

CHHATTISGARH SWAMI VIVEKANAND TECHNICAL UNIVERSITY

BHILAI (C.G.)

Scheme of Teaching & Examination

B.E. (VI Semester) Civil Engineering

S. No.	Board of Study	Subject Code	Subject	Periods per Week			Scheme of Examination			Total Marks	Credit L+(T+P)/2
				L	T	P	ESE	CT	TA		
1.	Civil Engineering	320651 (20)	Structural Engineering Design-II	4	1	-	80	20	20	120	5
2.	Civil Engineering	320652 (20)	Geotech Engineering-II	4	1	-	80	20	20	120	5
3.	Civil Engineering	320653 (20)	Environmental Engineering-I	3	1	-	80	20	20	120	4
4.	Civil Engineering	320654 (20)	Concrete Technology	3	1	-	80	20	20	120	4
5.	Civil Engineering	320655 (20)	Construction Planning	2	1	-	80	20	20	120	3
6.	<i>Refer Table-1</i>	<i>Professional Elective-I</i>		3	1	-	80	20	20	120	4
7.	Civil Engineering	320661 (20)	Structural Engineering Lab	-	-	3	40	-	20	60	2
8.	Civil Engineering	320662 (20)	Geotech Engineering-II Lab	-	-	3	40	-	20	60	2
9.	Civil Engineering	320663 (20)	Environmental Engineering-I Lab	-	-	3	40	-	20	60	2
10.	Civil Engineering	320664 (20)	Concrete Technology Lab	-	-	3	40	-	20	60	2
11.	Management	300665 (76)	Managerial Skills	-	-	2	-	-	40	40	1
12.			Library	-	-	1	-	-	-	-	-
Total				19	6	15	640	120	240	1000	34

Table – 1: Professional Elective - I

S. No.	Board of Study	Subject Code	Subject
1.	Civil Engineering	320671 (20)	Modern Construction Materials
2.	Civil Engineering	320672 (20)	Composite Materials
3.	Civil Engineering	320673 (20)	Advanced Strength of Materials
4.	Civil Engineering	320674 (20)	Modern Surveying Techniques
5.	Civil Engineering	320675 (20)	Remote Sensing and its Applications
6.	Civil Engineering	320676 (20)	GIS and its Applications
7.	Civil Engineering	320677 (20)	Computational Hydraulics
8.	Civil Engineering	320678 (20)	Instrumentation in Fluid Mechanics
9.	Civil Engineering	320679 (20)	Water Power Engineering
10.	Civil Engineering	320680 (20)	Earthquake Engineering

L: Lecture

T: Tutorial

P: Practical

ESE: End Semester Examination

CT: Class Test

TA: Teachers' Assessment

Note: Industrial Training of twelve weeks is mandatory for B.E. students. It is to be completed in two equal parts. The first part must have been completed in summer after IV sem. The second part to be completed during summer after VI sem. after which students have to submit a training report which will be evaluated by college teachers during B.E. VII sem.



Chhattisgarh Swami Vivekanand Technical University, Bhilai

Branch:	Civil Engineering	Semester:	VI		
Subject:	Structural Engineering Design - II	Code:	320651(20)		
Total Theory Periods:	40	Total Tutorial Periods:	10		
No. of class Tests to be conducted:	2 (Minimum)	No. of assignments to be submitted:	2 (Minimum)		
ESE Duration:	Three Hours	Maximum Marks in ESE:	80	Minimum Marks in ESE:	28

- Note:**
1. All designs should be as per latest version of code (IS: 800-2007)
 2. IS: 800-2007 and Steel Tables are permitted in Examination Hall.

Objectives of the Subject:

1. To know about the merits of steel structures.
2. To know about shapes and grades of structural steel available.
3. To know about the different methods of design and the advantages of limit state design over other methods.
4. To understand the behavior of structural steel under tension, compression and flexure.

Outcomes of the Subject:

1. To develop ability to select adequate shape and grade of structural steel.
2. To understand the basis of economical and safe design of steel structures.
3. To develop ability of choosing proper fastener for a particular joint.
4. To develop the ability to design structural steel elements by Limit State Method.

- UNIT I** **Materials and Methods:** Types of Structural Steel, Physical and Mechanical Properties, Advantages of steel as a structural material, Rolled Sections - Tapered Flange and Parallel Flange, Built up sections, Convention for Member Axes. Plastic Theory, Shape factor, Methods of design, Limitations of Working stress and Plastic design methods, Advantages of Limit State Design, Limit States of Strength and Serviceability, Partial Safety Factors, Loads and Load Combinations, Geometrical Properties, Classification of Cross Sections, Maximum effective slenderness ratio.
- UNIT II** **Fasteners:** Location details of fasteners, Bearing type bolts, Friction Grip type Bolting, Welds and Welding, Advantages and Disadvantages of Welded Connections, Lap and Butt Joints, Truss Joint Connections by bolts and welds.
- UNIT III** **Tension Members:** Design Strength due to Yielding of Gross Section, Rupture of Critical Section, Block Shear, Design of Axially Loaded Tension Members, Steel Angles under Tension.
- UNIT IV** **Compression Members:** Design Strength, Effective length of compression members, Design of Axially loaded compression members, Steel Angles under Compression, Design of Column bases under axial load, Laced Columns, Battered columns.
- UNIT V** **Flexural Members:** Design Strength in Bending (Flexure), Effective length for lateral torsional buckling, Shear, Design of Laterally Supported and Laterally Unsupported Beams with unstiffened webs.

Text Books:

1. Design of Steel Structures - N. Subramanian (Oxford University Press)
2. Limit State Design of Steel Structures – S. K. Duggal (Tata McGraw Hill)

Reference Books:

1. Indian Standard – General Construction in Steel –Code of Practice (3rd Revision) (IS:800 – 2007)
2. Design of Steel Structures – K. S. Sai Ram (Pearson Education)
3. Structural Steel Design : LRFD Method – J. C. McCormac, J. K. Nelson (Pearson Education)
4. Limit State design in Structural Steel – M. R. Shiyekar (PHI Learning)
5. Limit State Design of Steel Structures (IS:800-2007) – V. L. Shah, V. Gore (Structures Publications)
6. Design Manual for Designing Steel Structures according to New IS:800, Publication Number INS/PUB/114 – Institute for Steel Development and Growth, Kolkata.
7. Teaching Resource for Structural Steel Design, Vol. I – III, Publication Number INS/PUB/051, Institute for Steel Development and Growth, Kolkata.



