SCMS SCHOOL OF ENGINEERING AND TECHNOLOGY (AUTONOMOUS)
Vidya Nagar, Palissery, Karukutty, Ernakulam - 683576, Kerala, India.
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SCMS SCHOOL OF ENGINEERING AND TECHNOLOGY (AUTONOMOUS)

VIDYA NAGAR, PALISSERY, KARUKUTTY - 683576

DEPARTMENT OF CIVIL ENGINEERING

2026 Scheme

Syllabus

Semester 1

M.Tech. in Computer Aided Structural Engineering

Branch Code – CECS

SEMESTER 1

Sl.	Slot	Course Code	Type	Cat.	Course Title	Cr.	Hour Structure				Total Hrs.	Marks Distribution		
							L	T	P	SL		CIA	SEE	Total Marks
1	A	261TCECC01	CC	PC	Probability and Statistics	3	45	0	0	45	90	40	60	100
2	B	261TCECS02	PC	PC	Theory of Elasticity	4	45	15	0	60	120	40	60	100
3	C	261TCECS03	PC	PC	Structural Dynamics	4	45	15	0	60	120	40	60	100
4	D	261ECECS1X	PE	PE	Program Elective 1	3	45	0	0	45	90	40	60	100
5	E	261ECECS2X	PE	PE	Program Elective 2	3	45	0	0	45	90	40	60	100
6	F	261TCECC06	CC	SEC	Research Methodology and IPR	2	30	0	0	30	60	40	60	100
7	G	261LCECS07	PCL	PCL	Advanced Structural Engineering Lab	2	0	0	45	15	60	100	0	100
TOTAL						21	255	30	45	300	630			

Course Code	261TCECC1	**Course Name**	Probability and Statistics
Teaching Hours	L:45 T:0 P:0 SL:45	**Course Credits**	3
Continuous Internal Evaluation Marks	40	**Semester End Exam Marks**	60
Exam Hours	2½ Hours	**Total Marks**	100
Course Type	CC	**Course Category**	PC
Prerequisites	Nil		

Preamble

The objective of this course is to expose the students to the fundamental concepts of probability and statistics. The course aims to equip the students to find solutions for many real-world civil engineering problems and to understand basic data analysis tools by applying the principles of statistics.

Course Objectives

1. To introduce students to the fundamental concepts of probability theory and random variables.
2. To familiarize students with statistical techniques such as hypothesis testing, tests of significance, chi-square tests, and the basic concepts of least squares methods.

Course outcomes (CO)

CO#	CO Statement	Knowledge Level
CO1	Create an awareness of the concepts of statistics and probability distributions and explain the characteristics through correlation and regression tools	K2
CO2	Apply probability theory and mathematical expectations to analyze and solve engineering & real-world problems involving uncertainty	K3
CO3	Apply probability distributions to model and solve engineering and real-world problems by selecting appropriate probability distributions.	K3
CO4	Analyze sampling distributions and apply point estimation, confidence interval estimation, and large-sample hypothesis tests for means and proportions to support statistical decision-making in engineering applications.	K4
CO5	Solve the problems on testing of hypothesis on large samples and small samples and fitting of the curves.	K3

Course Syllabus

Module: 1	**Contact Hours: 9**
Elementary Statistics Introduction to statistics- definition-advantages-limitations-frequency distribution tables-Arithmetic mean, median, mode for grouped and ungrouped data-variance, standard deviation, co-efficient of variation. Correlation –properties, correlation co-efficient-Regression-properties-Regression coefficient- relation between correlation co-efficient and Regression co-efficient.	

Module: 2	**Contact Hours: 9**
Probability Theory Probability, probability axioms, addition law and multiplicative law of probability, conditional probability, Baye's theorem, random variables (discrete and continuous), probability density functions, properties, mathematical expectation.	

Module: 3	**Contact Hours: 9**
Random variables & Distributions Probability distribution - Binomial, Poisson approximation to the binomial distribution and normal distribution-their properties-Uniform distribution-exponential distribution.	

Module: 4	**Contact Hours: 9**
Testing of Hypothesis Estimation-parameters, statistics, sampling distribution, point estimation, Formulation of null hypothesis, alternative hypothesis, the critical and acceptance regions, level of significance, two types of errors and power of the test. Large Sample Tests: Test for single proportion, difference of proportions, test for single mean and difference of means. Confidence interval for parameters in one sample and two sample problems	

Module: 5	**Contact Hours: 9**
Testing of significance & Curve fitting Student t-distribution (test for single mean, two means and paired t-test), testing of equality of variances (F-test), $\chi 2$ - test for goodness of fit, $\chi 2$ - test for independence of attributes. Curve Fitting: Fitting of Linear, Quadratic, Exponential curves, least squares method	

Continuous Internal Assessment (CIA)

Micro project/Course based project	CTA	Test paper, 1 no (Test paper shall include minimum 80% of the syllabus)	Total
20	10	10	40

Suggested Assignments for Course Teacher's Assessment (CTA) Through Self-Learning Component:

1. Applications of Probability Distributions in Engineering Problems
2. Binomial, Poisson, and Normal Distributions: Comparative Analysis
3. Hypothesis Testing in Environmental and Civil Engineering Data Analysis
4. Confidence Intervals and Estimation Techniques for Engineering Data
5. Student's t-Test and F-Test in Experimental Data Analysis

Text Books

1. S.C.Gupta and V.K.Kapoor, Fundamentals of Mathematical Statistics, 11th Edition, Sultan
2. Vijay K Rohatgi, Statistical Inference, Aug 2003, Dover Publications Inc. Spivak, M. (2006). *Calculus*. Cambridge University Press.
3. S.P.Gupta, Statistical Methods, 33rd Edition, Sultan Chand & Sons.

Reference Books and Extended Learning

1. Benjamin, Jack.R and Comell.C, Allin, Probability, Statistics and Decision for Civil Engineers, Mc- McGraw-Hill.
2. Ross S Introduction to Probability and Statistics for Engineers and Scientists Elsevier 6th Edition 2021.
3. Johnson RA, Miller I, Freund J. Miller and Freund's Probability and Statistics for Engineers (9th edition) Pearson. 2018.
4. Schiller J, Srinivasan RA, Spiegal M Schaum's Outline of Probability and Statistics, raw Hill

Online repository

1. https://onlinecourses.nptel.ac.in/noc22_ce46

Course Code	261TCECS02	**Course Name**	Theory of Elasticity
Teaching Hours	L:45 T:15 P:0 SL:60	**Course Credits**	4
Continuous Internal Evaluation Marks	40	**Semester End Exam Marks**	60
Exam Hours	2½ Hours	**Total Marks**	100
Course Type	PC (Theory)	**Course Category**	Program Core Course
Prerequisites	Nil		

Preamble

This course advances students from the one-dimensional and linear solid mechanics problems, conventionally treated in courses of strength of materials, into more general, two and three-dimensional problems. Students will be introduced to rectangular and polar coordinate systems to describe stress and strain in an elastic continuum and solve various 2D linear elastic problems.

Course Objectives

1. To introduce and explain the fundamental concepts of elasticity and continuum mechanics to enable students to analyze deformable elastic bodies beyond one-dimensional stress analysis.
2. To guide students in developing stress, strain, and displacement relationships for two- and three-dimensional elastic continua using rectangular and polar coordinate systems.
3. To teach and demonstrate the application of constitutive equations, compatibility conditions, and equilibrium equations for formulating and solving boundary value problems in linear elasticity.
4. To facilitate students' understanding and problem-solving skills in two-dimensional elasticity under plane stress and plane strain conditions using analytical methods such as stress functions and Airy's stress function.

Course Outcomes (COs)

CO#	CO Statement	Knowledge Level
CO1	Explain the fundamental concepts of elasticity, stress, strain, and continuum mechanics for modeling deformable elastic bodies.	K2
CO2	Apply the principles of elasticity to determine stress, strain, and displacement fields in two-and three-dimensional elastic continua using rectangular and polar coordinate systems.	K3
CO3	Formulate and solve boundary value problems by applying equilibrium equations, constitutive relations, and compatibility conditions in linear elasticity.	K3

CO4	Analyze two-dimensional elasticity problems under plane stress and plane strain conditions using stress function methods, including Airy's stress function.	K4
CO5	Evaluate stress and deformation in engineering components subjected to different loading and boundary conditions by selecting appropriate elasticity-based analytical	K4

Course Syllabus

Module: 1	**Contact Hours: 9 Hrs**
Analysis of 3D state of stress : Definition of stress at a point – Notation and sign conventions for stress -Stress tensor - Differential equations of equilibrium and numerical examples-Stress components on an arbitrary plane – stress transformations-Numerical examples on stress transformations and Traction boundary conditions-Principal planes and principal stresses -stress invariants-State of stress referred to the principal coordinate system – stress ellipsoid – octahedral stresses-Maximum shear stress, Hydrostatic and Deviatoric Stress, Numerical examples.	

