Shri Shankaracharya Technical Campus, Bhilai

(An Autonomous Institute Affiliated to CSVTU Bhilai)

Scheme of Teaching & Examination (Effective from 2020-2021 Batch)

B. Tech. (Civil Engineering) Fifth Semester

S. No.	Board of Studies (BOS)	Courses	Category	Course Code	Period per Week			Scheme of Examination			Total Marks	Credit
								Theory/Lab				
					L	T	P	ESE	CT	TA		
1	Civil Engineering	Structural Analysis – II	PCC	CE101501	2	1	-	100	20	30	150	3
2	Civil Engineering	Structural Engineering Design – I	PCC	CE101502	2	1	-	100	20	30	150	3
3	Civil Engineering	Geotechnical Engineering - I	PCC	CE101503	3	-	-	100	20	30	150	3
4	Civil Engineering	Transportation Engineering – II	PCC	CE101504	3	-	-	100	20	30	150	3
5	Civil Engineering	Professional Elective–I	PCC	CE	3	-	-	100	20	30	150	3
6	Civil Engineering	Transportation Engineering Lab	PCC	CE101591	-	-	2	25	-	25	50	1
7	Civil Engineering	Geotechnical Engineering Lab	PCC	CE101592	-	-	2	25	-	25	50	1
8	Civil Engineering	Structural Analysis lab	PCC	CE101593	-	-	2	25	-	25	50	1
9	Civil Engineering	Minor Project-I	PSI	CE101594	-	-	2	25	-	25	75	1
10	Civil Engineering	Internship & Assessment/Industrial Training Report	PSI		-	-	2	-	-	25	25	1
11	Civil Engineering	Indian Constitutions	MNC							25	25	-
Total					**13**	**2**	**10**	**600**	**100**	**300**	**1000**	**20**

L-Lecture T- Tutorial P-Practical
CT- Class Test TA- Teachers Assessment ESE- End Semester Exam

Note:

(a) Abbreviations used : L-Lecture, T- Tutorial, P- Practical, ESE- End Semester Exam, CT- Class Test, TA- Teacher's Assessment

(b) The duration of end semester examination of all theory papers will be of three hours.

(c) Constitution of India will be conducted by / relevant discipline as decided by the Director.

Sl. No.	*Board of Studies (BOS)*	*Courses (Subject)*	*Course Code*	*Credit*
1	Civil Engineering	**Hydrology and Water Resources Engineering**	CE101521	3
2	Civil Engineering	Modern construction Material	CE101522	3
3	Civil Engineering	Composite Material	CE101523	3
4	Civil Engineering	Modern Surveying Techniques	CE101524	3

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Sl. No.	Board of Studies (BOS)	Courses	Category	Course Code	Period per Week			Scheme of Examination			Total Marks	Credit
								Theory/Lab				
					L	T	P	ESE	CT	TA		
1	Civil Engineering	Structural Engineering Design-II	PCC	CE101601	3	1	-	100	20	30	150	4
2	Civil Engineering	Geotechnical Engineering-II	PCC	CE101602	2	1	-	100	20	30	150	3
3	Civil Engineering	Environmental Engineering-I	PCC	CE101603	3	-	-	100	20	30	150	3
4	Civil Engineering	Professional Elective-II	PEC	CE	3	-	-	100	20	30	150	3
5	Civil Engineering	Open Elective Elective-I	OEC	CE	3	-	-	100	20	30	150	3
6	Civil Engineering	Structural Engineering Lab	PCC	CE101691	-	-	2	25	-	25	50	1
7	Civil Engineering	Environmental Engineering Lab	PCC	CE101692	-	-	2	25	-	25	50	1
8	Civil Engineering	Concrete Technology Lab	PCC	CE101693	-	-	2	25	-	25	50	1
9	Civil Engineering	Minor Project – II	PSI	CE101694	-	-	2	50	-	25	75	1
10	Civil Engineering	Internship & Assessment/Industrial Training Report	PSI	CE101695	-	-	2	-	-	25	25	1
11	Civil Engineering	Indian Constitutions	MNC	CE101696						25	25	-
Total					**14**	**2**	**8**	**625**	**100**	**275**	**1000**	**20**

L-Lecture
T- Tutorial
P-Practical
CT- Class Test
TA- Teachers Assessment
ESE- End Semester Exam