Chhattisgarh Swami Vivekanand Technical University, Bhilai

Branch:	Civil Engineering	Semester:	VI		
Subject:	Geotech Engineering - II	Code:	320652(20)		
Total Theory Periods:	40	Total Tutorial Periods:	10		
No. of class Tests to be conducted:	2 (Minimum)	No. of assignments to be submitted:	2 (Minimum)		
ESE Duration:	Three Hours	Maximum Marks in ESE:	80	Minimum Marks in ESE:	28

Objective of the Subject:

1. To know about the stability of slopes and stability analysis.
2. To study about the earth pressure in different condition of soil, Coulomb earth pressure theories, earthquake loading.
3. To study about the types of shallow foundation basic for design, bearing capacity of soil and settlement of foundation.
4. The knowledge about another types of foundation like well and pile foundation and their design criterion.
5. Know about problems associated with expansive soils and contaminated soils and their remedial measures.

Outcomes of the Subject:

1. To know how to achieve stability of soil against gravitational force and seepage of water infinite slope concept of factor of safety.
2. Design of earth structure and their stability against soil pressure.
3. Design of shallow foundation and their failure how to measure bearing capacity of soil, effect of settlement of foundation.
4. Design of deep foundation selection of type of deep foundation design criterion for pile foundation.
5. To learn about the effects of expansive soils and contaminated soils on foundation.

- UNIT I** **Stability of Slopes:** Embankment slopes, examples of embankment, road and earth dams, stability analysis for finite and infinite slopes concept of factor of safety, friction circle method, method of slices, Bishop's simplified method, limiting values of factor of safety; critical conditions for the stability of earth dams.
- UNIT II** **Earth Pressure:** Earth Pressure at rest, active and passive earth pressure, computations using Rankine's and Coulomb's earth pressure theories, Rabhann's and Coleman's graphical method, additional earth pressure due to surcharge and earthquake loading.
- UNIT III** **Shallow Foundations and Settlements:** Common types of foundations with examples, brief illustration of situations where each one of them is adopted, basis for design, review of major soil parameters used in proportioning of shallow foundations, types and their selection bearing capacity, various method of determination of bearing capacity, computation of bearing capacity in cohesion less and cohesive soils, effect of various factors on bearing capacity, use of field test data, limits of settlement, differential and permissible settlement of footing, rafts on sand using penetration and load test data, estimation of settlement of footing for rigid and flexible, proportioning of footings.
- UNIT IV** **Well and Pile Foundations:** Situations where adopted, elements of wells, types, method of construction, tilt and shift, remedial measures, bearing capacity and settlement, Terzaghi's lateral stability analysis, Pile Foundation, their types, criteria of selection of piles, outline of steps involved in proportioning, bearing capacity and settlement of single and group of piles, design of pile groups and settlement of pile group in clay, negative skin friction.
- UNIT V** **Expansive Soil and Contaminated Soil:** Foundations on expansive soil, identification of expansive soil, problems associated with expansive soil, design consideration of foundation on expansive soil, Types and sources of sub surface contamination, contaminant transport, effects of sub surface contamination, detection of polluted zones.

Text Books:

1. Soil Mechanics and Foundations – B.C. Punmia, A. K. Jain, A. K. Jain (Laxmi Publication)
2. Soil Engineering in Theory and Practice (Vol-II) – Alam Singh (Asia Publishing House)

Reference Books:

1. Basic and Applied Soil Mechanics (Revised Edition) – Gopal Rajan and Rao A.S.R. (New Age)
2. Foundation Engineering – R. B. Peck, W. E. Hanson, and T. H. Thornburn (John Wiley)
3. Foundation Design and Construction – M. J. Tomlinson (Pearson Education)
4. Foundation Analysis and Designing – J.E. Bowles (McGraw Hill, New Delhi)
5. Physical Methods of Soil Characterisation – J. Behari (Narosa Publishing Hall, New Delhi)
6. Soil Mechanics and Foundation Engineering – Purushothama Raj, Pearson Education
7. Text Book of Geotechnical Engineering – I. H. Khan (PHI Learning)
8. Foundation Design – Principles and Practices – D. P. Coduto (Pearson Education)



Name of the Programme: Bachelor of Engineering :::: Duration of the Programme: Four Years

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Branch:	Civil Engineering	Semester:	VI		
Subject:	Environmental Engineering - I	Code:	320653(20)		
Total Theory Periods:	40	Total Tutorial Periods:	10		
No. of class Tests to be conducted:	2 (Minimum)	No. of assignments to be submitted:	2 (Minimum)		
ESE Duration:	Three Hours	Maximum Marks in ESE:	80	Minimum Marks in ESE:	28

Objective:

1. To provide fundamental awareness about the water sources, population forecasting, water quality.
2. To develop an interest in pursuing the subject for P.G. studies because environmental pollution and its management is a critical topic of the hour.
3. To develop skills of designing a water treatment plant.
4. Developing a professional skill for design of water distribution system and environmental problems related to civil engineering.

Outcome:

1. Provide deep understanding about planning, designing, construction and monitoring of a water treatment plant as per a city's water demand.
2. Students possess the ability to design an analysis the complexities of water distribution system.
3. Ability to give meaningful result to the water supply project they get in hand.
4. Have a appreciation for the scope, complexity and requirement to treat the subject as the need of the hour and has a positive attitude to earth environment and its protection.

UNIT I Introduction: Necessity and importance of water supply schemes. Water demand: Classification of water demands, Estimation of quantity of water required by a town, per capita demand, factors affecting per capita demand, design period and population forecasting, variation in water demand. Sources of water supply Surface sources and underground sources, Intake works, site selection, type of intake works.

UNIT II Quality of Water: Common impurities, physical, chemical and biological characteristics of water, water quality standards for municipal and domestic supplies. Water Processing: Object of water processing, flow diagrams of typical ground water system and surface water systems. Sedimentation. Theory of sedimentation, sedimentation tanks and its types, design parameters related with sedimentation tanks, sedimentation with coagulations, coagulants and coagulant aids, Jar test for determining coagulant dosage.

UNIT III Filtration: Theory of filtration, slow sand and rapid sand filters, Construction and operation. Disinfection: Methods of disinfection, Chlorination, Types of chlorination, Break Point chlorination.

