KERALA TECHNOLOGICAL UNIVERSITY

(THRISSUR CLUSTER - 07)

SCHEME AND SYLLABI

of

M. TECH.

in

STRUCTURAL ENGINEERING

OFFERING DEPARTMENT

CIVIL ENGINEERING

CLUSTER LEVEL GRADUATE PROGRAM COMMITTEE

NO	MEMBER
1.	Dr Devdas Menon, Professor, IIT Madras, Chennai
2	Principal, AXIS College of Engineering & Technology, Kodali, Kodakara, Thrissur
3	Principal, Government Engineering College Trichur, Thrissur
4	Principal, IES College of Engineering , Chittilappilly, Thrissur
5	Principal, MET'S School of Engineering, Mala, Thrissur
6	Principal, Royal College of Engineering & Technology, Akkikkavu, Thrissur
7	Principal, Vidya Academy of Science & Technology, Thalakkottukara, Thrissur
8	Principal, Thejus Engineering College, Vellarakkad, Thrissur
9	Principal, Universal Engineering College, Vallivattom, Thrissur
10	Principal, Sahrdaya College of Engineering & Technology, Kodakara, Thrissur

CERTIFICATE

This is to certify that

1. The scheme and syllabi are prepared in accordance with the regulations and guidelines issued by the KTU from time to time and also as per the decisions made in the CGPC meetings.
2. The suggestions/modifications suggested while presenting the scheme and syllabi before CGPC on 25.6.2015 have been incorporated.
3. There is no discrepancy among the soft copy in MS word format, PDF and hard copy of the syllabi submitted to the CGPC.
4. The document has been verified by all the constituent colleges

Coordinator in charge of syllabus revision of the programme

Prof. K V Leela

Professor and Head

Vidya Academy of Science and Technology

Thalakkottukara, Thrissur

Dr.Sudha Balagopalan

Principal

Vidya Academy of Science and Technology, Thalakkottukara, Thrissur

Principals of the colleges in which the programme is offered

No	Name of the college	Principal's Name	Signature
1	Vidya Academy of Science and Technology, Thalakkottukara, Thrissur	Dr.Sudha Balagopalan	
2	Axis College of Engineering &Technology, Kodali, Kodakara, Thrissur	Dr. T.G.Ansalam Raj	
3	Universal Engineering College, Vallivattam, Thrissur	Dr. K.P.Mohandas	
4	Thejus Engineering College, Vellarakkad, Thrissur	Dr. K.Satheeshkumar	

Date:
Place:

Dr Devdas Menon,
Professor, IIT Madras
Chairman

Programme Educational Objective

I Our Graduates will apply fundamental technical knowledge and skills to technological challenges and problems in Structural Engineering and contribute to society and nation while producing reliable solutions.

II Our graduates will contribute to professional practice in structural engineering through effective communication, leadership, team work and service while exhibiting high ethical and professional standards in fulfilling their responsibilities to both employers and society.

III Our graduates will continue lifelong learning through professional activities and training and take up higher education, engage in research and development in structural engineering.

Programme outcome

After successful completion of the programme the student should be able to

a) Understand latest developments in structural engineering and analyse structures using the knowledge they acquired.

b) Design and conduct experiments meeting specifications including efficiency and economic requirements

c) Communicate fluently by both oral and writing.

d) Understand professional and ethical responsibilities to be nurtured in graduates.

e) Develop skills and motivation for continuous learning process and professional growth after graduation.

f) Take up research work in Structural Engineering

Scheme of M. Tech Programme in Structural Engineering

SEMESTER 1 (Credits 21)

Exam Slot	Course No:	Name	L- T - P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
A	07 MA 6005	Mathematical Methods in Structural Engineering	3-1-0	40	60	3	4
B	07 CE 6301	Theory of Elasticity	3-1-0	40	60	3	4
C	07 CE 6303	Advanced Design of Concrete Structures	3-0-0	40	60	3	3
D	07 CE 6305	Structural Dynamics	3-1-0	40	60	3	4
E	07 CE 63XX	Elective I	3-0-0	40	60	3	3
	07 GN 6001	Research Methodology	0-2-0	100	0	0	2
	07 CE 6307	Computational Lab	0-0-2	100	0	0	1
	07 CE 6309	Introduction to Seminar	0-0-1	0	0	0	0

L-Lecture T-Tutorial P-Practical

ELECTIVE I

07 CE 6311 Design of Bridges
07 CE 6313 Advanced Foundation Engineering
07 CE 6315 Experimental Stress Analysis and Instrumentation

Note: 8 hours/week is meant for departmental assistance by students.

