KERALA TECHNOLOGICAL UNIVERSITY

ERNAKULAM- I CLUSTER

DRAFT

SCHEME AND SYLLABI

FOR

M. Tech. DEGREE PROGRAMME

IN

COMPUTER AIDED STRUCTURAL ENGINEERING

(2015 ADMISSION ONWARDS)

SCHEME AND SYLLABI FOR M. Tech. DEGREE PROGRAMME IN COMPUTER AIDED STRUCTURAL ENGINEERING

SEMESTER-1

Exam Slot	Course No:	Name	L-T -P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
A	06CE6011*	Advanced Structural Design	4-0-0	50	50	3	4
B	06CE6021	Structural Dynamics	4-0-0	50	50	3	4
C	06CE6031	Theory of Elasticity	4-0-0	50	50	3	4
D	06CE6041	Numerical Methods in Civil Engineering	3-0-0	50	50	3	3
E	06CE6X51	Elective – I	3-0-0	50	50	3	3
F	06CE6061**	Research methodology	1-1-0	100	0	0	2
G	06CE6071	Seminar I	0-0-2	100	0	0	2
H	06CE6081	Computer Applications Lab	0-0-2	100	0	0	1

Credits: 23

	Elective I (06CE6X51)
06CE6151	Advanced Analysis of Structures
06CE6251	Soft Computing Tools for Engineering
06CE6351	Random Vibrations

* - Common to Structural Engineering and Construction Management

** - Common to Structural Engineering and Construction Management,

Construction Engineering and Management,

and Geo-Mechanics and Structures.

SEMESTER-II

Exam Slot	Course No:	Name	L- T – P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
A	06CE6012*	Finite Element Analysis	4-0-0	50	50	3	4
B	06CE6022**	Prestressed Concrete	3-0-0	50	50	3	3
C	06CE6032	Theory of Plates and shells	3-0-0	50	50	3	3
D	06CE6X42	Elective II	3-0-0	50	50	3	3
E	06CE6X52	Elective III	3-0-0	50	50	3	3
F	06CE6062	Mini Project	0-0-4	100	0	0	2
G	06CE6072	Structural Engineering Design Studio	0-0-2	100	0	0	1

Credits: 19

Elective II - **(**06CE6X42)		Elective III- (06CE6X52)	
06CE6142***	Bridge Engineering	06CE6152	Structural Stability
06CE6242	Structural Reliability	06CE6252	High Rise Structures
06CE6342	Design of Sub Structures and Offshore Structures	06CE6352	Experimental Stress Analysis

* - Common to Structural Engineering and Construction Management

** - Common to Structural Engineering and Construction Management and Geo-Mechanics and Structures.

*** - Common to Geo-Mechanics and Structures.

SEMESTER-III

Exam Slot	Course No:	Name	L- T – P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
A	06CE7X11	Elective IV	3-0-0	50	50	3	3
B	06CE7X21	Elective V	3-0-0	50	50	3	3
C	06CE7031	Seminar II	0-0-2	100	0	0	2
D	06CE7041	Project(Phase 1)	0-0-8	50	0	0	6

Credits: 14

Elective-IV(06CE7X1)		Elective-V(06CE7X21)	
06CE7111	Advanced Metal Structures	06CE7121	Advanced Concrete Technology
06CE7211	Analysis of Composite Structures	06CE7221	Engineering Fracture Mechanics
06CE7311	Structural Optimization	06CE7321	Forensic Engineering

SEMESTER-IV

Exam Slot	Course No:	Name	L- T – P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
A	06CE7012	Project (Phase 2)	0-0-21	100	0	0	12

Credits: 12

Total Credits for all semesters: 68

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6011	**Advanced Structural Design**	**4-0-0-4**	**2015**
Pre-requisites	**Basic concepts of analysis and design of structures**		

Course Objectives

To instruct the students on

- The concept of yield line and its analysis in structures
- The design aspects for special RC elements
- Concept of earthquake resistant design of structures

Syllabus

Yield line method of analysis of slabs: Characteristic features of yield lines, Design of special RC elements: Design of shear walls (with and without boundary elements), Design of Deep beams, Design of continuous beams Design of flat slabs Concept of Earthquake Resistant Design: Concept of capacity design, Strong Column weak beam. Ductile design - detailing of beams and shear walls. Calculation of Base shear and its distribution by using codal provisions.

Course Outcome

On completion of the course the students shall attain knowledge on the fundamental concepts on the analysis of slabs by yield line theory & design of R.C structures like grid floors, flat slabs, deep beams etc. and also earthquake resistant design of structures and ductile detailing.

Textbooks

1. Krishna Raju N., "Advanced Reinforced Concrete Design", CBS Publishers and distributers, New Delhi.
2. S. K. Duggal, "Earthquake Resistant Design of Structures", Oxford University Press, New Delhi

References

1. P C Varghese, "Limit State Design of concrete structures".
2. Pankaj Agarwal and Manish Shrikhande, "Earthquake Resistant Design of Structures", Prentice Hall of India Private Limited, New Delhi, India.

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I		

Yield line method of analysis of slabs:Characteristic features of yield lines– analysis by virtual work method – Yield line analysis by equilibrium method, Design of grid floor – Approximate method– Rigorous method (Concept only).	13	25
Module II **Design of special RC elements**: Design of shear walls (with and without boundary elements), Design of Deep beams, Design of continuous beams– Redistribution of moments. Design of flat slabs: – Introduction–components–IS Code recommendations– IS code method of design (with and without drop).	15	25
Module III **Concept of Earthquake Resistant Design:** Objectives, Design Philosophy, Limit states, Inertia forces in Structure. Response of Structures – Effect of deformations in structure, Lateral Strength, Stiffness, Damping and ductility. **Building Configurations:** Size of Building, Horizontal and Vertical layout, Vertical irregularities, Adjacency of Building, Open-ground storey and soft storey, short columns. Effect of shear wall on Buildings. **Torsion and Twists in Buildings:** Causes, Effects, Centre of mass and rigidity. , Effect of torsion, Torsionally coupled and uncoupled system, Lateral load distribution, Numerical example based on IS code recommendation.	15	25
Module IV **R.C.C for Earthquake Resistant Structures**: Concept of capacity design, Strong Column weak beam. Ductile design, detailing of beams and shear walls. Calculation of Base shear and its distribution by using codal provision. Detailing of columns and Beam joints. Performance of R.C.C. Building. **Ductiledetailing:-**Study of IS: 13920-1993. **Repair/Reduction of Earthquake Effects**: - Methods, Materials and retrofitting techniques.- Base Isolation and dampers.	13	25
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6021	Structural Dynamics	4-0-0-4	2015

Pre-requisites

- Basic knowledge of Mechanics of Materials
- A slight insight into the concepts of vibrations

Course Objectives
To provide an understanding of how structures vibrate under the influence of different types of dynamic loads.

Syllabus
Dynamic load - Degrees of freedom –Formulation of equations of motion - Natural frequency- -D' Alemberts Principle –Energy principle - Rayleigh's method − Principle of virtual displacements − Hamilton's principle.Single Degree of Freedom Systems -Undamped and damped free and forced vibrations − Vibration isolation − Transmissibility Response to periodic forces- Vibration measuring and absorbing equipments -Duhamel integral for undamped system-Response to impulsive loads–Earthquake excitation- Response history and construction of response spectra-Multiple Degrees of Freedom Systems and Continuous systems -Natural modes − orthogonality conditions − modal Analysis − free and harmonic vibration −Continuous systems- Mode superimposition method- Mode acceleration method Approximate methods Rayleigh's method − Dunkerley's method − Stodola's method − Rayleigh –Ritz method − Matrix method.

Course Outcome
On successful completion of the course the students will be able to

1. Convert any structural system into its equivalent mechanical system
2. Formulate and solve the equation of notion and calculate the structural response
3. Determine the natural frequency by means of analytical and approximate methods

Textbooks
1. Clough & Penzien, "Dynamics of Structures".
2. M.Mukhopadhyay , "Vibrations, Dynamics & Structural systems".

References
1. Timoshenko, "Vibration Problems in Engineering".
2. Anil K Chopra, "Dynamics of structures", Pearson Education

Course Plan

Contents	Contact	Sem.

	Hours	Exam Marks
Module I **Introduction**: Dynamic load - Types of dynamic loading–Significance of structural dynamics in civil engineering practice - Degrees of freedom –Equivalent mechanical systems –Formulation of equations of motion - Natural frequency- Determination of natural frequency-D' Alemberts Principle –Energy principle - Rayleigh's method − Principle of virtual displacements − Hamilton's principle.	10	20
Module II **Single Degree of Freedom Systems:** Undamped and damped free and forced vibrations − Critical damping − Over damping − Under damping − Logarithmic decrement –Energy dissipated in damping-Coulomb damping - Response to harmonic loading − Evaluation of damping − Vibration isolation − Transmissibility Response to periodic forces-Vibration measuring and absorbing equipments -Duhamel integral for undamped system-Response to impulsive loads–Earthquake excitation-Response history and construction of response spectra-Response spectrum characteristics-Base excited systems	16	30
Module III **Multiple Degrees of Freedom Systems and Continuous systems:** MDF sytems - Natural modes − orthogonality conditions − modal Analysis − free and harmonic vibration −Continuous systems- Free longitudinal vibration of bars − Flexural vibration of beams with different end conditions − Forced vibration - Mode superimposition method- Mode acceleration method	16	25
Module IV **Approximate methods:** Rayleigh's method − Dunkerley's method − Stodola's method − Rayleigh –Ritz method − Matrix method.	14	25
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6031	Theory Of Elasticity	4-0-0-4	2015
Pre-requisites	Nil		

Course Objectives

To enable the students to learn

- The fundamentals of stress, strain and displacement relationships, constitutional law, material characterization and Lami's parameters.
- Equilibrium equations, compatibility equations, stress functions, solution of two dimensional problems in Cartesian and polar coordinates.
- Torsion of circular bars.
- Fundamentals of Engineering Theory of Plasticity

Syllabus

Concept of Stress at a point. Strain and displacement. Constitutive equations Generalized Hooke's law. Equations of equilibrium. Compatibility equations. Stress functions. Two dimensional problems in Cartesian and Polar coordinates. Axis symmetrical problems and their solutions. Torsion of non circular bars. Saint Venant's method. Multi cellular sections. Shear flow. Membrane analogy. Enginering theory of plasticity**.** Levy-Misces and Prandtl-Rauss equations. flow rule. Mohr – Coulomb yield criterion for concrete. Yield surface in 3 D space of Principal stresses- Testing of concrete stress strain curve. Flow rule.

