE4116S	Earthquake Engineering
9	R4SE3102S	Advanced Foundation Engineering

Semester VII: Open Elective II

SN	Course Code	Course Title
1	R4CE4106S	Sustainable Development
2	R4CE4107S	Risk and value management

Semester VIII: Professional Elective III

SN	Course Code	Course Title
1	R4CE4108S	Solid and Hazardous waste Management
2	R4CE4109S	Watershed Management
3	R4CE4110S	Pavement Management System
4	R4CE4111S	Pavement Design and Construction
5	R4SE4103S	Design of Prestressed Concrete Structures
6	R4SE4104S	Geo-synthetic Engineering

Semester VIII: Professional Elective IV

SN	Course Code	Course Title
1	R4CE4112S	Unit Operations & Processes in Environmental Engineering
2	R4CE4113S	Transportation Planning & Traffic Engineering
3	R4SE4107S	Advanced Concrete Technology
4	R4CE4115S	Environmental Impact Assessment
5	R4SE4106S	Advanced Design of Steel structures

Programme Name	Bachelor of Technology in Civil Engineering	Semester – VII
Course Code	R4SE4001T	
Course Title	Design of Steel Structures	
Prerequisites	Structural Analysis I and II	

Course Outcomes:

After completion of course, students will be able to,

1. Apply the limit state design philosophy for analysis and design of structural steel components.
2. Apply the limit state design philosophy for analysis and design of structural steel connections.
3. Analyze and design structural steel roofing and flooring systems.

Course Contents

1 Bolted and welded connections

Introduction to riveted connection, design of bolted and welded connections, axially and eccentrically loaded joints, simple connection of bracket plates to columns, beam to beam and beam to column connections, design of framed, unstiffened and stiffened seat connections.

2 Roofing system

Imposed loads on flat and sloping roofs and floors, wind loads on sloping roofs and vertical cladding including effect of degree permeability and wind drag, analysis of pin-jointed trusses under various loading cases, computation of design forces in members, design and detailing of connections and supports.

3 Flooring system

Concept of floor system with secondary beams, main beams and columns, design of simply supported beams using rolled steel sections.

4 Columns and bases

Design of columns under axial loads using single or multiple rolled steel sections, design of lacing, battens, columns subjected to axial load and bending, design of slab and Gusseted base.

Text Books :

1. S.K. Duggal, Limit State Design of Steel Structures, Tata McGraw Hill Education Private Limited, 2017. (ISBN: 9789351343493/9351343499).
2. V.L. Shah and V. Gore, Limit State Design of Steel Structures IS:800-2007, Structures Publication, 2012. (ISBN: 8190371754).

Recommended Reading:

1. S.S. Bhavikatti, Design of Steel Structures, I.K. International Publishing House Limited, 2017.(ISBN: 9789385909559/938590955X).
2. N. Subramanian, Design of Steel Structures, Oxford University Press, 2011. (ISBN: 9780198068815/0198068816).
3. IS 800 (2007), General Construction in Steel- Code of Practice, Ced 7: Structural Engineering and Structural Section, Published by Bureau of Indian Standard ManakBhavan, New Delhi.
4. IS 875- Part 1 (1987): Dead Loads, Indian Standard Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures, Published by Bureau of Indian Standard ManakBhavan, New Delhi.
5. IS 875- Part 2 (1987): Imposed Loads, Indian Standard Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures, Published by Bureau of Indian Standard ManakBhavan, New Delhi.
6. IS 875- Part 3 (2017): Wind Loads, Indian Standard Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures, Published by Bureau of Indian Standard ManakBhavan, New Delhi.
7. IS 875- Part 4 (1987): Snow Loads, Indian Standard Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures, Published by Bureau of Indian Standard ManakBhavan, New Delhi.
8. IS 875- Part 5 (1987): Special Loads and Combinations, Indian Standard Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures, Published by Bureau of Indian Standard ManakBhavan, New Delhi.

Programme Name	Bachelor of Technology in Civil Engineering	Semester – VII
Course Code	R4SE4001P	
Course Title	Design of Steel Structures Laboratory	
Prerequisites	Design of Steel Structure, Structural Analysis I and II	

Course Outcomes:

After completion of course, students will be able to,

1. Identify and compute the design loads on various structural steel systems.
2. Apply principles and relevant codal provisions for the analysis and design of various structural steel systems.
3. Use commercial software for analysis and design of steel structures.
4. Prepare detailed structural drawings for any given design.

Course Contents:

- A. Design of roof truss system.
- B. Design of columns and columns bases.
- C. Design of structural steel flooring system.
- D. Design of bolted and welded connections.

Text Books:

1. S.K. Duggal, Limit State Design of Steel Structures, Tata McGraw Hill Education Private Limited, 2017. (ISBN: 9789351343493/9351343499).
2. V.L. Shah and V. Gore, Limit State Design of Steel Structures IS: 800-2007, Structures Publication, 2012. (ISBN: 8190371754).

Recommended Reading:

1. S.S. Bhavikatti, Design of Steel Structures, I.K. International Publishing House Limited, 2017. (ISBN: 9789385909559/938590955X).
2. N. Subramanian, Design of Steel Structures, Oxford University Press, 2011. (ISBN: 9780198068815/0198068816).

3. IS 800 (2007), General Construction in Steel- Code of Practice, Ced 7: Structural Engineering and Structural Section, Published by Bureau of Indian Standard ManakBhavan, New Delhi.
4. IS 875- Part 1 (1987): Dead Loads, Indian Standard Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures, Published by Bureau of Indian Standard ManakBhavan, New Delhi.
5. IS 875- Part 2 (1987): Imposed Loads, Indian Standard Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures, Published by Bureau of Indian Standard ManakBhavan, New Delhi.
6. IS 875- Part 3 (2017): Wind Loads, Indian Standard Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures, Published by Bureau of Indian Standard ManakBhavan, New Delhi.
7. IS 875- Part 4 (1987): Snow Loads, Indian Standard Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures, Published by Bureau of Indian Standard ManakBhavan, New Delhi.
8. IS 875- Part 5 (1987): Special Loads and Combinations, Indian Standard Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures, Published by Bureau of Indian Standard ManakBhavan, New Delhi.

Programme Name	Bachelor of Technology in Civil Engineering	Semester – VII
Course Code	R4CE4002T	
Course Title	Water and Wastewater Engineering	
Prerequisites	Environmental Engineering	

Course outcomes:

After completion of course students will be able to

1. Describe sources and suitability of water for portability.
2. Design unit operations and unit processes in water and wastewater treatments.
3. Select unit operations and unit processes together to plan and design scheme to meet Specific treatment objectives.
4. Examine wastewater with relation to disposal / reuse / recycle standards.

Course Contents:

1 Introduction

Importance of environmental sanitation, Impact of human upon the environment, Impact of environment upon the human.

2 Sources and characteristics of water and wastewater

Physical, Chemical, Bacteriological properties, Quality of water and wastewater at source, Water quality standards for drinking and various applications, Aerobic and anaerobic decomposition of wastewater.

3 Treatment of water

Aeration, Sedimentation: factors affecting efficiency, design values of various parameters, tube settlers.

Coagulation and flocculation: Mechanisms, common coagulants, rapid mixing and flocculating, devices, G and GT values, jar test, coagulant aids- polyelectrolyte etc. Filtration: classification, slow and rapid sand filters, dual media filters, sand, gravel and under drainage system, mode of action, cleaning, limitations, operational difficulties, performance, basic design consideration, pressure filters: construction and operation.

Water softening: lime soda and base exchange methods, principle reactions, design considerations.

Disinfection: chlorination, chemistry of chlorination, kinetics of disinfection, chlorine demand, free and combined chlorine, break point chlorination, superchlorination,

dechlorination, chlorine residual, use of iodine, ozone, ultraviolet rays, and chlorine dioxide as disinfectant, well water disinfection.

Treatments for removal of dissolved solids: Reverse osmosis, Distillation, Electrodialysis.

4 Miscellaneous treatment

Removal of iron and manganese, taste, odour and colour, Principles and methods of de-fluoridation and desalination.

5 Wastewater treatment and disposal

Wastewater treatment: Objectives, methods of sewage treatment and various flow sheets for preliminary, primary, and clarifiers, disposal of screenings and grits.

Biological treatment methods: principles, activated sludge process, sludge volume index, operational problems in activated sludge process, trickling filter.

Sludge digestion: principles of anaerobic digestion, quantity and characterization of sludge, design of sludge digestion tank, disposal of digested sludge, drying beds.

Disposal of wastewater: Discharge of raw and treated sewage on land and in water, Standards of disposal of raw and treated sewage on land and in water, limits of dilution, Self-purification of streams and oxygen economy.

6 Low cost sanitation

Design considerations, suitability and principles of septic tanks, up flow anaerobic filter.

7 Reuse and recycle of treated waste water

Disposal of treated effluent, gardening, sewage farming, W.C. Flushing, reuse in industry.

Text Books:

- 1 S. K. Garg, Sewage Disposal and Air Pollution Engineering, Khanna Publishers, Delhi, Thirty seventh edition, 2017. (ISBN: 9788174092304)
- 2 S. K. Garg, Water Supply Engineering, Khanna Publishers, Delhi, 28th edition, 2010. (ISBN: 9788174091208/8174091203)
- 3 Manual on Water Supply and Treatment, Ministry of Works & Housing, New Delhi, 1993.
- 4 Manual on Wastewater Treatment, Ministry of Works & Housing, New Delhi, 2013.

Reference Books:

- 1 T. J. McGhee, Water supply and sewerage, McGRAW Hill Inc., US, 6th editions, 1991. (ISBN: 0070609381/978-0070609389)

- 2 H. S. Peavy, D. R. Rowe and G. Tchobanoglous, Environmental engineering, McGRAW Hill Education, Indian edition, 1st edition 2013. (ISBN: 9351340260/978-9351340263)
- 3 Relevant Indian Standards Specifications.
- 4 CPHEEO manual on water supply and treatment, Ministry of urban development, May 1999.
- 5 CPHEEO manual on sewerage and sewage treatment systems, Ministry of urban development, Dec 2013.
- 6 Metcalf and Eddy, Wastewater Engineering Treatment and Reuse, Tata McGraw Hill Publications, 5th edition, 2017. (ISBN: 9780070495395, 0070495394)

Programme Name	Bachelor of Technology in Civil Engineering	Semester – VII
Course Code	R4CE4002P	
Course Title	Water and Wastewater Engineering Laboratory	
Prerequisites	Environmental Engineering	

Course Outcomes:

After completion of course students will be able to

1. Perform tests and analyze results of water and wastewater samples.
2. Assess the accuracy and precision of analytical results.
3. Use advanced water and wastewater characterization tools.

Course Contents:

List of experiments in water and wastewater samples:

- 1 Determination of alkalinity of water sample.
- 2 Determination of hardness of water sample.
- 3 Determination of pH value of water and wastewater sample.
- 4 Determination of turbidity of water sample.
- 5 Determination of the optimum dose of coagulant by Jar test.
- 6 Determination of residual chlorine in water sample.
- 7 Determination of chlorides in water sample.
- 8 Determination of conductivity of the water sample.
- 9 Determination of total solids, suspended solids, dissolved solids and volatile solids in water and wastewater sample.
- 10 Determination of Dissolved Oxygen (D.O.) in water sample.
- 11 Determination of Chemical Oxygen Demand (COD) of sample of wastewater.

- 12 Determination of Bio-Chemical Oxygen demand of wastewater sample.
- 13 Determination of Sludge Volume Index (SVI) of the wastewater sample.
- 14 Determination of Coli-form Bacteria in water sample by Most Probable Number (M.P.N.) test.
- 15 Demonstration of procedure for oxidation and reduction potential.
- 16 Demonstration of procedure for sampling.

Text Books:

- 1 Standard Methods for the Examination of Water and Wastewater, jointly published by American public health association (APHA), American Water Works Association (AWWA), Water Pollution Control Federation (WPCF) and Water Environment Federation (WEF), 23rd edition, 2017. (ISBN: 9781625762405/1625762402)

Reference Books:

- 1 T. J. McGhee, Water supply and sewerage, McGraw Hill Inc., US, 6th editions, 1991. (ISBN: 0070609381/978-0070609389)
- 2 H. S. Peavy, D. R. Rowe and G. Tchobanoglous, Environmental engineering, McGRAW Hill Education, Indian edition, 1st edition 2013. (ISBN: 9351340260/978-9351340263)
- 3 Relevant Indian Standards Specifications
- 4 CPHEEO manual on water supply and treatment, Ministry of urban development, May 1999.
- 5 CPHEEO manual on sewerage and sewage treatment systems, Ministry of urban development, Dec 2013.

Programme Name	Bachelor of Technology in Civil Engineering	Semester – VII
Course Code	R4CE4001S	
Course Title	Transportation Engineering	
Prerequisites	Pavement Engineering	

Course outcomes:

After completion of course students will be able to

1. Describe the terminology of infrastructure services like railway, docks and harbour and airport facilities.
2. Describe and sketch railway, docks and harbor and airport components.
3. Analyze the factors influencing the site selection for railway, docks,harbour and airport facilities.
4. Design the components of railway, docks and harbor and airport.
5. Propose appropriate method of construction & maintenance required for railway, docks and harbour and airport facilities.