SEMESTER 2 (Credits 21)

Exam Slot	Course No:	Name	L- T - P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
A	07 CE 6302	Finite Element Analysis	3-1-0	40	60	3	4
B	07 CE 6304	Earthquake Resistant Design of Structures	3-0-0	40	60	3	3
C	07 CE 6306	Advanced Design of Steel Structures	3-0-0	40	60	3	3
D	07 CE 63XX	Elective II	3-0-0	40	60	3	3
E	07 CE 63XX	Elective III	3-0-0	40	60	3	3
	07 CE 6308	Seminar I	0-0-2	100	0	0	2
	07 CE 6312	Mini Project	0-0-4	100	0	0	2
	07 CE 6314	Structural Engineering Lab	0-0-2	100	0	0	1

L-Lecture T-Tutorial P-Practical

ELECTIVES

07 CE 6316 Analysis of Plates and Shells
07 CE 6318 Marine Structures
07 CE 6322 Soil Structure Interaction
07 CE 6324 Design of Prestressed Concrete Structures
07 CE 6326 Pavement Analysis and Design
07 CE 6328 Structural Optimization and Reliability Analysis

Note: 8 hours / week is meant for departmental assistance by students.

▼▼▼▼▼

SEMESTER 3 (Credits 14)

Exam Slot	Course No:	Name	L- T - P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
A	07 CE 73XX	Elective IV	3-0-0	40	60	3	3
B	07 CE 73XX	Elective V	3-0-0	40	60	3	3
	07 CE 7301	Seminar II	0-0-2	40	60	0	2
	07 CE 7303	Main Project Phase I	0-0-12	50	0	0	6

L-Lecture T-Tutorial P-Practical

ELECTIVES

07 CE 7305 Probability Methods in Civil Engineering
07 CE 7307 Forensic Engineering and Rehabilitation of Structures
07 CE 7309 Elastic Stability
07 CE 7311 High Rise Buildings
07 CE 7313 Engineering Fracture Mechanics
07 CE 7315 Advanced Concrete Technology
07 CE 7317 Mechanics of Composite Materials

Note: 8 hours/week is meant for departmental assistance by students.

SEMESTER 4 (Credits 12)

Exam Slot	Course code	Name	L- T - P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
	07 CE 7302	Main Project Phase II	0-0-21	70	30	0	12

L-Lecture T-Tutorial P-Practical

Note: 8 hours/week is meant for departmental assistance by students.

Total credits for all semesters: 68

SEMESTER 1

Course No.	Course Name	L-T-P-Credits	Year of Introduction
07 MA 6005	MATHEMATICAL METHODS IN STRUCTURAL ENGINEERING	3-1-0-4	2015

Course Objectives

To give the students understanding of basic mathematics involved in advanced topics in structural engineering and to give the student knowledge regarding the numerical methods required in analysis of structures.

Syllabus

Variational Methods in Engineering: calculus of variations - applications - Hamilton's principle - Lagrangian, introduction to energy methods, linear algebra - vector spaces, linear transformations, linear independence, null space - eigenvalues and eigenvectors, diagonalisation, Gram-Schmidt procedure, simultaneous diagonalisation, partial differential equations - classification - characteristics elliptic, parabolic and hyperbolic equations, review of method of separation of variables, heat equation, wave equation, D'Alembert's solution, important equations of mathematical physics - Laplace's equation, Poisson's equation, biharmonic equations, Dirichlet's problem, Neumann's problem, Hilbert's problem, approximate method of solutions.

Course Outcome

Students after the completion of the course understand the higher mathematics involved in advanced topics in Structural Engineering and he is able to apply the knowledge acquired in numerical methods in solving problems in Structural Engineering.