Sl. No.	Board of Studies (BOS)	Courses (Subject)	Course Code	Credit
1	Civil Engineering	**Concrete Technology**	CE101621	3
2	Civil Engineering	Introduction to Earthquake Engineering	CE101622	3
3	Civil Engineering	Planning and Design of Airport	CE101623	3
4	Civil Engineering	Safety In Construction	CE101624	3
5	Civil Engineering	Transportation Planning & Management	CE101625	3

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Scheme of Teaching & Examination (Effective from 2020-2021 Batch)

B. Tech. (Civil Engineering) Sixth Semester

Table 2 : Open Elective - I

Sl. No.	Board of Studies (BOS)	Course(Subject)	Course Code	Link
1.	Civil Engineering	Project Construction Planning and Control	CE100641	https://archive.nptel.ac.in/courses/105/106/105106149/
2.	Civil Engineering	Remote Sensing Principle & Application	CE100642	https://nptel.ac.in/courses/105101206
3.	Computer Science & Engineering	Robotics		https://onlinecourses.nptel.ac.in/noc22_me109/preview
4.	Computer Science & Engineering	Data Visualization		https://onlinecourses.nptel.ac.in/noc22_cs72/preview
5.	Computer Science & Engineering	Pattern Recognition and Visual Recognition		https://onlinecourses.nptel.ac.in/noc22_ee119/preview
6.	Computer Science & Engineering	Predictive Analysis		
7.	Electrical & Electronics Engineering	Hybrid Electric Vehicle		
8.	Electrical & Electronics Engineering	Grid Integration of Renewable Energy Sources		
9.	Electrical Engineering	Renewable Energy Systems		nptel.ac.in/courses/1031032061
10..	Electrical Engineering	Industrial Automation and PLC		nptel.ac.in/courses/108105062
11.	Electronics & Telecommunication Engineering	Introduction to Wireless and Cellular Communications		https://nptel.ac.in/courses/106106167
12.	Electronics & Telecommunication Engineering	Cryptography & Network Security		https://nptel.ac.in/courses/106105162
13.	Information Technology	Human Computer Interaction		https://nptel.ac.in/courses/106106177
14.	Information Technology	Virtual reality		https://nptel.ac.in/uacourses/106106138
15.	MBA	Management for Technocrats		https://nptel.ac.in/courses/110105146 https://onlinecourses.nptel.ac.in/noc22_mg104/preview
				https://onlinecourses.swayam2.ac.in/nou22_mg07/
16.	MBA	Industrial Management		https://onlinecourses.swayam2.ac.in/nou22_mg06/preview
				https://onlinecourses.nptel.ac.in/noc22_mg81/preview https://nptel.ac.in/courses/110106141
17.	Mechanical Engineering	Operation Research		https://nptel.ac.in/courses/110106062
18.	Mechanical Engineering	Engineering Economics		https://nptel.ac.in/courses/112107209

Note:

(a) Abbreviations used : L-Lecture, T- Tutorial, P- Practical, ESE- End Semester Exam, CT- Class Test, TA- Teacher's Assessment

(b) 1/4th of total strength of students subject to minimum of 20 students is required to offer an elective in the department in a particular academic session.

(c) Choice of elective course once made for an examination cannot be changed in future examinations.

(d) The duration of end semester examination of all theory papers will be of three hours.

SYLLABUS

B.TECH. (Civil ENGINEERING)

FIFTH SEMESTER

Shri Shankaracharya Technical Campus, Bhilai

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SYLLABUS

B. Tech. (Civil Engineering) Fifth Semester

Subject Code: CE101501	Structural Analysis -II	L = 2	T = 1	P = 0	Credits = 3
Evaluation Scheme	ESE	CT	TA	Total	ESE Duration
	100	20	30	150	3 Hours

Course Objectives	Course Outcomes
Objective of the Subject: 1. To learn the methods which are applied to analyse indeterminate structures. 2.To gain the expertise in analysis of indeterminate beams and rigid frames. 3.To develop professional skill in analyzing indeterminate pin jointed structures. 4.To learn to draw influence line diagrams for stress functions in indeterminate beams which may be useful for moving the maximum values of the stress functions.	**CO1:** Leaner is able to differentiate and analyze the different kinds of structures- determinate and indeterminate. **CO2:** Learner is able to apply suitable method for given structure - rigid jointed or pin-jointed plane frames. **CO3:** Leaner is able to analyze indeterminate beams and frame (sway and non-sway) using Moment distribution method. **CO4:** Leaner is able to analyze indeterminate beams and frame (sway and non-sway) using slope deflection method. **CO5:** Learner is able to draw influence line diagram for determinate and indeterminate beams using Muller Breslau principle and is able to apply it for finding out maximum values of stress function.