Module: 2	**Contact Hours: 9 Hrs**
Analysis of 3D state of strain and Constitutive relations: Displacement field and strain field – elementary concept of strain-Strain-displacement relations for small deformations-Compatibility conditions – numerical examples-Strain transformations; Principal strains-Strain invariants, Octahedral strains, Hydrostatic and Deviatoric components of strain -Generalized Hooke's law: Reduction in number of elastic constants: general anisotropy, orthotropy and isotropy.	

Module: 3	**Contact Hours: 9 Hrs**
Boundary value problems of elasticity, energy theorems and failure theories: Boundary value problems of elasticity- Displacement, Traction and Mixed types -Navier equations and Beltrami-Michell's Equations -St. Venant's principle, Uniqueness of solutions -Energy theorems - Strain energy and Complimentary energy -Principle of stationary potential energy and minimum complementary energy-Principle of virtual work for deformable bodies – illustrative examples-Failure theories or Yield criteria: Maximum principle stress theory, Maximum shear stress theory, Maximum normal strain theory -Octahedral shear stress theory, Maximum elastic energy theory, Maximum distortion energy theory.	

Module: 4	**Contact Hours: 9 Hrs**
Two-Dimensional Problems of Elasticity: Plane stress and plane strain problems-Solution of plane problems in rectangular coordinates- stress function approach-Airy's stress function and Biharmonic equation in rectangular coordinates; Solution by polynomials – Numerical examples-Two dimensional problems in polar coordinates - Equations of equilibrium in polar coordinates-Strain displacement,	

compatibility and stress-strain relations in polar coordinates-Stress function approach for solution of 2D problems in polar coordinates- Airy's stress function and Biharmonic equations-Problems of axisymmetric stress distributions- Thick cylinders subjected to internal and external pressures-Stress concentrations due to circular hole in plates.

Module: 5	**Contact Hours: 9 Hrs**
Torsion of noncircular bars: St.Venant's Semi-inverse method- Prandtl's stress function approach-Stress function approach for solution of torsion of bars of elliptical cross section-Stress function approach for solution of torsion of bars with triangular cross section-Prandtl's membrane analogy-Membrane analogy application to prismatic bars of narrow rectangular cross-section and thin-walled open sections-Torsion of thin-walled single cell hollow closed sections-Torsion of thin-walled multiple cell closed sections.	

Continuous Internal Assessment (CIA)

Micro project/Course based project	CTA	Test paper, 1 no (Test paper shall include minimum 80% of the syllabus)	Total
20	10	10	40

Suggested Assignments for Course Teacher's Assessment (CTA) Through Self-Learning Component:

1. Study recent applications of elasticity theory in civil, mechanical, and aerospace engineering (e.g., bridges, dams, pressure vessels, biomedical implants) and prepare a technical report.
2. Solve a two-dimensional elasticity problem using MATLAB, Python, or ANSYS and compare the numerical solution with the analytical solution.
3. Formulate and solve boundary value problems for different loading and support conditions, discussing the assumptions and limitations of linear elasticity.
4. Formulate and solve boundary value problems for different loading and support conditions, discussing the assumptions and limitations of linear elasticity.
5. Select a classical elasticity problem (thick cylinder, rotating disc, cantilever beam, etc.) and derive the stress distribution using Airy's stress function. Present the findings with suitable plots.
6. Analyze the stress distribution in a civil engineering component (e.g., retaining wall, foundation slab, tunnel lining, or pressure pipe) using elasticity concepts and recommend suitable design improvements.

Reference Books and Extended Learning

1. Timoshenko S.P. and J. Goodier, McGraw-Hill.
2. Ugural A. C. and S. K. Fenster, "Advanced Strength and Applied Elasticity", Prentice Hall.
3. Ragab A.R. and S.E. Bayoumi, Engineering Solid Mechanics, Fundamentals and Applications, CRC Press New York.
4. Boresi A.P. and R. J. Shimidt, Advanced Mechanics of Materials, John Wiley & Sons, Pvt.Ltd.
5. Srinath L.S., Advanced Mechanics of Solids, Tata McGraw-Hill publishing company, NewDelhi.
6. Sadd. M., Elasticity: Theory, Applications and Numerics, Elsevier.
7. C. T. Wang, "Applied Elasticity", Mc-Graw Hill Book Company, New York.

Online repository

1. https://nptel.ac.in/courses/105105177

Course Code	261TCECS03	**Course Name**	Structural Dynamics
Teaching Hours	L:45 T:15 P:0 SL:60	**Course Credits**	4
Continuous Internal Evaluation Marks	40	**Semester End Exam Marks**	60
Exam Hours	2½ Hours	**Total Marks**	100
Course Type	PC (Theory)	**Course Category**	Program Core Course
Prerequisites	Nil		

Preamble:
The course provides the basic concepts of structural dynamics and the theoretical background to perform dynamic analysis of structures. The course focuses on analysis of single and multi-degree of freedom systems. An introduction to distributed parameter system is also included. The course also provides an introduction to earthquake analysis of structures.

Course Objectives

1. To introduce the fundamental concepts of structural dynamics and vibration behavior of engineering structures.
2. To develop the ability to formulate mathematical models and equations of motion for single and multi-degree of freedom structural systems.
3. To enable students to analyze the dynamic response of structures subjected to free, forced, and support-induced vibrations.
4. To familiarize students with vibration isolation techniques, distributed parameter systems, and continuous structural vibration analysis.
5. To provide knowledge of different principles and computational methods used in advanced structural dynamic analysis

Course Outcomes (COs)

CO#	CO Statement	Knowledge Level
CO1	Model single and multi-degree freedom systems for dynamic analysis and develop equations of motion.	K2
CO2	Estimate parameters of dynamic systems.	K3
CO3	Perform dynamic analysis of single degree freedom systems.	K3
CO4	Perform dynamic analysis of multi - degree freedom systems	K4

CO5	Analyze and design vibration isolation systems	K4
CO6	Perform dynamic analysis of distributed parameter systems	K4

Course Syllabus

Module: 1	**Contact Hours: 9**
Vibration studies and its importance to structural engineering applications – Types of dynamic loading – Systems with single degree of freedom – Elements of a vibratory system – Mathematical model for single degree of freedom systems - Equation of motion. Variational formulation of the equation of motion – Hamilton's principle - Lagrange's equation. Undamped and damped free vibration of single degree of freedom system. Measurement of damping from free vibration response - Logarithmic decrement.	

Module: 2	**Contact Hours: 11**
Response of single degree of freedom systems to harmonic loading, Measurement of damping from forced response – Half power band width method. Impulse response function, Response of single degree of freedom systems subjected to impulse, periodic and general loading- Duhamel integral. Single degree freedom subjected to support motion. Vibration isolation –Transmissibility.	

Module: 3	**Contact Hours: 8**
Multi-degree of freedom systems – Equation of motion. Shear building concept and models for dynamic analysis –Evaluation of natural frequencies and mode shapes by solution of characteristic equation.	

Module: 4	**Contact Hours: 8**
Forced vibration analysis of multi-degree of freedom systems - Mode superposition method of analysis. Response of multi degree of freedom systems to support motion.	

Module: 5	**Contact Hours: 9**
Distributed mass (continuous) systems – differential equation of motion – Axial vibration of rods. Flexural vibration of beams, natural frequencies and mode shapes of simply supported beam. Evaluation of frequencies and mode shapes of cantilever beam and fixed beam (formulation only).	

Continuous Internal Assessment (CIA)

Micro project/Course based project	CTA	Test paper, 1 no (Test paper shall include minimum 80% of the syllabus	Total
20	10	10	40

Suggested Assignments for Course Teacher's Assessment (CTA) Through Self-Learning Component:

1. Literature Review on Structural Vibrations in Civil Engineering – Conduct a review of at least five recent journal papers (2020 onwards) on dynamic analysis of structures such as buildings, bridges, towers, offshore structures, or wind turbines. Prepare a report highlighting the type of dynamic loading, analytical methods adopted, and key findings.
2. Case Study on Vibration Control Techniques in Structures – Study any two real-world structures where vibration control devices (base isolation, tuned mass dampers, viscous dampers, seismic isolators, etc.) have been implemented. Explain the principle of operation, dynamic behavior, advantages, limitations, and performance improvement using technical references.
3. Computational Modelling and Dynamic Response Analysis – Develop a simple numerical model of a Single Degree of Freedom (SDOF) or Two Degree of Freedom (2DOF) structural system using MATLAB, Python, Excel, or any structural analysis software. Determine the natural frequency, mode shape (if applicable), and dynamic response under harmonic loading or support excitation. Submit the model, plots, and interpretation of results.