Course Outcome

- On successful completion of the course one will be able to apply the principles of theory of elasticity to find solutions to the engineering problems related to the analysis and design of engineering structures and components. The determination of stress distributions will enable him to design satisfactorily the components.
- A student will also be able to use the principles of plasticity to be applied to solve simple problems and to design components.

Textbooks

1. Timoshenko S P and Goodier J. N, "Theory of Elasticity", Tata Mcgraw Hill International Student Edition.
2. Srinath L. S, "Advanced mechanics of solids", Tata McGraw– Hill Publishing Company Ltd., New Delhi**.**

References

1. Akhtar Khan, Sujian Huang "Continuum Theory of Plasticity", Wiley Publications.
2. Wai-Fah Chen, "Plasticity in reinforced concrete", J-Ross Publishing

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I **Theory of Elasticity:** Introduction to ToE-Equilibrium of a body subjected to forces-Continuum-Stress at a point-Stress Tensor-Stress matrix-Notations-Sign Conventions-Traction Vector on an oblique plane with arbitrary orientation-Stress Transformation rule-Normal Stress and Shear stresses on any plane- Principal Stresses and their directions-Stress invariants-Octahedral normal and shear stresses-Spherical and deviatoric stresses-Stress ellipsoid-Cauchy's stress quadric-One sheeted and two sheeted hyperboloids-Transformation equations in two and three dimensions-Mohr's Circle representations-Equilibrium equations(2D and 3D). Introduction to strain-Kinematic or strain displacement equations-Normal strain-Shearing strain-Strain matrix formulation-Displacement components and strain-Pure deformation-Rotation in three dimensions-Principal strains-Strain along a line in terms of components of strain-Strain and rotation rates-Strain transformation rule(3D and 2D Cases)-Strain compatibility equations-physical meaning-Strain measurement-Rosette analysis-Rectangular, Star, Delta rosettes. Material characterization-Typical uniaxial stress strain curve for steel and concrete -Conventional and true values-Generalized Hooke's law-Anisotropic materials-Materials with elastic symmetries-Orthotropic and isotropic cases-Homogeneous materials-Lami's constants -Hooke's law for linear elastic isotropic solids..	18	25
Module II **Two dimensional stress–strain problems in elasticity:** Formulation and method of solutions-Plane stress and plane strain problems–Equations of compatibility in stress- Airy's stress function-Boundary	10	25

conditions-Polynomial solutions-Examples of loaded beams-2D problems in polar coordinates-Axis symmetrical problems-Stress distribution in a hollow cylinder subjected to uniform internal and external pressures-Pure bending of curved bars-Strain components in polar coordinates-Rotating discs-stress components-effects of circular hole on stress distribution of plates-Concentrated force on a straight boundary-Stress function and stress components.		
Module III **Torsion of non-circular straight bars:** Saint Venant's semi inverse method-Assumed displacements-Warping function-Components of stress-Conditions satisfied by warping functions-Determination of stress function and its properties along the boundary of the cross section-Shearing stresses give torque-Solution for elliptic cross section and equilateral triangular cross section-Comparison of a closed tubular section and Slit tubular cross section-Multi cellular sections-Shear flow-Shear stresses-Torque-Membrane analogy and its applications to solution of torsional problems-Stress function contours and warping displacement contours for elliptical and triangular cross sections-Hollow thin walled sections-Shear stress, torque and angle of twist-Very thin rectangular sections-Stress function-Shear Stress-Torque for a composite section.	12	25
Module IV **Engineering theory of plasticity:** Introduction-foundation of plasticity-the criterion of yielding-representation in the principal stress space-the deviatoric stress vector-Tresca and Misces criterion-Plane stress yield locus-Strain hardening postulates-Rule of plastic flow-Plastic potential-Plastic flow rule in the deviatoric plane-Associated flow rule-Stress increment and strain increment vector for a given state of stress-Regular yield surface- singular yield surface-constitutive equations. Levy-Misces and Prandtl-Rauss equations-Geometrical representations for work hardening material-Tresca's associated flow rule-Plastic strain increment vector associated with the Tresca and Misces criteria-Anisotropic flow rule-Uniaxial stress strain cycles in a cyclic hardening material.	16	25

Mohr-Coulomb yield criterion for concrete-Yield surface in 3D space of principal stresses – Drucker- Prager yield surface Mohr – Coulomb strength criterion in the stress space and in the π plane. Testing of concrete – Uniaxial stress-strain curve, pre and post failure regime-Criteria of loading and unloading.-Elastic strain increment tensor-Flow rule- associated and non-associated-Uniqueness of solution and normality condition of flow.		
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6041	Numerical Methods In Civil Engineering	3-0-0-3	2015
Pre-requisites	Nil		

Course Objectives

- To give awareness to different numerical solutions
- To impart ability to apply mathematics for finding solutions to real-time problems

Syllabus

Systems of Linear Equations: Gaussian Elimination - Factorisation - Cholesky's Method. Systems of Non- linear equations:Newton Raphson Method- Newton's Modified Method. Finite difference methods.Initial and Boundary value problems .Eigen value Problems.Numerical Integration.Interpolation: Lagrange – Hermitian and cubic spline methods.Numerical Solution of Partial differential equations: Classification of second order equations – finite difference approximation to partial derivatives – Solution of Laplace equation and solution of wave equation.

Course Outcome

- Understand various computational methods available to solve practical problem
- Enhance the capacity to select appropriate techniques for tackling problems in engineering and science.

Textbooks

1. Krishna Raju N and Muthu K.U "Numerical Methods for Engineering Problems" Maemillan India Limited
2. Grewal B. S, "Numerical Methods in Engineering and Science", Khanna Publications.

References

1. Rajasekaran. S, "Numerical Methods in Science and Engineering – A practical approach", A.H Wheeler & Co.
2. Stanton R.C, "Numerical Methods for Science and Engineering", Prentice Hall ofIndia.
3. Smith G.D "Numerical Solutions for Differential equation".

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I **Systems of Linear Equations**: Gaussian Elimination - Factorisation - Cholesky's Method Systems of Non- linear equations: Newton Raphson Method- Newton's	10	25

Modified Method		
Module II **Finite difference methods:** Forward, Central and Backward differences. Initial and Boundary value problems – statically determinate and indeterminate beam problems- Buckling of columns. **Eigen value Problems**: Power method – Jacobi method	12	25
Module III **Numerical Integration:** Trapezoidal and Simpson's Rules - Gaussian quadrature formula – New mark's Method **Interpolation:** Lagrange – Hermitian and cubic spline methods.	10	25
Module IV **Numerical Solution of Partial differential equations:** Classification of second order equations – finite difference approximation to partial derivatives – Solution of Laplace equation and solution of wave equation.	10	25
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6151	**Advanced Analysis Of Structures**	**3-0-0-3**	**2015**
Pre-requisites	**Nil**		

Course Objectives

To instruct the students on

- The fundamentals of structural analysis and work energy principles
- Concept of matrix analysis of structures
- Advanced methods for the analysis of structures

Syllabus

Review of basic concepts of structural analysis and work energy principles, Stiffness method–coordinate systems–element stiffness matrix. Element approach: Stiffness method – analysis of pin and rigid jointed frames, continuous beams and grids. Direct stiffness approach: analysis of pin jointed frames, continuous beams, Analysis of 2D and 3D truss and frame elements using calculus of variation in finite element method. Flexibility method: analysis of beams & frames (rigid and pin jointed), grids.

Course Outcome

On completion of the course the students shall attain knowledge on the fundamental concepts in the advanced topics in structural analysis. This course is also expected to enable a good understanding of how standard software packages operate.

Textbooks

1. Rajesekharan & Sankarasubramanian,G., “Computational Structural Mechanics”, Prentice Hall of India, 2001.
2. Pandit G.S. and Gupta S.P., “Structural Analysis-A Matrix Approach”, Tata McGraw-Hill PublishingCompany Limited, New Delhi

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References

1. Mukhopadhyay M., “Matrix Finite Element Computer and Structural Analysis”, Oxford & IBH, 1984.
2. Reddy C.S., “Basic Structural Analysis”, Tata McGraw Hill Publishing Co.1996.

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I **Matrix methods**: Classification of structures–discrete structures–		

elements–nodes – Generalised Measurements -Degrees of freedom – static& kinematic indeterminacy Constrained Measurements - Behaviour of structures - Principle of superposition- Stiffness method–coordinate systems–element stiffness matrix	10	25
Module II **Element approach**: Stiffness method – analysis of pin jointed frames (temperature effect, lack of fit), continuous beams (settlement of supports), rigid jointed frames and grids.	10	25
Module III **Direct stiffness approach**: Structure stiffness matrix–assembly–equivalent joint load – incorporation of boundary conditions – solutions–Gauss elimination–matrix inversion– principle of contra-gradience analysis of pin jointed frames, continuous beams. Analysis of framed structure – 2D and 3D truss and frame elements using calculus of variation in finite element method.	12	25
Module IV **Flexibility method**: ElementFlexibility matrix–truss element–beam element–force transformation matrix – equilibrium–compatibility–analysis of beams & frames (rigid and pin jointed), grids	10	25
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6251	**Soft Computing Tools For Engineering**	**3-0-0-3**	**2015**
Pre-requisites	**Nil**		

Course Objectives

To instruct the students on

- The concept of Classical Optimization Techniques
- Engineering applications of Optimization
- Non-Linear Programming
- Optimum design RC, PSC, Steel structural elements

Syllabus

Need for soft computing techniques - components of soft computing, Classical Optimization Techniques: Engineering applications -Linear Programming: Standard form of Linear programming problem, simplex method, revised simplex Method. Non-Linear Programming Stochastic Programming Application Problems: Optimum design RC, PSC, Steel structural elements. Algorithms for optimum designs. Introduction to genetic algorithms: Natural evolution – properties –classification.