UNIT IV Softening: Methods of Softening, Iron Removal, Fluoridisation. Distribution System: Methods of distribution, layout of distribution system, methods of analysis, pressure in the distribution system, distribution reservoirs, functions and its types, storage capacity of distribution reservoir.

UNIT V Air Pollution: Introduction, causes, sources, characteristics, effects of air pollution on plants, humans, animals and materials and atmosphere, air pollution control methods and equipment.

Text Books:

1. Water Supply Engineering – S.K. Garg (Khanna Publication).
2. Water Supply Engineering – B.C. Punmia, A. K. Jain, A. K. Jain (Laxmi Publications)

Reference Books:

1. Environmental Engineering – Peavy and Rowe (Tata McGraw Hill).
2. Water Supply and Sanitary Engineering – G.S. Birdi (Dhanpat Rai Publications).
3. Introduction to Environmental Science – Y. Anjaneyulu (B.S. Publications)
4. Environmental Science and Engineering – Henry and Heinke (Pearson Education)



Chhattisgarh Swami Vivekanand Technical University, Bhilai

Branch: Civil Engineering	Semester: VI
Subject: Concrete Technology	Code: 320654(20)
Total Theory Periods: 40	Total Tutorial Periods: 10
No. of class Tests to be conducted: 2 (Minimum)	No. of assignments to be submitted: 2 (Minimum)
ESE Duration: Three Hours	Maximum Marks in ESE: 80 Minimum Marks in ESE: 28

Objective of the Subject:

1. To develop Fundamental knowledge of properties of concrete and its ingredients.
2. To acquire an interest in concrete technology and admixture and its filled requirements.
3. Developing a good skill of various methods of concrete making, placing and special formwork.
4. Developing a professional skill of concrete mix design by IS Code Method.

Outcomes of the Subject:

1. Ability to measure quality of concrete making materials.
2. Ability to design concrete mixes according to IS, ACI, BS Code methods.
3. Capable of understanding field requirements of various types of concrete.
4. Understanding the process of selection of materials and testing, uses of admixtures, professional practices in ready mix concrete.

UNIT I Concrete Making Materials: Hydration of cement, Structure of hydrated cement, General Purpose cements, Special purpose cements, Blended cements, Classification of Aggregates, Properties, Grading requirements, Methods of combining aggregates, Surface index, specified grading, Alkali aggregate reaction, Quality of mixing and curing water.

UNIT II Admixtures and Fresh Concrete: Chemical admixtures – Functions of Admixtures, Classification of Admixtures, Mineral Additives, effects on concrete properties. Workability, Factors affecting workability, Measurement of Workability, Requirements of Workability, Segregation, Bleeding

UNIT III Hardened Concrete and Durability: Compressive strength and parameters affecting it, Gain of strength with age, Maturity Concept, Elasticity, Creep and shrinkage, Permeability of Concrete, Durability of Concrete, relation between durability and permeability, corrosion of steel rebars.

UNIT IV Concrete Mix Design: Principles of concrete mix design, Concrete mix design steps as per Indian, American & British methods, destructive and non-destructive tests on concrete.

UNIT V Special Concrete & Concreting Methods: Need of special concrete, properties, ingredients, method of development and applications of Light weight concrete, Fibre reinforced concrete, Polymer Concrete, self-compacted concrete, High performance concrete, Ready mix concrete, Extreme weather concreting, special concreting methods, Vacuum dewatering - underwater concrete, special form work.

Text Books:

1. Concrete Technology – M.L. Gambhir (Tata McGraw Hill)
2. Concrete Technology Theory and Practice - M. S. Shetty, (S.Chand and Company Ltd. Delhi)

Reference Books:

1. Concrete Technology – A. M. Neville, J. J. Brooks, (Pearson Education)
2. Light Weight Concrete Academic Kiado – Rudhani G. (Publishing Home of Hungarian Academy of Sciences)
3. Concrete Technology – R.S. Varshney (Oxford, IBH Publishers)



Chhattisgarh Swami Vivekanand Technical University, Bhilai

Branch: Civil Engineering	Semester: VI
Subject: Construction Planning	Code: 320655(20)
Total Theory Periods: 40	Total Tutorial Periods: 10
No. of class Tests to be conducted: 2 (Minimum)	No. of assignments to be submitted: 2 (Minimum)
ESE Duration: Three Hours	Maximum Marks in ESE: 80 Minimum Marks in ESE: 28

Objective:

1. To develop fundamental knowledge of project management and cost control.
2. To learn about various techniques for project planning, scheduling and monitoring.
3. To develop awareness of safety and quality control.

Outcome of the Subject:

1. To understand objective of construction planning.
2. Ability to develop construction schedule.
3. To understand the application of safety and quality control in construction.

- UNIT I Introduction:** Objectives and functions of construction management, stages in construction, stages of planning, bar charts and milestone charts, project feasibility reports, scheduling job layout and line of balance technique, applications.
- UNIT II Construction Scheduling:** PERT: Necessity for good scheduling, Elements of Network, Development of Network, PERT: Time estimates, Time computation, Network Analysis – slack, critical path
- UNIT III Construction Scheduling:** CPM - Steps in CPM Project Planning, Network Analysis, Activity times and floats, Critical activities and Critical Path Determination
- UNIT IV Cost Control & Resource Allocation:** Cost control in construction-importance, objectives of cost control, cost control systems. Economic analysis of engineering projects, economic studies, Resources allocation, Resources leveling, Project updating, Construction cost monitoring
- UNIT V Construction Safety and Quality Control:** Importance, Causes of Accidents, Safety measures, Responsibility for safety, Safety benefits to various parties, Safety clauses in contract, Safety policy, Safety hazards.
Quality control in construction: Importance, Elements of Quality, Quality Assurance Techniques, Quality Control Circles.