Reference Books and Extended Learning

1. Clough R W and Penzien J, Dynamics of Structures, McGraw Hill, New Delhi.
2. Biggs J M, Introduction to Structural dynamics, McGraw Hill, New Delhi.
3. Weaver W, Timoshenko S P, Young D H, Vibration Problems in Engineering, John Wiley & Sons, USA.

Online repository

1. https://nptel.ac.in/courses/105106151
2. https://www.nptel.ac.in/courses/105102688

Course Code	261TCECC06	**Course Name**	Research Methodology and IPR
Teaching Hours	L:30 T:0 P:0 SL:30	**Course Credits**	2
Continuous Internal Evaluation Marks	40	**Semester End Exam Marks**	60
Exam Hours	2½ Hours	**Total Marks**	100
Course Type	CC	**Course Category**	SEC
Prerequisites	Nil		

Preamble

This course introduces the strategies and methods related to scientific research. The students are also trained in the oral presentation with visual aids and writing technical thesis/reports/research papers. The salient aspects of publication and patenting along with the crucial role of ethics in research is discussed.

Course Objectives

1. To enable students to understand the principles of research methodology, literature review, and problem identification in engineering research.
2. To enable students to develop skills in research design, methodology selection, data analysis, and problem-solving approaches.
3. To enable students to acquire effective technical communication skills through presentations, report writing, and documentation of research outcomes.
4. To enable students to understand the process of scholarly publication, intellectual property rights, and innovation through research and patenting.

Course Outcomes (COs)

CO	CO Statement	Knowledge Level
CO1	Approach research projects with enthusiasm and creativity.	K2
CO2	Conduct literature survey and define research problem	K3
CO3	Adopt suitable methodologies for solution of the problem	K3
CO4	Deliver well-structured technical presentations and write technical reports.	K3
CO5	Publish/Patent research outcome.	K3

Course Syllabus

Module: 1	**Contact Hours: 6**

Introduction

Meaning and significance of research, Skills, habits and attitudes for research, Types of research, Characteristics of good research, Research process. Motivation for research: Motivational talks on research: "You and Your Research"- Richard Hamming. Thinking skills: Levels and styles of thinking, commonsense and scientific thinking, examples, logical thinking, division into sub-problems,

verbalization and awareness of scale. Creativity: Some definitions, illustrations from day to day life, intelligence versus creativity, creative process, requirements for creativity

Module: 2	**Contact Hours: 6**

Literature survey and Problem definition

Information gathering – reading, searching and documentation, types of literature. Integration of research literature and identification of research gaps. Attributes and sources of research problems, problem formulation, Research question, multiple approaches to a problem. Problem solving strategies – reformulation or rephrasing, techniques of representation, Importance of graphical representation, examples. Analytical and analogical reasoning, examples, Creative problem solving using Triz, Prescriptions for developing creativity and problem solving.

Module: 3	**Contact Hours: 6**

Experimental and modelling skills

Scientific method, role of hypothesis in experiment, units and dimensions, dependent and independent variables, control in experiment, precision and accuracy, need for precision, definition, detection, estimation and reduction of random errors, statistical treatment of data, definition, detection and elimination of systematic errors. Design of experiments, experimental logic, documentation. Types of models, stages in modelling, curve fitting, the role of approximations, problem representation, logical reasoning, mathematical skills. Continuum/meso/micro scale approaches for numerical simulation, Two case studies illustrating experimental and modelling skills.

Module: 4	**Contact Hours: 6**

Effective communication - oral and written

Examples illustrating the importance of effective communication, stages and dimensions of a communication process. Oral communication –verbal and non-verbal, casual, formal and informal communication, interactive communication, listening, form, content and delivery, various contexts for speaking- conference, seminar etc. Guidelines for preparation of good presentation slides. Written communication – Rules of scientific writing, form, content and language, layout, typography and illustrations, nomenclature, reference and citation styles, contexts for writing – paper, thesis, reports etc. Tools for document preparation-LaTeX. Common errors in typing and documentation.

Module: 5	**Contact Hours:6**

Publication and Patents

Relative importance of various forms of publication, Choice of journal and reviewing process, Stages in the realization of a paper. Research metrics-Journal level, Article level and Author level, Plagiarism and research ethics. Introduction to IPR, Concepts of IPR, Types of IPR. Common rules of IPR practices, Types and Features of IPR Agreement, Trademark. Patents- Concept, Objectives and benefits, features, Patent process – steps and procedures

Continuous Internal Assessment (CIA)

Group Discussion/Literature surveys of suitable topics	CTA	Test paper, 1 no (Test paper shall include minimum 80% of the syllabus)	Total
15	15	10	40

Suggested Assignments for Course Teacher's Assessment (CTA) Through Self-Learning Component:

1. Research ethics and plagiarism prevention
2. Systematic literature review techniques
3. Reference management using Mendeley and Zotero
4. Research problem identification and hypothesis formulation
5. Experimental design and statistical analysis for research
6. Technical paper writing using the IMRAD format
7. Patent search and patent drafting fundamentals
8. AI tools for literature review and research assistance
9. Publishing in indexed journals (Scopus and Web of Science)
10. Research proposal writing and funding opportunities

Text Books

1. E. M. Phillips and D. S. Pugh, "How to get a PhD - a handbook for PhD students and their supervisors", Viva books Pvt Ltd.
2. G. L. Squires, "Practical physics", Cambridge University Press
3. Antony Wilson, Jane Gregory, Steve Miller, Shirley Earl, Handbook of Science Communication, Overseas Press India Pvt Ltd, New Delhi, 1st edition 2005
4. C. R. Kothari, Research Methodology, New Age International, 2004

Reference Books and Extended Learning

1. Panneerselvam, Research Methodology, Prentice Hall of India, New Delhi, 2012.
2. Leedy P. D., Practical Research: Planning and Design, McMillan Publishing Co.
3. Day R. A., How to Write and Publish a Scientific Paper, Cambridge University Press, 1989.
4. William Strunk Jr., Elements of Style, Fingerprint Publishing, 2020

Online repository

1. https://onlinecourses.swayam2.ac.in/e-learning/preview/ntr24_ed08
2. https://nptel.ac.in/courses/121106007

Course Code	261LCECS07	**Course Name**	Advanced Structural Engineering Lab
Teaching Hours	L:0 T:0 P:45 SL:15	**Course Credits**	2
Continuous Internal Evaluation Marks	100	**Semester End Exam Marks**	-
Exam Hours	2½ Hours	**Total Marks**	100
Course Type	PCL (Laboratory)	**Course Category**	Program Core Laboratory Courses
Prerequisites	Nil		

Preamble

To familiarize the students with the different sophisticated instrumentations used in the laboratory and field for measuring/monitoring stress, strain, deflection etc. in structures. New construction materials, their testing and construction practices are introduced. It also provides the students to observe the behaviour of reinforced concrete structural elements and steel sections. It also encompasses to develop a firm foundation for research
and practice in Civil Engineering.

General Instructions to Faculty

1. Any 10 of the 13 experiments included in the list of experiments need to be performed mandatorily. Virtual Lab facility cannot be used to substitute the conduct of these mandatory experiments.
2. Periodic maintenance and calibration of various testing instruments needs to be made.

Course Objectives

1. To acquaint students with the basic properties of construction materials and develop their skills in performing standard tests on concrete, steel, and other engineering materials.
2. To develop the students with the ability to design concrete mixes according to Indian Standards and evaluate the mechanical properties and behavior of concrete, reinforced concrete, and steel structural elements.
3. To familiarize students with modern laboratory instruments and experimental techniques used for testing and analyzing the performance of construction materials and structural members.

Course Outcomes (COs)

CO#	CO Statement	Knowledge Level
CO1	Understand basic test for the materials,	K2
CO2	Compute the mix proportion for various types of concrete as per IS guidelines.	K3
CO3	Evaluate the mechanical properties of concrete	K3
CO4	Analyse the behaviour of reinforced concrete elements.	K4
CO5	Analyse the behaviour of steel members	K4
CO6	Familiarise modern instruments.	K1

Course Syllabus

Mix design of concrete

Material characterisation-Mix design of normal-fibre reinforced and self-compacting concrete as per IS code guidelines.

Study of instruments

Mechanical strain gauges-Electrical strain gauges - Linear variable differential transducer -Hydraulic jack-load cells-indicators-Data logger- crack detection microscope –Nondestructive testing

Testing of Reinforced concrete elements and Structural steel sections

Behaviour of under-reinforced concrete beams under flexure-shear- Behaviour of short reinforced concrete columns under axial compression-Steel bending tests on steel joists-Buckling of steel angles-Torsion of closed and open sections- Behaviour of bolted connections.