Course Outcome

The course will give the students knowledge on the concept of Classical Optimization Techniques, the Engineering applications of Optimization, Linear Programming: Standard form of Linear programming problem, its applications and also Engineering optimization problem solving using genetic algorithm

Textbooks

1. Rao.S.S - Optimization Theory and Applications, Wiley Eastern Limited,1978.
2. Fox.R.L. - Optimization Methods for Engineering Design, Addison Wesley, 1971.

References

1. Stark. R.M. Nicholls.R.L., Mathematical Foundations for Design, McGraw Hill Book Company.
2. Narsingk Deo – System simulation with digital computer, Prentice – Hall of India Pvt, Ltd. New Delhi – 1989.

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I **Introduction**: Need for soft computing techniques - components of soft		

computing, Classical Optimization Techniques: Engineering applications, Statement of optimization problem, Classification of optimization problems, Optimization techniques. Single variable optimization, Multivariable optimization with no constrains, with equality constraints - Lagrange multiplier -method, constrained variation method - and with inequality constraints Kuhn Tucker conditions.	12	25
Module II **Linear Programming:** Standard form of Linear programming problem, simplex method, revised simplex Method. Non-Linear Programming: One dimensional minimization methods, Elimination and Interpolation methods, unconstrained Optimization Techniques, Direct Search methods, Descent Methods, Constrained Optimization Techniques, Direct methods, indirect methods.	12	25
Module III **Stochastic Programming:** For optimization of design of structural elements with random variables. **Application Problems**: Optimum design RC, PSC, Steel structural elements. Algorithms for optimum designs.	8	25
Module IV **Introduction to genetic algorithms:** Natural evolution – properties – classification- GA features – coding – selection – reproduction – cross over and mutation operators - basic GA and structure. Engineering optimization problem solving using genetic algorithm.	10	25
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6351	Random Vibrations	3-0-0-3	2015
Pre-requisites	Nil		

Course Objectives

To instruct the students on

- The concept of Probability Theory & Random variables
- Concepts of stochastic processes & The power spectral density function
- Linear Vibration Analysis

Syllabus

Introduction to Random vibration & probabilistic modeling Axioms of probability theory: probability space & random variables. Probability distributions and density functions of random variables concepts of stochastic processes power spectral density function. Numerical simulation of random processes.Linear Vibration Analysis system response to random excitations.Generalization to multi degree-of-freedom systems.Nonlinear Stochastic Vibration Method of equivalent statistical linearization. State space moment and cumulant equations. State space moment and cumulant equations

Course Outcome

On successful completion of the course the students shall attain knowledge on the concepts of Probability Theory & Random variables, stochastic processes, power spectral density function, probability distributions, moments, correlation and covariance functions, Linear Vibration Analysis- Review of deterministic dynamics and impulse response functions.

Textbooks

1. Nigam N.C, Introduction to random vibration, MIT press, 1983
2. Lin Y.K, Probabilistic theory in structural dynamics, McGraw Hill, 1983

References

1. Bendat J.S and Piersol A.G, Random data analysis and measurement procedure, John Wiley, 2011
2. Clough R.W and Penzien J, Dynamics of structures, McGraw Hill, 1975

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I Probability Theory & Random variables - Introduction to Random vibration & probabilistic modeling. Axioms of probability theory: probability space & random variables. Probability distributions and density functions of random variables, joint and marginal distribution	12	25

and density functions, functions of random variables. Expectations and moments of random variables, Baye's theorem, conditional random variables, conditional expectations. Characteristic functions, moment generating functions, cumulants, relationship between joint probability density functions and characteristic functions, numerical issues, covariance and independence. Sequences of random variables, stochastic convergence, limit theorems.		
Module II Concepts of stochastic processes, probability distributions, moments, correlation and covariance functions The power spectral density function. Stationarity and non-stationarity of stochastic processes, ergodicity of a stochastic process. Limits of a stochastic process, Continuity & Differentiability, stochastic derivatives and integrals. The Fokker-Planck-Kolmogorov equation. Introduction to stochastic calculus. Numerical simulation of random processes.	12	25
Module III Linear Vibration Analysis Review of deterministic dynamics and impulse response functions of systems, system response to random excitations. Response to stationary & weakly stationary excitations and to delta-correlated excitations, Response to Gaussian excitations.Non-stationary excitations.Joint behavior of the time deriative and its response & Markov vector approach.Linear dynamics and harmonic transfer functions.Generalization to multi degree-of-freedom systems.State space formulation of equations of motion.The Fokker-Planck equation for linear systems.	8	25
Module IV Nonlinear Stochastic Vibration The Fokker-Planck equation for sdof systems. The Fokker-Planck equation for mdof systems. Methods for Numerical solutions for the FPK equation: finite difference. Methods for Numerical solutions for the FPK equation: finite element Method. Numerical solutions for the FPK equation: Path integral method. Method of equivalent statistical linearization. State space moment and cumulant equations. State space moment and cumulant equations.	10	25
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6061	Research Methodology	1-1-0-2	2015
Pre-requisites	Nil		

Course Objectives

To teach and make the student aware about the methodology and techniques of doing research both in technology as well as in social sciences.

Syllabus

Objectives and types of research, research methods vs methodology, Different types of research, Research design and execution, Execution of the research, data collection and analysis, Reporting and thesis writing.

Course Outcome

On successful completion of the course the students will be equipped to carry out their research and emanate its outcomes to the outside world.

Textbooks

1. Kothari C.R., Research Methodology, New Age International Publishing.
2. Sam Daniel P. and Aroma G. Sam, Research Methodology, Gyan Publishing House

References

1. Panneerselvam R., Research Methodology, PHI Learning Pvt. Ltd.
2. Bhattacharyya D.K., Research Methodology, Excel Books India.

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I Objectives and types of research, research methods vs methodology; Different types of research, Defining and formulating the research problem, selecting the problem, necessity of defining the problem, importance of literature review in defining a problem, Literature review - primary and secondary data/information sources, reviews, monographs, patents, discussion series, white papers, research databases like CMIE, BB, UNSD etc., critical literature review, identifying gap areas from literature review.	7	25
Module II Research design and execution: Research design – basic principles, need of research design, features of good design, important concepts relating to research design, observation and facts, laws and theories,	7	25

prediction and explanation, development of models		
Module III Execution of the research, data collection and analysis: Aspects of method validation, observation and collection of data, methods of data collection, different sampling methods, data analysis techniques of hypothesis testing, ANOVA, randomized block design (RBD) and completely randomized design (CRD).	7	25
Module IV Reporting and thesis writing: Structure and components of scientific reports, types of report, technical reports and thesis. Different steps in thesis writing, layout, structure and language of typical reports, bibliography, referencing and footnotes. Research ethics – ethical issues, ethical committees, Scholarly publishing – design of research paper, citation and acknowledgement, plagiarism, reproducibility and accountability.	7	25
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6071	**Seminar – I**	**0-0-2-2**	**2015**
Pre-requisites	**Nil**		

Course Objectives

To enable the students to

- refer national & international journals
- interpret the data available and present the same in a systematic manner.

Syllabus

Students have to register for the seminar and select a topic in consultation withany faculty member offering courses for the programme. A detailed write-up onthe topic of the seminar is to be prepared in the prescribed format given by theDepartment. The seminar shall be of 30 minutes duration and a committee withthe Head of the department as the chairman and two faculty members from thedepartment as members shall evaluate the seminar based on the report and coverage of the topic, presentation and ability to answer the questions putforward by the committee.

Course Outcome

- the student will be able to present the seminar in a befitting manner and answer to the queries regarding the selected topic.

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6081	**Computer Applications Lab**	**0-0-2-1**	**2015**
Pre-requisites	**Nil**		

Course Objectives

To instruct the students on

- Practical training related to structural engineering.
- Structural analysis & design software STAAD Pro.
- Structural analysis & design software NISA with emphasis on NISA Civil.

Syllabus

Analysis and design of various structural elements like beams, portal frames , trussesAnalysis and design of framed structures under different loading conditions like Dead Load, Live Load, Wind Load (IS: 875 Part 1 / Part 2 / Part 3), Earth Quake Load (IS: 1893 Part 1) and its Combinations as per codal Provisions

Course Outcome

The student has to practice and attain thorough knowledge on the software packages by solving different types of problems.

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6012	Finite Element Analysis	4-0-0-4	2015
Pre-requisites	Nil		

Course Objectives

To familiarize the students on

- The concept of Basics of finite element method (FEM), Idealization of structures and general procedure of FEA
- Finite Element modeling of one and two dimensional problems.
- Applications of FEM in analysis of trusses Continuous Beam ,Plane Frames etc.

Syllabus

Introduction to FEM - Basic Equations of Solid Mechanics - Different approaches of FEM, Variational principles weighted residual approach and method of virtual work Basics of finite element method (FEM), Idealization of structures -Mathematical model - General procedure of FEA- Shape functions – Lagrange and serendipity elements, Isoparametric elements-Polynomials - Lagrangian and Hermition Interpolation -Convergence criteria - Conforming & nonconforming elements – Patch test. Stiffness matrix - Bar element - Beam element - Plane stress and plane strain and axisymmetric problems static condensation - Isoparametric elements - Numerical Integration.- Gauss- Quadrature ,Analysis of trusses, Finite Element Analysis of Continuous Beam ,Plane Frame Analysis,Analysis of Grid and Space Frame , Introduction to plate and shell elements

Course Outcome

On completion of the course the students shall attain knowledge on the fundamental finite element method (FEM), general procedure, development of stiffness matrices etc.The students shall gain ample knowledge on Finite Element Analysis of Continuous Beam ,Plane Frame Analysis,Analysis of Grid and Space Frame ,plate and shell elements etc.