Text Books:

1. Project Planning and Control with PERT and CPM – B. C. Punmia, and K. K. Khandelwal (Laxmi Publications)
2. Construction Planning and Management – P. S. Gahlot and B. M. Dhir (New Age International)

Reference Books:

1. Construction Planning, Equipment and Methods – R. Peurify, C. J. Schexnayder, A. Shapira, R. Schmitt (Tata McGraw Hill)
2. PERT and CPM: Principles and Applications – L. S. Sreenath (Affiliated East West Press)
3. Construction Management and Accounts – V. N. Vazirani and S. P. Chandola (Khanna Publishers)
4. Construction Planning and Scheduling – J. W. Hinze (Pearson Education)
5. Construction Project Planning and Scheduling – W. C. Patrick (Pearson Education)
6. Construction Management and Planning – B. Sengupta and H. Guha (Tata McGraw Hill)
7. Construction Engineering and Management – S. Seetharaman (Umesh Publications)
8. Construction Project Management – Planning, Scheduling and Controlling – K. K. Chitkara (Tata McGraw Hill)



Chhattisgarh Swami Vivekanand Technical University, Bhilai

Branch: **Civil Engineering**
Subject: **Structural Engineering Laboratory**
Total Lab Periods: **36**
Maximum Marks: **40**

Semester: **VI**
Code: **320661 (20)**
Batch Size: **30**
Minimum Marks: **20**

Experiments to be performed:

1. Introduction to latest version of a Standard Structural Engineering Design Package such as STAAD Pro.
2. Geometrical Modelling of RCC Frame on latest version of a Standard Structural Engineering Design Package such as STAAD Pro.
3. Modelling of loads and load combinations on RCC Frame on latest version of a Standard Structural Engineering Design Package such as STAAD Pro.
4. Analysis and Interpretation of Results of Analysis of RCC Frame on latest version of a Standard Structural Engineering Design Package such as STAAD Pro.
5. Design of RCC Frame on latest version of a Standard Structural Engineering Design Package such as STAAD Pro.
6. Interpretation of Results of Design of RCC Frame on latest version of a Standard Structural Engineering Design Package such as STAAD Pro.
7. Geometrical Modelling of Steel Frame on latest version of a Standard Structural Engineering Design Package such as STAAD Pro.
8. Modelling of loads and load combinations on Steel Frame on latest version of a Standard Structural Engineering Design Package such as STAAD Pro.
9. Analysis and Interpretation of Results of Analysis of Steel Frame on latest version of a Standard Structural Engineering Design Package such as STAAD Pro.
10. Design of Steel Frame on latest version of a Standard Structural Engineering Design Package such as STAAD Pro.
11. Interpretation of Results of Design of Steel Frame on latest version of a Standard Structural Engineering Design Package such as STAAD Pro.
12. Design of R.C.C. Column on latest version of a Standard Structural Engineering Design Package such as STAAD.etc
13. Design of R.C.C. Isolated Footing on latest version of a Standard Structural Engineering Design Package such as STAAD.etc
14. Case Study of design of a RCC Multistorey Building on latest version of a Standard Structural Engineering Design Package such as STAAD Pro.
15. Case Study of design of a Steel Industrial Building on latest version of a Standard Structural Engineering Design Package such as STAAD Pro.

List of Equipments / Machine Required:

1. Latest Release of Software Package STAAD Pro (Research Engineers International, Kolkata)
2. Latest Release of Software Package STAAD.etc (Research Engineers International, Kolkata)

Recommended Books:

1. Reference Manual for Respective Software
2. Verification Manual of Respective Software



Chhattisgarh Swami Vivekanand Technical University, Bilai

Branch: **Civil Engineering**
Subject: **Geotech Engineering – II Laboratory**
Total Lab Periods: **36**
Maximum Marks: **40**

Semester: **VI**
Code: **320662 (20)**
Batch Size: **30**
Minimum Marks: **20**

Experiments to be performed

1. Determination of water content dry density relation using light-compaction test.
2. Determination of water content dry density relation using heavy compaction test.
3. To determine California Bearing Ratio for the designing of pavements, laboratory determination of CBR test.
4. To determine in-situ bearing value of subgrade by North Dakota Cone Apparatus.
5. Direct Shear Test on the (1) Dry cohesionless / cohesive soil specimen remoulded / unremoulded (2) Direct shear test – undrained test, direct shear test-consolidated undrained.
6. Triaxial Compression Test (Triaxial compression test): (a) UU, (b) CU, (c) CC.
7. Determination of Unconfined Compression Strength of cohesive soils (Remoulded / Unremoulded)
8. Laboratory Vane Shear Test (Remoulded / Unremoulded)
9. Consolidated test (Remoulded / Unremoulded) Consolidated test (Fixed Ring / Floating Ring).
10. To determine swelling pressure of purely cohesive soil (Remoulded / Unremoulded specimen)
11. Determination of density index (relative density) of cohesionless soils.
12. Study of standard penetration.
13. Determination of bearing capacity of soil by plate load.

List of Equipments / Machine Required:

1. Light Compaction Mould
2. Heavy Compaction Mould
3. Oven
4. CBR Apparatus
5. North Dakota Cone Apparatus
6. Direct Shear Test Apparatus with full accessories
7. Triaxial Compression Test Apparatus with full accessories
8. Consolidometer Apparatus
9. Unconfined Compression Test Apparatus
10. Swell Pressure Test Apparatus
11. Standard Penetration Test Apparatus with full accessories
12. Plate Load Test Apparatus with full accessories
13. Soil Sampling Tube

Recommended Books:

1. Soil Mechanics and Foundation Engineering – B.C. Punmia (Laxmi Publication)
2. Soil Engineering in Theory and Practice (Vol-II) – Alam Singh (Asia Publishing House, New Delhi)



Chhattisgarh Swami Vivekanand Technical University, Bilai

Branch: **Civil Engineering**
Subject: **Environmental Engineering – I Laboratory**
Total Lab Periods: **36**
Maximum Marks: **40**

Semester: **VI**
Code: **320663 (20)**
Batch Size: **30**
Minimum Marks: **20**

Experiments to be performed

1. To determine acidity of water sample.
2. To determine alkalinity of water sample.
3. To determine hardness of water sample.
4. To determine chloride content of water sample.
5. To determine D.O. content of water sample.
6. To estimate the quantity of BOD from water sample.
7. To determine the availability of chlorine in bleaching powder.
8. To determine the residual quantity of Cl₂ Content.
9. Determination of quantity of Optimum Coagulant Dose.
10. Determination of Break Point Chlorination.
11. Determination of Total Solids.
12. Determination of Turbidity.
13. Determination of particulates in air.
14. Determination of MPN.
15. Determination of pH of water.