References

1. F B Hildebrand, "*Methods of Applied Mathematics"*, Prentice Hall (1965)
2. G Strang, "*Linear Algebra and Its Applications", Fourth Edition.*
3. K Sankara Rao "*Introduction to Partial Differential Equations", Second edition,* Prentice Hall

COURSE PLAN

Module	Contents	Contact Hours	Sem.Exam Marks ;%
I	**Variational Methods in Engineering** Variational methods in engineering Functions and functionals; analogy with the differential calculus; calculus of variations; Euler's equation for the simplest case; prescribed and natural boundary conditions. Slightly more general cases: extension to more unknowns and more independent variables; constraints and Lagrange multipliers; isoperimetric problems. Mention, but not discuss in detail, transversality	10	15

	conditions and ErdmannWeierstrass corner condition.		
II	**Variational Methods: applications** Applications: Hamilton's principle; introduction to energy methods; principle of virtual work; principle of complementary work; principle of minimum total potential energy; strain energy and complementary energy; general basis of the energy methods; Castigliano's first and second theorems	8	15
FIRST INTERNAL EXAM			
III	**Linear Algebra** Linear Algebra -Vector spaces Linear transformations , Linear Independence : null space	10	15
IV	**Linear Algebra (Contd)** Eigenvalues and eigenvectors; diagonalisation; Gram-Schmidt procedure, simultaneous diagonalisation	10	15
SECOND INTERNAL EXAM			
V	**Partial Differential Equations** Classification; characteristics; elliptic, parabolic and hyperbolic equations; review of method of separation of variables; heat equation; wave equation; D'Alembert's solution	10	20
VI	**Important Equations of Mathematical Physics** Laplace's equation; Poisson's equation; biharmonic equations, Dirichlet's problem Neumann's problem, Hilbert's problem; approximate method of solutions	8	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
07 CE 6301	THEORY OF ELASTICITY	3-1-0-4	2015

Course Objectives

To give the students understanding of the languages of both engineers and mathematicians and to have a strong foundation in fundamentals when problems in structural engineering are formulated solved and discussed.

Syllabus

Review of mechanics of solids - review of the topics in the undergraduate course from a slightly advanced point of view, theory of bending, special problems in bending, torsion, buckling, theories of failure, analysis of strain at a point - Strain-displacement relations, compatibility conditions (in rectangular and cylin-drical polar coordinate systems), governing equations of elasticity, solution of two-dimensional problems - plane stress and plane strain problems - Airy's stress function in rectangular coordinates, solution of three-dimensional problems - torsion of non-circular, prismatic bars - St. Venant's solution - membrane analogy - torsion of thin walled tubes (To be discussed in detail) - brief mention of general bending theory, introduction to energy methods, advanced topics.

Course Outcome

At the end of the course

- Students are able to understand the classics in the area.
- Students are able to read and understand subjects like theory of plasticity without much external help.

References

1. Mohammed Ameen, "*Computational Elasticity"*, Narosa Publishing House, New Delhi, (2005).
2. T.Wang, "*Applied Elasticity*", Wiley International
3. Timoshenko, S.P. and Goodier T.N. "*Theory of Elasticity*", McGraw Hill.
4. Chenn, W.P. and Henry D.J. "*Plasticity for Structural Engineers*", Springer Verlag Newyork
5. Sadhu Singh, "*Theory of Plasticity*", Khanna Publishers, New Delhi 1988.
6. Verma, P.D.S., "*Theory of Elasticity*", Vikas Publishing Pvt. Ltd. New Delhi -1997.
7. Filenenko & Boridith, "*Theory of Elasticity*", Mir publisher
8. Chwo P.C. and Pagano, N.J. "*Elasticity Tensor, Dyadic and Engineering applications*", D.Van Nestrand Co., 1988.
9. Sadhu Singh, "*Theory of Elasticity*", Khanna Publishers, New Delhi 1988.
10. Ernest E Sechler, "*Elasticity in Engineering*"
11. Xu, Z., "*Applied Elasticity"*, Wiley Eastern Ltd, India, 1992.
12. Durrelli, A.J., Phillips, and Tsao, "*An Introduction to the Theoretical and Experimental*

Analysis of Stress and Strain", McGraw-Hill Book company, New York, (1956).