Textbooks

1. O C Zienkiewicz,.”Finite Element Method”, fifth Edition,McGraw Hill, 2002
2. R.D.Cook, “Concepts and Applications of Finite Element Analysis”, John Wiley & Sons

References

1. C.S.Krishnamoorthy, ”Finite Element Analysis”,Tata McGraw Hill .New Delhi,1987.

2. S.Rajasekharan, "Finite Element Analysis in Engineering Design", S Chand & Co. Ltd.1999

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I **Introduction to FEM** - Basic Equations of Solid Mechanics - Review of equilibrium conditions, Strain-displacement relations, Stress - Strain relations, Plane stress and plane Strain problems, Different approaches of FEM, Direct method, Energy approach, Weighted residual Method; Variational principles weighted residual approach and method of virtual work. Derivation of equilibrium equations. Basics of finite element method (FEM), Idealization of structures - Mathematical model - General procedure of FEA	15	25
Module II **Shape functions** – Lagrange and serendipity elements, Element properties. Finite Element modeling of one and two dimensional problems. Isoparametric elements, four node, eight node elements. Polynomials - Lagrangian and Hermition Interpolation – Generalised coordinates – Natural coordinates - Compatibility - C0 and C1 elements - Convergence criteria - Conforming & nonconforming elements – Patch test.	15	25
Module III **Stiffness matrix** - Bar element - Beam element - Plane stress and plane strain and axisymmetric problems -Triangular elements - Constant Strain Triangle - Linear Strain Triangle – Legrangian and Serendipity elements, static condensation - **Isoparametric elements** - Numerical Integration.- Gauss- Quadrature .	12	25
Module IV Applications of FEM ,Analysis of trusses, Finite Element Analysis of Continuous Beam ,Plane Frame Analysis,Analysis of Grid and Space Frame , Introduction to plate and shell elements-FEM for thin and thick Plates – Shells.	14	25
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6022	Prestressed Concrete	3-0-0-3	2015
Pre-requisites	**Nil**		

Course Objectives

To impart to students

- Basic concept of Prestressing, Analysis of prestress and bending stress
- Design of Pretensioned and Post-Tensioned Flexural Members
- Prestressing of statically indeterminate structures
- Composite construction of Prestressed and in situ Concrete

Syllabus

Basic concept of Prestressing,Systems of Prestressing: - Pre tensioning and Post tensioning, Analysis of prestress and bending stress: - Stress concept, Strength concept-Losses of Prestress .

Deflection of beams Effect of tendon profile on deflections, Prediction of long term Elastic Design: Shear and Torsional Resistance of PSC members Simplified code procedure for bonded and unbonded symmetrical and unsymmetrical sections.Design of sections for flexure: - Expressions for minimum section modulus, Prestressing force and Eccentricity. Limiting zone for prestressingforce.Design of Pretensioned and Post-Tensioned Flexural Members Prestressing of statically indeterminate structures Concept of Linear transformation, Guyon's theorem, Concordant cable profile.End blocks: - Anchorage zone Stresses Composite construction -Tension membersDesign of Special Structures: Design and analysis of post and pre tensioned PSC slabs

Course Outcome

On completion of the course the students shall attain knowledge on analysis and design of prestressed concrete beams(determinate and indeterminate),post tensioned slabs, tension members etc andComprehend the design of various prestressed concrete members used in practice.

Textbooks

1. N. Krishna Raju, "Prestressed concrete", Tata McGraw Hill Publishing Co.Ltd.
2. N. Rajagopal, "Prestressed Concrete", Narosa Publishing House, New Delhi.

References

1. S. Ramamrutham, "Prestressed Concrete", DhanpatRai Publishing Company (P) Ltd.,

New Delhi.

2. Y. Guyon, "Prestressed Concrete", C. R. Books Ltd., London

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I **Introduction:** Basic concept of Prestressing,Systems of Prestressing: - Pre tensioning and Post tensioning, Thermo elastic and Chemical prestressing. Need of high strength concrete and steel, Advantages of prestressed concrete over reinforced concrete., Analysis of prestress and bending stress: - Stress concept, Strength concept: - Pressure line and internal resisting couple and Load balancing concept for extreme fiber stresses for various tendon profile. **Losses of Prestress:** Losses of Prestress:- Stages of losses,Types of losses in pre-tensioning and post-tensioning due to Elastic shortening, Shrinkage, Creep, Relaxation, Anchorage Slip, Friction and Sudden changes in temperature. **Deflection of beams:** Short term, Load deflection curve, Importance of control of deflections, factors influencing deflections, Pre- cracking and Post- cracking, Effect of tendon profile on deflections, Prediction of long term (Concept only,	10	25
Module II **Elastic Design**: Shear and Torsional Resistance of PSC members: - shear and Principal stresses, Ultimate shear resistance of PSC members: - Section cracked and uncracked, Design for shear using IS code. PSC members in torsion:-Pure torsion, Combined bending moment and torsion, Combined bending moment, shear and torsion, modes of failure, Design of reinforcement using IS code provision. Flexuralstrength: - Simplified code procedure for bonded and unbonded symmetrical and unsymmetrical sections. Behavior under flexure: - Codel provision for Limit state design:-Design stress strain curve for concrete. Design of sections for flexure: - Expressions for minimum section modulus, Prestressing force and Eccentricity. Limiting zone for prestressing force. **Design of Pretensioned and Post-Tensioned Flexural Members:**	12	25

Dimensioning of Flexural members, Estimation of Self Weight of Beams, Design of Pre tensioned and Post tensioned members symmetrical about vertical axis..		
Module III **Prestressing of statically indeterminate structures:** Advantages, Effect, Method of achieving continuity, Primary, Secondary and Resultant moments, Pressure line, Concept of Linear transformation, Guyon's theorem, Concordant cable profile. End blocks: - Anchorage zone Stresses, Stress distribution in end block, Methods of investigation, Anchorage zone reinforcements, Design (IS Code method only)	12	25
Module IV **Composite construction of Prestressed and in situ Concrete:** Types, Analysis of stresses, Differential shrinkage, Flexural strength, Shear strength, Design of composite section. **Tension members:** Load factor, Limit state of cracking, Collapse, Design of sections for axial tension. **Design of Special Structures:** Design and analysis of post and pre tensioned PSC slabs, Pipes, Circular water tanks.(Concepts only)	8	25
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6032	Theory Of Plates And Shells	3-0-0-3	2015
Pre-requisites	**Nil**		

Course Objectives

To enable the students to learn

- Classical and modern method of analysis of Love – Kirchhoff theory of thin plates under small deflections.
- Pure bending and symmetrical bending of circular plates.
- Bending of laterally loaded circular plates. Differential Equations.
- Navier and Levy's solutions for simply supported plates.
- Shell theories, shell statics, deformation of shells, Membrane theory of shells,
- Pucher stress function

Syllabus

Pure Bending of Thin Plates, Symmetrical Bending of Circular Plates. Small deflection of laterally loaded plates. Kirchhoff's –Love Theory. Navier and Levy's solutions for rectangular plates.

Shells – Geometrical relations. CODAZZI and GAUSS equations. Gauss curvature. Synclastic and anticlastic surfaces. General Shell classification. Shell theories. Love – Kirchhoff theory.Statics of a shell. Basic equation of doubly curved shell. Stress resultants and moment resultants. Membrane theory of doubly curved shell other than shell of revolutions. Pseudo stress resultant . Shell equations of equilibrium. Pucher stress function and applications.

Course Outcome

On successful completion of the course the student will be able to analyse and design plate structures as well as shell structures. A student is expected to acquire skill in the application of Membrane theory to analyse and design shells of different types like hyperbolic paraboloid, elliptic paraboloid and conoids.

Textbooks

1. Theory of Plates and Shells, Stephen P. Timoshenko, S. WoinowskyKrieger , Tata

McGraw Hills Ltd Publications 2010.

2. Thin Shell Structures- Classical and Modern Analysis, J.N Bandyopadhyay, Hard cover -2007, New Age International Publications

References

1. Design and Construction of Concrete Shell Roofs , G.S Ramaswamy, CBS Publications
2. Thin Plates and Shells, Theory, Analysis and Applications, Edward Ventsel, TheodorKrauthammer.

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I **Plate Theory**: Introduction to Pure Bending of Thin Plates with Small Deflections: Slpoe and curvature of slightly bent plates- Relation between curvature and bending moments in pure bending. Particular cases of pure bending. Symmetrical Bending of Circular Plates:- Differential equation for symmetrical bending of laterally loaded circular plates- Uniformly loaded circular plates- Circular plate with a circular hole at the center- Circular plate concentrically loaded- Circular plate loaded at the center.	10	25
Module II **Small Deflections of Laterally Loaded Plates:** The Differential equation of the deflection surface based on Kirchhoff's -Love hypothesis and assumptions. Boundary conditions – Reduction of the problem of bending of a plate to that of deflection of a membrane. **Simply Supported Rectangular Plates Under Sinusoidal Load:**Navier solution for simply supported rectangular plates. Navier solution for a single load uniformly distributed over the area of a small rectangle (Patch Load). Levy's solution for a simply supported and uniformly loaded rectangular plate. Simply supported rectangular plates under hydrostatic pressure.	8	25
Module III	9	25

Shell Theory: Introduction to the General Shell Theory: Examples of shell structures in engineering and other fields- Advantages of Shell forms- General definitions and fundamentals. Classifications- Thin shells – Linear shell theories- Love- Kirchhoff hypothesis- First order,second order approximation theories – improved theories- subsequent development of general nonlinear theories and specialized shell theories – shallow shells- Membrane or momentless state of stress. The highest efficiency of a shell as a structural member is associated with its thinness and curvature. **Statics of a shell:**Hookes law for thin shell – Differential element isolated from a shell by means of four sections normal to its middle surface and tangential to the lines α and α + dα , β and β + dβ. Stress resultants and Couples – Equilibrium of shell element – Six equations of equilibrium (reduced to 5 with 8 unknowns)- Reduced to three equations of equilibrium- Expressions for stress resultants and stress couples in terms of strains and curvatures. **Folded Plates:** Classifications, applications – analysis methods		
Module IV **Deformation of Sells:** Definitions and notations- Stress resultants and moment resultants – Bending strain considering the unit elongation of a thin lamina at a distance from the middle surface – Considering radii of curvature after deformation and stretching of the middle surface – Resultant forces per unit length and moment resultants in terms of the three components of the strains of the middle surface and three quantities representing the changes of curvature and the twist of the middle surface. Discussion on deformation of shells where bending stresses can be neglected and membrane theory can be accepted. Shells in the form of surface of revolution and loaded symmetrically with respect to their axis: Particular cases of shell in the form of surface of revolution – Spherical Dome. Membrane Theory of Cylindrical Shells: Equations of equilibrium and	15	25

solutions. **Membrane Theory of Shells of Double Curvature other than Shells of Revolution :** Geometrical relations – Radius vector of a point on a surface given in the form $z = f(x,y)$ – Area of element – the first and second quadratic forms- Equations of CODAZZI and GAUSS. Principal curvatures – Gauss curvature. Synclastic , developable or anticlastic surfaces. **Pseudo stress resultant:** Equations of equilibrium – Reduction of three equations of equilibrium to a single differential equation by introducing a stress function as suggested by Pucher . A shell in the form of an Elliptic Paraboloid – A shell in the form of a Hyperbolic Paraboloid.		
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6142	Bridge Engineering	3-0-0-3	2015
Pre-requisites	**Nil**		

Course Objectives

To instruct the students on

- The basic concepts in planning of bridges in terms of geographical location and functionality
- The design of various types of bridges
- The design aspects of bearings ,substructure and foundation
- Construction methods and rehabilitation of bridges

Syllabus

Planning of bridges:– selection of site, design of right, skew and curved slab bridges. Design of girder bridges, balanced cantilever bridges- pre stressed concrete bridges. Design of elastomeric bearings, Substructure design– piers and abutments, Bridge foundations design. Design of composite bridges (steel & concrete).Major construction methods and maintenance and rehabilitation of bridges.