List of Experiments

Expt. No.	Title	Hours Allotted
1	Determination of properties of constituent materials in concrete.	3
2	Study on the mix design of normal and high strength concrete as per IS code. Introduction to fibre reinforced concrete.	3
3	Casting of cubes, beams and cylinders with designed normal strength concrete and fibre reinforced concrete.	3
4	Introduction to self-compacting concrete. Study on the mix design and flow properties of self-compacting concrete as per IS code.	3
5	Study on the working of mechanical strain gauges-Electrical strain gauges - Linear variable differential transducer - Hydraulic jack-load cells indicators- crack detection microscope -Data logger	6

6	Behaviour of under-reinforced concrete beams under flexure	3
7	Behaviour of reinforced concrete beams under shear	3
8	Bending tests on steel joists	3
9	Behaviour of short reinforced concrete columns under axial compression	3
10	Buckling of steel angles	3
11	Torsion of closed and open sections	3
12	Behaviour of bolted connections	3
13	Non-destructive testing	6

Continuous Internal Assessment (CIA)

CIA	ESE	Total Marks
100	-	100

Continuous Internal Evaluation Pattern:

The laboratory courses will be having only Continuous Internal Evaluation and carries 100 marks. Final assessment shall be done by two examiners; one examiner will be a senior faculty from the same department.

Reference Books and Extended Learning

1. Pillai S.U &Menon D – Reinforced Concrete Design, Tata McGraw Hill Book Co.,2009.
2. “Concrete Technology”- Neville – Pearson Publishers, 2000
3. Subramanian, N., “Design of Steel Structures”, Oxford University Press.
4. Iyengar, N.G.R., "Elastic Stability of Structural Elements", Macmillan India Ltd.,New Delhi, 2007.
5. IS 456:2000, “PLAIN AND REINFORCED CONCRETE - CODE OF PRACTICE”,Bureau of Indian Standards New Delhi.
6. IS 10262: 2019-Concrete Mix Proportioning-Guidelines.
7. IS 800:2007, “GENERAL CONSTRUCTION IN STEEL - CODE OF PRACTICE”,Bureau of Indian Standards New Delhi.
8. SP 6(1) Hand book for structural Engineers.
9. IS 4000 (1992): Code of practice for high strength bolts in steel structures [CED 7: Structural Engineering and structural section.

PROGRAM ELECTIVE 1

Course Code	261ECECS11	**Course Name**	Advanced Theory and Design of Concrete Structures
Teaching Hours	L:45 T:0 P:0 SL:45	**Course Credits**	3
Continuous Internal Evaluation Marks	40	**Semester End Exam Marks**	60
Exam Hours	2½ Hours	**Total Marks**	100
Course Type	PE (Theory)	**Course Category**	Program Elective
Prerequisites	Nil		

Preamble:
Design of an advanced reinforced concrete structures are one of the primary requisites of any structural engineer. Hence the course aims to provide a detailed theoretical background of various design philosophies and their applications using national and international design guidelines. Therefore, at the end of the course the student is expected to analyse and design various special reinforced concrete structures. The students are also able to apply the knowledge in real civil engineering problems and to design new and advanced reinforced concrete structures.

Course Objectives

1. To enable students to understand the behavior of reinforced concrete members under different loading conditions.
2. To enable students to analyse the design of reinforced concrete beams, deep beams, corbels, and columns using IS and ACI code provisions.
3. To enable students to evaluate the behavior of shear walls, beam-column joints, and other reinforced concrete structural systems.
4. To enable students to apply reinforced concrete design principles and ductile detailing for safe and serviceable structures.

Course Outcomes (COs)

CO	CO Statement	Knowledge Level
CO1	Understand the behaviour of reinforced concrete and its components.	K2
CO2	Familiarise the various advanced reinforced concrete structural elements	K2
CO3	Analyse the various advanced reinforced concrete structural elements.	K4
CO4	Design the advanced reinforced concrete structural elements like deep beam, slender column.	K5
CO5	Design the special reinforced concrete structural elements like beam column joint.	K5

Course Syllabus

Module: 1	**Contact Hours: 9**
Stress-strain characteristics of concrete under single and multi- axial stresses- confined concrete--Effect of cyclic loading on concrete and reinforcing steel- Ultimate Deformation and ductility of members with flexure strength and deformation of members under shear-Moment-curvature relationship of RCC flexural members- Tension stiffening effect of concrete in flexural members, and corresponding equivalent moment of inertia-Codal procedures on immediate and long-term deflections in reinforced concrete beam and slab as per IS.	

Module: 2	**Contact Hours: 9**
Classical theory of cracking-factors affecting crack width-control of cracking- Codal procedures on crack width computation in reinforced concrete beams in flexure as per IS-Inelastic behaviour of reinforced concrete beams – Design of deep beam as per ACI 318 provisions	

Module: 3	**Contact Hours: 9**
Plastic hinge formation-length of plastic hinge-Conditions for moment redistribution-redistribution of moment in reinforced concrete fixed and two span continuous beams (numerical problems). Development-Design methodology- selecting dimensions for struts, tie and nodal zones compression fans- ACI 318 Provisions	

Module: 4	**Contact Hours: 9**
Biaxial bending of columns- interaction diagrams-IS method of design-Analysis and Design of slender RCC columns- Types of shear walls-Loads in shear walls-Principle of shear wall analysis-Distribution of lateral loads in uncoupled shear walls- Equivalent Stiffness Method-Shear Wall Frame Interactions.	

Module: 5	**Contact Hours: 9**
Beam column joint- classification –Type 1 and Type 2 joint- failures in joint-forces acting on joint- Ductile detailing as per IS code- joint shear strength as per ACI 318 code (numerical problem is not required)	

Continuous Internal Assessment (CIA)

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred)	CTA	Test paper, 1 no (Test paper shall include minimum 80% of the syllabus)	Total
15	15	10	40

Suggested Assignments for Course Teacher's Assessment (CTA) Through Self-Learning Component:

1. Analyze the structural behavior and failure of an RCC structure subjected to earthquake or extreme loading conditions.
2. Compare the provisions of IS 456 and ACI 318 for ductile detailing, beam-column joints, or shear wall design.
3. Present recent advancements in reinforced concrete structures, such as high-performance concrete, fiber-reinforced concrete, or seismic-resistant design.
4. Analyze the factors affecting crack width in reinforced concrete beams
5. Prepare interaction diagrams for biaxially loaded reinforced concrete columns.

Reference Books and Extended Learning

1. Varghese P.C, Advanced Reinforced Concrete Design, Prentice Hall of India Pvt Ltd, 2008.
2. Park,R and Paulay T, “Reinforced Concrete Structures”, (John Wiley & Sons, NewYork).
3. Purushothaman.P. “Reinforced Concrete Structural Elements”, Behaviour , Analysis and Design (Tata McGraw Hill 1986)
4. Relevant IS codes (IS 456, IS 13920), ACI 318-11, Building Code Requirements for Structural Concrete and Commentary, ACI Michigan

Online repository

1. https://nptel.ac.in/courses/105106224

Course Code	261ECECS12	**Course Name**	High Rise Buildings
Teaching Hours	L:45 T:0 P:0 SL:45	**Course Credits**	3
Continuous Internal Evaluation Marks	40	**Semester End Exam Marks**	60
Exam Hours	2½ Hours	**Total Marks**	100
Course Type	PE (Theory)	**Course Category**	Program Elective
Prerequisites	Nil		

Preamble

Due to urbanization and lack of land, it has become inevitable to construct high rise structures. This subject will make the students aware of the various structural systems for high rise structures and the suitability of each towards different varying parameters. The course provides the basic principles involved in the design of high-rise structures. Different types of loads acting on a high-rise building are to be discussed after which the structural system required to take these loads are to be dealt with. The methods of analysis of high-rise structure are also to be discussed.

Course Objectives

1. To equip students with the fundamental concepts of design philosophy, design criteria, and structural systems employed in tall buildings.
2. To familiarize students with the characteristics and effects of gravity, wind, and earthquake loads acting on high-rise structures
3. To enable students to select appropriate structural systems and apply modelling and analysis techniques for the design and performance evaluation of tall buildings.

Course Outcomes (COs)

CO#	CO Statement	Knowledge Level
CO1	Describe the design philosophy and design criteria for tall buildings.	K2
CO2	Identify the characteristics of wind and earthquake loads acting on high rise structure.	K2
CO3	Choose and apply appropriate structural systems for different sizes and heights of structures	K3
CO4	Analyse the effect of gravity and lateral loads on structural members of tall structures.	K4
CO5	Analyse the behaviour of different structural forms and systems to carry lateral loads of high-rise structures.	K4
CO6	Apply modelling and analysis methods for high rise buildings.	K3

Course Syllabus

Module: 1	**Contact Hours: 9**
Definition and need of tall building - Historic background – factors affecting growth. Design Criteria, Design Philosophy of High-Rise structures-Materials-Dead and live load, live load reduction techniques.	