13. J.P. Den Hartog, "*Advanced Strength of Materials"*, McGraw-Hill Book Company, New York
14. A.P. Boresi, "*Engineering Elasticity"*
15. I.S. Sokolnikoff, "*Mathematical Theory of Elasticity"*, McGraw-Hill Book Company, New York, (1956).

COURSE PLAN

Module	Contents	Contact Hours	Sem.Exam Marks ;%
I	**Review of Mechanics of Solids** Review of the topics in the undergraduate course from a slightly advanced point of view: theory of bending; special problems in bending; torsion; buckling;theories of failure. Analysis of stress at a point Stress components at a point; transformation of coordinates and induced transformations. Index notation and cartesian tensors; stress tensor; nature of a second order tensor; stress components on an inclined plane; principal stresses and principal planes; hydrostatic and pure shear components. Differential equations of equilibrium in rectangular cartesian and the other common coordinate (cylindrical polar and spherical polar) systems.	8	15
II	**Analysis of Strain at a Point** Displacement components at a point; analysis of displacements in different directions; transformation of coordinates and induced transformations; strain tensor; principal strains and principal planes; spherical and deviatoric components of strain. Strain-displacement relations; compatibility conditions (in rectangular and cylindrical polar coordinate systems). Constitutive equations - Generalised Hooke's law; systematic reduction of the constitutive coefficients from 9 x 9 = 81 to 3 - 1 = 2; general anisotropy, orthotropy and isotropy.	10	15
	FIRST INTERNAL EXAM		
III	**Governing Equations of Elasticity** Differential equations; strain-displacement equations; constitutive equations;boundary conditions. Other important equations of elasticity Beltrami-Mitchell equations; Navier's equations.	10	15
IV	**Solution of Two-dimensional Problems** Plane stress and plane strain problems; Airy's stress	10	15

	function in rectangular coordinates; some problems; Airy's stress function in polar coordinates; some important problems (thick cylinders: Lame's equations; curved bars; stress concentration, diametral compression of circular discs, stress due to a concentrated point load)		
SECOND INTERNAL EXAM			
V	**Solution of Three-dimensional Problems** Torsion of non-circular, prismatic bars; St. Venant's solution; membrane analogy; torsion of thin walled tubes (To be discussed in detail); brief mention of general bending theory.	10	20
VI	**Introduction to Energy Methods** Principle of virtual work for deformable bodies; strain energy and complementary energy; principles of minimum total potential energy and minimum complementary energy; Castigliano's theorems; a few illustrative examples Advanced topics	8	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
07 CE 6303	ADVANCED DESIGN OF CONCRETE STRUCTURES	3-0-0-3	2015

Course Objectives

To impart in depth knowledge of material and structural behaviour of concrete, background of provisions made in codes of design and to familiarize with the design of some important structures.

Syllabus

Stress-strain characteristics of concrete under single and multi- axial stresses- confined concrete- effect of cyclic loading on concrete and reinforcing steel, classical theory of cracking, design of shear walls, strut and tie Models - deep Beam - corbel - beam column joints, raft foundations, structural design of piles, pier and well foundations, inelastic behaviour of concrete beams- moment curvature diagrams – plastic hinge formation - moment redistribution in continuous beams.

Course Outcome

- Students after the completion of the course, are able to understand advances in structural design.
- Students are able to apply the knowledge in real civil engineering problems and they are able to design structures.

References

1. Varghese.P.C., "*Advanced Reinforced Concrete Design*", Prentice Hall of India, 2001
2. Park,R and Paulay T, "*Reinforced Concrete Structures"*, (John Wiley & Sons, New York)
3. Purushothaman.P. "*Reinforced Concrete Structural Elements*", Behaviour, Analysis and Design. (Tata Mc Graw Hill 1986)
4. Arthur. H. Nilson, David Darwin and Charles W Dolan, "*Design of Concrete Structures*", Tata McGraw Hill, 2004
5. Thomas T. C. Hsu, "*Unified Theory of Reinforced Concrete*", CRC Press, London,1993.
6. IS 456 –2000, Indian Standard for Plain and Reinforced Concrete- Code of Practice, New Delhi
7. ACI – 318: 2002, Building Code Requirements for Structural Concrete and Commentary, ACI Michigan.
8. Pillai.S.U. and Menon.D, "*Reinforced Concrete Design*", Tata McGraw Hill Book Co., first Edition, 2002
9. W. G. Curtin, Gerry Shaw, Gary Parkinson and J. Golding (2006) "*Structural Foundation Designers' Manual"*, Blackwell publishing
10. P C Varghese (2005) "*Foundation Engineering"*, Prentice Hall India
11. Nainan P Kurian (2004) "*Design of foundation systems - Principles and Practices"*, 3e,