Course Content:

1 Introduction

Role of transportation in society, Objectives of transportation system, Transportation Planning different types of modes, planning & co-ordination of different modes for Indian conditions, modern transportation system.

2 Railway Engineering

Merits of rail transportation, railway gauges and gauge problems

Cross section of permanent way and track components: Sleepers-functions and types,sleeper density, ballast functions and different ballast materials, ballast less track.

Rails: Coning of wheels and tilting of rails, rail cross sections, wear and creep of rails rail fastenings.

Geometric design: Gradients, transition curves, widening of gauges on curves, cant and cantdeficiency.

Point and crossing: Design of turnouts and description of track junctions.

Yards: details of different types of railway yards and their functions.

Signaling and interlocking: classification of signals, interlocking of signals and points, control of train movements.

Construction and maintenance of railway track, methods of construction, material requirements, special measures for high speed track, maintenance of tracks and traffic operations. monorail, metrorail, high speed train

3 Airport Engineering

Aircraft characteristics and their influence on airport planning.

Airport planning: topographical and geographical features, air traffic characteristics, and development of new airports, factors affecting airport site selection.

Airport obstruction: Zoning laws, classification of obstruction, imaginary surfaces, approach zones, turning zones.

Airport layout: runway orientation, wind rose diagrams, and basic runway length. Correction of runway length, airport classification, geometric design, airport capacity, runway configuration, taxiway design, geometric standards, exit taxiways, holding aprons, location of terminal buildings, aircraft hangers and parking.

Airport marking and lighting: marking and lighting of runways, taxiways and approach areas

Terminal area and airport layout: Terminal area, planning of terminal building, Apron: size of the gate position, number of gate position, aircraft parking system; Hanger: general planning considerations, blast considerations.

Air traffic control: Air traffic control aids, Enroute aids, landing aids.

Airport Drainage: requirement of airport drainage, design data, surface drainage design, subsurface drainage design.

4 Water Transportation

Harbours: Selection of site, entrance and channel requirement, ship characteristics and their influence on ports management and operations, harbour maintenance.

Harbour layout: harbour works, break waters, jetties, wharves, piers, berthing facilities, types and construction, dolphins. Navigational aids: buoys and lighthouses etc.

Port facilities: docks, transit sheds and warehouses, general layout, containers and container yard, layout and handling equipment.

Text Books:

- 1 Saxena S.C. and Arora S. P., A Text Book of Railway Engineering, Dhanpat Rai Publications, New Delhi, 2010. (ISBN-9788189928834)
- 2 Khanna and Arora, Airport planning & design, Nemchand Bros, Roorkee (ISBN-9788185240688)
- 3 M. M. Agarwal, Indian Railway Track, Prabha & Co., Sachdeva Press, Mayapuri, New Delhi, 2018. (ASIN: B074XSTCHS)

- 4 S. P. Bindra, Docks and Harbour Engineering, DhanpatRai and Sons, 2012. (ISBN-9788189928858)

Reference Books:

- 1 Robert, Horonjeff&Mcklerrey William, J Sproule, Seth B. Young, Planning & design of Airport, McGraw Hill, New Delhi,2010. (ISBN: 9780071446419)
- 2 A. D. Quinn, Design and Construction of Ports and Marine Structures, McGraw Hill, Inc, USA,1961. (ISBN: 0070510644)

Programme Name	Bachelor of Technology in Civil Engineering	Semester – VII
Course Code	R4CE4004L	
Course Title	Development Engineering	
Prerequisites		

Course Outcomes:

After completion of course student will be able to:

1. Formulate and analyze problems in rural area.
2. Apply modern techniques for planning, development and report preparation
3. Use the tools and processes required for feasibility analysis.

Course Contents:

1 Introduction to Development Engineering

Introduction to development engineering; need of development engineering; core disciplines and concept; major issues in development; urban development; rural development; socioeconomic development; scientific social research, formulation of research problem, field work and data collection, report drafting.

2 Design of Sustainable Communities

Concept and development of sustainable communities; Sustainable design principles, building regulations, codes and standards, approval process; green buildings-green building techniques energy solutions, site solutions, exterior and interior solutions, Certification development Indices.

3 Planning and Development of Rural Areas

District administration, District Planning, introduction to various sectors of rural areas such as drinking water, waste water treatment, electricity, public transport, irrigation, sanitation and cooking energy; issues and challenges associated with these sectors; People's participation and role in development of rural areas; various schemes and policies floated by state and central government - phases in the schemes; life cycle costing of these schemes. Introduction to the village-level census data. Engineering content in various amenities indices. Comparison plots and correlation plots.

4 A Sectoral Engineering System

The geography of area and its irrigation systems. Listing stakeholders, i.e., villages-farmers, people with and without land, local industrial workers, agriculture-cash crops and traditional crops, irrigation department and the market. History of irrigation for the region. Protective vs. command irrigation and its consequences. Developing a methodology for assessment. An example of a design document Socio-Technical challenges-increasing irrigated area, drip irrigation and better farm practices. Groundwater regulation. Field Visit to an irrigation system. Meeting with an NGO, farmers, a state officer and an elected representative.

5 Geoinformatics

Loading QGIS and a district data-set. Using a given data-set. Writing queries and manipulating appearances, Types of objects and manipulating objects. Linking Census data to GIS. Basic analysis and representation Introduction to a case-study. Basics of spatial planning queries such as computing net supply and net demand.

6 Tools and processes of feasibility analysis:

Demonstrate use of tools of market survey, demand forecasting, technology comparisons, environmental analysis, cash flow, risk analysis, return of investment.

Reference Books:

1. Chand, M. and Puri, U.K., Regional Planning in India, Allied Publishers, New Delhi, 2011. (ISBN-9788170230588)
2. E. J. Kaiser, Urban Land Use Planning, Urbana, University of Illinois Press, 2006. (ISBN-9780252030796)
3. K. V. Sundaram, Geography & Planning, Concept Publishing Co., New Delhi, 1985. (ISBN-9788170220480)
4. C.P.V. Ayyar, Town Planning in Early South India, Mittal Publications, Delhi, 2015. (ISBN-9788183245913)
5. L. Reeder and N. J. Hoboken, Guide to Green Building Rating Systems, John Wiley & Sons, Inc., 2010. (ISBN:9780470401941/9781118259894)
6. Longley, P. A., Michael F. Goodchild, Maguire, D.J., Rhind, D. W. (2005), 'Geographic Information Systems and Science', Second Edition 2005: John Wiley & Sons, New York. (ISBN-9780471892755)
7. Desai, V. (2010), 'Rural Development of India', Himalaya publishing house, Mumbai. (ISBN-9788184884128)

8. S. K. Rau, Global Search for Rural Development, NIRD, Hyderabad, 2001. (ISBN-9788185542638)
9. Institute of Town Planners, India, Ministry of Urban Affairs & Employment, Government of India, New Delhi, UDPFI Guidelines , 2014.
10. Miles R. Simon, Metropolitan Problems, Methuen Publications, Canada, 2013. (ISBN: 9780415860499)
11. B.I.S., National Building Code of India, ISI, New Delhi, 2007.
12. Prasanna Chandra, Projects Planning, analysis, selection, financing, implementation and review, Tata McGraw Hill Education, Sixth Edition. (ISBN: 9789332902572/9332902577)
13. Indian Standard: 15883 (2009), Project Management.

Programme Name	Bachelor of Technology in Civil Engineering	Semester – VII
Course Code	R4CE4101S	
Course Title	Terrain Data Analysis (Elective II)	
Prerequisites	Geomatics	

Course Outcomes:

After completion of course students will be able to

1. Interpret images for terrain data analysis.
2. Carry out spatial analysis of landforms with non-spatial data.
3. Generate thematic map for decision making on Civil Engineering project activities.

Course Contents:

1 Terrain Attributes and Their Significance

Topographic Relief, Slope and Aspects, Land use, Land cover, Drainage- density, Pattern texture etc, Geology, lithology and Structure of soil and their Properties

2 Sources of Terrain Data

Field Surveys, Topographic and other maps, Arial Photographs, satellite Images

3 Digital Terrain Modeling and Analysis

Sources, Representation and interpolation Electro Magnetic Interference and Vibration Measurement

4 Products of Digital Elevation Models(DEMs) and their use

Profiles, Sections, Contours, Slope, Shape and 3-D Views, Watersheds, River and its tributaries extraction

5 Applications of DEMs

Alignment Selection, Earth Works, Water resources potential, soil erosion potential etc.

6 Meteorological / Hydrological data

Rainfall, Humidity, Sunshine, Wind speed etc, Flow and sediment measurement, underwater survey.

7 Data Base Development

Principles, Programming and utilization

8 Compilation of Thematic Maps

Visual Interpretation and Digital analysis, Digitization and Rasterisation, information analysis systems: Principles and applications.

Text Books:

1. C.P. Lo and Albert K. W. Yeung, Concept and Techniques of Geographic Information Systems, Prentice Hall of India, New Delhi, 2nd edition, 2016. (ISBN: 9789332581883, 9332581886)
2. Kang-tsung Chang, Introduction to Geographic Information Systems, Tata McGraw Hill Education, 8th edition, 2015. (ISBN: 978-0078095139/0078095131)

Reference Books:

1. P.A. Burrough, Principles of Geographical Information Systems for Land Resources Assessment, Oxford science Publications, U.K, 1986. (ISBN: 978-0198545927 /0198545924)

Programme Name	Bachelor of Technology in Civil Engineering	Semester – VII
Course Code	R4CE4102S	
Course Title	Environmental Management (Elective II)	
Prerequisites	Environmental Engineering	

Course Outcomes:

After completion of course students will be able to

1. Use the principles of environmental management to carry out policy analysis and prepare environment management plan.
2. Apply various methods of environmental impact assessment and environmental audit.
3. Apply the tools and develop strategies for an environmentally sustainable project.
4. Prepare and assess disaster management plan for infrastructural projects.

Course Contents:

1 Environment legislation in India and Global scenario

Government Agencies & Programs; Environmental Protection Act 1986; Ministry of Environment & Forest, Function of State Pollution Control Board & CPCB, US EPA (Environmental Protection Agency)

2 Environmental Impact Assessment

Introduction – Concept of EIA- Scope and object of EIA, organization responsible for EIA, Site selection and area classification.

Description of the environmental setting - Inclusion or Exclusion of environmental Items, Suggested approaches for developing a list of environmental Factors – Informational Sources for Environmental factors.

Various steps of EIA – Content of EIA, Assessment methodology- Ad-hoc.

EIA for Building and Construction, Hydroelectric projects, Mining, Thermal and Nuclear Power plants, Roads and Airports.

Environmental Impact Assessment Notification (2006): Procedure for Environmental Clearance, List of the projects requiring Environmental Clearance, Composition of Expert Committee for Impact Assessment, Public hearing Committee, Procedure for public hearing- Project clearance.

3 Environmental audit, Environmental economics and Sustainable environment

Definition and principle

4 Environmental Safety, Health and Safety

Public health: communicable diseases, mode of transmission (epidemic and endemic diseases).

Occupational health and safety, Occupational health and hazards (physical, chemical and biological), Occupational diseases prevention and control.

Industrial safety standards and regulations, Accidents: definitions, prevention and control.

Safety management system: concepts of safety management systems, EMS; ISO 14000, 14001 and 18001, OSHA.

5 Disaster Management

Disaster: Introduction, Types of natural calamities, major and minor calamities, impact of calamities.

Natural disaster: cyclone, Tsunami, Flood, Landslides, Earth quake.

Manmade disaster: Wars, Biological war (introduction of pathogens), misuse of atomic bombs, major accidents from industries and thermal and nuclear power plants (Bhopal gas Tragedy, Love canal disaster – London Smog).

Environmental Disaster: Assessment, Planning: mitigation program, preparedness, resettlement rehabilitation, role of NGOS, GOs.

Text Books:

- 1 V. Kulkarni and T. V. Ramachandra, Environmental Management, Capital Publishing Company, New Delhi, 2006. (ISBN: 818558947X)
- 2 L. W. Canter, Environmental Impact Assessment, McGraw-Hill India, 2016. (ISBN: 9789339220464)
- 3 A. K. Mhaskar, Environmental Audit (An Overview), M/s. Media Enviro, Pune.

Reference Books:

- 1 The Environmental (Protection) Act, 1986, Universal Law Publishing Co.Pvt. Ltd. New Delhi. (ISBN: 9788175349247).

