Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2022-23

Course Information

Programme	M. Tech. Civil (Structural Engineering)
Class, Semester	First Year M. Tech., Semester I
Course Code	6ST501
Course Name	Research Methodology
Desired Requisites:	NIL

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	2 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	---	30	20	50	100
		Credits: 2			

Course Objectives

1	To prepare students for undergoing research, identify and formulate the research problems, state the hypothesis, design a research layout, set a research process and methodology.
2	To enable students to investigate the problem, interpret the results, propose theories, suggest possible/alternative solutions, solve, and prove the solution adapted–logically and analytically, conclude the research findings.
3	To impart knowledge to analyze critically the literature and publish research in conferences, journals and to expose students to research ethics, IPR

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	**Analyze** research and its significance in economic, social and legal aspects.	Analyzing
CO2	**Discuss** research problems and its design for solution logically and critically.	Evaluating
CO3	**Produce** research solution, publication, Dissertation, IPR and patent doc.	Creating

Module	Module Contents	Hours
I	**Engineering Research Process** Meaning of research problem, Sources of research problem, Criteria and Characteristics of a good research problem, Errors in selecting a research problem, Definition, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.	5
II	**Research Methodology Tools** Problem statement formulation, resources identification for solution, Experimental and Analytical modelling, Numerical and Statistical methods in engineering research, Software tools like spreadsheets, Effective literature studies approaches, critical analysis	6
III	**Research Ethics** Effective literature studies approaches, critical analysis, Plagiarism, Research ethics	3
IV	**Report Writing** Effective technical writing, How to write report, Research Paper. Presentation of paper/report/seminar.	3
V	**Intellectual Property Rights (IPR)** Nature of Intellectual Property: Patents, Designs, Trade and Copyright, Technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. New developments in IPR; IPR of Biological Systems, Traditional knowledge Case Studies	5
VI	**Patents** Procedure for grants of patents, Patenting under PCT. Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Administration of Patent System	5

Textbooks	
1	Melville Stuart and Goddard Wayne, "Research Methodology: An Introduction for Science & Engineering Students" Juta and Company Ltd, 2000.
2	Goddard Wayne and Melville Stuart, "Research Methodology: An Introduction", Juta and Company Ltd., 2nd Ed.-2004
3	Merges Robert, Menell Peter, Lemley Mark, "Intellectual Property in New Technological Age", ASPEN Publishers, 2016.
4	Kumar Ranjit, "Research Methodology: A Step-by-Step Guide for beginners", SAGE Publications, 4th Ed.-2014.
References	
1	Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007
2	Mayall, "Industrial Design", McGraw Hill, 1992.
3	Niebel, "Product Design", McGraw Hill, 1974
4	Asimov, "Introduction to Design", Prentice Hall, 1962
5	Ramappa T., "Intellectual Property Rights Under WTO", S. Chand, 2008
Useful Links	
1	NPTEL :: General - NOC:Introduction to Research
2	Introduction to Research - Course (nptel.ac.in)
3	Qualitative Research Methods And Research Writing - Course (nptel.ac.in)

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	**2**	3	4	5	6
CO1	3					
CO2		2		3	2	
CO3		3		2		
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO.						

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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AY 2022-23

Course Information

Programme	M.Tech. Civil (Structural Engineering)
Class, Semester	First year M. Tech., Sem. I
Course Code	6ST502
Course Name	Mechanics of Structures
Desired Requisites:	Solid Mechanics, Structural analysis, Structural Mechanics

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs./week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	1 Hr./week	30	20	50	100
		Credits: 4			

Course Objectives

1	To impart the knowledge of advanced methods of structural analysis
2	To provide knowledge for analyzing special types of structures
3	To prepare students to develop computer programs by using matrix methods of structural analysis

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	**Apply** advanced methods for analysis of structures	Applying
CO2	**Calculate** forces and displacements for special structures	Evaluating
CO3	**Formulate** program by using matrix methods of structural analysis for field applications	Creating

Module	**Module Contents**	**Hours**
I	**a) Basics in structural analysis** Types of structures, various loads and methods of structural analysis, energy theorems and application of virtual work principle. Introduction to basic software's for structural analysis **b) Influence line Diagrams for Indeterminate Structures** Concept of ILD, Muller-Breslau's principle and its application for continuous beams. ILD for two hinged arches	7
II	**Beams Curved in Plan** Structural behaviour of curved beam. Analysis of determinate and indeterminate beams curved in plan, bent beams.	7
III	**Beam Columns** Concept of geometric and material nonlinearity, governing differential equation. Analysis of beam-columns subjected to different loadings and support conditions. Buckling of frames–symmetrical and unsymmetrical, stiffness and carry-over factors for beam-columns, fixed end actions due to various loads	6
IV	**Beams on Elastic Foundations** Basic concept of beams on elastic foundation, analysis of infinite, semi-infinite and finite beams.	6
V	**Matrix method of analysis: Flexibility Method** Element approach, flexibility matrix, equivalent loads, applications to beams, frames and trusses, lack of fit, temperature stresses	6
VI	**Matrix method of analysis: Stiffness Methods** Element approach, stiffness matrix, equivalent loads, applications to beams, frames and trusses, direct stiffness method	7

Textbooks

1	Vazirani. V.N. & Ratwani M.M., "Advanced Theory of Structures", Khanna Publishers, 2008

2	Timoshenko. S. P. & Gere. J. M., "Theory of Elastic Stability", Tata McGraw-Hill Publishing ompany Ltd., 2nd Edition,1985
3	Gere. J. M. & Weaver. W.,"Matrix Analysis of Framed Structures", CBS Publishers and Distributor, 2nd Edition,2004.
4	Krishna Raju N., "Advanced Mechanics of Solids and Structures", McGraw-Hill Education, 08-Nov-2018 - Technology & Engineering
References	
1	Mcquire and Gallghar. R. H. "Matrix Structural Analysis", John Wiley, 2nd Edition, 2000
2	Beaufit F.W. et al. "Computer Methods of Structural Analysis", Prentice Hall, illustrated, 1970
3	John L. and Meek, "Matrix Structural Analysis", McGraw Hill Book Company, illustrated, 1971
4	Pandit G. and Gupta S., "Structural Analysis - A Matrix Approach2008", McGraw Hill Education; 1st edition
Useful Links	
1	https://nptel.ac.in/courses/105/105/105105108/
2	https://nptel.ac.in/courses/105/101/105101086/
3	http://engineeringvideolectures.com/course/281?pn=0#videolist
4	https://nptel.ac.in/courses/105/105/105105109/

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1			2	2		3
CO2			2	2		3
CO3	1		2			2
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO.						

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information	
Programme	M.Tech. Civil (Structural Engineering)
Class, Semester	First year M. Tech., Sem. I
Course Code	6ST503
Course Name	Theory of Elasticity & Plasticity
Desired Requisites:	Solid Mechanics

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs./week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial		30	20	50	100
		Credits: 3			

Course Objectives	
1	To impart knowledge of various theories of elasticity and apply them to solve 2D Cartesian and polar problems
2	To impart knowledge of various theories of torsion and apply them to solve 2D torsional problems
3	To provide knowledge of various theories of plastic behaviour and apply them to solve 2D problems.

Course Outcomes (CO) with Bloom's Taxonomy Level		
At the end of the course, the students will be able to,		
CO1	**Apply** the knowledge of fundamental methods of elasticity for 2-D Cartesian and Polar problems	Applying
CO2	**Analyse** torsional problems and apprise various theories to solve 2-D torsional problems.	Analysing
CO3	**Discuss** concept of material yielding and plastic behaviour of structures.	Evaluating

Module	**Module Contents**	**Hours**
I	**Introduction to Elasticity** Introduction to Elasticity: Body force, Surface force, Stress at a point, Stress & Strain, Transformation of stress, Equilibrium equations in two and three dimensions in Cartesian co-ordinates, Boundary conditions, Strain displacement relations, Compatibility equations, Generalized Hooke's Law, Stress invariants	8
II	**Plane Stress and Strain** 2D problems in Cartesian co-ordinates, Equations of equilibrium and compatibility, Plane stress and Plane strain problems, Airy stress function approach, 2D problems in polar coordinates, Thick walled cylinder under radial pressure, Plate with stress concentration.	8
III	**Torsion** Introduction to Torsion: St. Venant's theory, Warping function, Prandtl's membrane analogy, Torsion of circular, thin rectangular and open section. Strain energy in axial, bending and torsion. Principal of virtual work and minimum potential energy.	7
IV	**Plasticity** Introduction to plasticity: Plastic behavior of solids, Idealized plastic solids, Similarities & differences when compared with elasticity, Idealized material behavior, Coulomb friction model for elasticity and plasticity.	8

V	**Hydrostatic stresses** Hydrostatic stresses, Deviatoric stresses, Invariants of deviatoric stresses, Yield criteria, Graphical representation of yield criteria, Flow rules, Stress-strain relation for perfectly plastic flow, Elastic-plastic analysis of beam in bending, Thick walled cylinder and circular shaft under torsion.	7
VI	**Plastic analysis of structures** Plastic analysis of structures – plastic hinge, Moment – curvature relation, Shape factor, Upper bound, lower bound & uniqueness theorems, Methods of analysis to find collapse loads for beams and frames.	7

Textbooks	
1	Ameen M., "Computational Elasticity", Alpha Science International, 1st Revised Edition, 2008
2	Singh Sadhu, "Theory of Elasticity", Khanna Publishers, 4th Edition, 2012
3	Singh Sadhu, "Theory of Plasticity", Khanna Publishers, 3rd Edition, 2013

References	
1	Timoshenko. S & Goodier. J. N., "Theory of Elasticity", McGraw-Hill book Company, 3rd Edition, 2010
2	Chakrabarthy. J, "Theory of Plasticity", Tata McGraw-Hill P. Co. Ltd., 2nd Edtion, 2007.
3	Johnson W. and Mellor P. B., "Engineering Plasticity", Van Nostrand Reinhold, London, 1973.