List of Equipments / Machine Required:

1. BOD Incubator
2. Dust Sampler
3. Turbidity meter
4. Microscope
5. pH meter
6. Muffle Furnace
7. Hot Air Oven
8. Jar Test Apparatus

Name of Text Books:

1. Environmental Engineering Lab Manual – Dr. B. Kottaiah & N. Kumaraswamy (Charotar Publications)
2. Water Supply Engineering – S.K. Garg (Khanna Publication).
3. Water Supply Engineering – B.C. Punmia (Laxmi Publication, New Delhi)
4. Environmental Science and Engineering – Henry and Heinke (Pearson Education).



Chhattisgarh Swami Vivekanand Technical University, Bilai

Branch: **Civil Engineering**
Subject: **Concrete Technology Laboratory**
Total Lab Periods: **36**
Maximum Marks: **40**

Semester: **VI**
Code: **320664 (20)**
Batch Size: **30**
Minimum Marks: **20**

Experiments to be performed:

1. Determination of Strength of concrete
2. Determination of Workability by compaction factor
3. Determination of Slump test for a concrete mix
4. Determination of workability by Veebee test
5. Determination of workability by Flow table test
6. Determination of Modulus of elasticity of concrete and strain measurement by longitudinal compressometer
7. Determination of Soundness test on aggregate
8. Determination of Deleterious materials in fine aggregate
9. Determination of flexural strength of concrete
10. Mix Design by I.S. Code method (with OPC Cement)
11. Mix Design by I.S. Code method (with Slag Cement)
12. Mix Design by I.S. Code method (with Admixtures Cement)
13. Determination of Grading curve of Mix aggregate & sieve analysis
14. Determination of Compressive strength of concrete by non destructive test – Rebound Hammer

List of Equipments / Machine Required:

1. Slump Cone with Tamping Rod
2. Concrete Cubes (15 x 15 x 15) cm³
3. Tray (45 x 60) cm², (60 x 60) cm², (30 x 45) cm²
4. Trowel (6 Nos.)
5. I.S. Sieves for Coarse and Fine Aggregate
6. Compression Testing Machine (200 T)
7. Weighing Balance
8. Sieve Shaker
9. Compaction Factor Test Apparatus
10. Vee-Bee Consistometer
11. Flow Table
12. Longitudinal Compressometer
13. Cylindrical Mould
14. Concrete Test Hammer
15. Graduated Glass Cylinder (500 ml, 1000 ml)
16. Beaker (500 ml)
17. Rebound Hammer

Recommended Books:

1. Lab Manual Concrete – M.L. Gambhir (Tata McGraw Hill)
2. Concrete Technology – M.S. Shetty (S. Chand & Co.)
3. Concrete Technology – M.L. Gambhir (Tata McGraw Hill)



Chhattisgarh Swami Vivekanand Technical University, Bhilai

Name of Program:	Bachelor of Engineering	Semester:	VI
Branch:	Common to All Branches	Code:	300665 (76)
Subject:	Managerial Skills	Tutorial Period:	NIL
No. of Lectures:	2/Week	Marks in TA:	40
Total Marks in ESE:	NIL	Minimum number of Class Tests to be conducted:	Two

Objective:

The course is introduced to develop managerial skills tremendously and enrich the abilities to enable one to meet the challenges associated with different job levels. Managerial skills are essential for overall professional development of an individual apart from gaining technical knowledge in the subject.

Course Objectives

Upon completion of this course, the student shall be able

- To define and explain the concept of managerial, written and oral communication skill;
- To understand the leadership skill;
- To develop self-appraisal and understand distinction between leader and manager;
- To develop positive attitude and thinking; and
- To understand managerial functions and develop creativity.

- UNIT I Managerial Communication Skills:** Importance of Business Writing: writing business letters, memorandum, minutes, and reports- informal and formal, legal aspects of business communication, oral communication- presentation, conversation skills, negotiations, and listening skills, how to structure speech and presentation, body language.
- UNIT II Managerial skills - Leadership:** Characteristics of leader, how to develop leadership; ethics and values of leadership, leaders who make difference, conduct of meetings, small group communications and Brain storming, Decision making, How to make right decision, Conflicts and cooperation, Dissatisfaction: Making them productive.
- UNIT III Proactive Manager:** How to become the real you: The journey of self-discovery, the path of self-discovery, Assertiveness: A skill to develop, Hero or developer, Difference between manager and leader, Managerial skill check list, team development, How to teach and train, time management, Stress management, Self-assessment.
- UNIT IV Attitudinal Change:** Concept of attitude through example, benefits of right attitude, how to develop habit of positive thinking, what is fear? How to win it? How to win over failure? How to overcome criticism? How to become real you? How to Motivate? How to build up self confidence?
- UNIT V Creativity:** Creativity as a managerial skill, Trying to get a grip on creativity. Overview of Management Concepts: Function of Management: Planning, organizing, staffing, controlling.

Course Outcome

- The students will be able to develop formal and informal, negotiation, written and oral communication skill;
- The students will be able to develop manage groups, resolve conflicts and leadership skill and decision making qualities;
- The students will be able to develop self-appraisal, teaching, training and managing stress and time;
- The students will be able develop positive thinking, motivating team members and winning race; and
- The students will be able to develop creativity and fundamental management functions.

Text Books:

1. Basic Managerial Skills for all by E.H. Mc Grawth, Prentice Hall India Pvt Ltd,2006
2. Basic Employability Skills by P. B. Deshmukh, BSP Books Pvt. Ltd., Hyderabad, 2014

Reference Books:

1. How to develop a pleasing personality by Atul John Rego, Better yourself books, Mumbai,2006
2. The powerful Personality by Dr. Ujjawal Patni & Dr. Pratap Deshmukh, Fusion Books, 2006
3. How to Success by Brian Adams, Better Yourself books, Mumbai, 1969

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Branch:	Civil Engineering	Semester:	VI		
Subject:	Modern Construction Materials (Professional Elective-I)	Code:	320671(20)		
Total Theory Periods:	40	Total Tutorial Periods:	10		
No. of class Tests to be conducted:	2 (Minimum)	No. of assignments to be submitted:	2 (Minimum)		
ESE Duration:	Three Hours	Maximum Marks in ESE:	80	Minimum Marks in ESE:	28

Objective: To learn about various properties of modern construction materials.

Outcome: To know the importance and areas of application of modern construction materials.