- 2 P. A. Erickson, Environmental Impact Assessment - Principles and Applications, Academic Press, Inc., New York, USA. (ISBN: 0122415507)
- 3 J. G. Rau and D. C. Wooten, Environmental Impact Analysis Hand Book, McGraw Hill higher Education, USA. (ISBN: 978-0070512177/0070512175)

Programme Name	Bachelor of Technology in Civil Engineering	Semester – VII
Course Code	R4CE4103S	
Course Title	Water Resources Systems Planning and Management (Elective-II)	
Prerequisites	Engineering Hydrology, Water Resource Engineering	

Course Outcomes:

After completion of course students will be able to

1. Construct and analyze watershed model and solve watershed management problem
2. Optimize the water resource system
3. Simulate water resources system

Course Contents:

1 Environmental and Water Resources Problem

Watershed, Watershed-element and types, Watershed hydrology, Hydrological cycle, Precipitation, water losses, Runoff, Rainfall-Runoff analysis, Watershed problem.

2 Water Resources Management

Erosion control and watershed development: their benefit towards conservation of National water wealth. Rain water harnessing and recharge of ground water: role of society and people's participation for sustainable water resource development. Mitigation strategies for flood damage: structural and non-structural measures

3 Watershed Management techniques

Spatial Decision Support Systems (SDSS) for land and water management at the watershed scale, Integrated Watershed Management, On-site and off-site management structures for soil and water conservation.

Community Watershed Management.

4 Optimization

Optimization Multi - objective optimization, Review of probability theory, Uncertainty and reliability analysis, Stochastic optimization - Chance constrained LP, Stochastic DP with applications, Surface water quality control, Non-linear programming.

5 Simulation

Simulation – Reliability, Resiliency and Vulnerability of water resource systems, multipurpose reservoir operation for hydropower, flood control and irrigation, Groundwater Systems, Water quality modeling, River basin Planning and management, Advanced topics.

6 Soft computing techniques

Soft computing techniques ANN Genetic algorithms, Multi criteria decision making, decision Support Systems, Expert Systems, Mutagenesis.

Text Books:

1. G. L. Asawa, Irrigation Engineering, Wiley eastern Limited, New Delhi. (ISBN : 812240457X)
2. S. K. Garg, Irrigation Engineering & Hydraulic Structures, Khanna Publishers, 2018. (ISBN:978-8174090478/8174090479)
3. S. S. Rao, Engineering Optimization: Theory and Practice, New Age International Publishers, 3rd edition, 2013. (ISBN: 9788122427233/8122427235)
4. S. Vedula and P. P. Mujumdar, Water Resources Systems, Tata McGraw Hill Education, 2005. (ISBN: 0070590893/9780070590892)

Reference Books:

1. J. D. Zimmerman, Irrigation, John Wiley & Sons, 99th edition, 1966. (ISBN: 978-0471983798/0471983799)
2. P. N. Modi, Irrigation Water Resources and Water Power Engineering, Standard Book house, Rajsons Publications Pvt. Ltd., 9th edition, 2014. (ISBN: 9788189401290/8189401297)
3. V. P. Singh, Elementary Hydrology, Prentice Hall of India Pvt. Ltd., 1998. (ISBN: 978-0132493840)
4. R. A. Wurbs and W. P. James, Water Resources Engineering, Prentice Hall of India Private Limited, New Delhi, 2001. (ISBN: 978-0130812933/0130812935)

Programme Name	Bachelor of Technology in Civil Engineering	Semester – VII
Course Code	R4CE4104S	
Course Title	Rehabilitation of Structures (Elective II)	
Prerequisites	Construction Techniques	

Course Outcomes:

After completion of course students will be able to

1. Conduct POE and identify various types of distresses in buildings.
2. Identify the effects due to climate, temperature, chemicals, wear and erosion on structures.
3. Justify appropriate materials and techniques for repairs and rehabilitation

Course Contents:

1 Buildings

Post occupancy evaluation of buildings, deformation and common defects in buildings.

2 Concrete behaviour

Embedded metal corrosion. Disintegration mechanisms, moisture effect, exposure to aggressive chemicals, thermal effects, load effects, faulty workmanship. Models for deterioration.

3 Basics of cracking problems

Structural & Non-structural cracks, crack type, important characteristics & possible reasons.

4 Condition survey

Objective, preliminary inspection, visual inspection, Field & laboratory testing.

Non-destructive evaluation: Rebound Hammer, U.P.V, Infra-red Thermography, carbonation test, Half-cell potential, cover meter.

Structural appraisal and structural monitoring: Principles of appraisal, data collection, types of deficiencies/disorders.

5 Various materials for repair

Properties, Cement, aggregate, wire mesh, admixtures, bonding agents, corrosion protection, repair mortar, protective coating, and polymer modified mortar.

7 Various techniques of rehabilitation

Repairs to corrosion infected members, damaged water proofing, junction of beam, column, wall, jacketing, fibre wrapping technique Different types of shoring, under pinning.

8 Maintenance of buildings

Routine maintenance, Preventive measures, Remedial maintenance.

9 Repair and Rehabilitation of other structures

Pipelines (water/ sewage/ air/ gas): Purpose and methods of evaluation, evaluation of physical condition, methods of rehabilitation.

Roads: Evaluation and performance surveys, distress evaluation, methods of resurfacing, overlays, restoring and rehabilitation.

Bridges: Inspection and reporting methods, rehabilitation measures.

Ports and harbours: Maintenance of ports, port buildings, and services.

Text Books:

- 1 K. Saxena, Repairs, Rehabilitation & Restoration of structures, Anuvi Chemicals Ltd.
- 2 J. J. Shah, Point of View – Repair, Rehabilitation and Waterproofing of Structures-Some View, Published in April 1998 issue of The Indian Concrete Journal, Mumbai.

Reference Books:

- 1 P. K. Guha, Maintenance and Repairs of Buildings, New Central Book Agency (P) Ltd., Kolkata, 2nd edition, 2015. (ISBN: 9788173810732)
- 2 M. S. Shetty, Concrete Technology (Theory and Practice), S. Chand & Co Ltd., 2008. (ISBN: 9788121900034)
- 3 P. C. Varghese, Maintenance, Repair & Rehabilitation & Minor Works of Buildings, PHI Learning Private Limited, Delhi, 2004. (ISBN: 9788120349452)
- 4 J. Bhattacharjee, Concrete Structures- Repair, Rehabilitation and Retrofitting, CBS Publishers & Distributors Pvt Ltd, New Delhi, 2017. (ISBN: 9789385915901)
- 5 Published books in the relevant areas to be supplemented by latest journal articles and papers, seminar and conference proceedings, in-house publications, monographs.

Programme Name	Bachelor of Technology in Civil Engineering	Semester – VII
Course Code	R4CE4105S	
Course Title	Advance Construction Techniques (Elective II)	
Prerequisites	Construction Techniques	

Course Outcomes:

After completion of course students will be able to

1. Choose the appropriate construction technique for a particular construction project.
2. Select the appropriate construction material, equipment's for a particular construction project.
3. Integrate knowledge for development of intelligent building using smart material.

Course Contents:

1 Introduction to Large and heavy engineering projects

Characteristics and complexities, methods statement for major activities like excavation, concreting, steel fabrication and erection for projects like earthen dams, hydropower projects, nuclear power plant, refineries and other industrial projects etc.

2 Excavation for heavy engineering projects

Excavation in various types of soils, selection of equipment, safety measures in excavation, drainage in excavation, Blasting, Arrangements of Blasts and safety measures during blasts.

3 Concrete construction for heavy engineering projects

Dams, Ports , Power plants: Hydropower, Thermal and nuclear Plant, Tunnelling: Tunnel construction/underground infrastructure development
 Selection of equipment for batching, mixing, transporting, placing and compacting for various types of jobs, safety measures during concreting, Special concretes and mortars: preplaced aggregate concrete, roller compacted concrete, grouting. RCC in cold climate

Nuclear Power Plants and Petrochemical Plants: AERB Codes (Atomic Energy Regulatory Board) and cover design aspects like SSE / OBE earthquakes, seismic stability, inelastic response, performance levels, acceleration limits, crack control in concrete, cyclic loading, shock loading, impact

modular construction techniques e.g. a complete segment of reactor building construction, shop including concrete floor / walls, equipment supports, piping etc its transportation and installation.

4 Prefabricated construction

Planning for pre-casting, selection of equipment for fabrication, transport and erection, quality measures, safety measures during erection, Different techniques of Pre-tensioning and Post-tensioning. concepts of rebar detailing software, 3D modeling, automated fabrication at site.

5 Formwork

Requirement of formwork, loads carried by formwork, types of formwork such as timber formwork, Steel formwork, patent formwork, modular shuttering, slip forms, steel scaffolding.

6 Steel construction

Planning for field operations, selection of equipment and erection tools, tools and methods of welding, tools and methods of cutting and joining, bridge erection: transportation of girders , quality measures, safety measures during fabrication and erection, bar bending schedules and bar cutting & bending machines.

7 Specific issues related to planning, site layouts, equipment selection and pre-project activities for large size construction projects like earthen dams, concrete dams, thermal power stations, nuclear power stations, light houses, airports and ports, bridges

8 Information related to special equipment and their applications to Off-shore construction such as barges ,types of barges, underground utility construction, Control of water ingress in underground structures, Micro piling

9 New materials and equipment for construction- Types of mortars, Special mortars, types of Nanomaterial such as Fly ash, micro silica, Silica fume, GGBS. Self-compacting Concrete, Ferro cements, Fire resisting materials, demolition techniques for various structures, pumping of concrete

10 Case studies of heavy construction projects

Text book:

1. V. N. Vazirani and S. P.Chandola, Heavy Construction, Khanna Publishers, New Delhi(ISBN: 5551234023749)

Reference Books:

1. T. Barron, Erection of constructional steelwork: a textbook for junior site engineers and students, Iliffe, London, 1963.

2. F. W. Stubbs and J. A. Havers, Handbook of Heavy Construction, McGraw-Hill, 2nd edition, 1971. (ISBN: 978-0070272781/0070272786)
3. Journals of Civil Engineering and Construction Engineering

Programme Name	Bachelor of Technology in Civil Engineering	Semester – VII
Course Code	R4SE410ST	
Course Title	Introduction to Non-Linear Analysis of structures (Elective-II)	
Prerequisites	Engineering Mechanics, Strength of material/Mechanics of Solids, Structural Analysis -I and II	

Course Outcomes:

After completion of course, students will be able to,

1. Apply principles of nonlinear behavior in structural stability analysis.
2. Perform stability analysis for simple and complex structures.
3. Perform plastic analysis of simple and complex steel and concrete structures.
4. Design simple and complex steel and concrete structures using plastic design methods.

Course Contents:

1 Introduction to elastic stability

Geometric non-linearity: basic concept. Analysis of beam column with various end conditions, use of trigonometric series.

2 Introduction to torsional buckling

Pure torsion of thin walled beams of open cross section warping and warping rigidity, Torsional buckling of columns, combined buckling by torsion and flexure. Lateral torsional buckling of beams, Indian codal provisions regarding buckling of steel members (columns and beams).

3 Introduction to plastic analysis

Concepts of plastic analysis of structures, Stress strain relations of steel and concrete. Concept of Redistribution of Moments, Plastic modulus, Shape factor, Plastic hinge, rotation capacity for steel and concrete plastic hinges, Fully plastic moment, moment curvature relations for rigid, semi rigid and ductile joints, Effect of Axial Force and Shear Force on the fully plastic moment of a cross section, Various types of failure mechanisms, Statical and Mechanism method for calculation of collapse loads, Lower and upper bound theorems.

4 Determination of collapse loads for steel structures

Determination of Collapse loads for single and multiple span beams, carrying various types of loads, single/multi bay multi storied rigid jointed portal frames and single bay gable frames. Incremental Load Method for pin jointed and rigid jointed frames

5 Determination of collapse loads for concrete structure

Collapse load analysis of single/multiple span beams by Cambridge Method. Yield Line Analysis of Slabs.

Text Books:

1. M.Sathyamoorthy, Nonlinear Analysis of Structures, CRC Press, Boca Raton, Florida, 1997. (ISBN: 9781138105881/1138105880).
2. D.G. Fertis, Nonlinear Mechanics, CRC Press, Boca Raton, Florida, 1998. (ISBN: 0849390028/978-0849390029)

Recommended Reading

- 1 J.N. Reddy, Nonlinear Finite Element Analysis, Oxford University Press, 2008. (ISBN-019852529X/978-0198525295)
- 2 S. Chandrasekaran, L. Nunziante, G. Serino and F. Carannante, Seismic Design Aids for Nonlinear Analysis of Reinforced Concrete Structures, Taylor and Francis, 2010. (ISBN-1439809143/978-1439809143).

Programme Name	Bachelor of Technology in Civil Engineering	Semester – VII
Course Code	R4SE4102S	
Course Title	Soil Dynamics and Machine Dynamics (Elective-II)	
Prerequisites	Soil Mechanics, Geotechnical Engineering	

Course Outcomes:

After completion of course, students will be able to,

1. Apply theory of vibrations to solve dynamic soil problems
2. Calculate the dynamic properties of soils using laboratory and field tests
3. Analyze and design behavior of a machine foundation resting on the surface, embedded foundation and foundations on piles by elastic half space concept.
4. Analyze and design vibration isolation systems
- 5.