Useful Links	

CO-PO Mapping

	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1		3				
CO2		2				
CO3	2					

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information

Programme	M.Tech. (Structural Engineering)
Class, Semester	First year M. Tech., Semester I
Course Code	6ST504
Course Name	Structural Dynamics and Earthquake Engineering
Desired Requisites:	Engineering Mechanics, Engineering Geology

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs./week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	--	30	20	50	100
		Credits: 3			

Course Objectives

1	To impart knowledge of ground motion characteristics and its effect on Civil Engineering structures
2	To prepare students to solve problems on dynamics of structures in SDOF and MDOF Systems
3	To illustrate national and global codal provisions for design of earthquake resistant structures and implementation of same for seismic retrofit.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	**Use** engineering seismology and its characteristics for development of response spectra.	Applying
CO2	**Estimate** response of structures subjected to earthquake loads for various building configurations.	Analyzing
CO3	**Formulate** methods of earthquake resistant and Structural R	Creating

Module	**Module Contents**	**Hours**
I	**Seismological Aspect in Earthquake Engineering** Characteristics of Earthquakes, Elastic rebound theory, Measurement of earthquakes, Magnitude, Intensity, magnitude relationship, Seismograph, Liquefaction. Attenuation relationship, MCE and DBE, Performance of various structures in past earthquake.	6
II	**SDOF Systems and Estimation of Forces** Earthquake response of linear SDOF systems and its application in dynamic analysis. Concept of earthquake response spectrum, Tripartite plot of response spectrum, Construction of design response spectrum. Use of Code Spectra to find response of structures. Equivalent static method to find story shear and its distribution along height of building.	7
III	**MDOF Systems and Dynamic Analysis** Earthquake response of linear MDOF systems, Modal analysis, Participation factors, Modal contributions, Dynamic analysis of Multistoried buildings.	6
IV	**ERD of Structure and Roll of Ductility** Concept of earthquake resistant design, Objectives, Ductility and different types of ductility. Over strength, Response reduction factor, Ductile Detailing of structural components as per code. lateral stiffness, Conceptual design, Building configuration.	7
V	**Distribution of Lateral Forces and Codal Provisions** Floor diaphragm, Rigid floor diaphragm, Center of mass and center of stiffness, Torsionally un-coupled and coupled systems, Lateral load distribution, Minimum eccentricity, Provisions of IS: 1893 for buildings, Base shear, Application to Multistory buildings, Load combinations, Ductile detailing, Provisions of IS: 13920.	7

VI	**Structural Control and Retrofit Issues** Different lateral load resisting systems, Configuration of tall structures with modeling. Concepts of structural Control, Energy dissipating devices. Retrofit issues and their solutions with advanced techniques.	6

Textbooks	
1	Clough R. W. and Penziene Joseph, "Dynamics of Structures", McGraw Hill Education (ISE Editions); International 2 Revised edition August 1993.
2	Chopra A.K., "Dynamics of Structure: Theory & Application to Earthquake Engineering", Pearson Education Lim., 4th Edition, 2014
3	Agarwal P. and Shrikhande M., "Earthquake Resistant Design of Structures", PHI Learning Pvt. Ltd., 2006.
References	
1	Key David, "Earthquake Design Practice for Buildings", Thomas Telford Publication London, 2nd Edition, 2006.
2	Dowrick D. J., "Earthquake Resistant Design for Engineers & Architects", John Wiley & Sons., 2nd Edition, 1987.
3	Manual of "Earthquake Resistant Non-Engineering Construction", University of Roorkee, 2000.
Useful Links	
1	https://nptel.ac.in/courses/105/101/105101209/
2	https://nptel.ac.in/courses/105/104/105104200/
3	https://nptel.ac.in/courses/105/108/105108204/
4	https://nptel.ac.in/courses/105/107/105107204/

CO-PO Mapping

	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1		1	2	2	2	2
CO2	2		3	2		
CO3	1				3	3

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on any three modules out of six.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information

Programme	M. Tech. Civil (Structural Engineering)
Class, Semester	First Year M. Tech., Semester I
Course Code	6ST551
Course Name	Modern Materials & Testing Laboratory
Desired Requisites:	Concrete Technology

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	4 Hrs/ Week	**LA1**	**LA2**	**Lab ESE**	**Total**
Interaction	---	30	30	40	100
		Credits: 2			

Course Objectives

1	To provide students the necessary knowledge of properties & techniques of Mix design of advanced types of concrete.
2	To provide the technical information of modern concrete such as SCC, RMC, FRP, FRC and HPC etc.
3	To inculcate the information of structural health monitoring for repair and rehabilitation structures.
4	To impart the various concepts and testing methods adopted in non-destructive testing of concrete.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	**Study** of mix design for high performance of concrete of various grades	Analyzing
CO2	**Evaluate** experimentally properties of various advanced concretes.	Evaluating
CO3	**Design** experiments for vibration measurements & data acquisition system.	Creating

List of Experiments / Lab Activities/Topics

List of Topics (Applicable for Interaction mode):

List of Lab Activities:

1. Evaluate of static and dynamic modulus of elasticity of concrete and strain measurement.
2. Evaluate of flexural strength of concrete.
3. Evaluate Mix Design by I.S. Code method (with OPC Cement).
4. Evaluate Mix Design by I.S. Code method (with Slag Cement).
5. Evaluate Mix Design by I.S. Code method (with Admixtures Cement).
6. Determination of Grading curve of Mix aggregate & sieve analysis.
7. Non-destructive testing of concrete.
8. Determination of Poisson's ratio of concrete.
9. Determination of properties of SCC, RMC, FRP, FRC and HPC.
10. Experiments based on Vibration measurements and data acquisition system.

Textbooks

1	Gambhir M. L., "Concrete Technology", Tata McGraw Hill Publications, 3rd Edition 2004
2	Shetty M. S., "Concrete Technology", S. Chand Publications, Latest Edition 2005
3	Santhakumar A. R., "Concrete technology", Oxford Higher Education/Oxford University Press, 1st Edition 2006
4	Varshney R.S., "*Concrete Technology*", Oxford and IBH.

References

1	Neville A. M., "Concrete Technology", Addision Weslley.
2	Neville A.M., Properties of Concrete, Pitman, 1968.
3	Lue F.M., "Chemistry of Cement and Concrete", Edward Arnold, 3rd Edition, 1970.

4	

Useful Links	
1	
2	
3	
4	

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1	2	2				
CO2		3				
CO3		3		1	2	
The strength of mapping is to be written as 1,2,3; where, 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO, and preferably to only one PO.						

Assessment

There are three components of lab assessment, LA1, LA2 and Lab ESE.
IMP: Lab ESE is a separate head of passing.(min 40 %), LA1+LA2 should be min 40%

Assessment	Based on	Conducted by	Typical Schedule	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	30
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External Examiner as applicable	During Week 18 to Week 19 Marks Submission at the end of Week 19	40

Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments and related activities if any.

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Course Information

Programme	M. Tech. Civil (Structural Engineering)
Class, Semester	First Year M. Tech., Semester I
Course Code	6ST552
Course Name	Dynamics of Structures Laboratory
Desired Requisites:	Structural Dynamics and Earthquake Engineering

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	2 Hrs/ Week	**LA1**	**LA2**	**Lab ESE**	**Total**
Interaction	---	30	30	40	100
		Credits: 1			

Course Objectives

1	To impart knowledge of SDOF system under various dynamic loading by solving different types of problems.
2	To illustrate behavior of MDOF system under various dynamic loading by solving different types of problems by conducting experiments.
3	To provide knowledge of behavior of distributed mass model by conducting experiments.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	**Apply** principles of dynamics to solve SDOF and MDOF systems.	Applying
CO2	**Appraise** behavior of discrete systems.	Evaluating
CO3	**Evaluate** behavior of continuous system and **judge** effect of sloshing and liquefaction.	Evaluating

List of Experiments / Lab Activities/Topics

List of Lab Activities: (Any eight experiments in addition to assignments)

1. Dynamics of a three storied building frame subjected to harmonic base motion.
2. Dynamics of a one-storied building frame with planar asymmetry subjected to harmonic base motions.
3. Dynamics of a three storied building frame subjected to periodic (non-harmonic) base motion.
4. Vibration isolation of a secondary system.
5. Dynamics of a vibration absorber.
6. Dynamics of a four storied building frame with and without an open ground floor.
7. Dynamics of one-span and two-span beams.
8. Earthquake induced waves in rectangular water tanks
9. Dynamics of free-standing rigid bodies under base motions
10. Seismic wave amplification, liquefaction and soil-structure Interactions.

Textbooks

1	Clough R. W. and Penziene Joseph, "Dynamics of Structures", McGraw Hill Education (ISE Editions); International 2 Revised edition August 1993.
2	Craig Roy, "Structural Dynamics", John Willy & Sons.
3	Chopra A.K., "Dynamics of Structure: Theory & Application to Earthquake Engineering", Pearson Education Lim., 4th Edition, 2014.

References

1	Mukhopadhyay, "Dynamics of Structures", Ane Books Pvt. Ltd., 2nd Edition, 2010.
2	Paz Mario, "Structural Dynamics", CBS Publishers and Distributors, 5th Edition, 2003.
3	Jaikrishna A. R. and Chandra Brijesh, "Elements of Earthquake Engineering", South Asian Publisher Pvt. Ltd., 2nd Edition, 2000.

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1				3	2	
CO2				2	3	1
CO3				3	1	1
The strength of mapping is to be written as 1,2,3; where, 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO, and preferably to only one PO.						

Assessment				
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing. (min 40 %), LA1+LA2 should be min 40%				
Assessment	**Based on**	**Conducted by**	**Typical Schedule**	**Marks**
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	30
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External Examiner as applicable	During Week 18 to Week 19 Marks Submission at the end of Week 19	40
Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments and related activities if any.				