UNIT – I: **CO-1**

Analysis by Classical Methods: Introduction:- - What makes a structure and roles of a structural engineer.

Review of solid mechanics: Stability of structures, Indeterminate Structures, Static and kinematic indeterminacies, Boundary conditions, Redundancy, Flexural Rigidity, Elastic Curve, Degree of freedom, Force and Displacement methods of structure analysis, Principle of superposition.

Analysis of indeterminate beams using by Classical Methods: Consistent deformation method, Theorem of three moments (Clapeyorn's theorem of three moments).Application to problems of beams and frames to determine the support reactions, plot shear force and bending moment diagrams, considering sinking of support. **[8Hrs]**

UNIT - II **CO-2**

Analysis by Energy Method: Concepts of energy principles, Strain energy of linear elastic systems due to axial load, bending moment and torsion. Minimum strain energy and Castigliano's second theorem, Principle of virtual displacement and virtual forces - Castigliano's first theorem - Maxwell's reciprocal theorem, Betti's law. Resilience, lack of fit, Thermal stresses, Settlement of supports, Application to problems of indeterminate beams, 2D pin jointed frames (trusses), 2 hinged arches and 2D rigid frames to determine the support reactions, plot shear force and bending moment diagrams. **[7Hrs]**

UNIT - III: **CO-3**

Method of Moment distribution: Framed structure, sway and non-sway framed structure, causes of sway in framed structure, deformation in sway and non-sway framed structure, Stiffness, Fixed end moments due to various loads and settlement, Bending stiffness, Distribution factors,

Carryover factors, Sign convention. Application of Method of Moment Distribution to problems of indeterminate beams (also with cases of sinking of supports) and rigid frames (single/ multiple bay, single/ multi storey portals) without and with

Subject Code: CE101501	Structural Analysis -II	L = 2	T = 1	P = 0	Credits = 3
Evaluation Scheme	ESE	CT	TA	Total	ESE Duration
	100	20	30	150	3 Hours

Sway problem to determine the support reactions, plot shear force, bending moment diagrams and elastic curve. **[7Hrs]**

UNIT - IV **CO-4**

Method of Slope deflection: Joint equilibrium equations, compatibility and Boundary conditions Application of Method of Slope deflection to problems of indeterminate beams (also with cases of sinking of supports) and rigid frames (single/ multiple bay, single/ multi storey portals) without and with sway problem to determine the support reactions, slope, deflections, plot shear force, bending moment diagrams and elastic curve. Basics of Column analogy method and its application for fixed beams **[7Hrs]**

UNIT-V **CO-5**

Influence lines by Muller Breslau Principle: Review of Influence line, rolling load, Difference between ILD, SFD, BMD, Joint equilibrium equations, compatibility, Boundary conditions, Maxwell Betti's theorem. Muller Breslau Principle. Application of Muller Breslau principle: Qualitative and quantitative influence lines for Support Reactions, Shear Force Diagram and Bending Moment.Diagram of indeterminate beams - propped Cantilevers and continuous beams. Basics of Influence lines for Arches and stiffening girders. **[7Hrs]**

TEXT BOOKS :

S. No.	Title	Authors	Edition	Publisher
1)	SMTS – II Theory of Structures	Punmia B.C., A. K. Jain, A. K. Jain	12th	Laxmi Publications
2)	Fundamentals of Structural Analysis (with Computer Analysis and Applications)	Sujit Kumar Roy and SubrataChakrabarty	Revised edition 2009	(S. Chand Publications)
3)	Basic Structural Analysis	C.S. Reddy	3rd	Tata McGraw Hill Publications

REFERENCE BOOKS :