Course Contents:

1 Introduction

Vibration of elementary systems-vibratory motion-single degree freedom system- free and forced vibration with and without damping

2 Waves and wave propagation

Wave propagation in an elastic homogeneous isotropic medium- Raleigh, shear and compression waves-waves in elastic half space

3 Dynamic properties of soils

Elastic properties of soils-coefficient of elastic, uniform and non-uniform compression - shear-effect of vibration dissipative properties of soils-determination of dynamic properties of soil-codal provisions

4 Machine foundation

Types, Design criteria, Permissible amplitudes and Bearing pressure, Degrees of freedom, Analysis under different modes of vibration of block foundation Design criteria-dynamic loads – simple design procedures for foundations under reciprocating machines - machines producing impact loads - rotary type machines.

5 Vibration isolation

Vibration isolation technique-mechanical isolation-foundation isolation-isolation by location isolation by barriers- active passive isolation tests.

Text Books:

1. S. saran, “Soil Dynamics and Machine Foundations”, Galgotia Publications Pvt. Ltd., 2016. (ISBN: 9788175157279/8175157275).
2. S. Prakesh and V.K Puri, Foundation for machines, McGraw-Hill 1998.(ISBN-0471846864/978-0471846864).
3. S.L.Kramar, “Geotechnical Earthquake Engineering”, Prentice Hall International series, Pearson Education (Singapore) Pvt. Ltd. (ISBN: 9788131707180, 8131707180).
4. K. Rao, Dynamics Soil Tests and Applications, Wheeler Publishing, New Delhi, 2003.(ISBN-8175442034/978-8175442030).
- 5.

Recommended Readings:

1. K. Rao, “Vibration Analysis and Foundation Dynamics”, Wheeler Publishing, New Delhi,1998.(ISBN 8175440015).
2. IS code of Practice for Design and Construction of Machine Foundations, McGraw-Hill,1996.
3. P.J.Moore, “Analysis and Design of Foundation for Vibration”, Oxford and IBH,1995.(ISBN-9061915252/978-9061915256).
4. Barkan, “Dynamics of Bases and Foundations”, 2nd Edition McGraw Hill Publishing,1970.(ISBN-9780070036505/978-0070036505).
5. Richart, Hall and Woods, “Vibration of Soils and Foundations”, Prentice Hall,1981. ShamsheerPrakash, “Soil Dynamics”, 3rd Edition, John Wiley,2000.(ISBN- 0139417168/978-0139417160).

Programme Name	Bachelor of Technology in Civil Engineering	Semester – VII
Course Code	R4SE3102T	
Course Title	Advanced Foundation Engineering (P. Elective-II)	
Prerequisites	Soil Mechanics & Geotechnical Engineering	

Course Outcomes

After completion of this course, students shall be able to,

- 1 Evaluate shear strength behavior of soil under different drainage conditions and compressibility potential under complex pore pressure conditions.
- 2 Determine stresses due to applied loads for the analysis of settlement.
- 3 Explain the advanced methods of computation of bearing capacity for homogenous, layered and sloping soil deposit under the axial or eccentric/inclined loads and settlement for different types of soil.
- 4 Evaluate techniques of axial load carrying capacity of piles embedded in soil and weathered rock and lateral load capacity in granular soil.
- 5 Illustrate the methods of ground improvement technique for improvement of weak soil.

Course Contents

1. Consolidation & stress and strain behavior of soil

Terzaghi's theory of One-Dimensional Consolidation – derivation of equation (solution for different conditions of excess pore water pressure), degree of consolidation and average degree of consolidation, Field consolidation curves, Consolidation settlement of NC and OC clays, practical applications. Mohr – Coulomb's criteria, Shear strength of sand and clays. Skempton's pore pressure parameters. Soil elastic modulus.

2. Estimation of stresses

Boussinesq's theory, Westergard's theory, Newmarks charts.

3. Bearing capacity and settlement analysis of shallow foundations:

Bearing Capacity theories – Terzaghi solution (detailed approach), Vesic's theory. IS 6403 (1981) method and Skempton's method, Meterhof's theory. Assumptions in estimates of ultimate loads, Effect of shape, embedment of footing, eccentricity and inclination in loading. Effect of compressibility (including critical rigidity index), Bearing capacity of non-uniform soils (Meyerh of & Hamna). Foundation on Sloping Ground., Settlement Analysis: Elastic theory by Steinbrenner factor, Schmertmman's method, Secondary settlement. Bearing capacity of foundation on compact and weathered rock. Introduction to Raft foundation.

4. Pile foundations:

Pile load tests using girders and anchors, Separation of skin friction and end bearing capacity. Capacity from in-situ tests (SPT and SCPT). Piles in weathered rock: IS 14593 (1998), empirical methods, Special auguring tools & machines for forming the piles, Pile termination criteria. Piles subjected lateral load (Rees and Matlock Method). Introduction of pile raft and Uplift Capacity.

5. Ground improvement:

Dynamic compaction, basics of vacuum consolidation. Geological properties of reinforced soils, Design of Reinforced Earth wall using Geogrid using BS 8006 or other relevant codes, soil nailing. Instrumentation – mainly pore pressure gauges and settlement gauges and their applications.

6. Introduction to soil structures interaction

Introduction to soil - Foundation interaction problems, Soil behavior, Foundation behavior, Interface, behavior, soil response models, Winkler, Elastic continuum.

Text Books

1. B.M. Das, Shallow Foundation- Bearing Capacity & Settlement, Taylor & Francis. (ISBN- 9788131518786).
2. V.N.S. Murthy, Advanced Foundation Engineering, CBD Publishers and Distributors, New Delhi, 2010. (ISBN- 9788123915067/978-8123915067).
3. B.M. Das, Advanced Soil Mechanics, CRC Press, 4th Edition, Taylor & Francis 2012. (ISBN- 978-8131518786).

Recommended Reading

4. K. Terzaghi and R.B. Peck, Soil Mechanics in Engineering Practice, Wiley and Sons, 1996. (ISBN- 8126523816/978-8126523818).
5. A. Singh, Soil Mechanics and Foundation Engineering, Vol I & Vol II, Standard book House, 2013. (ISBN-8123900392/978-8123900391).
6. R.D. Holtz and W.D. Kovacs, An introduction to geotechnical engineering, Prentice Hall, 1981. (ISBN-10: 9332507619/978-9332507616).
7. H. Winterkorn and F.Y. Fang, Foundation Engineering Handbook, CBS Publishers & Distributors, New Delhi, 1990. (ISBN 9788123905457).
8. J.E. Bowles, Foundation Analysis and Design, McGraw-Hill Book Co, 2001. (ISBN-13: 978-0071188449).
9. P. Shamsher and H. Sharma, Pile Foundations in Engineering Practice, Wiley and Sons, 1990. (ISBN-13: 978-0471616535).

10. R. Purushothama, Ground Improvement Techniques (HB), Laxmi Publication Pvt Ltd., New Delhi, 2005.(ISBN-10: 9788170080985/978-8170080985).
11. M.R. Hausmann, Engineering Principles of Ground Modification McGraw-Hill Inc., US, 1990.(ISBN-978-0070272798).
12. R.M. Koerner, Designing with Geosynthetics, (Third Edition), Prentice Hall, 1997.
13. S. Saran, Soil Dynamics and Machine Foundations, Galgotia Publications pvt.ltd. (ISBN 81-7515-266-4).
14. IS1892 (1979), Subsurface Investigation for Foundation.
15. IS6403 (1981), Determination of Bearing Capacity of Shallow Foundation.
16. IS8009 Part I (1978), Calculation of Settlement of Foundation and Shallow Foundation Subjected to Symmetrical Static Vertical Loads.
17. IS2911 Part I (2010), Design and Construction of Pile Foundations, Part I Concrete Piles.
18. IS14593(1998), Design and Construction of Bored Cast-in-situ Pile Founded on Rocks-Guidelines.
19. IS 12070 (1995) Code and Practices for Design and Construction of Shallow Foundations on Rocks.
20. IS1888 (1982), Method of Load Test on Soil.
21. IS1904 (1986), Design and Construction of Foundation in Soil – General Requirements.
22. IS15284 Part I (2003), Design and Construction for Ground Improvement – Guidelines, Part I – Stone Columns.

Programme Name	Bachelor of Technology in Civil Engineering	Semester – VIII
Course Code	R4SE4002S	
Course Title	Earthquake Engineering	
Prerequisites	Structural Analysis I and II, Design of Reinforced Concrete Structures	

Course Outcomes

After completion of course, students will be able to,

1. Describe the causes and effects of earthquakes.
2. Apply the principles of structural dynamics to analyze systems under dynamic loads.
3. Perform dynamic analysis of systems in the frequency and time domain.
4. Apply the principles of structural dynamics to structural design.
5. Design multistoried building structures safe and serviceable under earthquakes

Course Contents

1 Fundamental of structural dynamics

Definitions of basic problems in dynamics, static v/s dynamic loads, different types of dynamic loads, undamped vibration of SDOF system, natural frequency and periods of vibration, damping in structure, response to periodic loads. Direct determination of frequencies and mode shapes, orthogonality principle, approximate methods for determination of frequencies and mode shapes, modal error of, forced vibration of MDOF system, modal analysis, applications to multistoried rigid frames subject to lateral dynamic loads

2 Seismological background

Seismicity of a region, earthquake faults and waves, structure of earth, plate tectonics, elastic-rebound theory of earthquake, Richter scale, measurement of ground motion, seismogram

3 Characterization of ground motion

Earthquake response spectra, factors influencing response spectra, design response spectra for elastic systems, peak ground acceleration, response spectrum shapes, deformation, pseudo-velocity, pseudo-acceleration response spectra, peak structural response from response spectrum, response spectrum characteristics. Introduction to concepts of probabilistic earthquake response. Introduction to Transient Analysis and Floor Response Spectra for design of secondary systems like piping, equipment, in-structure water pools etc

4 Deterministic earthquake response

Types of earthquake excitation, lumped SDOF elastic systems, translational excitation, unimped MDOF elastic systems, translational excitation time history analysis, multistoried buildings with symmetric plans, multistoried buildings with un-symmetric plans, torsional response of symmetric plan building, distributed-parameter elastic systems, translational excitation,

combining maximum modal responses using mean square response of a single mode, SRSS and CQCC combination of modal responses

5 I. S. code method of seismic analysis and design

Seismic co-efficient method and its limitation, response spectrum method, I. S. code provision for seismic analysis of buildings. Seismic design considerations, allowable ductility demand, ductility capacity, reinforcement detailing for members and joints

6 Review of damages during past earthquakes and remedial measures

Case studies of damage and remedial action taken for past earthquakes in India and abroad

Text Books

1. A.K. Chopra, Dynamics of Structures, Prentice Hall, India,2007. (ISBN- 8131713296/978-8131713297)

Recommended Reading

1. R.R. Craig, Fundamentals of Structural Dynamics, John Wiley and Sons, 2006.(ISBN- 978-0471430445/0471430447)
2. Clough and Penzien, Dynamics of Structures, Tata McGraw Hill. (ISBN–9788123926636/8123926634).
3. J. M. Biggs,Structural Dynamics, Tata McGraw Hill. (ISBN–9332902550/978-9332902558).
4. N.M. Newmarks and E. Rosenblueth, Fundamentals of earthquake engineering, Prentice Hall. (ISBN- 013336206X/978-0133362060).
5. K. and T. Telford, Earthquake Design Practice for building, London, 1988. (ISBN-9780727729477/978-0727729477).
6. R.L. Wiegel, Earthquake Engineering, 2nd Edition, Prentice Hall, London, 1989. (ISBN-0132226464/978-0132226462).
7. IS 1893- Part 1 (2002), General Provisions and Buildings, Criteria for Earthquake Resistant Design of Structures, Published by Bureau of Indian Standard ManakBhavan, New Delhi.
8. IS 1893- Part 4 (2002), Industrial Structures Including Stack- Like Structures, Criteria for Earthquake Resistant Design of Structures, Published by Bureau of Indian Standard Manak, Bhavan,NewDelhi.

Programme Name	Bachelor of Technology in Civil Engineering	Semester – VII
Course Code	R4CE4106S	
Course Title	Sustainable Development (Open Elective)	
Prerequisites		

Course Outcomes:

After completion of course students will be able to

1. Describe sustainable development, development processes and relate impact of various levels of development
2. Formulate the methodology for assessment of sustainability of project using various indicators.
3. Apply environmental legislations to various development processes and projects

Course Contents:

1 Development

Goals and means of development, MDG's and SDG's sustainable development, Comparing levels of development, GDP, GNP, global development level

2 Industrialization and Post-industrialization era

Major structural shifts, knowledge revolution, implications for development sustainability

3 Environmental episodes

Ozone depletion, global warming, greenhouse effect, Bhopal gas tragedy etc.