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Course Information

Programme	M.Tech. Civil (Structural Engineering)
Class, Semester	First year M. Tech., Sem. I
Course Code	6ST511
Course Name	Elective 1 - Advanced Design of Reinforced Concrete Structures
Desired Requisites:	Design of Concrete Structurers I, Design of Concrete Structurers II

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs./week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	--	30	20	50	100
		Credits: 3			

Course Objectives

1	To provide advanced knowledge for analyzing different kinds of RC structural members.
2	To impart advanced knowledge for design of different kinds of RC structures using IS codes.
3	To provide advanced knowledge for detailing of the structural members designed as per IS codes.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	**Analyze** various reinforced concrete structural members.	Analyzing
CO2	**Decide** the sizes of various structural components.	Evaluating
CO3	**Design** the appropriate section for structural members using codal provisions.	Creating

Module	**Module Contents**	**Hours**
I	**Flat Slabs and Circular Slabs** Introduction to flat slabs, Codal provisions, Analysis and design of flat slab, Circular slabs.	7
II	**Design of Foundation** Design of combined footing, (Rectangular and Trapezoidal), Introduction to pile foundation, Reinforcement, Group of piles, Design of pile foundation, Pile cap.	6
III	**Design of Concrete Deep Beams** Introduction, Minimum thickness, IS code requirements, Design of deep beams, Checking for local failures, Detailing, Design of Corbel.	6
IV	**Water Tank** Analysis and Design of overhead water tank- Rectangular and Circular with flat bottom, Design of staging for wind and seismic loads.	7
V	**Retaining Wall** Retaining Walls – Function, Theories of earth pressure, Stability of retaining wall, Reinforced concrete retaining walls, Cantilever retaining wall, Counterfort retaining wall.	7
VI	**Bunkers and Silos** Bunkers and Silos – Classification, Square bunkers, Circular bunkers, Silos, Lateral Pressure in silos, Airy's theory, Shallow bins, Deep bins, Design examples.	6

Textbooks

1	Ramamruthm, S., "Design of Reinforced Concrete Structures", Dhanpat Rai Publishing, 17th Edition, 2010.
2	Shah V. and Karve S., "Limit State Theory and Design of Reinforced Concrete", Structures Publications, 4th Edition, 2003.
3	Punmia, B. C., Jain, A. K. and Jain, A. K. "Limit State Design of Reinforced Concrete", Laxmi Publication, 1st Edition, 2013.

References	
1	Purushothaman, P. "Reinforced Concrete Structural Elements", Tata McGraw Hill, 3rd Edition, 2004.
2	Pillai. S. V. and Menon. D, "Reinforced Concrete Design", Tata McGraw Hill Book Co., 5th Edition, 2005.
3	Park. R and Paulay. T, "Reinforced Concrete Structures", John Wiley and Sons, 1975.
4	IS 456: 2000 Indian Standard Plain and Reinforced Concrete - Code of Practice
Useful Links	
1	https://nptel.ac.in/courses/105/105/105105108/
2	https://nptel.ac.in/courses/105/101/105101086/
3	http://engineeringvideolectures.com/course/281?pn=0#videolist
4	https://nptel.ac.in/courses/105/105/105105109/

CO-PO Mapping

	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1			2	2		3
CO2			2	2		3
CO3	1		2			2

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information

Programme	M. Tech. Civil (Structural Engineering)
Class, Semester	First Year M. Tech., Semester I
Course Code	6ST512
Course Name	Elective 1 - Structural Health Monitoring and Smart Materials
Desired Requisites:	Strength of Materials, Structural Mechanics

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hr/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	----	30	20	50	100
		Credits: 3			

Course Objectives

1	To impart knowledge of smart materials.
2	To illustrate principles of structural health monitoring
3	To provide quantitative means to assess the structural integrity loss a system undergoes after natural disasters and other hazardous events.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	**Apply** knowledge of smart materials and techniques to SHM	Applying
CO2	**Appraise** structural conditions by various techniques of SHM.	Analyzing
CO3	**Assess** civil engineering structures by SHM techniques and simulation.	Evaluating

Module	**Module Contents**	**Hours**
I	**Introduction to the Smart materials and their applications**: Emerging SHM Technologies using Piezo Sensors,SHM using Magnetstrictive Sensors SHM using Optical Fibres and other sensors Overview of Application Potential of SHM. **Piezoelectric materials** (Constitutive relation, unimorph, bi-morph, Electromechanical coefficient, resonance/anti-resonance) **Electrostrictive materials** (Constitutive relation, sensor, actuator, figures of merit), Magnetostrictive materials (Constitutive relation, sensor, actuator, figures of merit) **Shape Memory Alloys** (Constitutive relation, transition temperatures, shape memory effect, pseduoelasticity, sensor, actuator) **Optical Fiber** (Fiber Bragg grating, strain sensing, ultrasonic sensing).	**7**
II	**Introduction to Structural Health Monitoring (SHM)** : Definition & motivation for SHM, SHM - a way for smart materials and structures, SHM and bio mimetic - analog between the nervous system of a man and a structure with SHM, SHM as a part of system management, Passive and Active SHM, NDE, SHM and NDECS, basic components of SHM, materials for sensor design	7
III	**Condition Survey & NDE of Civil Structure**: Definition and objective of Condition survey, stages of condition survey (Preliminary, Planning, Inspection and Testing stages), possible defects in concrete structures, quality control of concrete structures - Definition and need,Quality control applications in concrete structures, NDT as an optionfor Non-Destructive Evaluation (NDE) of Concrete structures, case studies of a few NDT procedures on concrete structures, **Non Destructive Testing of Concrete Structures**: Introduction to NDT - Situations and contexts, where NDT is needed, classification of NDT procedures, visual Inspection, half-Cell electrical potential methods, Schmidt Rebound Hammer Test, resistivity measurement, electromagnetic methods, radiographic Testing, ultrasonic testing, Infra-Red thermography, ground penetrating radar, radio isotope gauges, other methods.	6
IV	**SHM of Composite Structures**: Introduction to composites and their applications in structural Industry. Learning from failures. Various kinds of damage detection techniques. Repair &rehabilitation & retrofitting of composite structures, damage	7

	assessment of composites structures, Case studies.	
V	**Introduction to FE Simulations of various SHM techniques:** Introduction to FE analysis of typical smart materials. Applications of FE simulation technique, case studies 1) Metallic structures 2) Composite structures.	6
VI	**Advanced Signal processing methods for Data processing and Result interpretation**. Wavelet, Neural networks, Vector support machine.	6

Textbooks	
1	Daniel Balageas, Claus - Peter FritzenamI Alfredo Guemes, Structural Health Monitoring, Published by ISTE Ltd., U.K. 2006.
2	Guide Book on Non-destructive Testing of Concrete Structures,Training course series No. 17, International Atomic Energy Agency,Vienna, 2002.
3	Gandhi, M.V., Thompson B. D., Smart Materials and Structures, ISBN 978-0-412-37010-6
References	
1	Hand book on "Repair and Rehabilitation of RCC Buildings", Published by Director General, CPWD, Govt. of India, 2002.
2	Hand Book on Seismic Retrofitting of Buildings, Published by CPWD & Indian Building Congress in Association with IIT, Madras, Narosa Publishing House, 2008.
Useful Links	
1	
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CO-PO Mapping

	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1			1			
CO2			2			
CO3			3			

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing).

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Course Information

Programme	M. Tech. Civil (Structural Engineering)
Class, Semester	First Year M. Tech., Semester II
Course Code	6ST521
Course Name	Theory of plates & Shells
Desired Requisites:	Theory of Elasticity and Plasticity

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	1 Hr/week	30	20	50	100
		Credits: 4			

Course Objectives

1	To impart knowledge of plate and shell behavior under different loading and boundary conditions.
2	To discuss use of classical, approximate and numerical methods to solve plate and shell problems.
3	To provide knowledge of plate and shell modeling for practical applications

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	**Illustrate** the behavior of various plates and shells.	Applying
CO2	**Analyze** plates and shells using different methods.	Analyzing
CO3	**Evaluate** structural actions for practical applications of plates and shells.	Evaluating

Module	**Module Contents**	**Hours**
I	**Bending of Circular Plates** Thin and Thick Plates, small and large deflection theory of thin plates - assumptions, moment-curvature relations, stress resultants, governing differential Equation for bending of plates, various boundary conditions. Bending of Circular Plates: Symmetrical loading.	6
II	**Bending of Rectangular Plates** Rectangular Plates Navier's and Levy's solutions for rectangular plates of various boundary conditions and subjected to various types of loads.	6
III	**Finite Difference Method for plates** Finite Difference Method Solution of plate problems derivation of delta/ pattern/ stencil for biharmonic form for a rectangular mesh, two stage solutions, solution for various loadings and boundary conditions, use of symmetry & anti-symmetry, extrapolation formula, introduction to improved Finite Difference Technique	8
IV	**Introduction to Shells** Shells Classification of shells based on geometry, thickness and loading. Thin shell theory, equation of shell surfaces, stress resultants, stress-displacement relations, compatibility and equilibrium equations	6
V	**Analysis of various shells by Membrane Theory** Membrane Analysis Equation of equilibrium for synclastic and anticlastic shells under self-weight and live load, equations of equilibrium in rectangular co-ordinate system. Spherical and cylindrical shells under internal pressure, Cylindrical shells-equation of equilibrium with different directrix and shells with closed ends. Cylindrical and Hyperbolic paraboloid roofs.	8
VI	**Cylindrical shell roofs** Symmetrically loaded circular cylindrical Shell-Derivation of Governing Differential Equation, resembling that for beam on elastic foundation, beam theory. Finsterwalder's Theory-Derivation of governing differential equation of 8th order. D. K. J. Theory-Donnell's equation, Characteristic equation. Schorer's theory-Derivation of differential equation	6

Textbooks	
1	Timoshenko. S.P. And Krieger. S.W, "Theory of Plates & Shells", Tata McGraw-Hill Publishing Company Limited, 2nd Edition, 1985.
2	Ramaswamy G. S., "Design and Construction of Concrete Shell Roofs", CBS Publishers and Disributors, 1st revised Edition, 1984.
References	
1	Chandrashekhara K., "Analysis of Thin Concrete shells", Tata McGraw-Hill Publishing Company Limited, 2nd Revised Edition, 2011.
2	Flugge. W., "Stresses in Shells", 2nd Edition, Springer, Berlin, 1990.
Useful Links	
1	https://nptel.ac.in/courses/105/103/105103209/
2	https://nptel.ac.in/courses/105/105/105105177/
3	https://nptel.ac.in/courses/105/105/105105108/
4	

CO-PO Mapping

	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1		1	2			
CO2		3				2
CO3		2				2