Course Outcome

On completion of the course the students shall attain knowledge on the basic concepts in proportioning and design of various types of bridges, helps to determine the actions to be considered for the design of bridge according to IRC codes, and the design of substructure and foundations for the bridge.

Textbooks

1. Krishna Raju N (1996), "Design of Bridges", TataMcGrawHill, publishing company, New Delhi.
2. Victor D.J (19991), "Essentials of Bridge Engineering", Oxford & IBH publishing company, New Delhi.

References

1. Ponnuswami S (1993), "Bridge Engineering", Tata Mc–GrawHill, publishing company, New Delhi.
2. Raina V.K (1988), "Concrete Bridge Practice– Construction Maintenance &Rehabilitation", Tata Mc–GrawHill, publishing company, New Delhi

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I **Planning of bridges:** Investigation for bridges– selection of site. Design of RCC bridges– IRC loading– types of bridges– components of bridges– analysis and design of right, skew and curved slab bridges.	12	25
Module II **Design of girder bridges:**T-beam bridges– Analysis and design of deck slab, longitudinal girders and cross girders–Pigeaud's method– Courbon's method– Morice and Little method– Hendry–Jaegar method– grillage analogy method- balanced cantilever bridges- prestressed concrete bridges(simply supported case only).	12	25
Module III **Bearings:**importance of bearings– bearings for slab bridges– bearings for girder bridges–Design of elastomeric bearings –Joints –Appurtenances.Substructure- different types- materials for piers and abutments- Forces on piers and abutments- substructure design– piers and abutments and approach structures - Bridge foundations - open, pile, well and caisson.	10	25
Module IV **Design of composite bridges (steel & concrete):**Introduction to analysis and design of long span bridges like suspension and cable stayed bridges. Major construction methods and maintenance and rehabilitation of bridges.	8	25

End Semester Exam

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6242	Structural Reliability	3-0-0-3	2015
Pre-requisites	Nil		

Course Objectives

To instruct the students on

- Basic Concepts of structural safety
- Probability theory, resistance distribution and parameters-statistics of properties of concrete and steel, strength of bricks and mortar
- Probabilistic analysis of loads, Basic structural reliability

Syllabus

Concepts of structural safety-histograms-sample correlation, Probability theory, resistance distribution and parameters-statistics of properties of concrete and steel, characterisation of variables of compressive strength of concrete in structures Probabilistic analysis of loads Wind load-introduction-wind speed-return period, Basic structural reliability computation of structural reliability. Monte carlo study of structural safety and applications, Level-2 Reliability method: - Introduction-basic variables and failure surface

Course Outcome

Students, on completion of the course will have the understanding on basic Concepts of structural safety, Probability theory, resistance distribution and parameters, dimensional variations, characterisation of variables of compressive strength of concrete in structures, yield strength of concrete in structures and yield strength of steel. Probabilistic analysis of loads: - Gravity load, Wind load, probability model of wind load and Basic structural reliability.

Textbooks

1. NobrertLlyd Enrick, "Quality control and reliability", Industrial press New York.
2. A K Govil, "Reliability engineering", Tata McGraw Hill, New Delhi..

References

1. Alexander M Mood, "Introduction to the theory of statistics", McGraw Hill, Kogakusha Ltd.
2. Ranganathan, "Reliability of structures".

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I **Concepts of structural safety**:-Basic statistics:-Introduction-data reduction-histograms-sample correlation.	8	25
Module II **Probability theory, resistance distribution and parameters:-** Introduction- statistics of properties of concrete and steel, statistics of strength of bricks and mortar, dimensional variations-characterisation of variables of compressive strength of concrete in structures and yield strength of concrete in structures and yield strength of steel – allowable stresses based on specified reliability.	14	25
Module III **Probabilistic analysis of loads: -** Gravity load-introduction-load as a stochastic process. Wind load-introduction-wind speed-return period-estimation of lifetime wind speed-probability model of wind load. **Basic structural reliability**: - Introduction-computation of structural reliability. Monte carlo study of structural safety and applications	12	25
Module IV **Level-2 Reliability method: -** Introduction-basic variables and failure surface-first order second moment methods like Hasofer and Linds method-nonnormal distributions-determination of B for present design-correlated variables.	8	25

End Semester Exam

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6342	Design Of Sub Structures	3-0-0-3	2015
Pre-requisites	Nil		

Course Objectives

To give the students an understanding on

- Ability to identify the soil-structure interaction
- Ability to select suitable foundation for different types of structures
- Should be able to analyse and design substructures

Syllabus

Soil -Structure Interaction Contact pressure distribution beneath rigid and flexible footings Principles of design of foundations for reciprocating and impact type of machine –Vibration isolation – types and methods of isolation – isolating materials and their properties. Foundations in Expansive soils Bearing capacity of Footings subjected to Eccentric and Inclined Loading –Design of spread footing, column footing,combined footing. Mat foundations on cohesive and cohesion less soilPile Foundations Pile Groups –Efficiency of pile groups – Laterally loaded piles –Pile-raft system-Caissons and well foundations -Design Criteria

Course Outcome

- Basic understanding of type and selection of foundations
- To analyse and design foundations

Textbooks

1. Soil Mechanics & Foundation Engineering by B.C. Punmia.
2. Vibration of Soils & Foundations – Richant Hall & Woods.

References

1. Analysis and Design of Substructures – Swami Saran
2. Donald P. Coduto, Foundation Design: Principles and Practices, Dorling Kinderseley

(India) Pvt. Ltd., 2012

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I Soil -Structure Interaction **-** Introduction to Soil -Structure interaction problems -Contact pressure distribution – factors influencing Contact pressure distribution beneath rigid and flexible footings contact pressure distribution beneath rafts – concentrically and eccentrically loaded Principles of design of foundations for reciprocating and impact type of machine – as per I.S. Codes. Vibration isolation – types and methods of isolation – isolating materials and their properties Foundations in Expansive soils – Problems in Expansive soils – Mechanism of swelling – Swell Pressure and Swelling potential – Heave foundation practices – Sand cushion – CNS cushion – under – reamed pile Foundations – Granular pile – anchor technique, stabilization of expansive soils.	14	25
Module II Bearing capacity of Footings subjected to Eccentric and Inclined Loading – Meyrhoff's and Hanse's theories – elastic settlement of Footings embedded in sands and clays of Infinite thickness – Footings on soils of Finite thickness-Schmertamaunn's method, Jaubu and Morgenstern method Bearing capacity of foundation based on in-situ tests. Design of spread footing, column footing , combined footing. Mat foundations on cohesive and cohesion less soil- rigid beam analysis- Winkler model	10	25
Module III Pile Foundations - Introduction – Estimation of pile capacity by static and dynamic formulae – Wave equation method of analysis of pile resistance – Load -Transfer method of estimating pile capacity – Settlement of single pile – Elastic methods. Pile Groups – Consideration regarding spacing – Efficiency of pile	10	25

groups – Stresses on underlying soil strata – Approximate analysis of pile groups –Settlement of pile groups- Pile caps –Pile load tests – Negative skin friction, Under reamed piles.		
Module IV Laterally loaded piles – Modulus of sub grade reaction method – ultimate lateral resistance of piles. Load deflection prediction for laterally loaded piles, Subgrade reaction and elastic analysis, Interaction analysis, Pile-raft system, Solutions through influence charts Caissons and well foundations : Types of caissons – well foundation Different shapes of wells – Components of wells – functions and Design – Design Criteria – Sinking of wells – lateral stability by Terzaghi's analysis.	8	25
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6152	**Structural Stability**	**3-0-0-3**	**2015**
Pre-requisites	• Basic knowledge of Strength of Materials • Basic understanding of buckling, crushing and crippling		

Course Objectives

- To impart the need for stability concepts
- To explain buckling
- To demonstrate the critical load computations on different structural members using analytical, approximate and numerical methods

Syllabus

Introduction to stability analysis:–Stable, unstable and neutral equilibrium–Stability Criteria.– Euler's theory–assumptions and limitations - Energy approach and principles-Approximate methods-Rayleigh Ritz–Galerkin's method. General treatment of column:- Stability problem as an Eigen value problem–Short and long columns - Elastic instability of columns Stability of Beam columns:–Beam column equation– Energy method – Solutions for various end conditions–Stability of Frames:-Buckling of frames with and without sway for fixed and hinged end conditions-Energy approach Stability of plates:–Inplane and lateral loads–Introduction to torsional buckling, lateral buckling and inelastic buckling. Finite element application to stability analysis– Finite element stability analysis–Element stiffness matrix – Derivation of element stiffness matrix and geometric stiffness matrix for a beam element.

Course Outcome

On the successful completion of the course students are expected to

- Understand the physical interpretation of buckling
- Compute critical load on columns, beam columns, frames and plates
- Use equilibrium, energy, approximate and numerical methods for the computation of critical loads

Textbooks

1. Ziegler H, “Principles of structural stability”, Blarsdell, Wallham, Mass, 1963.
2. Thompson J M, G W Hunt, “General stability of elastic stability”, Wiley,New York.
3. Timoshenko, Gere, “Theory of elastic stability”, McGraw Hill, New York.