Module: 2	**Contact Hours: 9**
Sequential loading, Impact loading-Wind Loading - Wind Characteristics, Static and Dynamic wind effects - Analytical and wind tunnel experimental method-Seismic Loading - Earthquake loading equivalent lateral force method, modal analysis, Introduction to Performance based seismic design.	

Module: 3	**Contact Hours: 9**
Structural form, Floor systems, Rigid frame Structures, rigid frame behavior-Approximate determination of member forces by gravity loading two cycle moment distribution-Approximate determination of member forces by lateral loading- Portal method, Cantilever method.	

Module: 4	**Contact Hours: 9**
Braced frames- Types of bracings-behaviour of bracings, behaviour of braced bents-method of member force analysis method of drift analysis. Infilled frames, behaviour of infilled frames-stresses in infill forces in frame- design of infill and frame (no numerical)- horizontal deflection. Shear wall Structures-behaviour of shear wall structures -proportionate wall systems, non-proportionate wall systems (no analysis required)- horizontal deflection, Coupled shear walls -behaviour of coupled wall structures. Wall frame structures- behaviour of wall frames.	

Module: 5	**Contact Hours: 9**
Tubular structures-framed tube structures-bundled tube structures braced tube structures. Core structures, Outrigger-Braced Structures-Foundations for tall structures-pile foundation-mat foundation-Modelling for analysis for high rise structures – approximate analysis, accurate analysis and reduction technique. Discussion of various Finite Element Packages for the analysis of High-Rise Structures	

Continuous Internal Assessment (CIA)

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred)	CTA	Test paper, 1 no (Test paper shall include minimum 80% of the syllabus)	Total
15	15	10	40

Suggested Assignments for Course Teacher's Assessment (CTA) Through Self-Learning Component:

1. Approximate determination of member forces by lateral loading- Portal method
2. Approximate determination of member forces by lateral loading – Cantilever method
3. Foundations for tall structures-pile foundation-mat foundation

Text Books

1. Bryan Stafford Smith and Alex Coull, Tall Building structures: Analysis and Design, Wiley-Interscience, New York, 1991.
2. Bungale S Taranath, Structural Analysis and Design of Tall Buildings, Tata McGraw Hill,1988.

Reference Books and Extended Learning

1. Robert L Wiegel, Earthquake Engineering. Prentice Hall, 1970.
2. Kolousek V, Pimer M, Fischer O and Naprstek J, Wind effects on Civil Engineering Structures. Elsevier Publications, 1984
3. IS 16700:2017, Criteria for Structural Safety for Tall Concrete Buildings, BIS
4. High Rise Building Structures, Wolfgang Schueller, Wiley
5. Designing and installation of services in building complexes and high rise buildings, Jain,V.K., Khanna Publishers, New Delhi.
6. High rise structures; design and constructions practices for middle level cities, Gupta, Y.P.,New Age International Publishers, New Delhi.

Online repository

1. https://nptel.ac.in/courses/124105002

Course Code	261ECECS13	**Course Name**	Experimental Methods in Structural Engineering
Teaching Hours	L:45 T:0 P:0 SL:45	**Course Credits**	3
Continuous Internal Evaluation Marks	40	**Semester End Exam Marks**	60
Exam Hours	2½ Hours	**Total Marks**	100
Course Type	PE (Theory)	**Course Category**	Program Elective
Prerequisites	Nil		

Preamble

The proposed course is expected to enhance and strengthen the knowledge on conducting laboratory experiments on structures. Purpose and structure of measurement system, strain gauge types, LVDT, photo elasticity, Nondestructive testing methods, Computer based data acquisition systems, Errors in measurement will be discussed.

Course Objectives

1. To familiarize students with the fundamental concepts of measurement systems, transducers, and recording instruments used in experimental stress analysis.
2. To enable students to understand the working principles and applications of strain gauges, force transducers, potentiometers, accelerometers, and non-destructive testing methods.
3. To develop students' ability to apply modern experimental techniques such as photo elasticity and advanced instrumentation for stress and strain analysis in engineering structures.

Course Outcomes (COs)

CO#	CO Statement	Knowledge Level
CO1	Understand characteristics of a measurement system	K2
CO2	Understand working and types of strain gauges and force transducers	K2
CO3	Understand working and types of potentiometers and accelerometers	K2
CO4	Understand different types of Non-destructive testing methods	K2
CO5	Understand the application of Two-dimensional photoelasticity in analysing stress or strain.	K2
CO6	Understand working of recording instruments like chart recorders and CROs.	K2

Course Syllabus

Module: 1	**Contact Hours: 9**
Measurement system: Measurement system – structure, purpose, components-Static Characteristics - Accuracy, Precision, Repeatability /Reproducibility, Threshold-Static Characteristics - Resolution, Sensitivity, Discrimination-Static error, Tolerance-Static Characteristics - Span, Range, Dead space, Hysteresis, Drift, Linearity-Dynamic Characteristics – Fidelity, Dynamic error, speed of response, measuring lag.- zero order, first order and second order instruments, Calibration – Standards and evaluation.	

Module: 2	**Contact Hours: 9**
Measurement of Strain and Force transducers : Strain gauge – Ideal characteristics – Types: Mechanical, Electrical resistance, Optical gauges; Electrical resistance strain gauges: working and types. Gauge materials: foils, backing, adhesives. Gauge construction –gauge factor; Vibrating wire strain gauges- working. Strain gauge bridges – Potentiometric and Wheatstone bridge –strain sensitivity; forms of wheat stone bridge. Strain gauge Rosette – two elements, three elements – rectangular, star- delta. Force transducers: working principle – Load cells: different types. Pressure transducer: working- types.	

Module: 3	**Contact Hours: 8**
Measurement of displacement and acceleration: Potentiometers – principle, working, different types- linear, rotary- Linear variable differential transformer – principle, working, advantages-Accelerometers – Application- Characteristics of Accelerometers-Working of Piezo electric and Piezo resistive accelerometer-Working of Capacitive accelerometer-Working of LVDT Type accelerometer-Working of potentiometric accelerometer-Calibration techniques.	

Module: 4	**Contact Hours: 10**
Non Destructive Testing Methods and Statistical Analysis: Uses- advantages and disadvantages of NDT methods –Ultrasonic pulse velocity Method- principle, working, advantages and disadvantages, correlation of each method with quality of concrete: Hardness methods - Rebound Hammer - principle, working, advantages and disadvantages, correlation of each method with quality of concrete -Core sampling technique- principle, working, advantages and disadvantages, correlation of each method with quality of concrete -Pullout experiment - principle, working, advantages and disadvantages -Detection of embedded reinforcement – acoustic emission and electromagnetic method- principle, advantages, Limitations, application-Errors in measurement: Systematic and Random; Uncertainties in measurement- Types; Normal Distribution-Confidence level- determination.	

Module: 5	**Contact Hours: 9**
Photo elasticity and Indicating & recording elements: Uses of polarised light - Maxwell's stress optic law – Two dimensional photo elasticity- polariscopes – use, components, working and Types. Photo elastic model materials- properties; Isoclinics and Isochromatics – properties. Moire fringe method of stress or strain analysis- techniques and its use. Advantages and disadvantages of Moire fringe method- Chart recorders – Types, working. Cathode ray oscilloscope – principle, components, working. Computer based data acquisition systems – structure and components, working.	

Continuous Internal Assessment (CIA)

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred)	CTA	Test paper, 1 no (Test paper shall include minimum 80% of the syllabus)	Total
15	15	10	40

Suggested Assignments for Course Teacher's Assessment (CTA) Through Self-Learning Component:

1. Conduct a literature survey on commonly used NDT techniques and prepare a technical report highlighting the selection of appropriate NDT methods for different field conditions.
2. Prepare and deliver a seminar on recent advancements in sensor technology, digital instrumentation, smart transducers, wireless sensing, or IoT-based structural health monitoring systems and submit a technical report summarizing the technology, applications, advantages, challenges, and future trends.