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information

Programme	M.Tech. Civil (Structural Engineering)
Class, Semester	First year. M. Tech., Sem. II
Course Code	6ST522
Course Name	Finite Element Method
Desired Requisites:	Mechanics of Structures

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	To impart knowledge of finite element method for 1-D, 2-D,3-D elements
2	To discuss finite element method in structural engineering
3	To illustrate applications of FEM for plates, shells and structural dynamics

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	**Implement** finite element methodology for solving 1-D, 2-D, 3-D problems	Applying
CO2	**Analyse** nodal degrees of freedom and stress resultants	Analysing
CO3	**Create** finite element model for solution of various field problems	Creating

Module	**Module Contents**	**Hours**
I	**1-D Elements** 1-D Elements Basic concept of finite element analysis, Discretization, nodes, element incidences, displacement model, shape function, selection of order of polynomials, application to bars with constant and variable cross sections subjected to axial forces. Principle of minimum potential energy, variation principle, development of element stiffness matrix and nodal load vector for truss, beam and plane frame elements, Transformation of matrices, relevant structural engineering applications.	8
II	**2-D Elements** 2-D Elements 2-D elements of triangular and quadrilateral shapes for plane stress and plane strain problems. Pascal's triangle, convergence requirements and compatibility conditions, shape functions, boundary conditions, element aspect ratio, applications to a continuum.	6
III	**3-D Elements** 3-D Elements Development of element stiffness matrix and nodal load vector for Tetrahedron, Hexahedral elements, Ax symmetric Elements - Development of element stiffness matrix and nodal load vector.	6
IV	**Isoperimetric Element** Isoperimetric Elements Shape function, Natural coordinate systems, classification of isoperimetric- subprarmatric, super parametric elements, 1-D & 2-D isoperimetric elements, Gauss-quadrature integration.	6
V	**Plate and Shell Elements** Plate and Shell Elements Formation of stiffness matrix for plate bending elements of triangular and quadrilateral shapes, cylindrical thin shell elements.	7
VI	**Finite Element Applications to Structural Dynamics** Finite Element Applications to Structural Dynamics Formulation, Hamilton's principle, element mass matrices, evaluation of Eigen values and eigenvectors.	6

Textbooks

1	Seshu P. N., “Finite Element Analysis”, 2003.
2	Reddy J. N., “An Introduction to the Finite Element Method” McGraw Hill, 3rd Edition, New York, 2006.
3	Cook Robert D., Malkus David S., Plesha Michael E., and Witt Robert J., “Concepts and Applications of Finite Element Analysis”, 2003
References	
1	Bathe Klaus-Jurgen, “Finite Element Procedures in Engineering Analysis”,1982.
2	Chandrupatla T. R. and Belegundu A. D., “Introduction to Finite Element in Engineering”, Prentice.
3	Zienkiewicz. O. C. & Taylor. R. L., “The Finite Element Method- Vol I &Vol II Tata McGraw-Hill Publishing Company Limited, 1989, 4th Edition.
Useful Links	
1	https://nptel.ac.in/courses/105/107/105107209/
2	https://nptel.ac.in/courses/105/106/105106051/
3	https://nptel.ac.in/courses/112/104/112104116/

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1	1	2		2		
CO2		3		2		2
CO3	1		2			3
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO.						

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher’s assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information

Programme	M. Tech. Civil (Structural Engineering)
Class, Semester	First Year M. Tech., Semester II
Course Code	6ST571
Course Name	Structural Health Monitoring Laboratory
Desired Requisites:	

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	2 Hrs/ Week	**LA1**	**LA2**	**Lab ESE**	**Total**
Interaction	----	30	30	40	100
		Credits: 1			

Course Objectives

1	To impart knowledge of smart materials.
2	To illustrate principles of structural health monitoring
3	To provide quantitative means to assess the structural integrity loss a system undergoes after natural disasters and other hazardous events.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	**Apply** knowledge of smart materials and techniques to SHM	Applying
CO2	**Appraise** structural conditions by various techniques of SHM.	Evaluating
CO3	**Assess** civil engineering structures by SHM techniques and simulation.	Evaluating

List of Experiments

1. Determination and simulation of compressive strength of Concrete elements using NDT such as a) ultrasonic pulse velocity b) rebound hammer test c) validation with destructive test for compressive strength.
2. Determination and simulation of characteristics of ultrasonic guided waves using Piezo sensors in various materials a) Concrete b) metallic plate c) Composite plate d) HCSS plate.
3. Damage detection of following materials and simulation a) Concrete b) metallic plate c) Composite plate d) HCSS plate
4. Determination of mode shapes for undamaged cantilever beams and simulation for following materials using accelerometers (piezo) a) metallic plate b) Composite plate c) HCSS plate.
5. Determination of mode shapes for damaged cantilever beams and simulations for following materials using accelerometers (piezo) a) metallic plate b) Composite plate c) HCSS plate.
6. Determination of deflection and bending stresses of the simply supported concrete beam under static and dynamic loading and simulation using LVDT transducers and verification with theory.

Textbooks

1	Daniel Balageas, Claus - Peter FritzenamI Alfredo Guemes, Structural Health Monitoring, Published by ISTE Ltd., U.K. 2006.
2	Guide Book on Non-destructive Testing of Concrete Structures,Training course series No. 17, International Atomic Energy Agency,Vienna, 2002. Gandhi, M.V., Thompson **B. D.,** Smart Materials and Structures, **ISBN 978-0-412-37010-6**

References

1	Hand book on "Repair and Rehabilitation of RCC Buildings, "Published by Director General, CPWD, Govt. of India, 2002.
2	Hand Book on Seismic Retrofitting of Buildings, Published by CPWD & Indian Building Congress in Association with IIT, Madras, Narosa Publishing House, 2008.

Useful Links

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CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1			1			
CO2			2			
CO3			3			
The strength of mapping is to be written as 1,2,3; where, 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO, and preferably to only one PO.						

Assessment

There are three components of lab assessment, LA1, LA2 and Lab ESE.
IMP: Lab ESE is a separate head of passing.(min 40 %), LA1+LA2 should be min 40%

Assessment	Based on	Conducted by	Typical Schedule	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	30
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External Examiner as applicable	During Week 18 to Week 19 Marks Submission at the end of Week 19	40

Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments and related activities if any.

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Course Information

Programme	M. Tech. Civil (Structural Engineering)
Class, Semester	First Year M. Tech., Semester II
Course Code	6ST572
Course Name	Finite Element Laboratory
Desired Requisites:	Finite Element Method

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	2 Hrs/ Week	**LA1**	**LA2**	**Lab ESE**	**Total**
Interaction	----	30	30	40	100
		Credits: 1			

Course Objectives

1	To impart knowledge to solve 1-D, 2-D, and 3-D problems by using finite element-based software's.
2	To develop critical thinking and interpretation techniques
3	To provide training on professional FE software.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	**Apply** knowledge of smart materials and techniques to SHM	Applying
CO2	**Appraise** structural conditions by various techniques of SHM.	Analyzing
CO3	**Assess** civil engineering structures by SHM techniques and simulation.	Evaluating

List of Experiments

1. Determination and simulation of compressive strength of Concrete elements using NDT such as a) ultrasonic pulse velocity b) rebound hammer test c) validation with destructive test for compressive strength.
2. Determination and simulation of characteristics of ultrasonic guided waves using Piezo sensors in various materials a) Concrete b) metallic plate c) Composite plate d) HCSS plate.
3. Damage detection of following materials and simulation a) Concrete b) metallic plate c) Composite plate d) HCSS plate
4. Determination of mode shapes for undamaged cantilever beams and simulation for following materials using accelerometers (piezo) a) metallic plate b) Composite plate c) HCSS plate.
5. Determination of mode shapes for damaged cantilever beams and simulations for following materials using accelerometers (piezo) a) metallic plate b) Composite plate c) HCSS plate.
6. Determination of deflection and bending stresses of the simply supported concrete beam under static and dynamic loading and simulation using LVDT transducers and verification with theory.

Textbooks

1	Daniel Balageas, Claus - Peter FritzenamI Alfredo Guemes, Structural Health Monitoring, Published by ISTE Ltd., U.K. 2006.
2	Guide Book on Non-destructive Testing of Concrete Structures,Training course series No. 17, International Atomic Energy Agency,Vienna, 2002. Gandhi, M.V., Thompson **B. D.,** Smart Materials and Structures, **ISBN 978-0-412-37010-6**

References

1	Hand book on "Repair and Rehabilitation of RCC Buildings, "Published by Director General, CPWD, Govt. of India, 2002.
2	Hand Book on Seismic Retrofitting of Buildings, Published by CPWD & Indian Building Congress in Association with IIT, Madras, Narosa Publishing House, 2008.

Useful Links

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2	

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CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1			1			
CO2			2			
CO3			3			
The strength of mapping is to be written as 1,2,3; where, 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO, and preferably to only one PO.						

Assessment

There are three components of lab assessment, LA1, LA2 and Lab ESE.
IMP: Lab ESE is a separate head of passing (min 40 %), LA1+LA2 should be min 40%

Assessment	Based on	Conducted by	Typical Schedule	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	30
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External Examiner as applicable	During Week 18 to Week 19 Marks Submission at the end of Week 19	40

Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments and related activities if any.

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Course Information

Programme	M.Tech. (Structural Engineering)
Class, Semester	First year M. Tech., Sem. II
Course Code	6ST574
Course Name	Predissertation Work and Seminar
Desired Requisites:	Research Methodology

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	2 Hrs/week	**LA1**	**LA2**	**Lab ESE**	**Total**
		30	30	40	100
		Credits: 1			

Course Objectives

1	To help in identifying potential research areas in the field of structural engineering.
2	To guide the students for acquiring necessary knowledge about selected research topic.
3	To enhance knowledge by interaction with students during presentation.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	**Identify** the literature available on the selected topic.	Analysing
CO2	**Analyse** and breakdown the latest information of selected research topic	Analysing
CO3	**Appraise** and conclude predissertation work and seminar work effectively	Evaluating

Lab Activities

Predissertation work and seminar shall be delivered on one of the advanced topics after carrying out rigorous literature review on various potential areas by identifying appropriate research gaps in consultation with the guide. Proposed scope of the research work should be presented during seminar along with case study and same may be extended as dissertation topic. All modern methods of presentation are to be used by the student. A hard copy of the report (25 - 30 pages as per prescribed format) should be submitted to the guide before delivering the seminar. A PDF copy of the report along with all the referred research material must be submitted to the guide.