S. No.	Title	Authors	Edition	Publisher
1)	Intermediate Structural Analysis	Wang. C.K.		Tata McGraw Hill Publications
2)	Fundamentals of Structural Analysis	Harry H. West and Louis F. Geschwindner		Wiley India Publications
3)	Theory of Structures (Vol. I & Vol. II)	G. Pandit, S. Gupta & R. Gupta	1999	Tata McGraw Hill Publications
4)	Structural Analysis	Hibbeler		Pearson Education Publications
5)	Fundamentals of Structural Mechanics and Analysis	M. L. Gambhir		PHI Learning Publications

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SYLLABUS

Subject Code: CE101502	Structural Engineering Design – I	L = 2	T = 1	P = 0	Credits = 3
Evaluation Scheme	ESE	CT	TA	Total	ESE Duration
	100	20	30	150	3 Hours

Course Objectives	Course Outcomes
1. To educate the student about the concept of reinforced cement concrete and different method of design of reinforced concrete. 2. To educate the student about concept of working stress method to analysis and design of beams. 3. To educate the student about concept of limit state method to analysis and design of beams, slabs and columns. 4. To educate the student about analysis and design of footings and staircases by limit state method.	**On successful completion of the course, the student will be able to:** **CO1:** The student will be able to understand the importance of RCC, various design philosophies used in structure engineering design and design of rectangular beam using working stress method. **CO2:** The student will be able to analyze and design rectangular beam section using Limit State method. **CO3:** The student will be able to analyze and design T-beam section and slab using Limit State method. **CO4:** The student will be able to analyze and design Compression members using Limit State method. **CO5:** The student will be able to analyze and design single footing and stairs using Limit State method.

UNIT – I: **CO-1**

General: Objectives of structural design, Steps in RCC Structural Design Process, Role of structural designer.

Design philosophies: Working stress design and limit state design method. Advantages of limit state method over other methods.

Introduction: Properties of Concrete and reinforcing steel, stress-strain curves, permissible stresses, modular ratio, loads on structure, shrinkage, creep, Type of Loads on Structures and Load combinations. Introduction to IS 456:2000 and IS 875.

Introduction to working stress method: Basis for design of rectangular beam using working stress method. Analysis and design of singly reinforced and doubly reinforced sections by working stress method, shear in beams. **[8Hrs]**

UNIT - II **CO-2**

Limit State Method: Rectangular Beams: Introduction to limit state method, characteristic loads, partial safety factor, safety and serviceability considerations

Limit state of Collapse (Flexure): Assumptions, stress block parameters, neutral axis, analysis and design of singly and doubly reinforced section. Effective span to effective depth ratio, modification factors for singly reinforced, doubly reinforcement and flanged beams.

Limit State of Collapse (Shear, bond and torsion): shear in beams, Torsion in beams, bond and development length, design of lintels.

Limit State of Serviceability: Deflection. **[7Hrs]**

UNIT - III: **CO-3**

Limit State Method: T-Beams and Slab: Properties of T-section, moment of resistance and design of singly reinforced T-beam. Dead loads, imposed loads, thickness of slabs, modification factors, effective

Subject Code: CE101502	**Structural Engineering Design – I**	**L = 2**	**T = 1**	**P = 0**	**Credits = 3**
Evaluation Scheme	**ESE**	**CT**	**TA**	**Total**	**ESE Duration**
	100	**20**	**30**	**150**	**3 Hours**

span, reinforcement in slab, design of one-way slab and two-way slabs. **[7Hrs]**

UNIT - IV **CO-4**

Limit State of Collapse (Compression): Columns: Axially loaded short columns, minimum eccentricity, longitudinal and transverse reinforcement, effective length of column, safe load on columns, circular columns, Pu – Mu interaction curves, combined axial load and uni-axial bending, combined axial load and bi-axial bending. **[7Hrs]**

UNIT-V **CO-5**

Limit State Method: Column Footings- Isolated footings: General principle of design of reinforced concrete footing, proportioning of footings, edge thickness, depth of footing, design of isolated column footings – square and rectangular footings, Design of stairs – dog legged stair, open newel stair. **[7Hrs]**

TEXT BOOKS :

S. No.	**Title**	**Authors**	**Edition**	**Publisher**
1)	Limit State Design of Reinforced Concrete	B. C. Punmia	11th	A. K. Jain and A. K. Jain (Laxmi Publications
2)	Design of Reinforced concrete structures	S. Ramamurtham	17th	Dhanpat Rai Publishing company (P) Ltd
3)	Reinforced Concrete Design	S. U. Pillai and D. Menon	3rd	Tata McGraw Hill
4)	Reinforced Cement Concrete Design	Neelam Sharma	2nd	S.K.Kataria & Sons