References

1. Don O Brush, B O OAlmorth, Buckling of Bars, plates and shells,
2. Cox H L, The buckling of plates and shells, Macmillam, New York, 1963.
3. O C Zienkiewicz ,.Finite Element Method ,fourth Edition,McGraw Hill.

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I **Introduction to stability analysis:**–Stable, unstable and neutral equilibrium–Stability Criteria. Fourth order Elastica – large deflection of bars differential equation for generalized bending problems–Euler’s theory–assumptions and limitations -Introduction to methods for the determination of buckling loads on columns – Moment equilibrium method-Fourth order elastica - Energy approach and principles-Approximate methods-Rayleigh Ritz–Galerikin’s method.	14	25
Module II **General treatment of column:-** Stability problem as an Eigen value problem–Short and long colummns - Elastic instability of columns - Various modes of failure for various end conditions– both ends hinged–both ends fixed–one end fixed other end free– one end fixed other end hinged–Energy approach.	14	25
Module III **Stability of Beam columns:**–Beam column equation–Solution of differential equation for various lateral loads–udl and concentrated loads– Energy method – Solutions for various end conditions–bottom fixed– bottom hinged –Horizontal compression members- **Stability of Frames**:-Buckling of frames with and without sway for fixed and hinged end conditions-Energy approach	16	30
Module IV **Stability of plates:–**Inplane and lateral loads– Boundary conditions–		

Critical buckling pressure–Aspect ratio – Introduction to torsional buckling, lateral buckling and inelastic buckling. **Finite element application to stability analysis**– Finite element stability analysis–Element stiffness matrix –Geometric stiffness matrix–Derivation of element stiffness matrix and geometric stiffness matrix for a beam element.	12	20
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6252	**High Rise Structures**	**3-0-0-3**	**2015**
Pre-requisites	**Nil**		

Course Objectives

- To impart the ability to identify the structural systems for various combinations of gravity and horizontal loading considering their functional use and heights.
- To analyse the behaviour and drift capacities of various high rise structuralforms

Syllabus

Design Criteria, Design Philosophy of High Rise structures, Loading –gravity loading- Dead and live load, live load reduction techniques-sequential loading, Impact loading,Wind Loading, Earthquake loading- Introduction to Performance based seismic design.Structural form, Floor systems, Rigid frame Structures- Determination of member forces by lateral loading- Braced frames- Infilled frames -Shear wall Structures- Wall frame structures- behaviour of wall frames,

Tubular structures-framed tube structures-bundled tube structures-braced tube structures, Core structures, Outrigger-Braced Structures,foundations for tall structures-Modelling for analysis for high rise structures – Design for differential movement, creep and shrinkage effects, temperature effects and fire resistance

Course Outcome

On the successful completion of the course students are expected to

- Understand behaviour of common high rise structures under gravity and lateral loading
- Understand the drift capabilities of different structural forms

Textbooks

1. Beedle.L.S., "Advances in Tall Buildings", CBS Publishers and Distributors, Delhi, 1986.
2. Bungale S Taranath, Structural Analysis and Design of Tall Buildings, Tata McGraw

Hill,1988.

References

1. Gupta.Y.P.,(Editor), Proceedings of National Seminar on High Rise Structures - Design and Construction Practices for Middle Level Cities, New Age International Limited, New Delhi,1995.
2. Lin T.Y and Stotes Burry D, "Structural Concepts and systems for Architects and Engineers", John Wiley, 1988.

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I Definition of tall building-need for constructing tall building-Historic background-factors affecting growth. Design Criteria, Design Philosophy of High Rise structures, Materials Loading –gravity loading- Dead and live load, live load reduction techniques-sequential loading, Impact loading, Wind Loading, Wind Characteristics, Static and Dynamic wind effects, Analytical and wind tunnel experimental method, Earthquake loading-equivalent lateral force method, modal analysis,Introduction to Performance based seismic design..	14	25
Module II Structural form, Floor systems, Rigid frame Structures- rigid frame behaviour –approximate determination of member forces by gravity loading- two cycle moment distribution, approximate Determination of member forces by lateral loading- Portal method, Cantilever method, approximate analysis of drift, 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- design of frame- horizontal deflection.	10	25
Module III Shear wall Structures-behaviour of shear wall structures-proportionate wall systems, non proportionate wall systems- horizontal deflection, Coupled shear walls-behaviour of coupled wall structures-method of	8	25

analysis, Wall frame structures- behaviour of wall frames, Tubular structures-framed tube structures-bundled tube structures-braced tube structures, Core structures, Outrigger-Braced Structures,		
Module IV Foundations for tall structures-pile foundation-mat foundation, Modelling for analysis for high rise structures – approximate analysis, accurate analysis and reduction techniques, Design for differential movement, creep and shrinkage effects, temperature effects and fire resistance,Discussion of various Finite Element Packages for the analysis of High Rise Structures.	10	25
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6352	Experimental Stress Analysis	3-0-0-3	2015
Pre-requisites	Nil		

Course Objectives

- To impart the basic knowledge to design experiments related to stress analysis problems
- To familiarize the methodology for conducting laboratory and field experiments
- To Analyse and interpret experimental observations and results

Syllabus

The measurement system: Purpose Structure and Elements Dynamic Characteristics – zero order, first order and second order instruments. Measurement of Strain: Electrical resistance strain gauges - strain gauge bridges - Load cells different types – design of force transducers; Force balance pressure gauges –Potentiometers – different types; Linear variable differential transformer – principle and working. Accelerometers - Photo elasticity- Two dimensional photo elasticity. Moire fringe method- Non Destructive Testing Methods: Ultrasonic Methods; Hardness methods-Computer based data acquisition systems-Multi-Scale Analysis in Experimental Mechanics

Course Outcome

Capability to provide suitable instrumentation for conducting experiments , Acquire capacity to organize laboratory experiments for project and thesis works ,Building capacity to conduct destructive and non-destructive experiments as a practicing engineer.

Textbooks

1. Dally JW & Riley WF – Experimental stress Analysis - McGraw Hill, 1991
2. L.S.Srinath, M.R. Raghavan,K. Lingaiah, G. Gargesa,B.Pant, and K. Ramachandra, Experimental Stress Analysis, Tata McGraw Hill, 1984

References

1. Nakra B.C & Chaudhry - Instrumentation Measurement & Analysis - Tata McCraw

Hill, 2004

2. Adams L F - Engineering Measurements and Instrumentation – English University Press, 1975.

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I The measurement system: Purpose Structure and Elements - Characteristics of measurement system - Accuracy, Precision, Repeatability; Calibration – Standards and evaluation; Dynamic Characteristics – zero order, first order and second order instruments. Measurement of Strain: Electrical resistance strain gauges - Gauge materials - gauge construction – gauge factor; Vibrating wire strain gauges ; strain gauge bridges – Potentiometric and Wheatstone bridge - sensitivity Force transducers: Load cells different types – design of force transducers; Force balance pressure gauges – construction - sensitivity. Measurement of displacement: Potentiometers – different types; Linear variable differential transformer – principle and working.	14	25
Module II Measurement of acceleration: Accelerometers - Characteristics of Accelerometers – typesdesign of accelerometers – calibration techniques - Integration technique for displacement from acceleration. Photo elasticity- use of polarised light - Maxwell's law - polariscopes and their use; Photoelastic model materials ; Two dimensional photo elasticity - analysis and reduction of data. Moire fringe method- techniques and its use..	12	25
Module III Non Destructive Testing Methods: Ultrasonic Methods; Hardness methods - Rebound Hammer ; Core sampling technique; Pullout experiment; Detection of embedded reinforcement . Indicating & recording elements – Chart recorders – Cathode ray oscilloscope; Computer based data acquisition systems – structure and components. Statistical Analysis - Errors in measurement - best estimate of true	8	25

value Normal Distribution - Confidence level.		
Module IV Multi-Scale Analysis in Experimental Mechanics Trends in experimental mechanics, Discussion on selection of an experimental technique, Selection of an Experimental Technique Discussion on selection of an experimental technique contd., Review of solid mechanics, definition of free surface, ambiguity in associating the correct value of principal stress direction to the magnitude of the principal stress, Eigen value approach or use of Mohr's circle,Shear distribution in a three point bend specimen.	8	25
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6062	Mini Project	0-0-4-2	2015
Pre-requisites	STAAD Pro.,SAP 2000,NISA		

Course Objectives

To give the students an understanding on effective use of a suitable design/analysis software package.

Syllabus

During the course of the second semester each student is expected to do a mini project. The student can execute this project by effective use of a suitable design/analysis software package. This may be as far as possible, a software studied as part of the curriculum or any other suitable package. In any case, at the end of the mini project the student should be well versed with the different aspects of the software. Each student must keep a project notebook, which shall be checked periodically throughout the semester, as part of evaluation. At the end of the training student shall submit a report in the prescribed format to the department.

Course Outcome

After the successful completion of the mini project, the students should be capable of conducting the analysis and design of structures and be well versed in the software package chosen.

<table>
<tr><th>Course No.</th><th>Course Title</th><th>L-T-P-Credits</th><th>Year of Introduction</th></tr>
<tr><td>06CE6072</td><td>Structural Engineering Design Studio</td><td>0-0-2-1</td><td>2015</td></tr>
<tr><td>Pre-requisites</td><td colspan="3">Nil</td></tr>
<tr><td colspan="4">Course Objectives
To instruct the students on
• Practical training related to structural engineering.
• Ability to solve stress analysis problems.
• Structural analysis & design software SAP2000& ANSYS</td></tr>
<tr><td colspan="4">Syllabus
Linear Static Analysis of Continuous Beams, Portal Frames, Truss (2D and 3D), Multistoried Building.Loading : Dead Load, Live Load, Wind Load (IS: 875 Part 1 / Part 2 / Part 3), Earth Quake Load (IS: 1893 Part 1) and its Combinations as per codal Provisions
Linear Static Analysis of Continuous Beams, Portal Frames, Truss (2D and 3D), Plates (Plane Stress and Plane Strain)Linear dynamic analysis of Continuous Beams, Portal Frames</td></tr>
<tr><td colspan="4">Course Outcome
• To understand the concepts and principles involved in structural engineering
• To equip the students to perform experimental work for project and thesis</td></tr>
</table>

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE7111	Advanced Metal Structures	3-0-0-3	2015
Pre-requisites	Nil		

Course Objectives

- To make students to learn principles of Plastic analysis and design of steel structures
- Design of different components of industrial building and to detail these structures including the connection design.
- To understand the design of steel concrete composite elements.