4 Pollutions

Major sources, permissible standards and controls of urban air pollution, water pollution, Solid and hazardous waste disposals

5 Climate Change

The Risk of Global Climate Change

6 Environmental legislation

Legislative provisions and measures towards sustainability

7 Indicators of Development Sustainability

Composition of National wealth, Accumulation of National Wealth as an Indicator of Sustainable Development, Development Goals and Strategies, Gross happiness index, Millennium Development Goals, Role of National Development Policies, Life cycle assessment, Carbon foot print

Text Books:

- 1 Tatyana P. Soubbotina, Beyond Economic Growth: An Introduction to Sustainable Development, World Bank Institute Learning Resources Series, 2nd edition, 2004. (ISBN: 0-8213-5933-99)
- 2 P. P. Roger, F. J. Jalal and J. A. Boyd, An Introduction to Sustainable Development, Earthscan Publications, 2nd edition, 2008. (ISBN: 9781844075201/1844075206)

Reference Books:

- 1 T. Strange and A. Bayley, Sustainable Development: Linking Economy, Society, Environment, 2008. (ISBN: 9789264047785)
- 2 H. G. Brauch, Sustainable Development and Sustainability Transition Studies, Series: Springer Briefs in Environment, Security, Development and Peace, Series Ed.
- 3 G. Marletto, S. Franceschini, C. Ortolani and C. Sillig, Mapping Sustainability Transitions: Networks of Innovators, Techno-economic Competences and Political Discourses, Springer Briefs in Business, 2016. (ISBN: 9783319422725/9783319422749)

Programme Name	Bachelor of Technology in Civil Engineering	Semester – VII
Course Code	R4CE4107S	
Course Title	Risk and Value Management (Open Elective)	
Prerequisites		

Course Outcomes:

After completion of course students will be able to

1. Articulate and relate risk and value issues of a project
2. Provide an assessment of risks a
3. long the risk management matrix
4. Prepare disaster recovery plans
5. Formulate and conduct value engineering study

Course Contents:

1. Project Risks

Definition, dynamic and static risk, uncertainty and risk.

Risk and construction project time, money and technology, the people and the risks, processes and risks, risks and clients, consultants and contractors, risk allocation in contracting

2. Insurance and Risk

Accidental, intentional, criminal, types or lines of insurance, value of insurance, bonding, insurer side- Public policy and affordability/ availability, insurance product overview, Types of insurer and marketing system, Insurance company operations, Financial operations of insurer, analysis of insurance contract, Social insurance and workers compensation, Crime insurance and surety bonds.

3. Human Aspects

Personnel attitude towards risk, perceptions and risks, individuals and groups, communication in risk management, concept of utility and risks.

4. Risk management system

Risk identification, sources of risks, risk classification, types, impact and consequences of risk, risk analysis, Sensitivity analysis, breakeven analysis, scenario analysis, risk response: retention, reduction, transfer, avoidance.

5. Qualitative and quantitative methods in risk management

Qualitative risk assessment, risk register, probability – Impact matrix, project appraisal, cost benefit analysis, Monte- Carlo technique, portfolio theory, Delphi method, influence diagrams, decision trees

6. Disasters

Natural and manmade, possible effects, Disaster recovery plan Disaster recovery plan: basic requirements, documenting disaster recovery plan, rehearsing the disaster recovery plan, example disaster recovery plan

7. Value Engineering

Value, Reasons of poor value in constructed facilities, habits, road blocks and attitudes

8. Value management

Value Engineering job plan, function analysis, purpose and implications of life cycle costs, Impact of energy on cost of constructed facilities

Text Books:

- 1 N. J. Smith, T. Merna and P. Jobling, Managing Risk in Construction Projects, Wiley Blackwell, 3rd edition, 2014. (ISBN:9781118347232)
- 2 L. W. Zimmerman and G. D. Hart, Value Engineering: A Practical Approach for Owners, Designers, and Contractors, Wiley & Sons. (ISBN: 9780442295875/0442295871)

Reference Books:

1. Melvin W. Lifson, Edward F. Shaifer, Decision and Risk Analysis for Construction Management, John Wiley & Sons Inc, 1982. (ISBN:978-0471031673/0471031674)
2. I. Cameron and R. Raman, Process Systems Risk management, Elsevier Academics Press, 1st edition, 2005. (ISBN: 9780121569327)
3. C.Marrison, Fundamentals of Risk Measurements, Tata McGraw Hill Education, 1st edition, 2002. (ISBN:9780071386272/0071386270)

4. H. Buhlmann, *Mathematical Methods in Risk Theory*, Springer-Verlag Berlin Heidelberg, New York, 1st edition, 1970. (ISBN: 9783540051176/9783540307112)
5. P. P. Calow, *Hand book of Environmental Risk Assessment and Management*, Wiley-Blackwell Science Ltd. Oxford, UK, 1998. (ISBN: 9780865427327)

Programme Name	Bachelor of Technology in Civil Engineering	Semester – VII
Course Code	R4CE4901D	
Course Title	Project I	
Prerequisites		

Course Outcomes:

After completion of course students will be able to

1. Review available knowledge with reference to specific problem
2. Formulate the problem and collect relevant data.
3. Define systematic approach to arrive at solution

Course Contents:

Every student has to work on a one year project in the last year under the guidance of a Guide allotted by the department. A project can also be done in a group of not more than four students. In case of a group project, role of every individual should be clearly defined.

The project may be related to theoretical analysis, fabrication of a model and experimental work, etc. Through the project, students have to exhibit both the analytical and practical skills.

The evaluation shall be done at the end of seventh semester. Students are expected to define the problem and its scope, complete literature survey and finalize methodology for data collection. They are also expected to give critical comments, necessity of work, scheme of experiments etc.

Programme Name	Bachelor of Technology in Civil Engineering	Semester – VII
Course Code	R4CE4003L	
Course Title	Industry Internship	
Prerequisites		

Course Outcomes:

After completion of course students will be able to

1. Relate engineering knowledge and civil engineering works
2. Use Standard practices in civil engineering projects
3. Write technical report
4. Work as an individual and team

Course Contents

Student will undergo internship for summer vacation for minimum of 30 days in any of the Civil engineering firms to have an exposure to practical aspects of structural engineering, geotechnical engineering, environmental engineering, transportation engineering, water resources engineering, construction engineering and management etc.

Student will submit a report and give presentation based on internship. The internship report shall cover the following:

Introduction, Brief History of the Organization, Summary of the Project Assignment, Technical and practical information gained during the summer training period, Planning, Designing, check lists, Quality practices, safety measures, record keeping etc. (This must constitute the major part of the report), Conclusion and Recommendations , Photo gallery, References, Appendices.

Programme Name	Bachelor of Technology in Civil Engineering	Semester – VIII
Course Code	R4CE4006T	
Course Title	Construction Management	
Prerequisites		

Course Outcomes:

After completion of course students will be able to

1. Explain need for management and management functions.
2. Develop and analyze plans and resolve resource conflicts.
3. Relate monitoring and control issues with reference to time, cost and quality.

Course Contents:

1 Management

Definition, functions of management, advances and societal influences in construction management

2 Construction projects

Relationships with Project, Program and Portfolio Management, Project lifecycle, Phases of a project, agencies involved, Indian standards on construction and project management, lean construction techniques

3 Construction project planning

Stages of project planning: pre-tender planning, pre-construction planning, detailed construction planning, role of client and contractor, level of detail.

Process of development of plans and schedules, work break-down structure, activity lists, assessment of work content, estimating durations, sequence of activities, activity utility data.

4 Techniques of planning

Bar charts, Networks: basic terminology, types of precedence relationships: finish to start, Start to start, finish to finish, start to finish, preparation of CPM networks: activity on link and activity on node representation, analysis of single relationship (finish to start) networks, computation of float values, critical and semi-critical paths, calendaring networks.

5 Resource Scheduling

Bar chart, line of balance technique, resource constraints and conflicts, resource aggregation, allocation, smoothening and leveling

6 PERT

Assumptions underlying PERT analysis, determining three time estimates, analysis, slack computations, calculation of probability of completion

7 Construction costs

Classification of costs, time cost trade-off in construction projects, compression and decompression

8 Monitoring & control

Project communications, record keeping, periodic progress reports, periodical progress meetings, earned value management, scope creep and change management, updating of plans: purpose, frequency and methods of updating common causes of time and cost overruns and corrective measures. PMI / PMBOK for efficient management of projects.

Quality control: concept of quality, quality of constructed structure, supervision, use of manuals and checklists for quality control, role of inspection, basics of statistical quality control.

Delay analysis: Techniques- As planned, As Built, Impacted As Planned, As Planned But For, Collapsed As Built, Window analysis, Time Impact analysis

9 Project Closure

Closeout documentation, Project punch list, Lessons Learned, as build drawing, operation and maintenance manual.

Text Books:

- 1 K. K. Chitkara, Construction Project Management- Planning, Scheduling and Controlling, Tata McGraw Hill Education, 2nd edition, 2010. (ISBN: 9780070680753/ 0070680752)
- 2 K. N. Jha, Construction Project Management- Theory and Practice, Pearson Education India, 2nd edition, 2015. (ISBN: 978-9332542013/9332542015)

Reference Books:

1. J. M. Antill and R. W. Woodhead, Critical Path Methods in Construction Practice, Wiley-Interscience, 4th edition, 1990. (ISBN:9780471620570/0471620572)
2. D.S. Barrie & B. C. Paulson, Professional Construction Management: Including CM, Design-Construct and General Contracting, McGraw Hill Inc, 3rd edition, 1991. (ISBN: 9780070038899)
3. Indian and other relevant Standards.

Programme Name	Bachelor of Technology in Civil Engineering	Semester – VIII
Course Code	R4CE4006P	
Course Title	Construction Management Laboratory	
Prerequisites		

Course Outcomes:

After completion of course students will be able to

1. Develop plan for construction of civil engineering facility
2. Use project management software for generation of plans, schedules and reports.

Course Contents:

- 1 Preparation of a project plan for one of the following projects using working drawings
 - Residential bungalow
 - Single storied building for commercial purpose
 - Single span bridge.
- 2 Use of project management software, capability, input requirements, possible outputs. use of software like MS Project and Primavera for real time applications.

Text Books:

1. K. K. Chitkara, Construction Project Management- Planning, Scheduling and Controlling, Tata McGraw Hill Education, 2nd edition, 2010. (ISBN: 9780070680753/ 0070680752)
2. K. N. Jha, Construction Project Management- Theory and Practice, Pearson Education India, 2nd edition, 2015. (ISBN: 978-9332542013/9332542015)

Reference Books:

1. J. M. Antill and R. W. Woodhead, Critical Path Methods in Construction Practice, Wiley-Interscience, 4th edition, 1990. (ISBN:9780471620570/0471620572)
2. P. K. Joy, Handbook of Construction Management, Macmillan Publishers India, 2nd edition, 2000. (ISBN:9780333926932/0333926935)

3. M. L. Sidney, Project Management in Construction, McGraw-Hill Education, 7th edition, 2017. (ISBN: 9781259859700/1259859703)

Programme Name	Bachelor of Technology in Civil Engineering	Semester – VIII
Course Code	R4CE 4005S	
Course Title	Construction Entrepreneurship	
Prerequisites		

Course Outcomes:

After completion of course students will be able to

1. Describe economics of construction environment
2. Prepare and submit bids for participating in bidding process
3. Define policies regarding planning & organizing resources.
4. Identify the risks and define strategy to manage risk and safety.

Course Contents:

1 Indian construction industry and project environment

Projects in construction and the unique features, Role of a Project Manager, Project Stakeholders and governance, project delivery methods, enterprise environmental factors.

2 Business Terminologies

Types of entities, Special Purpose Vehicle, Partner, Company, Sole Proprietorship firm, Trust, Society, Articles of Association and MOA, BOT, Joint venture

3 Construction enterprise organization

Forms of business organization, structure of construction organization, organization structures for managing projects, management levels, organizational influences on construction project management.

4 Construction economics

Economic decision making, time value of money, evaluating alternatives, Investment criteria: Net present value, benefit cost ratio, internal rate of return, urgency, payback period, accounting rate of return.

5 Construction contract

Bidding process, General contract conditions (CPWD and FIDIC), sub-contracting, models of PPP

6 Bidding

Estimation of costs and bidding strategies, bid preparation, bidding models

7 Planning and organizing construction site and resources

Site: site layout, developing site organization, record keeping at site, Manpower: planning, organizing, staffing, motivation, Materials: concepts of planning, procurement and inventory control, Equipment: basic concepts of planning and organizing.

8 Project financing

Accounting process, revenue recognition, working capital needs, financing for working capital, Funds: cash flow, sources of funds.

9 Claims management

Claims identification, claim quantification, claim prevention, claim resolution, contract dispute and project closure, and settlement method. Arbitration and its detailed procedure

10 Risk in construction entrepreneurship

Risk management process, insurance in construction.