REFERENCE BOOKS :

S. No.	Title	Authors	Edition	Publisher
1)	**Relevant IS codes:** 1) IS: 456:2000 Indian standard Plain and reinforced concrete -Code of practice. 2) IS 875 for design loads (Part-1 for Dead loads, part 2 for imposed loads and Part-3 for wind loads)			
2)	Reinforced Concrete Structures	Dayaratam P	5th	Vika Oxford and IBH Publishing Co.
3)	Reinforced Concrete Limit State Design	Jain, A.K.	7th	Nem Chand and Bros. Roorkee
4)	Fundamentals of Reinforced Concrete Design	M. L. Gambhir	1st	PHI Learning
5)	Design of Reinforced Concrete Structures	M. L. Gambhir	Revised	PHI Learning

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SYLLABUS

Evaluation Scheme	ESE	CT	TA	Total	ESE Duration
	100	20	30	150	3 Hours

Course Objectives	Course Outcomes
This course will enable students to 1. To provide basic knowledge about Geotechnical Engineering, soil formation, index properties of soil. 2. To know about the types of soil according their classification, classification system, field identification, study of effective stress, capillary seepage force. 3. How to measure the compaction and permeability of soil by lab experiments theoretically uses of Darcy law. Two dimensions flow and develop flow net and characteristics. 4. To know about stresses due to applied load a soil mass, consolidation and their factor one dimensional consolidation as per Terzaghi theory 5. To find shear strength in soil with the help of Mohr circle. How shear strength can be determine in laboratory, soil exploration.	After studying this course, students will be able to: **CO-1:** Know about soil and development of soil mechanics and soil formation and characteristic of soil **CO-2**: Field identification, soil classification system **CO-3**: Study the lab experiments and simulations of experiment result with the theoretical characteristic of soil. **CO-4:** Study of different theory Newmart Charts, Westergaard and Boussinesq equation. **CO-5:** Able to find at experiment, shear strength of soil and different method of soil exploration.

UNIT – I: **CO-1**

Introduction: Introduction to Geotechnical Engineering; Unique nature of soil; Soil formation and soil types, inter relationship of soil, soil mechanics and geotechnical engineering, aim and scope of soil mechanics. Index Properties of Soil Basic definitions; phase relations; physical and engineering properties of soil, soil grain and properties coarse and fine grained soils, Stoke's law, method of fine grained analysis **[8Hrs]**

UNIT - II **CO-2**

Soil Classification and Effective Stress: Indian standard soil classification system, Purpose of soil Classification, Different System of soil Classification, Field Identification, Principal of Effective Stress and Related Phenomena, Types of soil moisture, principal of effective stress; capillarity; seepage force and quicksand condition. **[7Hrs]**

UNIT - III: **CO-3**

Soil Classification and Effective Stress: Clay mineralogy, soil structure, compaction theory, laboratory compaction tests, method of compaction control, permeability, one dimensional flow, permeability of soil, Darcy's law, laboratory methods of determination, pumping out tests for field determination of permeability, seepage through soils, two-dimension flow problems, confined flow and unconfined flow, flow net and their characteristics, exit gradient and failure due to piping, criteria for design of filters. **[7Hrs]**

UNIT - IV **CO-4**

Stresses due to Applied Loads and Consolidation: Stresses due to applied Loads, Boussinesq equation of vertical pressure under concentrated loads, rectangularly loaded area, circular Loaded Area Newmart's Chart, Westergaard's equation, compressibility, effects of soil type, stress history and effective stress on compressibility, consolidation, factors affecting consolidation and compressibility parameters. Normally consolidated and over consolidated soils, different forms of primary consolidation equation – transient flow condition, Terzaghi theory of one-dimensional consolidation and time rate of consolidation. **[7Hrs]**

UNIT-V **CO-5**

Shear Strength and Soil Exploration: Introduction, stress at a point and Mohr's stress circle; Mohr-Columb Failure criterion: Laboratory tests for shear strength determination; shear strength parameters; UU, CU and CD tests and their relevance to field problems; Shear strength characteristics of normally consolidated and reconsolidated clays; Shear strength Characteristics of sands, Soil Exploration, Various Method of field Exploration, Undisturbed Soil Sampling equipments and Field test (Static and Dynamic Penetration Test, PLT), cyclic plate load test and modern electronic test of site characterization. **[7Hrs]**