Narosa Publishing House

12. N Krishna Raju (2009) "*Design of bridges"*, 4th edition, Oxford and IBH Publishing Company Pvt Ltd.

COURSE PLAN

Module	Contents	Contact Hours	Sem.Exam Marks ;%
I	Stress-strain characteristics of concrete under single and multi- axial stresses- confined concrete- Effect of cyclic loading on concrete and reinforcing steel - Ultimate Deformation and ductility of members with flexure-strength and deformation of members under flexure and shear - Control of deflections- immediate and long term deflections. Control of cracking in beams and slabs.	7	15
II	Classical theory of cracking- codal procedures on crackwidth computation as per IS comparison with Euro and ACI codes. Design of shear walls.	7	15
FIRST INTERNAL EXAM			
III	Strut and Tie Models- Development- Design methodology- selecting dimensions for struts- IS and ACI Provisions- Applications: shear and torsion in beams, Deep Beam and corbel-beam column joints.	7	15
IV	Raft Foundations – Structural Design of rectangular and circular rafts and mats using conventional method of analysis,	7	15
SECOND INTERNAL EXAM			
V	Structural design of piles including pile caps, under-reamed piles, Structural Design of pier, Well Foundation – Types, Structural Design of Well Foundations.	7	20
VI	Inelastic behaviour of concrete beams- moment curvature diagrams – plastic hinge formation-moment redistribution in continuous beams - Baker's method of plastic design - Design of cast in-situ frames- principles of capacity design – ductile detailing of frames.	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
07 CE 6305	STRUCTURAL DYNAMICS	3-1-0-4	2015

Course Objectives

To impart in depth knowledge of structural behaviour under dynamic loads and thus to establish foundation for acquiring principles of seismic design.

Syllabus

Fundamental objective of structural dynamic analysis – D'Alembert's principle - influence of gravitational forces - generalized SDOF system, free vibration of single degree of freedom system, Fourier series expansion of the loading- response to Fourier series loading, response to impulsive loads, multi degree of freedom system, distributed parameter system - partial differential equation of motion.

Course Outcome

- Students after the completion of the course, understand behaviour of structures under dynamic loadings.
- They are able to apply the knowledge acquired in earthquake resistant design of structures.

References

1. Anil.K.Chopra, *Dynamics of Structures (Theory and Applications to Earthquake Engineering)*, 2nd Edition, Prentice Hall of India Private Limited. New Delhi, 2003
2. Clough, R.W. & Penzein, J. "*Dynamics of Structures*", McGrawHill 1995
3. Mukhopadhyay, M., "*Structural Dynamics*", Ane Books, India, 2006
4. Mario Paz, "*Structural Dynamics - Theory and Computations*", CBS Publications, New Delhi, 1983
5. Timoshenko, "*Vibration problems in Engineering*", Van Nostrand Co., Inc.
6. Biggs, "*Introduction to Structural Dynamics*", McGraw Hill Book Co. 1975
7. Hurty and Rubinsteian, "*Dynamics of structures*"
8. Short course on Seismic Design of Reinforced Concrete Buildings, CEP, IIT, Kanpur, Dec.1995
9. IS 1893 – Criteria for Earthquake Resistant Design of Structures.