Text Books

1. Bently JP - Principles of Measurement Systems – Longman, 1995
2. Nakra B. C. &Chaudhry - Instrumentation Measurement & Analysis - Tata McCraw Hill, 2004

Reference Books and Extended Learning

1. Adams L F - Engineering Measurements and Instrumentation – English University Press, 1975
2. Doebelin E O - Measurement Systems Application & Design - McGraw Hill, 2003
3. Dally JW & Riley WF – Experimental stress Analysis - McGraw Hill, 1991

Online repository

1. https://nptel.ac.in/courses/112106198

Course Code	261ECECS14	**Course Name**	Structural Optimization and Reliability of Structures
Teaching Hours	L:45 T:0 P:0 SL:45	**Course Credits**	3
Continuous Internal Evaluation Marks	40	**Semester End Exam Marks**	60
Exam Hours	2½ Hours	**Total Marks**	100
Course Type	PE (Theory)	**Course Category**	Program Elective
Prerequisites	Nil		

Preamble

Uncertainty is inherent in the design of structural systems, whether it be on the loading front or be on the material strength front or even on the analysis model. Optimization and Reliability techniques help engineers arrive at an optimal design solution for engineering structures in an uncertain environment. This course is designed to introduce structural optimization and structural reliability methods to graduate students. The course, through first two modules introduces conventional techniques as well as genetic algorithm methods for structural optimization application. Modules III & IV covers the elementary probability theory, random variables and univariate and bivariate distributions. Level 2 reliability methods and simulation techniques are introduced in Module V.

Course Objectives

1. To equip students with the knowledge to formulate optimization problems and understand the concepts of uncertainty and reliability in structural engineering.
2. To enable students to apply optimization algorithms and probabilistic methods for solving structural engineering problems involving uncertainty.
3. To develop students' ability to evaluate the reliability of structural systems using reliability analysis methods and simulation techniques.

Course Outcomes (COs)

CO#	CO Statement	Knowledge Level
CO1	Formulate optimization problems in structural engineering	K2
CO2	Apply appropriate algorithms for the solution of optimization problems in structural engineering	K3
CO3	Identify the various sources of uncertainty in variables encountered in structural design / assessment and apply the mathematical theory of probability for modelling uncertainties encountered in engineering systems.	K2
CO4	Evaluate the probability of failure / reliability of structural elements and simple structural components using level 2 reliability methods as well as simulation techniques.	K3

Course Syllabus

Module: 1	**Contact Hours: 8**
Measurement system: Engineering application of Optimization- statement of an optimization problem-Design vector, design constraints, objective function-classification of optimization problems. Classification of optimization problem based on nature of objective function- linear and nonlinear programming problems standard form of linear programming problems. Simplex algorithm-identifying an optimal point-Duality in linear programming, symmetric primal-dual relation. Primal dual relation when the primal is in standard form degeneracy-Application of linear programming in Civil Engineering-Linear programming problem examples on design of tubular column-Limit design of steel portal frames-graphical method of solution.	

Module: 2	**Contact Hours: 10**
Measurement of Strain and Force transducers: Dynamic programming-multistage decision process-conversion of a numerical system in to a serial system-Concept of sub optimization and the principle of optimality-Computational procedure in dynamic programming-Unconstrained minimization problem-solution of an unconstrained geometric programming problem using differential calculus History and development of genetic algorithm-basic concepts biological Background-Genetic modelling-Representation of design variables, objective function and constraints. Creation of off springs-search space binary-encoding-fitness function-Genetic operators-reproduction-roulette wheel selection-cross-over-mutation-Convergence of genetic algorithm. Comparison of Genetic algorithm with other metaheuristic approaches-Solution of constrained optimization problems using genetic- algorithm-Numerical example using genetic algorithm.	

Module: 3	**Contact Hours: 9**
Measurement of displacement and acceleration: Uncertainties in engineering design- sources; Need for reliability analysis; Review of fundamental theory of probability- events & associated probability; Combination of events; De Morgan's rule; Axioms of probability, conditional probability, statistical independence and total probability theorem. Note: examples related to structural engineering for illustration to be given as hand out and discussion on the solved example. Random events and random variables- Probability structure of discrete & continuous random variables-Main descriptors of random variables; Moments of random Variables-Common continuous probability distributions (Continuous & Discrete) - Binomial, Poisson, Exponential, Gamma, Uniform, Normal and lognormal distributions. Note: examples related to structural engineering for illustration to be given as hand out and discussion on the solved example.	

Module: 4	**Contact Hours: 9**
Non Destructive Testing Methods and Statistical Analysis: Joint probability distributions– Discrete random variables (bivariate case) – Marginals and conditional distributions - illustrative examples from	

structural engineering. Joint probability distributions– Continuous random variables (bivariate case) Marginal and conditional distributions- illustrative examples from structural engineering. Correlation and correlation coefficients - discrete and continuous RV case-Functions of random variables- one linear function of multiple random variables – second moment statistics – illustrative examples from structural engineering. Nonlinear function of multiple random variables- second moment statistics - illustrative examples from structural engineering.

Module: 5	**Contact Hours: 9**
Photo elasticity and Indicating & recording elements: Basics of structural reliability- concept of limit states/ performance functions; Space of state variables. Probability failure for performance function involving normally distributed random variables and lognormally distributed random variables. Definition of reliability in standard Normal space (Cornell's reliability index). FORM for linear performance functions-MVFOSM for non-linear performance functions. Hasofer-Lind's definition of reliability. Rackwitz- Feissler algorithm. Second order reliability methods. Simulation based reliability estimation-Monte-Carlo Methods simulation of random numbers with arbitrary distributions – estimation of failure probability.	

Continuous Internal Assessment (CIA)

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred)	CTA	Test paper, 1 no (Test paper shall include minimum 80% of the syllabus)	Total
15	15	10	40

Suggested Assignments for Course Teacher's Assessment (CTA) Through Self-Learning Component:

1. Solve a civil engineering optimization problem (e.g., design of a tubular column or resource allocation problem) using both the graphical method and the simplex algorithm. Interpret the optimal solution and discuss the engineering significance of duality and sensitivity of the solution.
2. Select a structural engineering problem involving uncertainty (e.g., variation in material strength or applied loads) and identify an appropriate probability distribution and prepare a report explaining the probabilistic model, estimation of reliability, and interpretation of engineering decisions based on uncertainty analysis.
3. Prepare and deliver a seminar on any one of the following topics:
    a. Reliability-Based Design Optimization (RBDO)
    b. Metaheuristic Optimization Techniques in Structural Engineering
    c. Monte Carlo Simulation in Structural Reliability
    d. Artificial Intelligence for Structural Optimization
    e. Applications of Genetic Algorithms in Civil Engineering

Text Books

1. Singiresu S. Rao, "Engineering Optimization (Theory and Practice)" 3rd Edition, New Age International (P) Ltd.
2. Kirsch U., "Optimum Structural Design", McGraw Hill
3. Fox R.L., "Optimization Methods for Engineering Design", Addison Wesley

Reference Books and Extended Learning

1. Goldberg D.E., "Genetic Algorithms in Search, Optimisation and Machine Learning",Addison Wesley Publishing Company.
2. Rajasekaran, S. & Vijayalakshmi, G.A., "Neural Networks, Fuzzy Logic and Genetic Algorithms-Synthesis and Applications", PHI Learning Private Ltd, 2012
3. Krishnamoorthy E.V. and Sen S.K., "Numerical Algorithms", Affiliated East West Press
4. Haldar A & Mahadevan S. Probability, Reliability and Statistical Methods in Engineering Design, John Wiley & Sons, Inc. NewYork, 2000
5. Haldar A & Mahadevan S. Reliability Assessment Using Stochastic Finite Element Analysis, John- Wiely & Sons Inc., New York, USA, 2000
6. Ayyub B M, McCuen R H. Probability, Statistics and Reliability for Engineers and Scientists, Chapman & Hall, Florida, USA, 2000.
7. Ang A H S & Tang W H. Probability Concepts in Engineering Planning and Design, Vol I, John Wiley, New York, 1984
8. Nowak A.S. and Collins K.R. Reliability of Structures, McGraw-Hill International Editions, USA, 2000.
9. Papoulis A. Probability, Random Variables and Stochastic Processes, McGraw-Hill, New York, USA, 1991.
10. Ranganathan R. Structural Reliability Analysis & Design. Jaico Publishing House, Mumbai, India, 1999.
11. Melchers R E. Structural Reliability: Analysis and Prediction, John Wiley, Chichester,1999

Online repository

1. https://nptel.ac.in/courses/105103140

PROGRAM ELECTIVE 2

Course Code	261ECECS21	**Course Name**	Advanced Design of Steel Structures
Teaching Hours	L:45 T:0 P:0 SL:45	**Course Credits**	3
Continuous Internal Evaluation Marks	40	**Semester End Exam Marks**	60
Exam Hours	2½ Hours	**Total Marks**	100
Course Type	PE (Theory)	**Course Category**	Program Elective
Prerequisites	Nil		

Preamble:

The proposed course is expected to enhance and strengthen the knowledge on detailed design methods for steel structures, in compliance with Indian and International codes. Analysis and design of bolted and welded connections, Design of steel members under special loads like fire and blast loads, design of industrial structures with gantry girders and design of light gauge structures will be discussed.