References

1	National and International journals, Conference Proceedings in Structural Engineering.
2	Technical Reports of Professional societies.
3	International and national codes of Practices and Handbooks.
4	Internet sources and Distance Learning.
5	Published Ph.D. and M. Tech Thesis of Reputed Institutes.

Useful Links

CO-PO Mapping

	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1			2	2		3
CO2			2	2		3
CO3	1		2			2

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment				
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing (min 40 %), LA1+LA2 should be min 40%				
Assessment	**Based on**	**Conducted by**	**Typical Schedule**	**Marks**
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	30
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External Examiner as applicable	During Week 18 to Week 19 Marks Submission at the end of Week 19	40
Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the nature and requirement of the lab course.				

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Course Information

Programme	M.Tech. Civil (Structural Engineering)
Class, Semester	First year M. Tech., Semester II
Course Code	6ST531
Course Name	Elective 2 – Analysis and Design of Bridges
Desired Requisites:	Design of Concrete Structures

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs./week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	--	30	20	50	100
		Credits: 3			

Course Objectives

1	To provide knowledge of loads and analysis for different types of bridges.
2	To impart knowledge for design of different types of bridges including substructures with relevant codes.
3	To provide knowledge for construction, inspection and maintenance of bridges.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	**Illustrate** types of bridges, their components and selection of bridge site.	Applying
CO2	**Analyze** various types of bridges with appropriate loads and methods.	Analyzing
CO3	**Design** bridges and bearings along with reinforcement details.	Creating

Module	**Module Contents**	**Hours**
I	**Introduction to Bridge** Components of bridge, Importance of bridge, Types of bridges, Selection of bridge type and site, Economic span, Superstructure – Alignment, Drainage, Clearance, Road curb, Design loads for bridges, IRC Loading	7
II	**Analysis of Culverts** Design of RC Culvert, Pipe culvert, Box culvert.	6
III	**RC Deck Slabs** Design of RC deck slab, Beam and slab, T-beam bridge, Pigeaud's theory, Corbon's theory, Balanced cantilever bridge.	6
IV	**Prestressed Concrete Bridges** Prestressed Concrete Bridges – General aspects, Advantages, Design of pre-tensioned and post-tensioned concrete bridge decks.	7
V	**Design of Composite Bridges** Design of composite bridges, Reinforced concrete slab on steel plate girder, Stiffeners, Shear connectors, Connections.	7
VI	**Design of Substructure** Design of substructure – Abutment, Pier, Approach slab, Pile and well foundation. Bearings and expansion joints.	6

Textbooks

1	Krishna Raju N., "Design of Bridges, Oxford and IBH Publishing Co. Ltd.", New Delhi and Kolkata, 2001.
2	Jagdeesh T. R., Jayaram M. A., "Design of Bridge Structures, Prentice Hall of India Pvt. Ltd.", New Delhi, 2003.
3	Johnson Victor, "Essentials of Bridge Engineering, Oxford and IBH Publishing Co. Ltd.", 5th Edition, 2001.

References

1	Raina V. K., “Concrete Bridge Practice: Construction and maintenance and rehabilitation”, Tata Mc Graw Hill Publishing Company, New Delhi.
2	Raina V. K., “Concrete Bridge Practice: Analysis, design and economics”, Tata Mc Graw Hill Publishing Company, New Delhi.
3	IRC Codes.
Useful Links	
1	Reinforced Concrete Road Bridges - Course (nptel.ac.in)
2	NPTEL :: Civil Engineering - NOC: Reinforced Concrete Road Bridges

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1			2			3
CO2				2		
CO3	1		2			
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO.						

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher’s assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2022-23

Course Information	
Programme	M.Tech. Civil (Structural Engineering)
Class, Semester	First year M. Tech., Sem. II
Course Code	6ST532
Course Name	Elective 2 – Advanced Earthquake Engineering
Desired Requisites:	Dynamics of Structures

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs./week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	--	30	20	50	100
		Credits: 3			

Course Objectives	
1	To provide knowledge of various concepts of earthquake resistant design of structures.
2	To impart the knowledge of modelling and analysis of structures for displacement-based design.
3	To illustrate seismic behaviour and codal provisions for design of various earthquake resistant structures.

Course Outcomes (CO) with Bloom's Taxonomy Level		
At the end of the course, the students will be able to,		
CO1	**Illustrate** various concepts of earthquake resistant design of structures	Applying
CO2	**Calculate** response of structures for displacement and performance-based design.	Evaluating
CO3	**Design** earthquake resistant structures based on its performance.	Creating

Module	**Module Contents**	**Hours**
I	**Concepts of Earthquake Resistant Design** Force based vs. displacement-based design, performance-based design, seismic input characteristics and their effect on seismic design, comparative study of different national codes.	6
II	**Modelling and Analysis of Structures for Displacement Based Design** Back-bone curve, Idealized component models, estimation and modelling of stiffness, strength and ductility of RC, steel and masonry structures, nonlinear static and dynamic analyses.	7
III	**Direct Displacement Based Design** Structure performance objectives, performance levels and limit states; P-Delta effects; Torsion; Capacity design for direct displacement-based design.	6
IV	**Performance Based Design and Pier Analysis** Structural and non-structural performance, quantification of performance, performance evaluation of structures, services and equipment. Pier analysis for shear wall and masonry structures	6
V	**Overhead Water Tanks** Modelling and analysis of overhead water tanks, hydrostatic and hydrodynamic effects, earthquake resistant provisions.	7
VI	**Seismic Risk Assessment** Seismic vulnerability assessment, HAZUS, Different types of MBT, Fragility curve, DPM, Simplified Vulnerability assessment as per ASCE 41.Assesment procedures of NDT results	7

Textbooks	
1	Agarwal P. and Shrikhande M., "Earthquake Resistant Design of Structures", PHI publications, New Delhi, 3rd Edition, 2006.

2	Key David, “Earthquake Design Practice for Buildings”, Thomas Telford Publication, London,2nd Edition, 2006.
3	Paulay, T. and Priestley, M.J.N. “Seismic Design of Reinforced Concrete and Masonry Buildings,” John Wiley & Sons, 1992.
References	
1	Kelly James M., “Earthquake Resistant Design with Rubber”, Springer-Verlag Publication, London, 2nd Edition, 2012.
2	George G. Penelis and Andreas J. Kappos, “Earthquake Resistant Concrete Structures,” E & FN Spon, 1997.
3	FEMA-356, “Prestandard and Commentary for the Seismic Rehabilitation of Buildings,” Federal Emergency management Agency, 2000.
Useful Links	
1	https://nptel.ac.in/courses/105/101/105101209/
2	https://nptel.ac.in/courses/105/104/105104200/
3	https://nptel.ac.in/courses/105/108/105108204/
4	https://nptel.ac.in/courses/105/107/105107204/
5	https://nptel.ac.in/courses/105/101/105101004/

CO-PO Mapping

	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1		1	2			3
CO2			3	2	3	
CO3	1		2		3	2

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on any three modules out of six.
ISE shall be taken throughout the semester in the form of teacher’s assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli

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AY 2022-23

Course Information

Programme	M. Tech. Civil (Structural Engineering)
Class, Semester	First Year M. Tech., Semester II
Course Code	6ST533
Course Name	Elective 2 - Numerical Methods in Structural Engineering
Desired Requisites:	Applied Mathematics, Structural Engineering

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	---	30	20	50	100
		Credits: 3			

Course Objectives

1	To provide knowledge of Matrix methods and statistical tools for solution of problems.
2	To impart knowledge of numerical differentiation, integration, root finding, curve fitting and other numerical approximations.
3	To provide exposure to field application of numerical methods in structural engineering.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	**Execute** numerical recipes for problem solving in engineering.	Applying
CO2	**Examine** different numerical tools for solution of engineering problems.	Analyzing
CO3	**Discuss** numerical schemes for modelling and solving field applications.	Evaluating

Module	**Module Contents**	**Hours**
I	**Solving Linear Algebraic Equations and Eigen Analysis** System of linear algebraic equations, conditions for existence of solution, Classification of solution approaches as direct and iterative, solution by matrix decomposition, Introduction to methods for solving Block-diagonal, triangular, block-triangular systems. Introduction to sparse linear systems: Thomas algorithm for tridiagonal and block tridiagonal matrices, Iterative methods: Jacobi, Gauss-Siedel and successive over relaxation methods, Convergence of iterative solution schemes. Ill conditioning of equations. Eigen Analysis by Jacobi and other Methods.	8
II	**Solving Nonlinear Algebraic Equations [Root Locating methods]** Method of successive substitutions derivative free iterative solution approaches, Secant method, regulafalsi method, Modified Newton's method and qausi-Newton method with Broyden's update, Optimization based formulations and Leverberg-Marquardt method	7
III	**Solving Ordinary Differential Equations and Approximations** Solutions of Linear ODE-IVPs by implicit and explicit methods, Taylor series based and Runge-Kutta methods, Multi-step approaches, Stability issues. Problem discretization using approximation theory, polynomial approximations, Finite difference method for solving ODE-BVP with examples, Polynomial and function interpolations, Least square approximations, Model Parameter Estimation using linear least squares method, Gauss Newton Method.	6
IV	**Probability, Statistics, Reliability Analysis** Probability basics and applications in engineering, Statistical parameters, distributions, methods and applications. Reliability analysis in structural engineering.	8
V	**Numerical Integration** Newton-Cotes schemes, Romberg, Gauss-quadrature, Multiple Integrals.	7
VI	**Structural Engineering Applications** Digital Signal Processing, Nonlinear structural analysis, Structural dynamics and Earthquake engineering applications. SHM.	6

Textbooks	
1	Chapra Steven and Canale Raymond, “Numerical Methods for Engineers”, Mc-Graw Hill, 7th Edition, 2012.
2	Gourdin A. and Boumhrat M., “Applied Numerical Methods”, Prentice Hall India, New Delhi, 2000.
3	Joe D Hoffman, “Numerical Methods for Engineers and Scientists”, Marcel Dekker, 2nd Edition, 2001.
References	
1	Gilbert Strang, “Computational Science and Engineering”, Wellesley-Cambridge Press.
2	Gilbert Strang, “Linear Algebra and Its Applications”, Wellesley Cambridge Press, 4th Edition, 2009.
3	Philips, G. M., and Taylor P. J. “Theory and Applications of Numerical Analysis”, Academic Press, 2nd Edition, 1996.
Useful Links	
1	https://nptel.ac.in/courses/105/105/105105043/
2	https://nptel.ac.in/courses/111/107/111107107/
3	https://nptel.ac.in/courses/111/107/111107105/

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1	1		2			
CO2	1		2			
CO3	1			3		3
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO.						