SP 22: Explanatory Handbook on Codes for Earthquake Engin

COURSE PLAN

Module	Contents	Contact Hours	Sem.Exam Marks ;%
I	Introduction: Fundamental objective of structural dynamic analysis – types of prescribed loadings – essential characteristics of a dynamic problem – method	8	15

	of discretization, lumped mass procedure – generalized displacements – Single degree of freedom system – Components of the basic dynamic system – formulation of the equation of motion – D'Alembert's principle - influence of gravitational forces - generalized SDOF system- Rigid body assemblage - expression for generalized system properties.		
II	Free vibration of single degree of freedom system:- Solution of equation of motion, undamped free vibration - Damped free vibration, critically damped, under damped and over damped systems, Negative damping. Response to harmonic loading, Undamped system- damped system, Response to periodic loading	10	15
FIRST INTERNAL EXAM			
III	Fourier series expansion of the loading- response to Fourier series loading - Exponential form of Fourier series loading and response- Complex frequency transfer functions Response to impulsive loads :- Suddenly applied load, sine wave impulse, rectangular impulse, triangular impulse, spike loading, approximate analysis	10	15
IV	Response to general dynamic loading:- Duhamel integral for undamped system – unit impulse response function – numerical evaluation, response of damped system- classical and non classical damping- numerical evaluation, Numerical analysis in the frequency domain, fast Fourier transform analysis.	10	15
SECOND INTERNAL EXAM			
V	Multi degree of freedom system:- Two degree of freedom system – equation of motion, characteristic equation, frequencies and mode shapes, Vanello Stodola method, coordinate coupling and choice of degree of freedom, orthogonality of modes, natural coordinates, superposition of natural modes , response of two degree of freedom system to initial excitation, response to harmonic excitation Multi- degree of freedom system – analysis of multi- degree of freedom system- mode superposition analysis.	10	20
VI	Distributed Parameter System: Partial differential equation of motion - Axial and torsional vibration of prismatic bars - Elementary case of flexural vibration of beams - Beam flexure including axial force effects. Free and forced vibrations of beams - Approximate solutions - Rayleigh and Rayleigh - Ritz Methods - Vibrations of building frames - Modal Analysis (principle only). Numerical evaluation of dynamic response – Time stepping method – methods based of interpolation of	8	20

	excitation – central difference method – Newmark's method.		
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
07 CE 6311	DESIGN OF BRIDGES	3-0-0-3	2015

Course Objectives

To impart knowledge on important types of bridge structures, their selection and planning, structural configurations, assessment of loads, choose the appropriate method of analysis according to the situation and perform design.

Syllabus

Classification of bridges, Review of road and railway bridges, steel and concrete bridges, loads on bridges - Indian Road Congress (IRC) bridge codes, design of skew slab culverts, R.C. Bridges, analysis and design of T - beam bridges, principles of design of balanced cantilever bridges, design of sub structure - design of piers and abutments, prestressed concrete bridges, steel bridges, temperature, shrinkage, creep, construction techniques and effects of construction sequence on design.

Course Outcome

Students after the completion of the course, are able to assess loads on different types of bridges and they are able to design it.

References

1. Johnson Victor D.- *Essentials of Bridge Engineering*.
2. Krishna Raju. N. "*Design of Bridges*", Oxford & IBM Publishing Co, Bombay, 1988
3. Raina.V.K. "*Concrete Bridge Practice*", Tata McGraw Hill Publishing Co., New Delhi - 1991
4. Taylor F.W, Thomson S.E. and Smulski.E. "*Reinforced Concrete Bridges*", John Wiley & Sons, New York 1955
5. FR Jagadeesh, M.A. jaya Ram, "*Design of Bridge structures*", Eastern Economy edition.
6. Murthy S.S. and Santhakumar A.R., "*Transmission Line Towers'*, McGrawHill.
7. Punmia B.C., Asok K. Jain and Arun K. Jain, "*Design of Steel Structures*", Lexmi Publications.
8. Rowe R.E., "*Concrete Bridge Design"*.
9. Leon Hardit F. "*Prestressed Concrete Design and Construction"*.
10. Conference Proceedings, '*Advances and Innovations in Bridge Engineering*', IIT, Madras and Indian Institute of Bridge Engineers, Tamilnadu, Allied Publisher, New Delhi, 1999 IS:802, IRC.6-2000, IRC. 21-2000 and charts giving EUDLL are permitted for the examination