- UNIT I **Concretes:**** High strength and High performance concrete-Fiber Reinforced concrete.
- UNIT II **Metals:**** New Alloy steels-Aluminium and its products-Other alloys.
- UNIT III **Composites:**** Plastics-Reinforced polymers-FRP-Celular cores.
- UNIT IV **Other Materials:**** Water proofing compounds-Non -weathering Materials-Flooring and Facade Materials.
- UNIT V **Smart and Intelligent Materials:**** Brief outline and uses.

Text Books:

1. Civil Engineering Materials (2nd Edititon) – Shan Somayaji (Prentice Hall Inc., 2001)
2. Materials for Civil and Construction Engineers – Mamlouk, M.S. and Zaniewski, J.P. (Prentice Hall Inc., 1999)

Reference Books:

1. Materials for Civil and Highway Engineers (4th Edition) – Derucher, K.Korfiatis. G. and Ezeldin, S. (Prentice Hall Inc., 1999)
2. High Performance Concrete – Aitkens (McGraw Hill, 1999)



Chhattisgarh Swami Vivekanand Technical University, Bhilai

Branch:	Civil Engineering	Semester:	VI		
Subject:	Composite Materials (Professional Elective-I)	Code:	320672(20)		
Total Theory Periods:	40	Total Tutorial Periods:	10		
No. of class Tests to be conducted:	2 (Minimum)	No. of assignments to be submitted:	2 (Minimum)		
ESE Duration:	Three Hours	Maximum Marks in ESE:	80	Minimum Marks in ESE:	28

Objective: To learn about various properties of Composite Materials.

Outcome: To know the importance and areas of application of Composite Materials.

- UNIT I** Introduction, Historical background, Technological Applications, Composites – various reinforcement and matrix materials, Classification of composites.
- UNIT II** Forms of fibre reinforcement, Comparisons of composites with R.C.C. and metals, Strength and stiffness properties, Effective moduli.
- UNIT III** Fibre reinforced composite materials, Manufacturing Technique, Cost and Weight advantages.
- UNIT IV** Behaviour of uni-directional, cross-ply, angle-ply and other composites-strength and stiffness, anisotropy, Generalized Hooks law. Laminates-Laminated Plates, Analysis, Strength and design with composites, Fibre reinforced Pressure vessels.
- UNIT V** Laminates-Laminated Plates, Analysis, Strength and design with composites, Fibre reinforced Pressure vessels.

text Books:

1. Mechanics of Composite Materials – Robert M.Jones (Taylor & Francis, Philadelphia, 1998)
2. Fibre Reinforced Composites – P.K. Mallick (Marcel Dekker, Inc., New York, 1993)

Reference Books:

1. Introduction to Design and Analysis with Advanced Composite Materials – Stephen R. Swanson (Prentice Hall, New Jersey, 1997)
2. Stress Analysis of Fiber-Reinforced Composite Materials – M.W. Hyer (WCB McGraw Hill, New York, 1998)



Chhattisgarh Swami Vivekanand Technical University, Bilai

Branch:	Civil Engineering	Semester:	VI		
Subject:	Advanced Strength of Materials (Professional Elective-I)	Code:	320673(20)		
Total Theory Periods:	40	Total Tutorial Periods:	10		
No. of class Tests to be conducted:	2 (Minimum)	No. of assignments to be submitted:	2 (Minimum)		
ESE Duration:	Three Hours	Maximum Marks in ESE:	80	Minimum Marks in ESE:	28

Objective: To learn about stresses and strains in detail and their impact on the behaviour of structures.

Outcome: To know about stresses and strains due to bending and torsion.

- UNIT I** Stresses and Strains in three dimensions, Theories of failure.
- UNIT II** Beams on elastic foundations, infinite, semi-infinite and finite beams.
- UNIT III** Bending of curved beams in the plane of loading-crane hooks and chain links. Bending of curved beam out of its initial plane, Saint Venant's equations and equations of equilibrium.
- UNIT IV** Bending of circular beams subjected to symmetric loading. Bending of thin plates, Assumptions of plate theory, GDE for deflection of plates, Boundary conditions. Solutions for rectangular plates, Navier's and Levy's solutions, circular plates, Membrane theory of shells of revolution and cylindrical shells.
- UNIT V** Torsion of non-circular members, St. Venant's theory, Torsional stresses in elliptical, triangular shafts. Approximate solutions for rectangular section, Membrane analogy, Torsion of hollow sections, Torsional stresses in thin walled open and closed sections, Plastic, yielding of circular shafts.

Text Books:

1. Advanced Strength of Materials – R. Solecki, R. J. Conant (Oxford University Press)

Reference Books:

1. Boresi, A.P. and Sidebottom, O.M., "Advanced Mechanics of Materials", John Willey and Sons.



Chhattisgarh Swami Vivekanand Technical University, Bilai

Branch:	Civil Engineering	Semester:	VI		
Subject:	Modern Surveying Techniques (Professional Elective-I)	Code:	320674(20)		
Total Theory Periods:	40	Total Tutorial Periods:	10		
No. of class Tests to be conducted:	2 (Minimum)	No. of assignments to be submitted:	2 (Minimum)		
ESE Duration:	Three Hours	Maximum Marks in ESE:	80	Minimum Marks in ESE:	28

Objective: To learn in depth about modern surveying techniques.

Outcome: To know the importance and areas of application of modern surveying instruments.

UNIT I Modern Surveying Equipment: E.D.M. Instruments – Geodimeter, Tellurometer, Distomat, Total Station, Applications of Lasers in distance and angular measurements, Introduction of Electronic navigation and Position Fixing – different systems and their Characteristics.

UNIT II Global Positioning System: Global Positioning System – working principle and methods, Different Approaches to use GPS and their accuracies, Advantages of GPS in Navigation, Survey, Planning and Mapping.

UNIT III Geographic Information System: Geographic Information System – data requirement and database creation; Use of field data, maps, aerial and satellite data; Advantages of GIS.

UNIT IV GIS Analysis: Types of GIS analysis, map topology, map feature elements, queries, features in a topographic base map, base map accuracy standards.

UNIT V Surveying Mapping through Software: Introduction of ARC Info, ARC View, ARC Gms, Intergraph, MGE, Modular GIS Environment, Map Info and Geomedia web map, etc.