Syllabus

Basics of plastic analysis, plastic moment capacity, beams portal frames-plastic design. Estimation of deflection. Connections, Design of bolted and welded connection – both simple and moment connections. Analysis and design of industrial buildings, loads – wind load, purlin, bracings etc. basics of pre engineered buildings. Introduction to composite materials – shear connection, steel concrete composite member designs

Course Outcome

On successful completion of the course the student will be able to design steel industrial buildings including the connection design. The student will acquire skill in the area of plastic analysis of basic steel structures and in the design of steel-concrete composite structural elements

Textbooks

1. Design of steel structures, N Subbramanian, Oxford University Press, 2008

References

1. R.P. Johnson, “Composite Structures of Steel & Concrete”, Blackwell Scientific publications, UK, 1994.
2. S.K. Duggal “Limit State Design of Steel Structures” McGraw Hill Education Private Ltd., New Delhi.
3. Gaylord& Gaylord “Design of Steel Structures”, Tata McGraw Hill, Education Edition 2012.
4. IS 800: 2007, IS 875: 1987

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I **Theorems of Plastic Analysis and Design:** General methods of Analysis - non-linearity - Plastic method of analysis – moment redistribution – static, kinematic and uniqueness theorems-effect of axial and shear force on plastic moment capacity – Analysis of single and two bay portal frames – requirements of plastic design- advantages – Plastic design of Continuous beams and portal frames-estimation of deflection..	12	25
Module II **Design of Connections:** Bolted Connections- Load Transfer Mechanism – Failure of Bolted Joints – Type of Connections Design of Fillet Welds - Design of Groove welds - Design of Intermittent fillet welds- Failure of Welds. Design of frame connections – simple and moment connections, beam to beam and beam to column – un-stiffened, stiffened seat connections, -- both welded and bolted.	12	25
Module III **Analysis and Design of Industrial Buildings:** Layout – sway and non sway frames – braced and rigid frames – Loads - dead, live and wind loads - wind pressure on roofs and walls - design of angular roof truss, tubular truss - design of purlins for roofs, built up purlins, knee braced trusses and stanchions -design of bracings. Introduction to Pre-engineered buildings (basics only)	10	25
Module IV **Steel-Concrete Composite Design**: Introduction to composite design – shear connectors – types of shear connectors – degrees of shear connections – partial and full shear connections – composite sections under positive bending – negative bending – propped conditions – un-propped conditions.	8	25
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE7211	**Analysis Of Composite Structures**	**3-0-0-3**	**2015**
Pre-requisites	**Nil**		

Course Objectives

The main objective of this course is to introduce the concept of composite laminates and equip them to analyse simple structures made of laminated composites. Also to make them understand about the theories underlying the analysis of laminated composite structures.

Syllabus

Introduction to laminated compositesand its manufacture. Various macromechanical and micro mechanical theories developed to analyse these structures. Failure analysis of the laminated composite. Analysis of laminated composite plates.

Course Outcome

The student will be able to understand the basics of laminated composites, its behaviour and will be able to do projects involving laminated composites structures.

Textbooks

1. Mechanics of Composite Materials by Autar.K.Kaw, Second Edition (2005), Taylor and Francis Press.
2. Mechanics of Laminated Plates and Shells by J.N.Reddy,CRC Press

References

1. Principles of Composite Material Mechanics by Ronald F.Gibson
2. Practical Analysis of Composite Laminates by J.N.Reddy, 1995, CRC Press.
3. Structural Analysis of Laminated Anisotropic Plates by James Whitney, 1995, CRC Press.
4. Mechanics of Composite Material and Structures by M.Mukhopadhyay, Universities Press
5. Mechanics of Composite Materials by R.M.Jones, CRC Press.

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I		

Introduction--Classification and Characteristics of Composite Materials, Basic Terminology, Uses of Fibrous Composites, Application of composites, manufacture, advantages and limitations, Lamina and Laminate. Introduction to Micro mechanics, constituent materials and properties..	8	25
Module II Laminate Analysis- Stress strain relations for lamina and laminate, Transformation of Elastic Constants, Classical Lamination Theory, Extensional, Bending and Coupling Stiffness, Different Configurations and Corresponding Stiffness, Shear Deformation Theories.	11	25
Module III Failure of Laminates- Various failure theories- Maximum Stress theory, Maximum Strain theory, Tsai-Hill Theory, Tsai- Wu Theory, Comparison of failure theories.Interlaminar failure of laminates	11	25
Module IV Behaviour and Analysis of Laminated Plates Subjected to Bending, Buckling and Vibrations using Classical Lamination Theory.	12	25
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE7311	Structural Optimization	3-0-0-3	2015
Pre-requisites	Nil		

Course Objectives

To impart knowledge to the students on

- The ability to identify the importance of optimization in the engineering field
- Should be able to use optimization techniques for real life time applications
- Ability to apply optimization concepts for solving multi task applications

Syllabus

Single Variable Unconstrained Optimisation Techniques – Optimality Criteria;Multi Variable Unconstrained Optimisation Techniques Constrained Optimisation Techniques;Classical methods –Linear programming problem: Standard form, Simplex method; Indirect methods – Direct methods - Specialized Optimisation techniques – Dynamic programming, Geometric programming, Genetic Algorithms.

Course Outcome

On the successful completion of the course students are expected to

- Understand various optimization methods
- Understand capabilities of optimization programmes
- Understand , Analyse various techniques and apply them for real time applications

Textbooks

1. Rao S. S., "Engineering Optimisation – Theory and Practice", New Age International.
2. Deb, K., "Optimisation for Engineering Design – Algorithms and examples", Prentice Hall.

References

1. Arora J S. "Introduction to Optimum Design", McGraw Hill
2. Rajeev S and Krishnamoorthy C. S., "Discrete Optimisation of Structures using Genetic Algorithms", Journal of Structural Engineering, Vol. 118, No. 5, 1992, 1223–

Course Plan

Contents	Contact Hours	Sem. Exam Marks

Module I Introduction –Problem formulation with examples;Single Variable Unconstrained Optimisation Techniques – Optimality Criteria;Bracketing methods– Unrestricted search, Exhaustive search;Region Elimination methods:–Interval Halving methods, Dichotomous search, Fibonacci method, Golden section method;Interpolation methods–Quadratic Interpolation method, Cubic Interpolation method;Gradient Based methods– Newton–Raphson method, Secant method, Bisection method.	12	25
Module II Multi Variable Unconstrained Optimisation Techniques – Optimality Criteria; Unidirectional Search ; Direct Search methods – Random search, Grid search, Univariate method, Hooke's and Jeeves' pattern search method, Powell's conjugate direction method, Simplex method; Gradient based methods–Cauchy's (Steepest descent) method, Conjugate gradient (Fletcher–Reeves) method, Newton's method, Variable metric (DFP)method, BFGS method..	10	25
Module III Constrained OptimisationTechniques;Classical methods – Direct substitution method, Constrained variation method, method of Lagrange multipliers, Kuhn–Tucker conditions. Linear programming problem: Standard form, Simplex method; Indirect methods –Elimination of constraints, Transformation techniques, and Penalty function method;Direct methods – Zoutendijk's method of feasible direction, Rosen's gradient Projection method.	10	25
Module IV Specialized Optimisation techniques – Dynamic programming, Geometric programming, Genetic Algorithms.	10	25
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction

06CE7121	Advanced Concrete Technology	3-0-0-3	2015
Pre-requisites	Nil		

Course Objectives

- To have an understanding of the manufacture of concrete.
- To analyse the behaviour of concrete subjected to loads
- To have an understanding of mix design of concrete
- To understand various forms of concrete

Syllabus

Manufacture of concrete, theological behaviour of concrete, mix design of concrete, durability of concrete, special concretes

Course Outcome

On successful completion of the course the student will have in-depth knowledge about constituents of concrete and manufacture procedure. The student will have thorough understanding about the mix design of concrete and its behaviour when subjected to various loads

Textbooks

1. Neville, A.M. and Brooks, J.J.," CONCRETE TECHNOLOGY", ELBS .1990.
2. Powers, T.C., "THE PROPERTIES OF FRESH CONCRETE".JOHN WILEY & SONS, INC. 1968.

References

1. Newman, K., "CONCRETE SYSTEMS in COMPOSITE MATERIALS".EDT BY L.Holliday. Elsevier Publishing Company. 1966.
2. Neville, A.M., "PROPERTIES OF CONCRETE", PITMAN. 1983
3. Newman, John &Choo, Ban Sang. "ADVANCED CONCRETE TECHNOLOGY - Constituent Materials" Elsevier 2003.
4. Newman, John &Choo, Ban Sang. "ADVANCED CONCRETE TECHNOLOGY - Concrete Properties" Elsevier 2003.
5. Wesche, K., "FLY ASH IN CONCRETE Properties and Performance." E & FN SPON 1991
6. Popovics.S., "FUNDAMENTALS OF PORTLAND CEMENT CONCRETE: A Quantitative Approach VOL 1 FRESH CONCRETE" JOHN WILEY & SONS.1982.