COURSE PLAN			
Module	**Contents**	**Contact Hours**	**Sem.Exam Marks ;%**
I	Classification of bridges, Review of road and railway bridges, steel and concrete bridges, Components of bridges, Need for investigation - Bridge site - Data collection - design discharge - linear waterway – alignment - economical span - scour depth - traffic projection - choice of bridge type. Loads on bridges: Indian Road Congress (IRC) bridge codes - dimensions - dead and live loads - impact effect - wind and seismic forces - longitudinal and centrifugal forces - hydraulic forces - earth pressure - temperature effect and secondary stresses-specifications and I.R.C. provisions.	7	15
II	Design of skew slab culverts. R.C. Bridges: - box culverts. T-beam bridges - Pigeaud curves - Courbon's theory - Hendry Jaegar method	7	15
FIRST INTERNAL EXAM			
III	Analysis and design of T - beam bridges. Principles of design of Balanced Cantilever bridges. Introduction to continuous girder bridges, box girder bridges, rigid frame bridges and arch bridges.	7	15
IV	Design of Sub structure: Design of piers and abutments-forces-combinations-design principles of foundations-well, piles (detailed designs not expected). Bearings:- Design of elastomeric bearings, steel bearings.	7	15
SECOND INTERNAL EXAM			
V	Prestressed Concrete Bridges: Design of single span bridges. – design principles of composite prestressed concrete(RCC+PSC) super structures – methods of erection of precast girders - Introduction to continuous bridges -continuous construction - recent trends.	7	20
VI	Steel Bridges: Design of Plate girder and Pratt truss bridges. Introduction to Arch Bridges, Suspension and Cable Stayed Bridges. Introduction to Secondary Effects, Temperature, Shrinkage, Creep. Construction Techniques and Effects of Construction Sequence on Design.	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
07 CE 6313	ADVANCED FOUNDATION ENGINEERING	3-0-0-3	2015

Course Objectives

To impart the knowledge in the analysis and design of various foundation systems required for various infrastructure projects .

Syllabus

Shallow foundations, design principles and methodology of footings and raft, pile foundation , well foundation, soil dynamics and design of machine foundations - types of machine foundations - IS code practice for design of machine foundation for reciprocating and impact type machines, foundations for steel towers and chimneys.

Course Outcome

Students after the completion of the course, are able to design different types of foundations.

References

1. P.C.Varghese, "*Foundation Engineering"*, Prentice-Hall of India Pvt-Ltd, New Delhi.
2. B.C.Punmia, "*Soil Mechanics and Foundations"*, Laxmi Publications Pvt Ltd, New Delhi
3. Braja M Das, "*Principles of Foundation Engineering"*
4. Koerner R M, "*Construction and Geotechnical methods in Foundation Engineering"*
5. Joseph E. & Bowles, "*Foundation Analysis & Design"*, McGraw Hill
6. Leonards G.A., "*Foundation Engineering"*, McGraw Hill
7. Arora K.R., "*Soil Mechanics & Foundation Engineering"*., Standard Publications

COURSE PLAN

Module	Contents	Contact Hours	Sem.Exam Marks ;%
I	Shallow foundations- Introduction- Models used in design of foundation-Review of various theories for bearing capacity-settlement-allowable bearing pressure-SPT-Ultimate bearing capacity and settlement in sand from N values-Bearing capacity of footings and raft on clay-Bearing capacity of stratified soils	7	15
II	Design principles and methodology of footings and raft. Pile foundation-Introduction-Review of static and dynamic methods-load carrying capacity from SPTStructural design of concrete piles and pile cap-Group action of piles. Piled raft foundation-Introduction-Types-Design considerations	7	15

FIRST INTERNAL EXAM			
III	Well foundation- Introduction-Bearing capacity-method of analysis-Terzaghi's method-IRC and IS design recommendations-Elastic theory-Checking ultimate failure conditions for abutments Bending strength of well-Check for settlement-depth of scour-Minimum thickness of RC wells.	7	15
IV	Soil dynamics and Design of Machine foundations-Introduction-Mass spring system-Free vibrations-vibrating spring mass system with damping-forced vibrations-natural frequency of foundation soil system-Barken's method-bulb of pressure concept	7	15
SECOND INTERNAL EXAM			
V	Basic principles of design of machine foundation-method of analysis-static analysis –dynamic analysis-soil properties for dynamic analysis-Types of machine foundations-IS Code practice for design of machine foundation for reciprocating and impact type machines.	7	20
VI	Foundations for Steel Towers and Chimneys:-Introduction-Loads on foundation-Common types of foundation for steel towers-Behaviour of pad and Chimney foundation-Design of Chimney and Pad foundations-Anchor foundations-Rock Anchors-Design of foundation for concrete towers and chimneys-Analsis of shallow steel tower foundation.	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
07 CE 6315	EXPERIMENTAL STRESS ANALYSIS AND INSTRUMENTATION	3-0-0-3	2015