Text Books:

1. Surveying (Vol - I, II & III) – Arora, K.R. (Standard Book House, Delhi)
2. Elements of Photogrammetry – Wolf, P.R. (McGraw Hill Book Company, New Delhi)

Reference Books:

1. Solving Problems in Surveying – Bannister, A. and Baker, R. (Longman Scientific Technical, U.K.)
2. Electronic Distance Measurement – Burnside, C.D. (Oxford, BSP Professional Books, London)
3. Engineering Surveying Technology – Kennie, T.J.M. and Petrie, G. (Blackie & Sons Ltd., London)
4. Electronic Surveying in Practice – Laurilla, S.H. (John Wiley & Sons, New York)



Chhattisgarh Swami Vivekanand Technical University, Bhilai

Branch:	Civil Engineering	Semester:	VI		
Subject:	Remote Sensing and its Applications (Professional Elective-I)	Code:	320675(20)		
Total Theory Periods:	40	Total Tutorial Periods:	10		
No. of class Tests to be conducted:	2 (Minimum)	No. of assignments to be submitted:	2 (Minimum)		
ESE Duration:	Three Hours	Maximum Marks in ESE:	80	Minimum Marks in ESE:	28

Objective: To learn in depth about Remote Sensing and its Applications in Civil Engineering.

Outcome: To know the importance and areas of application of Remote Sensing.

- UNIT I Remote Sensing:** Introduction and definition of Remote Sensing terminology, Photogrammetry, Types of Photographs, Geometry of Photographs, Stereophotogrammetry.
- UNIT II Image Processing Systems:** Principles of interpretation of aerial and satellite images, equipments and aids required for interpretation ground truth collection and verification, advantages of multiband and multiband images.
- UNIT III Initial Statistics Extraction:** Digital Satellite data products and their characteristics, Histogram and its utility, Enhancement, Different methods of digital satellite data interpretation.
- UNIT IV Radiometric and Geometric Correction in Image Processing:** Introduction, radiometric correction of remotely sensed data, correction for sensor system, detector error, spatial interpolation using coordinate transformations, intensity interpolation.
- UNIT V Micro Wave Remote Sensing:** Introduction, the radar principle, radar removal advantages, synthetic aperture radar (SAR), interpreting SAR images.

Text Books:

1. Campbell, J.B., "Introduction to Remote Sensing", The Guilford Press, Lond, 1986.
2. Wolf, P.R., "Elements of Photogrammetry", McGraw Hill Book Company, New Delhi, 1986.

Reference Books:

1. Curran, P.J., "Principles of Remote Sensing", Longman, London, 1985.
2. Engman, E.T. and Gurney, R.J., "Remote Sensing in Hydrology", (Chapman and Hall, London, 1991).



Chhattisgarh Swami Vivekanand Technical University, Bhilai

Branch:	Civil Engineering	Semester:	VI		
Subject:	GIS and its Applications (Professional Elective-I)	Code:	320676(20)		
Total Theory Periods:	40	Total Tutorial Periods:	10		
No. of class Tests to be conducted:	2 (Minimum)	No. of assignments to be submitted:	2 (Minimum)		
ESE Duration:	Three Hours	Maximum Marks in ESE:	80	Minimum Marks in ESE:	28

Objective: To learn in depth about GIS and its Applications in Civil Engineering.

Outcome: To know the importance and areas of application of GIS.

- UNIT I Basic Concept of GIS:** Introduction, Information systems, spatial and non-spatial information, Geographical concepts and terminology, Advantages of GIS, Basic components of GIS, Organisation of data in GIS, Hardware & Software.
- UNIT II GIS Data:** Input data, Field data, Statistical data, Maps, Aerial photographs, Satellite data, Points, lines and areas features, Vector and Raster data, Advantages and Disadvantages, Data entry through keyboard, digitizers and scanners, Digital data, GIS data formats and standards.
- UNIT III Data Management:** Data Management, Data Base Management System (DBMS), various data Models, Run – length encoding, Quadrees, Data Analysis – Data layers, analysis of spatial and non-spatial data, Data overlay and modelling, smart features of DBMS.
- UNIT IV Applications of GIS:** Applications of GIS in Map Revision, Landuse, Agriculture, Forestry, Archaeology, Municipal, Geology, Water Resources, Soil Erosion, Land suitability analysis, Change detection.
- UNIT V Case Study:** A case study in GIS implementation, the consultant, the client, the initial applications, types of GIS analysis used for case study.

Text Books:

1. Introduction to Remote Sensing – Campbell, J.B. (The Guilford Press, London, 1986)
2. Remote Sensing and Geographic Information Systems – Legg, C.A. (Ellis Horwood, London, 1992)

Reference Books:

1. Principles of Geographic Information System for Land Resources Assessment – Burrough, P.A. (Monograph on Soil Resources Survey No. 12, Claredon, Press, Oxford, 1988)
2. Remote Sensing in Hydrology – Engaman, E.T. and Gurney, R.J. (Chapman and Hall, London, 1991)



Chhattisgarh Swami Vivekanand Technical University, Bhilai

Branch:	Civil Engineering	Semester:	VI		
Subject:	Computational Hydraulics (Professional Elective-I)	Code:	320677(20)		
Total Theory Periods:	40	Total Tutorial Periods:	10		
No. of class Tests to be conducted:	2 (Minimum)	No. of assignments to be submitted:	2 (Minimum)		
ESE Duration:	Three Hours	Maximum Marks in ESE:	80	Minimum Marks in ESE:	28

Objective: To learn in depth about importance and use of Computational Hydraulics.

Outcome: To know the importance and areas of application of Computational Hydraulics.

- UNIT I** Introduction, significance of computational hydraulics, discrete forms of the laws of conservation of mass, momentum and energy, examples of free surface flows.
- UNIT II** Continuous forms of the conservation laws, lateral inflow's 1-D expansions and contractions, homogeneous and stratified fluid flows.
- UNIT III** Method of characteristics – Characteristics and invariants, regions of state, computation of hydraulic jump, indeterminacy conditions, the linearised method of characteristics.
- UNIT IV** Difference forms of conservation laws, weak solutions applications, storm-sewer networks, diffusion problems, river morphotogy, linear wave propagation.
- UNIT V** Numerical methods – Finite difference method with example 1-D horizontal flow.