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I Materials - Concrete materials –Cement-Production, composition, and properties; cement chemistry- Types of cements; special cements-		

Aggregates- Mineralogy; properties, tests and standards-Chemical and mineral admixtures-Water reducers, air entrainers, set controllers, specialty admixtures - structure properties, and effects on concrete properties- supplementary cementing materials and pozzolans- Fly ash, blast furnace slag, silica fume, and metakaolin - their production, properties, and effects on concrete properties-Other mineral additives - reactive and inert-Reinforcements and admixtures. Behaviour of Concrete - Modern trends in concrete manufacture and placement techniques - Theological behaviour of fresh concrete and hardened concrete - Resistance to static and dynamic loads.	12	25
Module II Mix Design -Basic principles– Specifications - Design of concrete mixes by IS code method - ACI method - Road Note No:4 method-new approaches based on rheology and particle packing	9	25
Module III Compressive strength and parameters affecting it-Tensile strength - direct and indirect; Modulus of elasticity and Poisson's ratio-Stress strain response of concrete-Testing of Concrete - Non-destructive testing and quality control – Durability -Introduction to durability; relation between durability and permeability- Chemical attack of concrete; corrosion of steel rebars; other durability issues-Corrosion protection and fire resistant.Creep and relaxation - parameters affecting; Shrinkage of concrete - types and significance-Parameters affecting shrinkage; measurement of creep and shrinkage.	11	25
Module IV Special Concretes-Pre-cast concrete -Under water concrete – Pump concrete - Polymer concrete - Composites and fibre reinforced concrete.Properties and applications of: High strength - high performance concrete, reactive powder concrete-Lightweight, heavyweight, and mass concrete; fibre reinforced concrete; self-compacting concrete; shotcrete; other special concretes.	10	25
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of

			Introduction
06CE7221	**Engineering Fracture Mechanics**	**3-0-0-3**	**2015**
Pre-requisites	**Nil**		

Course Objectives

To impart knowledge to the students Fracture Mechanics and its applications to Structural Engineering problems**.**

Syllabus

Significance of fracture mechanics, Griffith energy balance approach- Fracture toughness, Influence of material behaviour, I, II & III modes, Mixed mode problems. Linear Elastic Fracture Mechanics (LEFM) Elastic stress field approach. Crack tip plasticity: Irwin plastic zone size, Energy Balance Approach: Griffith energy balance approach, LEFM Testing: Plane strain and plane stress fracture toughness testing, Elastic plastic fracture mechanics (EPFM):, J–integral, Crackopening displacement (COD) approach, COD design curve, Relation between J and COD, Fatigue Crack Growth: Description of fatigue crack growth using stress intensity factor, Effects of stress ratio and crack tip plasticity – crack closure, Mixed mode failure Initiation of initial crack propagation direction in ductile materials under plane stress conditions-Product of principal stresses.

Course Outcome

On the successful completion of the course students are expected tounderstand fracture mechanics which has wide applications in Structural Engineering.

Textbooks

1. Ewalds, H.L. &Wanhill, R.J.H., "Fracture Mechanics" – Edward Arnold
2. Ed L. Elfgren and S.P. Shah, "Analysis of Concrete Structure by Fracture Mechanics", Proc of Rilem Workshop, Chapman and Hall, London.

References

1. David Broek, "Elementary Engineering Fracture Mechanics", Sijthoff and Noordhaff Alphen Aan Den Rijn, The Netherlands.

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I **Introduction:** Significance of fracture mechanics, Griffith energy balance approach, Irwin's modification to the Griffith theory, Stress intensity approach, Crack tip plasticity, Fracture toughness, sub–critical		

crack growth, Influence of material behaviour, I, II & III modes, Mixed mode problems. **Linear Elastic Fracture Mechanics (LEFM):** Elastic stress field approach, Mode I elasticstress field equations, Expressions for stresses and strains in the crack tip region, Finitespecimen width, Superposition of stress intensity factors (SIF), SIF solutions for wellknown problems such as centre cracked plate, single edge notched plate and embedded elliptical cracks	12	25
Module II **Crack tip plasticity:** Irwin plastic zone size, Dugdale approach, Shape of plastic zone, State of stress in the crack tip region, Influence of stress state on fracture behaviour. **Energy Balance Approach:** Griffith energy balance approach, Relations for practical use,Determination of SIF from compliance, Slow stable crack growth and R–curve concept,Description of crack resistance. **LEFM Testing:** Plane strain and plane stress fracture toughness testing, Determination of R–curves, Effects of yield strength and specimen thickness on fracture toughness, Practical use of fracture toughness and R–curve data.	12	25
Module III **Elastic plastic fracture mechanics (EPFM):** Development of EPFM, J–integral, Crackopening displacement (COD) approach, COD design curve, Relation between J and COD, Tearing modulus concept, Standard JIc test and COD test. **Fatigue Crack Growth:** Description of fatigue crack growth using stress intensity factor, Effects of stress ratio and crack tip plasticity – crack closure, Prediction of fatigue crackgrowth under constant amplitude and variable amplitude loading, Fatigue crack growth from notches – the short crack problem	8	25
Module IV **Mixed mode fialure:** Introduction to crack initiation and propagation in material which are brittle or ductile, Factor envelope for material under mixed mode stress intensity factors, Test results for various materials.		

Initiation of initial crack propagation direction in ductile materials under plane stress conditions. Angled crack problem. Elasto-plastic boundary around a cracked tip. A discussion on various criteria to determine the initial crack propagation direction. like total strain energy density, dilatational strain energy density, Distortional strain energy density, Product of principal stresses, The various criteria related to the above. The application of above criteria along the Elasto-plastic boundary, the influence of crack angle on the crack propagation direction.	10	25
End Semester Exam		

Course No.	**Course Title**	**L-T-P-Credits**	**Year of**

			Introduction
06CE7321	**Forensic Engineering**	**3-0-0-3**	**2015**
Pre-requisites	**Nil**		

Course Objectives

To impart knowledge to the students forensic engineering and its applications to Structural Engineering problems

Syllabus

Forensic Engineering –Structural Health Monitoring Failure Analysis Decision Criteria - Failure of Structures- Environmental Problems and Natural Hazards. Causes of deterioration in concrete and steel structures. Diagnosis and assessment of deterioration, ,non destructive tests-Methods of repair of cracks, Modern Techniques of Retrofitting. Structural health monitoring approaches - Sensors, Fiber-optic sensors Wireless smart sensors Vibration-Bridge SHM applications-Forensics Case Studies – Applications of NDT with Analytical and Destructive Methods.

Course Outcome

On the successful completion of the course students are expected tounderstand forensic engineering which has wide applications in Structural Engineering

Textbooks

1. Sidney M Johnson, Deterioration, Maintenance and Repairs of Structures, McGraw Hill Book Company, New York
2. Dovkaminetzky, Design and Construction Failures, Galgotia Publication., NewDelhi Jacob Field and Kennenth L Carper, Structural Failures, Wiley Europe

References

1. Jacob Field and Kennenth L Carper, Structural Failures, Wiley Europe.

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I Forensic Engineering –Structural Health Monitoring Evaluation of Deterioration in Service Post-Failure Analysis Decision Criteria for Evaluation/Repair/Rehabilitation. Condition Assessment of Existing Structures 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.	14	25

Environmental Problems and Natural Hazards. Causes of deterioration in concrete and steel structures. Preventive measures, maintenance and inspection.		
Module II Diagnosis and assessment of deterioration, visual inspection, non destructive tests, ultrasonic pulse velocity method, rebound hammer method, pull out tests, Bremer test, Windsor probe test, crack detection techniques, etc.	6	25
Module III Methods of repair of cracks, repairing spalling and disintegration, repairing concrete floors and pavements. Repairing of corrosion damage of reinforced concrete. Modern Techniques of Retrofitting. Strengthening by pre-stressing. Repair of steel structures.	10	25
Module IV Structural health monitoring approaches - Sensors, data acquisition, and signal processing Fiber-optic sensors Wireless smart sensors Vibration-based structural health monitoring (SHM) Bridge SHM applications Forensics Case Studies – Applications of NDT with Analytical and Destructive Methods	12	25
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of

			Introduction
06CE7031	**Seminar II**	**0-0-2-2**	**2015**
Pre-requisites	**Nil**		

Course Objectives

Syllabus

Students have to register for the seminar and select a topic in consultation with any faculty Member offering courses for the programme. The paper should be on a recent advancement/trend in the field of structural engineering. A detailed write-up on the topic of the seminar is to be prepared in the prescribed format given by the Department. The seminar shall be of 30 minutes duration and a committee with the Head of the department as the chairman and two faculty members from the department as members shall evaluate the seminar based on the coverage of the topic, presentation and ability to answer the questions put forward by the committee.

Course Outcome

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE7041	Project (Phase 1)	0-0-8-6	2015
Pre-requisites	Nil		

Course Objectives

Syllabus

Normally students are expected to do the project within the college. However they are permitted to do the project in an industry or in a government research institute under a qualified supervisor from that organization. Progress of the project work is to be evaluated at the end of the third semester. For this a committee headed by the head of the department with two other faculty members in the area of the project, of which one shall be the project supervisor. If the project is done outside the college, (provision is available for them only in the fourth semester), the external supervisor associated with the student will also be a member of the committee. Final evaluation of the project will be taken up only on completion of the project in the fourth semester. This shall be done by a committee constituted for the purpose by the principal of the college. The concerned head of the department shall be the chairman of this committee. It shall have two senior faculty members from the same department, project supervisor and the external supervisor, if any, of the student and an external expert either from an academic/R&D organization or from Industry as members. Final project grading shall take into account the progress evaluation done in the third semester and the project evaluation in the fourth semester. If the quantum of work done by the candidate is found to be unsatisfactory, the committee may extend the duration of the project up to one more semester, giving reasons for this in writing to the student. Normally further extension will not be granted and there shall be no provision to register again for the project.

M.Tech projects should be socially relevant and research oriented ones. Each student is expected to do an individual project. The project work is carried out in two phases – Phase I in III semester and Phase II in IV semester.Project work is to be evaluated both in the third and the fourth semesters. Based on these evaluations the grade is finalised in the fourth semester.

Project evaluation weights shall be as follows:-

For convenience the marks are allotted as follows.

Total marks for the Project: 150

In the 3rd Semester:- Marks:50

Project Progress evaluation:

Progress evaluation by the Project Supervisor : 20 Marks

Presentation and evaluation by the committee : 30 Marks
Course Outcome On completion of the project (Phase 1) the student is expected to conduct preliminary work and review previous literatures on a relevant and research oriented topic to be continued in the following semester.

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE7012	Project (Phase 2)	0-0-21-12	2015
Pre-requisites			

Course Objectives

Syllabus

Phase II of the project work shall be in continuation of Phase I only. At the completion of a project the student will submit a project report, which will be evaluated (end semester assessment) by duly appointed examiner(s). This evaluation will be based on the project report and a viva voce examination on the project. The method of assessment for Phase II is as given:

In the 4th Semester:- Marks:100

Project evaluation by the supervisor/s : 30 Marks

Evaluation by the External expert : 30 Marks

Presentation & evaluation by the Committee : 40 Marks

Course Outcome

At the successful completion of a project, the student will be well versed in the work and should submit a report of the work done.