11 Health, Safety, Security and Environmental (HSSE) management on project sites

Accidents; their causes and effects, costs of accidents, occupational health problems in construction, organizing for safety and health. LCA of various infrastructure components

Text Books:

1. P.C.Tripathi and P. N. Reddy, Principles of Management, Tata McGraw-Hill Education, 4th edition, 2010. (ISBN: 9780070220881/0070220883)
2. K. K. Chitkara, Construction Project Management- Planning, Scheduling and Controlling, Tata McGraw Hill Education, 2nd edition, 2010. (ISBN: 9780070680753/ 0070680752).
3. P. M. Charantimath ,Entrepreneurship Development and Small Business Enterprise, Dorling Kindersley (India) Pvt. Ltd., Licensees of Pearson Education, 2006.(ISBN: 9788177582604)
4. U. K. Shrivastava, Construction Planning and Management, Galgotia Publications Pvt. Ltd, New Delhi, 2013. (ISBN: 9788175152465, 817515246X)

5. Bureau of Indian standards – IS 7272 (Part-1) - 1974: Recommendations for labour output constant for building works.

Reference Books:

1. R.L.Peurifoy, C. J. Schexnayder, A. Shapira and R. Schmitt, Construction Planning, Equipment, and Methods (Civil Engineering), McGraw-Hill Education, 8th edition, 2010. (ISBN: 9780073401126/0073401129)
2. H. Koontz and H. Weihrich, Essentials of Management: An International, Innovation, and Leadership perspective, McGraw Hill Education, New Delhi ,9th edition, 2012. (ISBN: 9781259005121/1259005127)
3. F. Harris, R. McCaffer with Francis Edum-Fotwe, Modern Construction Management, Wiley-Blackwell, 7th edition, 2013.. (ISBN:ISBN: 9780470672174)
4. M. W.Martin and R. Schinzinger, Ethics in Engineering, McGraw-Hill Education, 4th edition.2004. (ISBN: 978-0072831153/0072831154)
5. C. Hendrickson and T. Au, Project Management for Construction - Fundamentals Concepts for Owners, Engineers, Architects and Builders, Prentice Hall, Pittsburgh, 2000.
6. J. L. Riggs, D. D. Bedworth and S. U. Randhawa, Engineerng Economics, Tata McGraw hill. 4 edition, 1996..(ISBN: 9780079122483/0079122485)
7. S.C Sharma, Construction Equipments and its Management, Khanna Publishers.

Programme Name	Bachelor of Technology in Civil Engineering	Semester – VIII
Course Code	R4SE4003L	
Course Title	Structural Engineering Design Laboratory	
Prerequisites	Structural Analysis I and II, Design of Reinforced Concrete Structures	

Course Outcomes

After completion of course, students will be able to,

1. Plan and design multistoried building structures to resist all types of applicable loads.
2. Design elevated water towers of various shapes and configurations.
3. Apply pre-stressed concrete design principles in design of pre-stressed concrete girders.

Course Contents

1. Design and drawing of G+7 storied residential building (limit state method of design)

Design and Drawing of G+7 Storied Residential Building for gravity and lateral loads (Wind and Earthquake) as per relevant I.S Codes. A design report and at least three A1 (imperial) size drawings sheets covering the above design shall be submitted as term work.

2. Design of pre-stressed concrete girders

Design of Pre-tensioned and Post-tensioned pre-stressed concrete girders. A design report and at least one A1 (imperial) size drawings sheets covering the design of at least one pre-stressed concrete large span girder shall be submitted as term work.

3. Design of water tanks: (working stress method)

Design of Circular and rectangular overhead water tanks both by ARE coefficient and approximate methods, supporting structure for overhead water tanks. A design report and at least one A1 (imperial) size drawings sheets covering the design of at least one overhead water tank shall be submitted as term work.

4. Study of tests on shake table:

Conduct test on one structural model or soil slopes or rock slopes, to verify their seismic performance. An analysis report along with detailed procedure of conducting experiment/test should be submitted as term work

Text Books

1. Jain and Jaikrishna, Plain and Reinforced Concrete, Vol. I, NemchandBrothers. (ISBN 8185240086/978-8185240084).

2. V.L. Shah and Karve, Limit State Design - Reinforced Concrete Structures Publications. (ISBN-9788190371711/8190371711).
3. K. Raju, Pre-stressed Concrete, TataMcGrawHill. (ISBN- 9789387886209/9387886204).

Recommended Reading

1. P. Dayaratnam, Design of Reinforced Concrete Structures, Oxford & IBH. (ISBN-9789386479785/9386479788).
2. T.Y. Lin, Design of Prestressed Concrete Structures, John Wiley and Sons Inc., 2010. (ISBN-9788126528035/978-8126528035).
3. P.D.Arthur and V.Ramkrishnan, Ultimate Strength Design for Structural Concrete, Wheeler &Co. Pvt. Ltd. (ISBN-0273403230/978-0273403234).
4. B.P. Hughes, Limit State Theory for Reinforced Concrete Design, Pitman. (ISBN-0273010239/978-0273010234).

Programme Name	Bachelor of Technology in Civil Engineering	Semester – VII
Course Code	R4CE4902D	
Course Title	Project II	
Prerequisites	Project I	

Course Outcomes:

After completion of course students will be able to:

1. Formulate methodology for the defined problem
2. Execute/analyze and interpret the data and find solution
3. Prepare technical report and present.

Course Contents:

At the time of evaluation, substantial data collection and analysis work should be completed. In the final stage student has to submit a report in standard format prescribed by the institute. The report must contain introduction of the research, literature review, materials and methods, results and discussion, conclusions and bibliography.

Programme Name	Bachelor of Technology in Civil Engineering	Semester – VIII
Course Code	R4CE4108S	
Course Title	Solid and Hazardous waste Management (Elective III)	
Prerequisites	Environmental Engineering	

Course Outcomes:

After completion of course students will be able to

1. Use the principles of solid & hazardous waste management.
2. Design & optimize techniques for solid & hazardous waste management.
3. Acquire knowledge on specialized solid & hazardous waste treatment.
4. Analyze policies and legal implications of solid and hazardous wastes.

Course Contents:

- 1 Solid Wastes - sources, types: Municipal solid waste, Industrial solid waste, e-waste, construction and demolition waste, composition, physical, chemical, and biological properties of solid wastes
- 2 Functional Elements of Solid waste management- generation, collection, handling, storage, processing, transportation
- 3 Disposal of Solid waste - materials separation and processing, thermal conversion, biological and chemical conversion, recycling and reuse of municipal solid wastes, land filling, composting, gas generation, closure of landfills, design of landfills.
- 4 Industrial solid waste composition, biodegradable, non-biodegradable, hazardous, toxic solid wastes, methods of detoxification, disposal on land
- 5 Hazardous wastes - origin, sources and types of hazardous and infectious wastes in municipal solid wastes, quality parameters.
- 6 Treatment and disposal methods of Hazardous waste - physicochemical and biological. Stabilization and solidification, thermal methods, land disposal, site remediation.
- 7 Legal aspects of municipal and hazardous solid waste collection, conveyance, treatment and disposal.

Text Books:

- 1 G. Tchobanoglous, H. Theisen and S. A. Vigil, Integrated Solid Waste Management, McGraw Hill Education (Indian Edition), 1st edition, 2014. (ISBN: 9789339205249/9339205243)
- 2 M. D. LaGrega, P. L. Buckingham and J. C. Evans, Hazardous Waste Management, Waveland Press Inc., 2nd edition, 2010.(ISBN: 978-1577666936/1577666933)
- 3 A.D. Bhide and B. B. Sundaresan, Solid waste Management in Developing Countries, National Environmental Engineering Research Institute (NEERI) Nagpur.
- 4 T V Ramachandra, Management of Municipal Solid Waste, The Energy and Resources Institute, TERI, 2009. (ISBN:9788179931875)

Reference Books:

- 1 Tchobanoglous, Theissen and Vigil, Integrated Solid Waste Management, McGraw Hill Book Co.
- 2 G. Tchobanoglous, H. Theisen and R Eliassen, Solid wastes - Engineering Principles and Management Issues, McGraw-Hill Book Company, 1st edition, 1977. (ISBN: 9780070632356)
- 3 D. J. Hagerty, J. L. Pavoni and J. E. Heer (Jr.), Solid Waste Management, Van Nostrand Reinhold Co., New York, 1973. (ISBN: 0442230265)
- 4 J. L. Pavoni, Handbook of Solid Waste Disposal: Materials and Energy Recovery, Van Nostrand Reinhold environmental engineering series, Krieger Pub Co., 1st edition, 1975. (ISBN: 978-0442230272/0442230273)
- 5 P. A. Reinhardt and J. G. Gordon, Infectious and Medical Waste Management, CRC Press, 1st edition, 1990. (ISBN:9780873711586/0873711580)

Programme Name	Bachelor of Technology in Civil Engineering	Semester – VIII
Course Code	R4CE4109S	
Course Title	Watershed Management (Elective-III)	
Prerequisites	Engineering Hydrology, Water Resource Engineering.	

Course Outcomes:

After completion of course students will be able to

1. Use integrated watershed management approach.
2. Analyze socio-economic aspects of watershed.
3. Apply techniques to analyze and solve watershed problems.

Course Contents:

1 Introduction and Basic Concepts

Concept of watershed, introduction to watershed management, different stakeholders and their relative importance, watershed management policies and decision making.

2 Sustainable Watershed Approach & Watershed Management Practices

Sustainable integrated watershed management, natural resources management, agricultural practices, integrated farming, Soil erosion and conservation. Watershed Management Practices in Arid and Semiarid Regions, Case studies, short term and long term strategic planning.

3 Integrated Watershed Management

Introduction to integrated approach, Integrated water resources management, conjunctive use of water resources, rainwater harvesting; roof catchment system.

4 Social Aspects of Watershed Management

Community participation, Private sector participation, Institutional issues, Socio-economy, Integrated development, Water legislation and implementations, Case studies.

5 Use of modern techniques in watershed management

Applications of Geographical Information System and Remote Sensing in Watershed Management, Role of Decision Support System in Watershed Management.

6 Management of Water Quality

Water quality and pollution, types and Sources of pollution, water quality modelling, environmental guidelines for water quality.

7 Storm Water and Flood Management

Storm water management, design of drainage system, flood routing through channels and reservoir, flood control and reservoir operation, case studies on flood damage.

8 Drought Management

Drought assessment and classification, drought analysis techniques, drought mitigation planning.

9 Water Conservation and Recycling

Rain water harvesting, Perspective on recycle and reuse, Waste water reclamation.

Text Books:

1. J. V. S. Murty, Watershed Management, New Age International Publishers, New Delhi, 2nd edition, 2017. (ISBN: 9788122435184/8122435181)
2. J.V.S.Murty, Watershed Management in India, Wiley Eastern Limited, New Delhi, 1994. (ISBN: 8122405665/9788122405668)
3. A. P. Purandare and A. K. Jaiswal, Watershed Development in India, National Institute of Rural Development, Hyderabad, 1995. (ISBN: 978-8185542348/8185542341)
4. R. Singh, Watershed Planning and Management, Yash Publishing House, Bikaner, 3rd edition, 2003. (ISBN: 9788186882122 / 818688212x)

Reference Books:

- 1 Allam, Gamal Ibrahim Y., Decision Support System for Integrated Watershed Management, Colorado State University, 1994.
- 2 American Society. of Civil Engineer, Watershed Management, American Society of Civil Engineers, New York, 1975.
- 3 Black Peter E., Watershed Hydrology, Prentice Hall, London, 1991.
- 4 A. M. Michael, Irrigation Theory and Practice, Vikas Publishing House, 2nd edition, 1992. (ISBN: 9788125918677)

Programme Name	Bachelor of Technology in Civil Engineering	Semester VIII
Course Code	R4CE4110S	
Course Title	Pavement Management System (Elective III)	
Prerequisites	Pavement Engineering	

Course Outcomes:

After completion of course students will be able to:

1. Acquire the knowledge of pavement management systems at network level and project level.
2. Perform the functional and structural evaluation of pavement.
3. Design strategies of pavement and economic evaluation.

Course Contents:

1 Pavement Management System (PMS)

Components of PMS and their Activities, Major Steps in Implementing PMS, Inputs, Design, Construction and Maintenance, Rehabilitation and Feedback Systems.

Pavement Structural Design and Economic Analysis. Emerging Technology in Pavement Management systems. life cycle cost analysis of pavements

2 Pavement distresses

Distresses in flexible/rigid pavements: causes & remedies. Visual Surface distress survey procedures and techniques. Serviceability indicators for roads.

Functional evaluation of pavements: Serviceability Concepts, Visual Rating, Pavement Serviceability Index, Skid Resistance, Roughness, and Safety Aspects. Inventory System

3 Maintenance operations/alternatives

Classification of maintenance operations, Routine, Periodic, Special.

Common types of maintenance: Potholes, Cracked surface, Ruts & undulations Resurfacing, Interface treatments, White topping: Types of white toppings, precast concrete panel roads, rehabilitation of pavements

Bituminous Thin Surface Courses: Seal Coat, Surface Dressing, Premixed carpet, Mixed seal surfacing, Micro asphalt concrete (MAC).