Text Books:

1. Computational Hydraulics – Brebbia, C.A. and Ferrante, A.J. (Butterworth & Company Publishers)
2. Applied Hydraulic Transients (2nd Edition) – Chaudhary, M.H. (Van Nostrand Reinhold Company Inc.)

reference Books:

1. Unsteady Flow in Open Channels (Vol. - I & II) – Mahmood, K. and Yeyjevieh, V. (Water Resources Publications, Fort Collins, Colorado, U.S.A.)
2. Computational Hydraulics – M.B. Abbott (Pitman Publication Company)
3. Engineering Applications of Computational Hydraulics – M.B. Abbott & J.A. Gunge (Pitman Books Ltd.)
4. Computational Hydraulics: An Introduction – Vreugdenhill, C.B. (Springer-Verlag, Berlin)
5. Computational Hydraulics – Abbot, M.B. & A.W. Minns (Ashgate Publication)



Chhattisgarh Swami Vivekanand Technical University, Bhilai

Branch:	Civil Engineering	Semester:	VI		
Subject:	Instrumentation in Fluid Mechanics (Professional Elective-I)	Code:	320678(20)		
Total Theory Periods:	40	Total Tutorial Periods:	10		
No. of class Tests to be conducted:	2 (Minimum)	No. of assignments to be submitted:	2 (Minimum)		
ESE Duration:	Three Hours	Maximum Marks in ESE:	80	Minimum Marks in ESE:	28

Objective: To learn in depth Instrumentation in Fluid Mechanics.

Outcome: To know the importance and areas of application of Instrumentation in Fluid Mechanics.

UNIT I

Introduction

Need for instrumentation in various fluid flow processes, types of measurements: pressure, velocity, temperature, discharge, water levels, force, shear stress, basic principles of transducers, microprocessors and data-acquisition systems, calibration of instruments.

UNIT II Pressure Measurements

Manometers, capacitance and inductance transducers, non-contact probes.

UNIT III Velocity measurements

Pitot tube, Pitosphere and Pitocylinder, current meter, Hot wire anemometer, Laser-Doppler anemometer.

UNIT IV Discharge Measurement

Venturimeter, orifice meter, bend meter, electromagnetic and ultrasonic flow meters, rotameer, weirs and flumes, tracer techniques, Hot wire anemometer and thermistors.

UNIT V Other Measurements

Water level recorders direct and indirect measurement of shear stress, force transducers, use of tracers in dispersion and diffusion studies.

Text Books:

1. Instrumentation: Devices and Systems – Rangan C.S., Sharma G.R. and Mani V.S.S. (Tata McGraw Hill Publishing Company)

Reference Books:

1. . Instrumentation for Engineers and Scientists – J. D. Turner, M. Hill (Oxford University Press)



Chhattisgarh Swami Vivekanand Technical University, Bhilai

Branch:	Civil Engineering	Semester:	VI		
Subject:	Water Power Engineering (Professional Elective-I)	Code:	320679(20)		
Total Theory Periods:	40	Total Tutorial Periods:	10		
No. of class Tests to be conducted:	2 (Minimum)	No. of assignments to be submitted:	2 (Minimum)		
ESE Duration:	Three Hours	Maximum Marks in ESE:	80	Minimum Marks in ESE:	28

Objective: To learn about power generation from conventional sources of energy.

Outcome: To know about the importance and areas of Application of water power.

UNIT I Introduction

Development of water power, hydroelectric power, power potential, important hydropower plant in India, comparison of hydro, thermal & nuclear powers, future of hydro power, relation of water power and hydrology.

UNIT II Water Power Estimate

Estimate of stream flow for water power studies, flood formulae, rational method, unit hydrograph method, analysis of stream flow data, mass curve and determination of reservoir capacity, pondage, and estimation of available water power.

UNIT III Types of hydropower plant

Classification of hydro power plants, run-off river plant, storage plants, diversion canal plants, pumped storage plants, hydro electric power from sea and oceans.

UNIT IV Water conveyance

Pen stocks, classification of pen stocks, design criteria for pen stocks, economical diameter of pen stock, water hammer, surge tank, intakes, canals.

UNIT V Power House Planning

General layout of power house and arrangement of hydro power units, general arrangement of hydro electric unit, sub structure, super structure, abbreviated power houses, underground power house.

Text Books:

1. Water Power Engineering – M.M. Dandekar, K.N. Sharma (Vikas Publishing House Pvt. Ltd.)
2. Water Power Engineering – Deshmukh (Dhanpat Rai & Sons)

Reference Books:

1. Irrigation and Water Power Engineering – B.C. Punmia (Laxmi Publication)
2. Hydro Electric Engineering – Creager and Justin (Willay Institutional)
3. Hydro Electric Engineering Practice – Brown, J.G. (Blackie and Sons Ltd., London)
4. Irrigation and Water Power Engineering – Dr. P.N. Modi (Standard Book House)



Chhattisgarh Swami Vivekanand Technical University, Bhilai

Branch:	Civil Engineering	Semester:	VI		
Subject:	Earthquake Engineering (Professional Elective-I)	Code:	320680(20)		
Total Theory Periods:	40	Total Tutorial Periods:	10		
No. of class Tests to be conducted:	2 (Minimum)	No. of assignments to be submitted:	2 (Minimum)		
ESE Duration:	Three Hours	Maximum Marks in ESE:	80	Minimum Marks in ESE:	28

Objective: To learn about the causes of earthquakes and its effect on structures.

Outcome: To know about the ways of analyzing for earthquake forces and ways of minimizing the damages because of earthquake.

- UNIT I** Definitions of basic problems in dynamics, static versus dynamic loads, different types of dynamic loads, undamped vibration of SDoF system, natural frequency and period of vibration, damping in structure.
- UNIT II** 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.
- UNIT III** Direct determination of frequencies and mode shape, orthogonality principle, approximate methods for determination of frequencies and mode shape model error of forced vibration of MDoF.
- UNIT IV** Characterization of ground motion, earthquake response spectra, factors influencing response spectra, design response spectra for elastic system, peak ground acceleration, response spectrum shapes.
- UNIT V** Review of damage during past earthquakes and remedial measures, seismic design consideration, ductility demand, reinforcement detailing for member and joints.

Text Books:

1. Earthquake Resistant Design of Structures – P. Agrawal & M. Srikhande (Prentice Hall)
2. Earthquake Resistant Design of Structures – S. K. Duggal (Oxford University Press)

Reference Books:

1. Dynamics of Structures Theory & Applications to Earthquake Engineering – A. K. Chopra (Pearson Education)
2. Structural Dynamics – Theory & Computation – Mario Paz (CBS Publishers)
3. Basics of Structural Dynamics and Asesismic Design – S. R. Damodarasamy, S. Kavitha (PHI Learning)