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher’s assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli

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AY 2022-23

Course Information

Programme	M.Tech. Civil (Structural Engineering)
Class, Semester	First year M. Tech., Sem. II
Course Code	6ST534
Course Name	Elective 3 - Advanced Prestressed Concrete
Desired Requisites:	Design of Concrete Structurers I, Design of Concrete Structurers II

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs./week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	--	30	20	50	100
		Credits: 3			

Course Objectives

1	To illustrate basic concepts and systems of prestressing.
2	To impart knowledge of analysis of Prestressed concrete structures.
3	To provide knowledge for design of Prestressed concrete structures using relevant IS codes.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	**Estimate** losses of prestress due to various causes.	Analyzing
CO2	**Verify** appropriate section using flexure, shear, torsional design approach for Prestressed concrete structures	Evaluating
CO3	**Design** Prestressed concrete components and structures.	Creating

Module	Module Contents	Hours
I	**Introduction** Basics of pre-stressed concrete, stress concept, strength concept and load balancing concept, systems of prestressing, loss of prestress, Material properties: steel, allowable stresses, relaxation, fatigue. Stages of prestressing.	7
II	**Analysis of Sections under flexure** Analysis of rectangular sections under flexure at ultimate loads: equations of equilibrium and compatibility and constitutive models, stress block for concrete, solution procedure, minimum and maximum amount of prestressed reinforcement. Analysis of flanged sections under flexure at ultimate loads. Introduction of software for prestressed sections.	6
III	**Design of Section- Limit state method** Design of Prestressed concrete beams and slabs, rectangular and I Sections. choice of cross section: flexural efficiency; determination of limiting zone; post-tension in stress. Magnel's graphical method. Design based on ultimate loads. Detailing requirement. Thermal stresses in prestressed slab.	6
IV	**Shear and Torsion** Analysis and Design for shear and torsion, Analysis for shear: principal stress trajectories of linear elastic beams crack patterns, modes of failure, component of shear resistance. Capacity for web shear cracking capacity for flexural shear cracking. Design of shear reinforcement detailing requirements, design steps. Analysis for torsion behavior of linear elastic beams, crack pattern. Modes of failure, components of torsion resistance.	7
V	**Design of anchorage zone** Calculations for deflection and crack-width, Pretensioned members: Hoyer effect, transmission length, bond length, development length, transverse tensile stresses, end zone reinforcement. Post-tensioned members: Bursting force, anchorage zone reinforcement, bearing stress, design of end block. Circular Prestressing design.	7

VI	**Design of continuous beams** Cantilever beams and Continuous beams, Cantilever beams: choice of cable profile, determination of limiting zone. Continuous beams: advantages and disadvantages, choice of cable profile, analysis for bending moment. Principle of linear transformation, principle of concordant cable.	6
Textbooks		
1	Krishna Raju N., "Prestressed Concrete", McGraw Hill Education (ISE Editions); 5th Edition 2014.	
2	Ramamrutham S. "Design of reinforced concrete structures", Dhanpat Rai publishing company, 17th Edition 2010.	
3	Nagarajan Praveen, "Prestressed concrete designs", Pearson publications, 2013.	
References		
1	Lin T. Y. and Burns N. H. "Design of Prestressed concrete structures", Wiley publications, 3rd Edition, 2010.	
2	Arthur H. Nilson, "Design of Prestressed concrete", John Wiley publications, 2nd Edition.	
3	IS: 1343 Indian standard code of practice for Prestressed concrete BIS New Delhi	
4		
Useful Links		
1	https://nptel.ac.in/courses/105/106/105106117/	
2	https://www.youtube.com/watch?v=4KYPltsNAWs	

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1			2	2		3
CO2			2	2		3
CO3	1		2			2
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO.						

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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AY 2022-23

Course Information

Programme	M. Tech. Civil (Structural Engineering)
Class, Semester	First Year M. Tech., Semester II
Course Code	6ST535
Course Name	Elective 3 - Design Optimization
Desired Requisites:	Engineering Mathematics, Structural Analysis and Design

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	To provide knowledge of optimization approach and significance of optimization.
2	To impart knowledge of application of optimization tools required for analysing and solving problems in structural and other engineering fields.
3	To provide exposure to modern techniques of global optimization for design optimization of Processes/Designs in engineering field in general and structural engineering.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	**Apply** various optimization techniques for solution of linear, nonlinear, and general optimization problems.	Applying
CO2	**Analyse** various optimization problems in engineering field.	Analyzing
CO3	**Create** optimized global engineering designs of structural and other engineering facilities having different complexity.	Creating

Module	**Module Contents**	**Hours**
I	**Classical Optimization Techniques** Relevance and Significance of optimization, Various optimization problems in different fields of engineering, Introduction to optimization theory-objective function/design variables/constraints, Classification of optimization problems and optimization techniques, Formulation of Various optimization problems, linear programming and simplex algorithm, Nonlinear programming by Lagrange Multiplier with equality and inequality constraints.	7
II	**Optimization of Trusses and Structural Components** Minimum weight criteria, fully stressed design and displacement constraints, optimization of truss, cable and arch structures, optimization of beams and columns.	6
III	**Constrained Optimization and Multi-Objective Optimization** Optimality criterion methods. Sequential Quadratic Programming, Penalty Methods, Sensitivity of optimum solution, Aspects of Multi-objective optimizations, Multi-objective optimization techniques.	7
IV	**Optimization by Stochastic and Heuristic Algorithms I** Particle Swarm Optimization, Introduction, Computational Implementation, Solution of the Constrained Optimization Problem, Ant Colony Optimization, Basic Concept, Ant Searching Behavior, Path Retracing and Pheromone, Updating, Pheromone Trail Evaporation, Algorithm. Examples.	6
V	**Optimization by Stochastic and Heuristic Algorithms II** Simulated annealing, Procedure, Algorithm, Features of the Method, Optimization solutions. Response surface methodology, Three-level factorial design, Box–Behnken design, Central composite design, Doehlert design, Desirability function, Examples.	6
VI	**Optimization by Evolutionary and Fuzzy Algorithms**	

	Genetic algorithm, Representation of design variables, Representation of Objective Function and Constraints, Genetic Operators, Algorithm flowchart, Design examples. Fuzzy Set Theory, Optimization of Fuzzy Systems, Computational Procedure, Numerical Example, Neural-Network-Based Optimization. Taguchi Method.	7

Textbooks	
1	Singiresu S. Rao, "Engineering Optimization-Theory and Practice", New Age International Publishers, 2013, 4th Edition.
2	Uri Kirsh, "Optimum Structural Design", McGraw Hill, 1988.
3	R. Fletcher, "Practical Optimization", John Wiley & Sons, New York, 2nd Edition, 1987.

References	
1	Edgar, Himmelblau and Lasdon, "Optimization of Chemical ProcessesMc", Graw Hill International Edition, 2nd Edition, 2001.
2	M.S. Bazaraa, H.D. Sherali and C. Shetty, "Non-Linear Programming-Theory and Algorithms", John Wiley and Sons, New York, 1993.
3	Richard Vinter, "Optimal Control", Springer, 2010.
4	Du, Ke-Lin, Swamy, M. N. S., "Search and Optimization by Metaheuristics", Birkhäuser Basel-Springer International, 1st Edition, 2016

Useful Links	
1	https://nptel.ac.in/courses/105/108/105108127/
2	https://nptel.ac.in/courses/103/103/103103164/

CO-PO Mapping

	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1	2					2
CO2			2	3		1
CO3	1			3		2

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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AY 2022-23

Course Information

Programme	M. Tech. Civil (Structural Engineering)
Class, Semester	First Year M. Tech., Semester II
Course Code	6ST536
Course Name	Elective 3 - Advanced Design of Steel Structures
Desired Requisites:	Design of Steel Structures

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hr/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	----	30	20	50	100
		Credits: 3			

Course Objectives

1	To provide the knowledge of design of steel structures such as bridges, multistory buildings and portal frames.
2	To impart the knowledge of cold formed sections and composite beams.
3	To illustrate plastic analysis and design of steel frames.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	**Apply** basic concepts of design of steel structures to multistorey buildings and portal frames.	Applying
CO2	**Evaluate** cold formed sections and composite beams.	Evaluating
CO3	**Design** steel frames considering plastic analysis.	Creating

Module	**Module Contents**	**Hours**
I	**Foot Bridges** Analysis and design of footbridges, Deck of through type bridges, Flooring system, Bracing system.	7
II	**Cold Formed Sections** Cold formed light gauge steel sections, Various profiles, Stiffened and unstiffened sections, Roof sheeting, Purlins, Flexure and column behavior, IS code provisions.	6
III	**Composite Sections** Composite section consisting of structural steel and concrete, Composite beams, Shear connectors, Composite decks using light gauge steel and concrete, Composite columns, IS code provisions.	7
IV	**Introduction to Plastic Analysis** Introduction to Plastic Analysis, Plastic bending of beam, Plastic hinge, Shape factor of cross section, Static and kinematic methods of analysis, Plastic analysis and design of propped cantilever, fixed beam and continuous beams.	6
V	**Multistorey Buildings** Multistory buildings, Lateral load resisting systems, Types of bracing systems, Shear wall, Inelastic analysis of multistory, multi-bay frames.	7
VI	**Low Rise Portal Frames** Analysis of low rise rectangular and gable portal frames, Various basic mechanisms, Combination of mechanisms, Limit state design of frames, Haunches and column bases.	6

Textbooks

1	Vazirani V. N., and Ratwani M. M., "Steel Structures and Timber Structures", Khanna Publishers, Delhi.
2	Ramchandran, "Design of Steel Structures – Vol. II", Standard Book House, Delhi.
3	Punmia B. C., Jain A. K. and Jain A. K. "Design of Steel Structures", Firewell Media.