TEXT BOOKS :

S. No.	Title	Authors	Edition	Publisher
1)	Soil Mechanics and Foundations	B.C. Punmia	Tenth	Laxmi Publication
2)	Basic and Applied Soil Mechanics	Gopal Ranjan and Rao A.S.R	fourth	New Age International Publication

REFERENCE BOOKS :

S. No.	Title	Authors	Edition	Publisher
1)	Soil Mechanics and Foundation Engineering	S K Garg	Tenth	Khanna Publications
2)	Geotechnical Engineering	C Venkataramaiah	fourth	New Age International Publishers

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SYLLABUS

Subject Code: CE101504	Transportation Engineering – II	L = 3	T = 0	P = 0	Credits = 3
Evaluation Scheme	ESE	CT	TA	Total	ESE Duration
	100	20	30	150	3 Hours

Course Objectives	Course Outcomes
The objective is to make the students understand about: 1.To educate the students on the various means of transportation Railway Engineering 2.To educate the students about the concept of Geometric design of Railway track. 3.To educate the students about the different stresses and elements of railway track. 4.To educate the students about the concepts of Tunnel Engineering. 5:To educate the students about the concepts of Harbour Engineering	On successful completion of the course, the student will be able to: **CO1:-** Students will be able to learn about different components of Rail section **CO2:-** Students will be able to learn about geometric design of railway track. **CO3:-** Students will be able to learn about different stresses and elements of railway track. **CO4:-** Students will be able to learn about details of construction of Tunnel. **CO5:-** Students will be able to learn about Harbour structures.

UNIT – I: **CO-1**

Introduction of Rails: Gauges in railway track , Selection and uniformity of gauges, Railway track cross-section, Coning of wheels, Theory of coning ,Rail cross-section, Weight of rail, Length of rail, Wear of rails, Creep of rails, Rail joints and welding of rail **[8Hrs]**

UNIT - II **CO-2**

Geometrics Design of Railway Track: Sleepers -Requirements, various types, spacing and density, rail fixtures, fastenings. Ballast - Requirements, various types. Geometrics – gradient and grade compensation classification of gradients, cant and cant deficiency, transition curves, widening of gauges on curves. **[7Hrs]**

UNIT - III: **CO-3**

Stresses and Elements of Railway Track: Stresses in railway track , Point and crossing, Design of turn outs, Various types of track junctions, Signaling and interlocking, Signals, Control of movements of trains, Station yards and its type, Maintenance of railway track. **[7Hrs]**

UNIT - IV **CO-4**

Tunnel Engineering: Consideration in tunneling shape and size, methods of tunnel, constructions, tunneling in soft soil and rocks, lining of tunnels, ventilation, drainage of tunnels **[7Hrs]**

UNIT-V **CO-5**

Harbour Engineering: Harbour layout, harbor works, break water jetties, wharves, piers and berthing facilities, port facilities, docks, transit shed and ware houses. **[7Hrs]**

Subject Code: CE101504	**Transportation Engineering – II**	**L = 3**	**T = 1**	**P = 0**	**Credits = 3**
Evaluation Scheme	**ESE**	**CT**	**TA**	**Total**	**ESE Duration**
	100	**20**	**30**	**150**	**3 Hours**

TEXT BOOKS :

S. No.	**Title**	**Authors**	**Edition**	**Publisher**
1)	Railway Engineering	S.C. Saxena and S.P. Arora	10th edition	(Dhanpat Rai Publications)
2)	Railway Engineering	S.C.Rangwala,	27th edition	(Charotar Publishing House Pvt. Ltd.)
3)	Tunnel Engineering	S.C. Saxena	2nd edition	(Dhanpat Rai Publications)
4)	Harbour Engineering	R. Srinivasan	30th eddition	(Charotar Publishing House Pvt. Ltd.)

REFERENCE BOOKS :

S. No.	**Title**	**Authors**	**Edition**	**Publisher**
1)	Harbour Dock and tunnel Engineering	R. Srinivasan	28th eddition	(Charotar Publishing House Pvt. Ltd.)