Course Objectives

1. To impart advanced knowledge of the analysis and design principles of steel structural members and connections, including bolted and welded joints, in accordance with Indian Standards and relevant international design codes.
2. To enable students to understand and apply the design methodologies for specialized steel structural systems, including light gauge (cold-formed) steel members, industrial buildings with gantry girders, and steel structures subjected to fire and blast loading.
3. To develop students practical skills in the preparation of structural detailing and engineering drawings for steel connections, light gauge steel sections, and industrial steel structures, facilitating their readiness for professional structural engineering practice.

Course Outcomes (COs)

CO	CO Statement	Knowledge Level
CO1	Design bolted joints	K5
CO2	Design of welded joints	K5
CO3	Design light gauge columns, beams, and tension members.	K5
CO4	Understand fire and blast loads	K2
CO5	Understand various elements in an industrial building and Design gantry girders	K3
CO6	Draw structural details of bolted and welded joints, light gauge sections and gantry girder.	K3

Course Syllabus

Module: 1	**Contact Hours: 10**
Bolted Connections: Classification (Simple, Rigid, Semi-rigid)- Moment-rotation-Characteristics-Failure modes of a joint Types of bolts-Bearing and High strength-Bolts-Prying Force-Beam to Column Connections-Design of seat angle-Unstiffened-Design of seat angle-Stiffened Web angle & end plate connections, Beam and column bolted-Splices-continuous beam to beam connection.	

Module: 2	**Contact Hours: 9**
Welded Connections: Structure and properties of weld metal. Beam-to-column-Connections-Angle seat, stiffened beam seat connection-Web angle and end plate-Connections-Beam and column welded splices. Tubular connections-Parameters of an in-plane joint. Welds in tubular joints- Weld defects.	

Module: 3	**Contact Hours: 10**
Design of Light Gauge Structures: Design of light gauge steel structures: Introduction-Types of cross sections-Materials Local and post buckling of thin-Elements-Stiffened and multiple stiffened compression elements -Tension Members-Beams-and deflection of beams.	

Module: 4	**Contact Hours: 8**
Design of Blast, Impact, Snow, and Fire-resistant structures: Blast loads-impact-Loads-Ice-infested loads on structures-Fire loads-Fire-resistant design-Simple problems in-Fire loads calculations.	

Module: 5	**Contact Hours: 8**
Design of Industrial buildings and Gantry girders: Introduction to members subjected to lateral loads and axial loads. Sway and non-sway frames, bracings, and bents Rigid frame joints-Knees for rectangular frames and pitched roofs - Knees with curved flanges Valley joints - Rigid joints in multistorey buildings Vierendeel girders Design of gantry girders-Introduction-Loading consideration-Selection of gantry girder Position of moving load for maximum effects, profile of gantry girder, limitation on vertical deflection Design of gantry girders.	

Continuous Internal Assessment (CIA)

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred)	CTA	Test paper, 1 no (Test paper shall include minimum 80% of the syllabus)	Total
15	15	10	40

Suggested Assignments for Course Teacher's Assessment (CTA) Through Self-Learning Component:

1. Prepare a report highlighting the advantages, limitations, and recent applications of light gauge steel structures in residential, commercial, and industrial buildings.
2. Deliver a seminar and submit a technical report discussing recent research, practical applications, and case studies related to steel structures under extreme loading conditions.
3. Select an existing industrial steel building and identify its structural components, framing system, bracing arrangement, roof trusses, and gantry girders and discuss the structural load path and design considerations adopted in the building.

Text Books

1. Subramanian.N, Design of steel structures, Oxford.

Reference Books

1. Gaylord, Design of steel structures, McGraw Hill, New York.
2. Duggal.S.K., Limit state design of steel structures, McGraw-Hill.
3. Wie-Wen Yu.,Cold-Formed Steel Structures, McGraw Hill Book Company.
4. Hetherington John and Smith P. D., Blast, and ballistic loading of structures.

Online repository

1. https://nptel.ac.in/courses/114106047

Course Code	261ECECS22	**Course Name**	Forensic Engineering and Rehabilitation of Structures
Teaching Hours	L:45 T:0 P:0 SL:45	**Course Credits**	3
Continuous Internal Evaluation Marks	40	**Semester End Exam Marks**	60
Exam Hours	2½ Hours	**Total Marks**	100
Course Type	PE (Theory)	**Course Category**	Program Elective
Prerequisites	Nil		

Preamble

The proposed course is expected to enhance and strengthen the knowledge on role and responsibility of a forensic engineer, different cause of deterioration in structures and its prevention, the uses of different NDT equipment's, awareness regarding the structural health monitoring, knowledge in Different modern techniques of retrofitting will be discussed.

Course Objectives

1. To familiarize students with the role and responsibilities of forensic engineers and the causes of structural deterioration.
2. To enable students to understand the principles and applications of non-destructive testing (NDT) techniques and structural health monitoring systems for the assessment of structures.
3. To develop students knowledge of modern retrofitting and rehabilitation techniques for enhancing the safety and serviceability of existing structures.

Course Outcomes (COs)

CO#	CO Statement	Knowledge Level
CO1	To understand role and responsibility of a forensic engineer	K2
CO2	To understand different cause of deterioration in structures and its prevention	K2
CO3	To gain adequate knowledge for the uses of different NDT equipments	K3
CO4	To get awareness regarding the structural health monitoring	K2
CO5	To gain adequate knowledge in Different modern techniques of retrofitting	K3

Course Syllabus

Module: 1	**Contact Hours: 11**
Failure of Structures: Review of the construction theory – performance problems – responsibility and accountability-Causes of distress in structural members-Design and material deficiencies – over loading.	

Module: 2	**Contact Hours: 8**
Environmental Problems and Natural Hazards: Effect of corrosive, chemical and marine environment - Preventive measures, maintenance and inspection.	

Module: 3	**Contact Hours: 9**
Measurement of displacement and acceleration: Visual inspection – non-destructive tests – ultrasonic pulse velocity method-Rebound hammer technique – pull-out tests – Windsor probe test -Crack detection techniques.	

Module: 4	**Contact Hours: 9**
Structural Health Monitoring: Introduction – Needs and Benefits of Structural Health Monitoring -Fibre Optic method for prediction of structural weakness – Methods of repair of cracks.	

Module: 5	**Contact Hours: 8**
Modern Techniques of Retrofitting: Structural first aid after a disaster – guniting, jacketing – use of chemicals in repair- Strengthening by prestressing. Repair of steel structures.	

Continuous Internal Assessment (CIA)

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred)	CTA	Test paper, 1 no (Test paper shall include minimum 80% of the syllabus)	Total
15	15	10	40

Suggested Assignments for Course Teacher's Assessment (CTA) Through Self-Learning Component:

1. Conduct a case study on the failure of a building, bridge, industrial structure, or other civil engineering structure and identify the causes of failure and recommend suitable preventive measures based on relevant design codes and engineering practices.

2. Conduct a literature review on recent advances in structural rehabilitation adopted worldwide and discuss innovative materials and technologies adopted and prepare a technical report highlighting their potential applications in Indian infrastructure.
3. Study post-disaster structural assessment procedures following earthquakes, floods, cyclones, or fires and explain emergency stabilization measures, structural first aid, and decision-making criteria for repair, retrofitting, or demolition prepare a report supported by relevant case studies.

Text Books

1. Sidney M Johnson, Deterioration, Maintenance and Repairs of Structures, Mc Graw Hill Book Company, New York
2. Concrete Repair and Maintenance, Peter H Emmons, Galgotia Publications, 2010

Reference Books and Extended Learning

1. Dovkaminetzky, Design and Construction Failures, Galgotia Publication., NewDelhi
2. Jacob Field and Kennenth L Carper, Structural Failures, Wiley Europe
3. Concrete – Building Pathology, Macdonald S, John Wiley and Sons, 2002.
4. Forensic Structural Engineering Handbook, Robert. T Ratay, Mc Graw Hill, 2009.
5. Understanding Building Failures, James Douglas and Bill Ransom, Taylor and Francis Group, 2007.

Online repository

1. https://nptel.ac.in/courses/105106202

Course Code	261ECECS23	**Course Name**	Design of Offshore Structures
Teaching Hours	L:45 T:0 P:0 SL:45	**Course Credits**	3
Continuous Internal Evaluation Marks	40	**Semester End Exam Marks**	60
Exam Hours	2½ Hours	**Total Marks**	100
Course Type	PE (Theory)	**Course Category**	Program Elective
Prerequisites	Nil		

Preamble:
The course aims to provide a basic understating of the theory and concepts of analysis and design of Offshore Structures. After the completion of the subject the student is expected to apply the knowledge to design Jacket Platforms which is most relevant for Indian Offshore Region.