References

1	Taranath B. S., “Structural Analysis and Design of Tall Buildings”,McGrawhill.
2	Bekar J. F., Horne M. R., Heyman J., “Steel Skeleton Vol. II Plastic Behavior& Design”, ELBS
3	Neal B. G., “Plastic Methods of Structural Analysis”, Chapter & Hall.
Useful Links	
1	https://nptel.ac.in/courses/105/105/105105162/
2	https://nptel.ac.in/courses/105/106/105106112/
3	https://nptel.ac.in/courses/105/106/105106113/

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1	1		2	3		
CO2	1		2	3		
CO3				3	2	2
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO.						

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher’s assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing).

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AY 2023-24

Course Information	
Programme	M.Tech. (Structural Engineering)
Class, Semester	Second year M. Tech., Semester III
Course Code	6ST645
Course Name	Dissertation Phase I
Desired Requisites:	Courses of Semester I and II of F. Y. M. Tech (Civil-Structures)

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	6 Hrs/week	**LA1**	**LA2**	**ESE**	**Total**
		100			100
		Credits: 3			

Course Objectives	
1	To impart knowledge for establishing objectives by carrying out extensive literature review on selected dissertation topics.
2	To develop methodology to execute the proposed research work through analytical/experimental work.
3	To analyse, interpret, debate, and classify the findings of the work.

Course Outcomes (CO) with Bloom's Taxonomy Level		
At the end of the course, the students will be able to,		
CO1	**Execute** detailed literature survey to understand research developments and set up research hypotheses.	Applying
CO2	**Construct** research methodology to evaluate the research hypothesis	Analysing
CO3	**Assess** research idea with perspective scope.	Evaluating

Contents

The dissertation work will start in semester III, and should involve scientific research, design, collection, and analysis of data, determining solutions and must bring out the individual's contribution. Dissertation Phase 1 will have presentation and report submission (synopsis). The presentation will include identification of the research problem based on the extensive literature review on the topic referring to latest literature available, defining objectives of the work, and the methodology to be adopted.

References

1	National and International journals, Conference Proceedings in Structural Engineering.
2	Technical Reports of Professional societies.
3	International and national codes of Practices and Handbooks.
4	Internet sources and Distance Learning.
5	Published Ph.D. and M. Tech Thesis of Reputed Institutes.

CO-PO Mapping

	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1			2	2		3
CO2			2	2		3
CO3	1		2			2

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO.

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2023-24

Course Information

Programme	M.Tech. (Structural Engineering)
Class, Semester	Second year M. Tech., Semester III
Course Code	6ST646
Course Name	Dissertation Phase II
Desired Requisites:	Dissertation Phase I

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	6 Hrs/week	**LA1**	**LA2**	**ESE**	**Total**
			100		100
		Credits: 3			

Course Objectives

1	To analyze/experiment selected research topic further.
2	To review, classify and consolidate observations/results based on the detailed analytical/ experimental work.
3	To document the research work in the prescribed format and present it effectively.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	**Execute** detailed literature survey to understand research developments.	Applying
CO2	**Apprise** analytical/experimental work in detail for the selected research problem.	Analysing
CO3	**Classify** and assess research outcomes critically.	Evaluating

Contents

Dissertation Phase 2 will have mid semester evaluation based on presentation. Mid semester presentation will include the validation work and completion of one to two objectives of the study. The literature review should continue to study the latest research material available in the chosen field.

References

1	National and International journals, Conference Proceedings in Structural Engineering.
2	Technical Reports of Professional societies.
3	International and national codes of Practices and Handbooks.
4	Internet sources and Distance Learning.
5	Published Ph.D. and M. Tech Thesis of Reputed Institutes.

CO-PO Mapping

	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1			2	2		3
CO2			2	2		3
CO3	1		2			2

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Walchand College of Engineering, Sangli

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AY 2023-24

Course Information

Programme	M.Tech. (Structural Engineering)
Class, Semester	Second year M. Tech., Semester III
Course Code	6ST647
Course Name	Dissertation Phase III
Desired Requisites:	Dissertation Phase II

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	8 Hrs/week	**LA1**	**LA2**	**ESE**	**Total**
				100	100
		Credits: 4			

Course Objectives

1	To analyze/experiment selected research topic further.
2	To review, classify and consolidate observations/results based on the detailed analytical/ experimental work.
3	To document the research work in the prescribed format and present it effectively.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	**Apprise** analytical/experimental work in detail for the selected research problem.	Applying
CO2	**Classify** and assess research outcomes critically.	Analysing
CO3	**Compose** and conclude the results for presentation and dissertation report writing.	Evaluating

Contents

Dissertation Phase 3 will have end semester presentation. End semester presentation will include the validation work and completion of nearly half the work defined for the dissertation. The literature review should continue to study the latest research material available in the chosen field. The external examiner should assess the work done by the individual student based on the detailed report on identification of topic for the work, the methodology adopted, and presentation followed by viva-voce.

References

1	National and International journals, Conference Proceedings in Structural Engineering.
2	Technical Reports of Professional societies.
3	International and national codes of Practices and Handbooks.
4	Published Ph.D. and M. Tech Thesis of Reputed Institutes.

CO-PO Mapping

	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1			2	2		3
CO2			2	2		3
CO3	1		2			2

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

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AY 2023-24

Course Information

Programme	M. Tech. Civil (Structural Engineering)
Class, Semester	Second Year M. Tech., Semester III
Course Code	6ST611
Course Name	Elective 4 - Computer Aided Analysis and Design
Desired Requisites:	Dynamics of Concrete Structures, Design of Steel Structures

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	To provide knowledge of numerical approach and significance of analysis by computers.
2	To impart necessary knowledge of numerical tools required for analyzing and solving problems in the field of engineering.
3	To provide pre-requisite knowledge to the students for analyzing and designing structures by professional software.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	**Execute** various programs using software for modeling of structures.	Applying
CO2	**Analyze** various reinforced concrete and steel structures.	Analyzing
CO3	**Create** various programs for design of structures.	Creating

Module	**Module Contents**	**Hours**
I	**Algorithm Development and Programming Languages** Basics of computer hardware and os, WWW and Apps, Algorithm essentials: problem analysis and flowcharting, fundamentals of sequential programming: Variables, data types & functions + input-output + data handling + various development units, Introduction to programming in MS EXCEL®, MATLAB®, PYTHON.	5
II	**Matrix Methods and Programming** Matrix operations: product-inverse etc., Simultaneous linear equations, Eigen analysis method, Algorithm /Programming techniques of above methods.	5
III	**Numerical Methods and Programming** Numerical Integration methods, Numerical differentiation methods, Regression Analysis tools and curve fitting, Numerical Methods in structural dynamics. Algorithm/Programming techniques of above methods.	5
IV	**Computer Aided Structural Analysis** Analysis of Trusses by Stiffness method. Analysis of CB by Stiffness method, Analysis of PF by Stiffness method. 3D Analysis issues. Algorithm development for each structural analysis type.	5
V	**Computer Aided Structural Design** Design of Steel Truss members by IS-800, Design of Beam sections in RCC, Design of One way and Two-way slabs by IS-456. Algorithm development for each structural design type.	4
VI	**Commercial Software Applications** Application in commercial software SAP®/ABACUS®/ANSYS®: Analysis of TRUSS, Analysis of 2D frame, Analysis of 3D structure for various LOAD COMBINAIONS. Design of building members- Beam, Slab, Column, Footing by STAAD®, Introduction to other commercial soft-wares.	4

Textbooks

1	PratapRudra,"Getting started with MATLABTM", Oxford University press, 2010.
2	Jain M. K., Iyengar S. R. K. & Jain R. K. " Numerical Methods for Scientific and Engineering Computation ", 4th ed. 2004.
3	Pundit & Gupta "Structural Analysis", Tata MC Graw Hill Book company.

References	
1	Steve Otto and James P. Denier "An Introduction to Programming and Numerical Methods" in, Springer International books, 1st Edition, 2007
2	Cotes, R.C., Couties, M.G., and Kong, F.K., Structural Analysis, ELBS.
3	Chopra A. K., "Structural Dynamics for Earthquake Engineering", Pearson Publications.

Useful Links	
1	https://nptel.ac.in/courses/105/105/105105180/
2	http://www.nptelvideos.in/2012/11/numerical-methods-in-civil-engineering.html
3	https://in.mathworks.com/matlab/trial
4	http://www.gnumeric.org/freewarespreadsheetshttps://d.wps.com/?from=premiumpage#/

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1	2					
CO2		3			2	
CO3			3		1	
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO.						