Bituminous Surface Courses: Semi-Dense Bituminous Concrete, Bituminous Concrete, and Bitumen Mastic. use of plastic waste in pavement construction

Road maintenance in high rainfall areas. Choice of materials. Modified bitumen & geofabrics. Maintenance alternatives including recycling. Cement stabilization for road pavement

Text Books:

1. L. R. Kadiyali and N. B. Lal, Principles and Practice of Highway Engineering, Khanna Publishers, Edition 2017. (ISBN: 978-8174091659/8174091653)
2. S. K. Khanna and C. E. G. Justo, Highway engineering, Nem Chand & Sons, Revised 10th edition, 2017. (ISBN: 9788185240930)

Reference Books:

1. IRC 58-2012, Guidelines for the design of rigid pavements for highways
2. Specifications for rural road, MORD 2004
3. Rural roads manual, Indian Road Congress September 2016 edition.
4. Guidelines for the design of flexible pavements, Indian Road Congress, 3rd Revision July 2012
5. IRC 81-1997, Guidelines for strengthening of flexible road pavements using Benkelman deflection technique.
6. D. Croney and P. Croney, The Design and Performance of Road Pavements, McGraw Hill Professional, 3rd edition, 1997. (ISBN: 978-0070144514/0070144516)
7. E. J. Yoder and M. W. Witczak, Principles of Pavement Design, Wiley International, 2nd edition, 1991. (ISBN: 978-0471977803)

Programme Name	Bachelor of Technology in Civil Engineering	Semester VIII
Course Code	R4CE4111S	
Course Title	Pavement Design and Construction (Elective III)	
Prerequisites	Pavement Engineering	

Course Outcomes:

After completion of course students will be able to

1. Modeling to analyze flexible and rigid pavements.
2. Apply the pavement management concepts to better manage road pavement and its construction.
3. Apply the various types of highway appurtenance to enhance the safety of users.

Course Contents:

- 1 Pavement structure and functional attributes, factors affecting pavement design, types of wheel loads for highways and airports, development of design method for highway and airport pavements.
- 2 Stresses in flexible pavements 1-layer, 2-layers, 3-layer theories, EWF, ESWL load coverage
- 3 Stresses in rigid pavement: load and temperature stresses, combined stresses.
- 5 Evaluation of sub-grade and pavement materials: group index, FAA classification, CBR, Triaxial compression, Dynamic/ Resilient modulus, embankment design and construction Grading requirements for aggregates, selection of bases and sub-base materials (including stabilized materials), selection of different grades of bitumen, types of bituminous surfaces, skid qualities, bituminous mix design, design aspects of paving concrete.
- 6 Flexible Pavement Design:
 Airport pavement: Corps of Engineers (CBR) method, FAA Method, CDOT method, Asphalt Institute method.
 Highway pavement: Empirical methods using no soil strength criteria, Empirical methodbased on soil strength-CBR, Design procedure in Road Note 29(U.K.), IRC(1984) guidelines, AASHO method, Asphalt Institute method.
- 6 Rigid pavement Design:
 Airport pavement: PCA methods, corps of engineers method, FAA method

Joints and reinforcement requirement

Highway pavement: current British procedure, IRC method

7 Drainage:

Importance, principles of good drainage, surface drainage, sub-surface drainage, role of shoulders, Use of geotextiles.

Culverts, Causeways; Importance, types, site selection

8 Evaluation and strengthening:

Flexible and rigid pavement distresses, condition and evaluation surveys, present serviceability index, Roughness measurement, Benkelman Beam deflections, design of overlays, skid-resistance and its measurement

9 Economics of pavement types, basis for comparison, period of analysis, cost of initial construction, cost of maintenance, cost of vehicle operation, equivalencies in thickness.

10 Economic evaluation of highway scheme basic principles of economic evaluation, Net present value method, Benefit/cost ratio method, internal rate of return method

11 Concrete Road construction:

Mix design, concrete strength, size of aggregates, and gradation, workability, preparation of base, form work, placing of reinforcement, compacting, and finishing, curing, joints

12 Quality control in highway engineering: importance - process control and end product control, statistical methods in quality control, control charts, frequency of testing

Text Books:

1. L. R. Kadiyali and N. B. Lal, Principles and Practice of Highway Engineering, Khanna Publishers, Edition 2017. (ISBN: 978-8174091659/8174091653)
2. S. K. Khanna and C. E. G. Justo, Highway engineering, Nem Chand & Sons, Revised 10th edition, 2017. (ISBN: 9788185240930)

Reference Books:

1. D. Croney and P. Croney, The Design and Performance of Road Pavements, McGraw Hill Professional, 3rd edition, 1997. (ISBN: 978-0070144514/0070144516)
2. E. J. Yoder and M. W. Witzak, Principles of Pavement Design, Wiley International, 2nd edition, 1991. (ISBN: 978-0471977803)

Programme Name	Bachelor of Technology in Civil Engineering	Semester – VIII
Course Code	R4SE4103S	
Course Title	Design of Prestressed Concrete Structures (Elective III)	
Prerequisites	Mechanics of Solids, DRCC	

Course Outcomes

After completion of this course, students will be able to,

1. Implement the principles of pre-stressed concrete for analysis of pre-stressed concrete sections.
2. Evaluate losses in pre-stressed concrete sections.
3. Design pre-stressed concrete sections.
4. Analyze and design the determinate pre-stressed structural members.

Course Contents

1. Introduction to pre-stressed concretes

Basic concept and general principles, materials used and their properties, methods and techniques of pre-stressing, pre-stressing systems, loss of pre-stress, segmental box girder. pre-stressed material testing and calibration, Introduction to enabling works for pre-stressed concrete

2. Analysis of pre-stressed concrete sections

Loading stages and computation of section properties, critical sections under working load for pre-tensioned and post tensioned members, load balancing method of analysis of pre-stressed concrete beams.

3. Design of pre-stressed concrete sections for flexure

General philosophy of design, design approaches in working stress method and limit stress method, critical conditions for design, limit state of collapse in flexure, permissible stresses in concrete and steel, kern points, choice and efficiency of sections, cable profiles and layouts, cable zone, deflections of pre-stressed concrete members.

4. Design for shear

Calculation of principle tension under working load, permissible principle tension, shear strength calculation under limit state of collapse for both sections cracked and un-cracked in flexure

5. End zone stresses in pre-stressed concrete members

Transfer of pre-stress in pretension member: pretension transfer bond, transmission length, end zone reinforcement

Anchor zone stresses in post tensioned members: stress distribution in end block, anchor zone reinforcement

6. Design of pre-stressed concrete beams

Design of simply supported pretension and post tensioned slabs and beams, introduction to application of pre-stressing to continuous beams, linear transformation and concordance of cables.

7. Miscellaneous structures

Design of tension and compression members-design of sleepers, tanks, pipes and poles. Partial pre-stressing-definition, methods of achieving partial pre-stressing, merits and demerits of partial prestressing, design of pre-stressed concrete roads, design of launching girder

Text Books

1. N. Krishna Raju, Pre-stressed Concrete, Tata McGraw Hill Publishing Co., 2018. (ISBN: 9789387886209/9387886204).
2. G.S.Pandit and S.P.Gupta, Prestressed concrete, CBS Publishers and Distributors Pvt.Ltd, second edition,2014.(ISBN: 9788123901534/8123901534).

Recommended Reading

1. T.Y. Lin, Design of Pre-stressed Concrete Structures, John Wiley and Sons Inc., 2010. ISBN: 9788126528035/8126528036.
2. J. Libby, Modern Pre-stressed Concrete, Springer Science & Business Media, 2012.
3. A. E. Naaman, Pre-stressed Concrete Analysis and Design, McGraw-Hill College, 2014.(ISBN: 9789332901469/9332901465)
4. Y. Guyon, Pre-stressed Concrete, Contractors Record, 1955. ASIN: B0000CIK24.
5. N. Rajgopalan, Prestressed Concrete, Narosa publishing House,2002. (ISBN: 9788173195433/8173195439).

Programme Name	Bachelor of Technology in Civil Engineering	Semester – VIII
Course Code	R4SE3102T	
Course Title	Geosynthetic Engineering (Elective III)	
Prerequisites	Soil Mechanics & Geotechnical Engineering	

Course Outcomes:

After completion of course, students will be able to,

1. Select geo-synthetics for intended purpose.
2. Evaluate properties of geo-synthetics.
3. Design geo-synthetics for intended purpose.
4. Design geo-composite systems to solve contemporary geotechnical and landfill problems.

Course Contents

1. Introduction

Historical Development: Types of Geo-synthetics, Geo-textiles, geo-grids, geo-nets, geo-membranes, geo-composites, functions, reinforcement, separation, filtration, drainage, barrier Functions.

2. Physical mechanical, hydraulic & durability properties

Physical properties: Mass per unit area, thickness, specific gravity, hydraulic properties: Apparent open size, permittivity transmissivity. Mechanical Properties: Uni-axial Tensile Strength, Burst and Puncture Strength, Soil Geosynthetic friction tests; Durability: Abrasion resistance, Ultraviolet resistance.

3. Testing methods for geosynthetics

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

4. Drainage and filtration applications of geosynthetics

Different filtration requirements, filtration in different types of soils and criteria for selection of geotextiles, estimation of flow of water in retaining walls, pavements, etc. and selection of geosynthetics.

5. Reinforced soil slope

Basal reinforcement for construction on soft clay soils, construction of steep slopes with reinforcement layers on competent soils, Different slope stability analysis methods like planar wedge method, bi-linear wedge method, and circular slip methods. Erosion control on slopes using geosynthetics

6. Pavement application

Geosynthetics for separation and reinforcement in flexible pavements, design by GiroudNoiray approach, reflection cracking and control using geosynthetics. Use of geosynthetics for construction of heavy container yards and railway lines.

7. Construction of landfills using geosynthetics

Different components of modern landfills, collection techniques for leachate, application of different geosynthetics like geonets, geotextiles for drainage in landfills, use of geomembranes and Geosynthetic Clay Liner (GCL) as barriers.

Text Books

1. G.V. Rao and G.V. SuryanarayanaRaju, Engineering with Geo-synthetics, Tata McGraw Hill, New Delhi, 1990. (ISBN: 007460323X/978-0074603239).
2. M.Robert Koerner, Designing with Geosynthetics, Prentice Hall, New Jersey, U.S., 2012. (ISBN: 9781465345240/1465345248).
3. S.K.Shukla Handbook of Geo-synthetic Engineering: Geo-synthetics and their applications. (ISBN: 9780727741752/ 0727741756).

Recommended Reading

1. M.Robert Koerner, Construction and Geotechnical Methods in Foundation Engineering, McGraw Hill, New York, 1985.(ISBN-0070352453/978-0070352452).
2. R.A. Jewell, Soil Reinforcement with Geo-textile, CIRIA, London, 1996. (ISBN-0860174255/978-0860174257).
3. N.W.M.John, Geotextiles, John Blackie and Sons Ltd., London, 1987. (ISBN-0216919959/978-0216919952).
4. Proc. Conference on polymer and Reinforcement, Thomas Telford Co., London, 1984. (ISBN-0727702424/978-0727702425).

Programme Name	Bachelor of Technology in Civil Engineering	Semester – VII
Course Code	R4CE4112S	
Course Title	Unit Operations & Processes in Environmental Engineering (Elective IV)	
Prerequisites	Environmental Engineering	

Course Outcomes:

After completion of course students will be able to

1. Describe types of process units for different treatments.
2. Compare pollutant removal mechanisms of physicochemical and biological treatment units.
3. Design the treatment processes of water and wastewater based on environmental, economic and social factors.
4. Evaluate emerging technologies for advanced wastewater treatment and water recycling based on operational characteristics

Course Contents:

1 Introduction

Need of preliminary, primary, secondary, tertiary, advanced treatments, Unit operations and processes: definition; examples.

2 Unit Operations

Screens: classification, design consideration, screen characteristics and quantities.

Flow equalization: Description, application and design consideration.

Mixing and flocculation: rapid mixing & flocculation, different types, design consideration.

Gravity Separation: Discrete & flocculent particle settling.

Flotation: Description, applications, design consideration.

Aeration: Oxygen transfer, types of aeration systems.

Filtration: Slow sand filter and rapid sand filter.

3 Chemical Unit Processes

Role of chemical unit processes in treatment, coagulation for removal of turbidity and colour; chemical precipitation for removal of heavy metals, phosphorous removal; chemical oxidation for removal of BOD/COD, chemical neutralization.

4 Biological Unit Processes

Oxidation of organic matter, synthesis, auto oxidation, aerobic and anaerobic processes, biological removal of nitrogen and phosphorous, biological removal of toxic organic compounds.

Text Books:

1. T. D. Reynolds and P. D. Richards, Unit Operations and Processes in Environmental Engineering, PWS publishing Company, 2nd edition, 1996. (ISBN: 0534948847)
2. Robert Noyes, Unit Operations in Environmental Engineering, 2nd Edition, William Andrew Publishing, 1994. (ISBN: 978-0815513438)
3. M. N. Rao and A. K. Datta, Wastewater Treatment: Rational Methods of Design and Industrial Practices, Oxford and IBH Publishing, 3rd edition, 2007. (ISBN: 9788120417120)
4. Manual on Water Supply and Treatment, Ministry of Works & Housing, New Delhi, 1993.
5. Manual on Wastewater Treatment, Ministry of Works & Housing, New Delhi, 2013.