Course Objectives

1. To introduce the fundamentals of wave mechanics and environmental loading on offshore structures.
2. To develop the ability to analyse and design fixed offshore jacket platforms under static and dynamic loading conditions.
3. To impart knowledge of the design of steel tubular members and joints in accordance with API code provisions.
4. To enable students to evaluate the fatigue behaviour of offshore structural components and apply engineering principles for safe and efficient offshore structural design.

Course Outcomes (COs)

CO	CO Statement	Knowledge Level
CO1	Understand the basics of wave mechanics and estimate the wave kinematics for regular and random waves	K2
CO2	Estimate the functional and environmental loads acting on offshore structures.	K3
CO3	Apply theoretical principles and analytical models in the design of offshore structures conforming to code provisions	K3
CO4	Design tubular members and joints following API specifications	K5
CO5	Evaluate the fatigue life of Tubular joints of Jacket Platforms	K5
CO6	Practice the profession of Structural engineering with adequate proficiency in analysis and design of Offshore Structures	K5

Course Syllabus

Module: 1	**Contact Hours: 9**
Basics of Wave Mechanics – Introduction to Offshore structures-classification-fixed, compliant-floating platforms-examples- Wave Theories: Basics of wave motion- Small amplitude wave theory- velocity potential- dispersion relationship- wave kinematics- Pressure under wave-wave energy and power (Numerical exercises to be done)- Finite amplitude waves- classification- Random waves-Wave spectral density-Mathematical spectrum models- Design Wave Method-Spectral Method.	

Module: 2	**Contact Hours: 9**
Loads on Offshore Structures- Loads on Off shore Structures: Functional loads- Environmental loads-Wave, Wind, and Current Forces- Estimation as per API recommendations - Morison equation- force on vertical and inclined piles- Numerical examples -Wave forces on large structures-linear diffraction theory.	

Module: 3	**Contact Hours: 9**
Analysis and Design Concepts of Jacket Platforms- Concepts of Fixed Platform Jacket: Components and Funcions, Design Wave Method-Spectral Method- Extreme and Operating Conditions -Estimation of Maximum Wave forces and Moments Maximum Base Shear Method- In-service and Pre-service loads-Principles of Static and dynamic analyses of fixed platforms-In-Place Analysis-Analytical modelling of jacket platforms-deck, jacket and foundation	

Module: 4	**Contact Hours: 9**
Steel Tubular Member Design- Principles of WSD and LRFD; Allowable stresses and Partial Safety Factors API specifications for steel-allowable stresses-Design procedure Tubular Members, Slenderness effects; Column Buckling- Design for Hydrostatic pressure; Design for combined axial and bending stresses (API RP 2A guidelines)-Numerical Examples- Design for Hydrostatic pressure; Design for combined axial and bending stresses (API RP 2A guidelines)-Numerical Examples.	

Module: 5	**Contact Hours: 98**
Fatigue in Tubular Joints - Tubular Joints-Classification-Analysis of Joints- Stress Concentration in Tubular joints, S-N curves-Cumulative damage ratio-Fatigue analysis methods- Palmgren- Miner rule-evaluation of Fatigue life of components-numerical examples	

Continuous Internal Assessment (CIA)

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred)	CTA	Test paper, 1 no (Test paper shall include minimum 80% of the syllabus)	Total
15	15	10	40

Suggested Assignments for Course Teacher's Assessment (CTA) Through Self-Learning Component:

1. Study the different types of offshore structures and prepare a comparative report on their applications, advantages, and limitations.
2. Prepare a report on wave theories and compare linear and nonlinear wave models used in offshore engineering.
3. Conduct a case study on the environmental loads acting on an offshore platform, including wave, wind, and current effects.
4. Prepare a presentation on the components and structural behaviour of fixed jacket platforms.
5. Analyse the influence of extreme and operating environmental conditions on the design of offshore structures.
6. Design a steel tubular member subjected to axial load and bending using API RP 2A provisions.

Reference Books and Extended Learning

1. Dr. Sundar V.," Ocean Wave Mechanics -Applications in Marine Structures" John Wiley and Sons Ltd
2. Chakrabarti,S.K., "Hydrodynamics of Offshore Structures", Computational Mechanics Publications, Southampton, Boston
3. Sreenivasan Chandrasekharan," Dynamic Analysis and Design of Offshore Structures" Second Edition, Springer
4. API-Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms.API-RP2A-WSD (2014)-API-RP2A-LRFD (1993)

Online repository

1. https://nptel.ac.in/courses/114106011

Course Code	261ECECS24	**Course Name**	Analysis and Design of Substructures
Teaching Hours	L:45 T:0 P:0 SL:45	**Course Credits**	3
Continuous Internal Evaluation Marks	40	**Semester End Exam Marks**	60
Exam Hours	2½ Hours	**Total Marks**	100
Course Type	PE (Theory)	**Course Category**	Program Elective
Prerequisites	Nil		

Preamble:

Goal of this course is to expose the students to the concepts of soil structure interaction and design of various sub structures. By completion of this course the students will be able to analyse and design different types of substructures and thereby develop solutions for real world problems.

Course Objectives

1. To impart knowledge of soil–structure interaction and the behaviour of shallow and deep foundation systems.
2. To develop the ability to analyse and design shallow foundations, pile foundations, retaining walls, and well foundations.
3. To introduce the principles of machine foundation design and the effects of dynamic loading and vibration.
4. To enable students to apply geotechnical engineering principles and relevant design standards for safe and economical foundation systems.

Course Outcomes (COs)

CO	CO Statement	Knowledge Level
CO1	Understand the soil-structure interaction	K2
CO2	Analyse and Design shallow foundation	K4
CO3	Design Pile foundation and Pile cap	K5
CO4	Analyse and Design Retaining walls	K4
CO5	Design various components of Well foundation	K5
CO6	Analysis and Design Machine foundation	K4

Course Syllabus

Module: 1	**Contact Hours: 9**
Soil-structure interaction: Introduction to soil-structure interaction - Soil-structure interaction problems. Contact pressure distribution beneath rigid and flexible footing on sand and clay. Contact pressure distribution beneath raft. Selection of foundation. **Shallow foundations:** Structural design of spread footing, combined footing and raft foundation.	

Module: 2	**Contact Hours: 10**
Pile foundation: Introduction- load carrying capacity -Settlement of single pile-Laterally loaded piles-Borm's method-Ultimate lateral resistance of piles- Structural Design of straight Piles and Structural Design of pile cap	

Module: 3	**Contact Hours: 8**
Retaining walls: Types-Stability analysis of cantilever retaining wall against overturning and sliding-Bearing capacity considerations-structural design of retaining walls.	

Module: 4	**Contact Hours: 9**
Well foundation: Introduction to well foundations-Types-Elements of well foundations-Grip length- depth of scour-load carrying capacity-Design of well cap, well steining, well curb, cutting edge and bottom plug.	

Module: 5	**Contact Hours: 9**
Machine foundation: Types of machine foundation-Basic principles of design of machine foundation-Dynamic properties of soil-vibration analysis of machine foundation-Design of foundation for reciprocating machines and impact machines-Vibration isolation	

Continuous Internal Assessment (CIA)

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred)	CTA	Test paper, 1 no (Test paper shall include minimum 80% of the syllabus)	Total
15	15	10	40

Suggested Assignments for Course Teacher's Assessment (CTA) Through Self-Learning Component:

1. Study the types of soil–structure interaction problems and prepare a report on their effects on foundation performance.
2. Design a spread footing for a given loading condition using relevant IS code provisions.
3. Prepare a comparative study of pile foundations, well foundations, and raft foundations with their applications.
4. Analyse the stability of a cantilever retaining wall for a given soil condition.
5. Prepare a case study on the failure of a retaining wall or foundation system and suggest remedial measures.
6. Study the construction procedure and components of well foundations used in bridge engineering.
7. Prepare a report on the methods of pile load testing and interpret sample test results.
8. Investigate the principles of machine foundations and prepare a note on vibration isolation techniques.
9. Collect and present a case study of foundation systems adopted for high-rise buildings, bridges, or industrial structures.
10. Review the latest advancements in deep foundation techniques and ground improvement methods.
11. Prepare a seminar or presentation on innovative foundation construction methods used in challenging soil conditions.

Reference Books and Extended Learning

1. Bowles. J.E., “Foundation Analysis and Design”, McGraww Hill Publishing co., New York, 1997.
2. Swamy Saran, Analysis and Design of substructures, Oxford and IBH Publishing Co.Pvt.Ltd., 2006.
3. Tomilson.M.J, “Foundation Design and Construction”, Longman, Sixth Edition, New Delhi, 2009.
4. Varghese.P.C, “Design of Reinforced Concrete Foundations”-PHI learning private limited, New Delhi-2009

Online repository

1. https://nptel.ac.in/courses/105105176