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information

Programme	M. Tech. Civil (Structural Engineering)
Class, Semester	Second Year M. Tech., Semester III
Course Code	6ST612
Course Name	Elective 4: Advances in Concrete Composites
Desired Requisites:	Concrete technology

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	To impart knowledge of various concrete composites used in practice
2	To demonstrate variations in strength of concrete composites
3	To provide knowledge of various advanced types of concrete in modern construction industry.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	**Demonstrate** engineering properties, behavior and applications of FRC and Ferro cement.	Applying
CO2	**Differentiate** applications of silica fume concrete and polymer concrete by knowing their properties.	Analyzing
CO3	**Propose** importance of light weight and high strength concrete in modern constructions.	Creating

Module	**Module Contents**	**Hours**
I	**Fiber Reinforced Concrete** Introduction, Properties of constituent materials, Mix proportion, mixing, casting methods, properties of freshly mixed concrete (fiber reinforced concrete), workability tests, mechanical properties, behavior of fiber reinforced concrete under compression, tension flexure, research findings, and application of fiber reinforced concrete.	7
II	**Ferro Cement concrete** Introduction, materials used, mechanical properties, construction techniques, design in direct tension, applications, and merits as structural materials	7
III	**Silica Fume Concrete** Introduction, physical and chemical properties of silica Hume, reaction mechanism of silica fume, properties of silica fume concrete in fresh state, mechanical properties and durability of silica fume concrete.	7
IV	**Polymer Concrete** Introduction, classification, properties of constituent materials, polymer impregnated concrete, polymer concrete, application.	6
V	**Light Weight Concrete** Introduction, classification, properties of constituent materials, artificial aggregates, application.	6
VI	**High Strength Concrete** Introduction, properties of constituent materials, Mix Design, application.	6

Textbooks

1	Rafat Siddique, "Special Structural Concretes", Galgotia Publication Private Ltd.,2000

References

1	R. N. Swamy, "Concrete Technology & Design", Surrey University Press., illustrated, 1984.

2	P.N. Balaguru, S.P. Shah, “Fiber Reinforced Cement Composites, McGraw Hill., illustrated, 1992.
3	D. J. Hannant, “Fiber Cement and Fiber Concrete”, John Wiley & Sons.illustrated,1978
Useful Links	
1	NPTEL :: Civil Engineering - Concrete Engineering and Technology
2	NPTEL :: Civil Engineering - NOC:Advanced Concrete Technology
3	NPTEL :: Metallurgy and Material Science - NOC:Theory and Practice of Non Destructive Testing
4	Module 12 (nptel.ac.in)

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1	3					
CO2	2			2		
CO3			2	2		
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO.						

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher’s assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information

Programme	M. Tech. Civil (Structural Engineering)
Class, Semester	Second Year M. Tech., Semester III
Course Code	6ST613
Course Name	Design of Tall Structures
Desired Requisites:	Mechanics of Structures

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	----	30	20	50	100
		Credits: 3			

Course Objectives

1	To impart the overall knowledge about the material used in tall structural systems and its components.
2	To provide advanced knowledge for analyzing different types of Tall structures.
3	To impart advanced knowledge for design of different types of Tall structures using prevailing IS Codes.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	**Demonstrate** design philosophy & loading on tall structures.	Applying
CO2	**Analyse** tall structures for vertical and lateral loads.	Analyzing
CO3	**Justify** design of tall structures.	Evaluating

Module	**Module Contents**	**Hours**
I	**Introduction**: Design Philosophy - History - advantages and disadvantages - Vertical city concepts - essential amenities - fire safety - water supply - drainage and garbage disposal - service systems - structural and foundation systems. Factors affecting height, growth and form - Human comfort criteria.	6
II	**Loads And Materials:** Gravity loading - Dead and Live load - calculation - Impact and construction loads. Wind loading - static and dynamic approach - Analytical and wind tunnel experimental method. Earthquake loading - Equivalent lateral force, Modal analysis - combination of loading in various design philosophies. Materials for tall buildings - High strength concrete - Lightweight concrete - Fibre reinforced concrete Composite Materials.	6
III	**Structural Systems**: Behaviour of High Rise structures - Different system for load distribution in steel and concrete - Vertical and horizontal load resistant systems - Rigid frames - braced frames - in filled frames - shear walls - wall frames - tubular systems - outrigger braced systems - Mega systems.	8
IV	**Analysis And Design:** Analysis and Design principles of various horizontal load transfer systems - approximate methods - Modeling for accurate analysis - 3D analysis - Member forces - displacements. Analysis for various secondary effects - Creep, shrinkage and temperature.	6
V	**Stability Analysis** - Overall buckling analysis of frames, wall frames, approximate methods, second order effects of gravity loading, P - effect and various methods of analysis - influence of foundation instability, out of plumb effects - Elastic Deformations. Dynamic Analysis - Principles of design of tall braced frames for earthquake and blast resistant design.	7
VI	**Advanced Topics:** Structural systems for future generation buildings - Expert systems for consultations - Economics - Research needs in tall building materials, systems and designs.	6

Textbooks	
1	Schuller.W.G., *"High Rise Building Structures",* John Wiley & sons, 1977
2	Lynn.S. Beedle, *"Advances in Tall Buildings",* CBS Publishers and Distributors, New Delhi, 1986.
References	
1	Lin T.Y and StotesBurry.D, "Structural Concepts and Systems for Architects and Engineers", John Wiley and Sons, 1988
2	Dr.Gupta.Y.P, Editor*, "Proceedings of National Seminar on High Rise Structures - Design and construction practices for Middle Level Cities"*, Nov - 14 - 16, 1955. New Age International Publishers Ltd., Chennai
3	Lecture Notes on *"Tall Buildings"* - Short Term Course organized by Civil Engineering Department, SRM Engg college, Kattankulathur. June 2002
Useful Links	
1	
2	
3	
4	

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1	2		2			
CO2		3			2	2
CO3			3		2	2
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO.						

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information

Programme	M.Tech. (Structural Engineering)
Class, Semester	Second year M. Tech., Semester IV
Course Code	6ST691
Course Name	Dissertation Phase IV
Desired Requisites:	Dissertation Phase III

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	10 Hrs/week	**LA1**	**LA2**	**ESE**	**Total**
		100			100
		Credits: 5			

Course Objectives

1	To analyze/experiment selected research topic further.
2	To review, classify and consolidate observations/results based on the detailed analytical/ experimental work.
3	To document the research work in the prescribed format and present it effectively.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	**Apprise** analytical/experimental work in detail for the selected research problem.	Applying
CO2	**Classify** and assess research outcomes critically.	Analysing
CO3	**Compose** and conclude the results for presentation.	Evaluating

Contents

Dissertation Phase 4 will have a presentation based on the progress of work after Phase 3. The presentation should be done after completion of one more objective in continuation with the Phase 3. The literature review should continue to study the latest research material available in the chosen field.

References

1	National and International journals, Conference Proceedings in Structural Engineering.
2	Technical Reports of Professional societies.
3	International and national codes of Practices and Handbooks.
4	Published Ph.D. and M. Tech Thesis of Reputed Institutes.

CO-PO Mapping

	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1			2	2		3
CO2			2	2		3
CO3	1		2			2

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

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Course Information

Programme	M.Tech. (Structural Engineering)
Class, Semester	Second year M. Tech., Semester IV
Course Code	6ST692
Course Name	Dissertation Phase V
Desired Requisites:	Dissertation Phase IV

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	10 Hrs/week	**LA1**	**LA2**	**ESE**	**Total**
			100		100
		Credits: 5			

Course Objectives

1	To analyze/experiment selected research topic further.
2	To review, classify and consolidate observations/results based on the detailed analytical/ experimental work.
3	To document the research work in the prescribed format and present it effectively.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO	**Course Outcome Statement/s**	
CO1	**Apprise** analytical/experimental work in detail for the selected research problem.	Applying
CO2	**Classify** and assess research outcomes critically.	Analysing
CO3	**Compose** and conclude the results for presentation.	Evaluating

Contents

Dissertation Phase 5 will have a presentation based on the progress of work after Phase 4. The presentation should be done after completion of one more objective in continuation with the Phase 4. The research paper based on the completed work through 5 phases should be drafted and submitted to respective guide or communicated to reputed journal or conference.

References

1	National and International journals, Conference Proceedings in Structural Engineering.
2	Technical Reports of Professional societies.
3	International and national codes of Practices and Handbooks.
4	Internet sources and Distance Learning.
5	Published Ph.D. and M. Tech Thesis of Reputed Institutes.

CO-PO Mapping

	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1			2	2		3
CO2			2	2		3
CO3	1		2			2

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

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Course Information	
Programme	M.Tech. (Structural Engineering)
Class, Semester	Second year M. Tech., Semester IV
Course Code	6ST693
Course Name	Dissertation Phase VI
Desired Requisites:	Dissertation Phase V

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	12 Hrs/week	**LA1**	**LA2**	**ESE**	**Total**
				100	100
		Credits: 6			

Course Objectives	
1	To analyze/experiment selected research topic further.
2	To review, classify and consolidate observations/results based on the detailed analytical/ experimental work.
3	To document the research work in the prescribed format and present it effectively.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO	**Course Outcome Statement/s**	
CO1	**Apprise** analytical/experimental work in detail for the selected research problem.	Applying
CO2	**Classify** and assess research outcomes critically.	Analysing
CO3	**Compose** and conclude the results for presentation and dissertation report writing.	Evaluating

Contents

Dissertation Phase 6 will have end semester presentation. End semester presentation will include the presentation based on the entire dissertation work. The external examiner should evaluate the students based on the completion of work, findings of the study, report submission, contributions to the body of knowledge etc.

References

1	National and International journals, Conference Proceedings in Structural Engineering.
2	Technical Reports of Professional societies.
3	International and national codes of Practices and Handbooks.
4	Internet sources and Distance Learning.
5	Published Ph.D. and M. Tech Thesis of Reputed Institutes.

CO-PO Mapping

	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1			2	2		3
CO2			2	2		3
CO3	1		2			2

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

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Course Information

Programme	M.Tech. Civil (Structural Engineering)
Class, Semester	Second year M. Tech., Sem. IV
Course Code	6ST671
Course Name	Internship
Desired Requisites:	Courses of Semester I and II of F. Y. M. Tech (Civil-Structures)

Teaching Scheme		**Examination Scheme (Marks)**			
Interaction	1 Hr/week	**ISE**	**MSE**	**ESE**	**Total**
		100			100
		Credits: 1			

Course Objectives

1	To provide acquaintance of real-life structural engineering problems in industry/society.
2	To provide an opportunity to work in collaborative and professional environment.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	**Demonstrate** knowledge to solve societal problems and apply it for efficient management of projects independently and in teams.	Applying
CO2	**Inspect** structural engineering activities effectively with industry/society and comprehend and write effective reports.	Analysing
CO3	**Integrate** ethical behavior with professional code of conduct and contribute to sustainable societal development.	Analysing

Contents

The objective of internship is to expose the students to industry environment and practices. Students will be sent to leading Structural Engineering organizations or research laboratories or design consultancy organizations to undergo a rigorous training for a minimum period of one month during summer or winter vacation. The evaluation should be carried out through a presentation and a detailed report about the internship.

References

1	
2	

CO-PO Mapping

	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1				2		
CO2		2				
CO3					2	

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.