Reference Books:

1. S. J. Arceivala and S.R. Asolekar, Wastewater Treatment for pollution control & reuse, , Tata McGraw Hill Pvt Ltd, New Delhi, 3rd edition, 2008. (ISBN: ISBN: 9780070620995)
2. S. R. Qasim, Wastewater Treatment Plants: Planning, Design and Operation, 2nd Edition, Taylor and Francis Publishing, CRC Press 1998. (ISBN: 9781566766883)
3. Metcalf and Eddy, Wastewater Engineering Treatment and Reuse, Tata McGraw Hill Education, 5th edition, 2017. (ISBN: 9780070495395/0070495394)

Programme Name	Bachelor of Technology in Civil Engineering	Semester – VIII
Course Code	R4CE4113S	
Course Title	Transportation & Planning & Traffic Engineering (Elective IV)	
Prerequisites	Pavement Engineering	

Course Outcomes:

After completion of course students will be able to

1. Apply techniques for collecting and analyzing traffic data and its evaluation.
2. Develop appropriate model of traffic flow.
3. Use methods for demand forecasting and economic evaluation of transport projects

Course Contents:

1 Traffic Engineering and control

Review of various traffic surveys and traffic studies. Greenshield Model

Statistical methods for traffic engineering and their applications: Distributions, sampling theory and Significance testing, Regression and Correlation.

Intersection design: Principles, various available alternatives, rotary design, mini roundabout, traffic signals: types of traffic signals, advantages, determination of optimal cycle time and signal setting for an intersection with fixed time signals, co-ordination of signals, types, area traffic control, delay at signalized intersection.

Accident and road safety: accident causes, recording system, analysis and preventive measures, accident cost, alternative methodologies for calculation.

Traffic management: various measures and their scope, relative merits and demerits.

Highway capacity: Passenger's car units, level of service, factor affecting capacity and level of service, influence of mixed traffic.

2 Transportation Planning and management

Introduction to the process of urban transport planning. Travel demand forecasting.

Trip generation analysis, trip classification, multiple regression analysis, category analysis
Modal split analysis: introduction, earlier modal split models, modal split models with behavioral basis.

Trip distribution analysis: introduction, methods of trip distribution, uniform and average factor method, Fratar method, Furness method, The Gravity model, Intervening and competing, Linear programming approach to trip distribution.

Traffic Assignment: purpose of traffic assignment, traffic flow characteristics, Assignment techniques: All or nothing assignment, Multiple route assignment, Capacity restraint assignment, Diversion curves. Rout building algorithms.

Land-use transport models: Introduction, selection of Land-use transport models, The Lowry model, Grain – Lowry model, Applications of Lowry model.

3 Theory of traffic flow

Scope, definitions and basic relationship, review of flow density speed studies, hydrodynamic analogies, Application of hydrodynamic analogy, Car-following theory and its application to traffic engineering, probabilistic description of traffic flow, an introduction to queuing theory as applied to traffic flow problems for study state conditions, simulation studies.

4 Transport Economics

Economic evaluation of highway schemes, need for economic evaluation, cost and benefits of transportation projects, basic principles of economic evaluation, Net present value method, benefit/cost ratio method, internal rate of return method. Vehicle operating costs, Value of travel time saving, Accident costs.

5 Public Transportation

Mass transit systems: Bus and rail transit, characteristic capacities etc. monorail, metrorail, high speed train

6 Introduction to intelligent transportation systems, Introduction to advanced computational techniques for transportation planning.

Text Books:

- 1 L. R. Kadiyali, Traffic Engineering and Transport Planning, Khanna Publishers, Delhi, 2011. (ISBN: 9788174092205)
- 2 P. Chakraborty and A. Das, Principles of Transportation Engineering, Prentice Hall India, 2011. (ISBN-9788120320840)

- 3 C. S. Papacostas and P. D. Prevedouros, Transportation Engineering and Planning, Prentice Hall, New Jersey, 3rd edition, 2015. (ISBN-9789332555150)

Reference Books:

- 1 M. Wohl and B. V. Martin, Traffic System Analysis for Engineering and Planners, McGraw Hill Inc., U.S., 1983. (ISBN: 978-0070712744/0070712743)
- 2 Manual of Economic Evaluation of Highway Projects in India (SP30), Indian Road Congress, 2008.

Programme Name	Bachelor of Technology in Civil Engineering	Semester – VIII
Course Code	R4SE4107T	
Course Title	Advanced Concrete Technology	
Prerequisites	Concrete Technology	

Course outcomes

After completion of course students will be able to,

1. Understand the functional role of advanced ingredients of concrete and their use for special purpose concrete.
2. Formulate detail mechanism of concrete with various advance ingredients.
3. Use advanced testing mechanism to evaluate concrete properties.

Course Contents

1. Concrete and its Ingredients.

Introduction to concrete, Mineral and chemical admixtures, Structure of hydrated cement paste, Transition zone in concrete. Design of concrete mix proportions by ACI and IS 10262:2009 method, Rheological behavior of fresh concrete. Properties of hardened concrete and their significance.

2. Mechanic of Concrete

Strength-Porosity relationship. Failure modes in concrete, Behaviour of concrete under various stress states, Elastic behaviour in concrete, Creep, shrinkage and thermal properties of concrete.

3. Durability of Concrete

Classification of causes of concrete deterioration, Permeability of concrete, Chloride penetration, Acid attack, Sulphate attack, Alkali-aggregate reaction, Concrete in sea water, AC impedance test, Corrosion of embedded steel in concrete, Case histories.

4. Testing of concrete

Rebound hammer, Windsor probe, Ultrasonic pulse velocity, Acoustic emission, Pulse-echo method, Initial surface absorption, Radar technique, Infrared Thermography, Quantab test Portable crack measuring microscope, Cover meter, Resistivity of concrete, Semi-destructive testing.

5. Special Concrete and Construction Equipment's

Concreting under special circumstances, Special materials in construction, Concreting machinery and equipment, Future trends in concrete technology.

Text Books

1. M.L. Gambhir, Concrete Technology, McGraw Hill Book Company, Fifth Edition, 2017. ISBN-1259062554, 978-1259062551.

Reference Books

1. Adam. M. Neville., Properties of Concrete, Fourth and Final edition, Wiley Publications, 1996. ISBN: 9788131791073, 8131791076.
2. A.R. Santhakumar, Concrete Technology” Oxford University Press, 2018. ISBN: 9780195671537,0195671538.
3. P.C.Aïtcin, High Performance Concrete, E &FN SPON, 1998. ISBN: 9780419192701, 0419192700.

Programme Name	Bachelor of Technology in Civil Engineering	Semester – VIII
Course Code	R4CE4115S	
Course Title	Environmental Impact Assessment (Elective IV)	
Prerequisites	Environmental Engineering	

Course Outcomes:

After completion of course students will be able to

1. Describe EIA process and relate various government notifications.
2. Formulate the methodology for prediction and assessment of various impacts on environment
3. Analyze the issues and mitigation measures through case study

Course Contents:

1. Fundamental Approach To EIA

History of EIA: Evolution Environmental Laws in World & India, Development of EIA in India, Environmental Clearance Procedure in India.

Basic Concept of EIA: Introduction, EIA Procedure, Objective of EIA, Significance.

Systematic Approach for Using EIA: Introduction, Identification of Study Area, Classification of Environmental Parameters, Terms of References, Preparation of EIA Report, Scoping in EIA, Rapid EIA: Introduction, Procedure, Advantages and Limitation.

Baseline Studies in EIA, Environmental Monitoring & Management Planning, Draft and Final EIA, Impact Analysis, Final EIA Report.

2. EIA Methodologies

Introduction, Criteria for the Selection of EIA Methodology, EIA

Methods: Adhoc Methods, Checklists Methods, Matrices Methods, Networks Methods, and Overlays Methods.

3. Environmental Impact Statement (EIS)

Introduction, Basic Concepts behind EIS, Various Stages in EIS Production, Typical EIS Outline.

4. Prediction and assessment of impacts on soil and ground water environment: introduction, soils and ground water, methodology for the prediction and assessment of impacts on soil and groundwater.

Prediction and Assessment of Impacts on Surface Water Environment: Introduction, Project Which Create Impact Concerns for the Surface-Water Environment, Systematic Methods for Evaluation of Impacts of Various, Developmental Activities on SurfaceWater Environment.

Prediction and Assessment of Impacts on Biological Environment: Introduction, General Methodology for the Assessment of Impacts on Biological Environment, Systematic Approach for Evaluating Biological Impacts.

Prediction and assessment of impacts on the air environment: Introduction, a generalized approach for assessment of air pollution impact.

Prediction and assessment of impacts of noise on The environment: Introduction, Basic Information of Noise, Noise Measurement, Effects of Noise on People, Systematic Methodology for Assessing Environmental Impacts of Noise.

Prediction and Assessment of Impacts on the Socio-Economic Environment: Introduction, Social Assessment, Conceptual Frame Work for Socio Economic Assessment.

5. Case studies on Environmental Impact assessment for current projects in process.

Text books:

1. L. W. Canter, Environmental Impact Assessment, McGraw-Hill International editions, 2nd edition, 1995. (ISBN: 9780070097674/0070097674)
2. Y. Anjaneyulu and V. Manickam, Environmental Impact Assessment Methodologies, CRC Press, B S Publications, 2nd edition, 2011. (ISBN: 9780415665568)

Recommended books:

1. D. P. Lawrence, Environmental Impact Assessment, Willy Interscience, New Jersey.
2. L. N. Patraik, Environmental Impacts of Industrial & Mining activities, Ashish Publication house.
3. R. K. Trivedi and M. P. Sinha, Impact of Mining on Environment, Ashish Publication House.
4. J. R. Cooper, K. Randle, and R. S. Sokhi, Radioactive Releases in the Environment: Impact and Assessment, John Wiley sons, 2003. (ISBN: 9780471899242)
5. Environment, construction and sustainable development vol. 1, The Environmental Impact of Carpenter T. G., 2001, John Wiley & sons.

Programme Name	Bachelor of Technology in Civil Engineering	Semester – VIII
Course Code	R4SE4106S	
Course Title	Advanced Design of Steel Structures (Elective-IV)	
Prerequisites	Design of Steel Structures, Structural Analysis I and II	

Course Outcomes

After completion of course, students will be able to,

1. Analyze and design a moment resisting beam connections.
2. Analyze and design welded plate girder and gantry girder.
3. Design steel structural system by using round tubular steel members.
4. Analyze and design circular and rectangular elevated steel tanks.
5. Analyze and design chimney and lattice tower steel structures.

Course Contents

1. Moment resisting connections

Design of moment resistant bolted and welded beam end connections.

2. Welded plate girder and gantry girder

Proportioning, loading calculation and design of plate girder section and connections, curtailment of flange plates, design of web splices, design of stiffeners. Loading calculation, fatigue effect and design on gantry girder.

3. Design of round tubular structural members

Properties of steel tubes, design of tension and compression members, design of welded connections, design of flexural members. Analysis and design of tubular trusses including purlin and supports.

4. Elevated steel tanks and stacks

Loads acting on tanks including wind and earthquake. Design of circular tanks with conical bottom, supporting ring beam, staging for circular tanks, design of rectangular steel tanks and design of foundation for columns.

5. Steel chimney

Forces acting on chimney, design of self-supporting welded chimney including design of foundation.

6. Lattice tower

Loads acting on lattice towers, analysis and design of lattice tower including welded or riveted connections for members.

TextBooks:

- 1 S.K. Duggal, Limit State Design of Steel Structures, Tata McGraw Hill Education Private Limited, 2017. (ISBN: 9789351343493/9351343499).
- 2 V.L. Shah and V. Gore, Limit State Design of Steel Structures IS: 800-2007, Structures Publication, 2012.(ISBN: 8190371754).

Recommended Reading

- 1 S.S. Bhavikatti, Design of Steel Structures, I.K. International Publishing House Limited, 2017. (ISBN: 9789385909559/938590955X).
- 2 N. Subramanian, Design of Steel Structures, Oxford University Press, 2011. (ISBN: 9780198068815/0198068816).
- 3 IS 800 (2007), General Construction in Steel- Code of Practice, Ced 7: Structural Engineering and Structural Section, Published by Bureau of Indian Standard ManakBhavan, New Delhi.
- 4 IS 875- Part 1 (1987): Dead Loads, Indian Standard Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures, Published by Bureau of Indian Standard ManakBhavan, New Delhi.
- 5 IS 875- Part 2 (1987): Imposed Loads, Indian Standard Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures, Published by Bureau of Indian Standard ManakBhavan, New Delhi.
- 6 IS 875- Part 3 (1987): Wind Loads, Indian Standard Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures, Published by Bureau of Indian Standard ManakBhavan, New Delhi.
- 7 IS 875- Part 4 (1987): Snow Loads, Indian Standard Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures, Published by Bureau of Indian Standard ManakBhavan, New Delhi.
- 8 IS 875- Part 5 (1987): Special Loads and Combinations, Indian Standard Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures, Published by Bureau of Indian Standard ManakBhavan, New Delhi.