Course Objectives

To make students aware of various measurement techniques required instrumentation, experimental planning and procedures adopted in laboratory .

Syllabus

The measurement system – purpose, structure and elements, dynamic characteristics, statistical analysis – errors in measurement, strain gauges - different types of mechanical strain gauges, strain rosettes, force transducers, load cells, different types force balance pressure gauges, photo elasticity - principles of 3D photo-elasticity, non destructive testing methods – ultrasonic methods – hardness methods – rebound hammer

Course Outcome

- Students after the completion of the course, understand various measurement techniques.
- They are able to apply the knowledge in instrumentation, experimental planning and procedures adopted in laboratory.

References

1. Dally, J. W. and Raliey W.F., Experimental Stress Analysis, McGraw Hill.
2. Srinath L.S., Experimental Stress Analysis, Tata McGraw Hill
3. Roy, T.K., Experimental Analysis of stress and strain
4. Dove and Adams, Experimental Stress Analysis and Motion measurement, Prentice Hall
5. Hetenyi M., Hand book of Experimental Stress Analysis, John Wiley
6. Bently JP – Principles of Measurement Systems, Longman, 1983
7. Nakra & Chowdhary – Instrumentation Measurement & Analysis – Tata McGraw Hill, 1995
8. Doblins E A – Measurement Systems Application & Design Mc Graw Hill 1975

COURSE PLAN

Module	Contents	Contact Hours	Sem.Exam Marks ;%
I	The measurement system – Purpose, structure and Elements – Characteristics of measurement system. Accuracy, precision, repeatability, calibration – Standards and evaluation. Dynamic Characteristics. Statistical Analysis – Errors in measurement – best estimate of true value Normal Distribution – Confidence level.	7	15
II	Strain gauges - definition of gauge length - sensitivity and range - characteristics of an ideal strain gauge - different	7	15

	types of mechanical strain gauges, optical strain gauge - acoustic strain gauge - pneumatic strain gauge - merits and demerits - electrical strain gauges - inductance, capacitance and piezo electric gauges - bonded and unbonded resistance gauges and their application in stress analysis - fixing techniques and measurement of strains – procedures.		
FIRST INTERNAL EXAM			
III	Strain rosettes - determination of principal strains and stresses - construction of stress, strain circles - analytical solutions- Strain gauge circuits-characteristics- strain gauge bridges, temperature compensation,	7	15
IV	Force transducers, Load cells different types force balance pressure gauges. Measurement of displacement by Linear variable displacement transducer (LVDT)	7	15
SECOND INTERNAL EXAM			
V	Photo elasticity - basics of optics, stress optic law - plane and circularly polarized light and their use in photos elasticity - polariscopes - diffusion type - lens type polariscopes - isoclinics and isochromatics - Model materials - calibration methods for finding material fringe values - model fringe values - examples of beam flexure and diametrically loaded circular plates. - Principles of 3D photo-elasticity	7	20
VI	Non Destructive Testing Methods – Ultrasonic Methods – Hardness methods – Rebound Hammer – Detection of embedded reinforcement. Computer based data acquisition systems. Model analysis - direct and indirect models - laws of structural similitude - choice of scales - limitation of model studies - buckingham pi-theorem - dimensional analysis - model materials - Begg's deformater and its use - simple design of direct and indirect models	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
07 GN 6001	RESEARCH METHODOLOGY	0-2-0-2	2015

Course Objectives

The main objective of the course is to provide a familiarization with research methodology and to induct the student into the overall research process and methodologies. This course addresses:

- *The scientific research process and the various steps involved*
- *Formulation of research problem and research design*
- *Thesis preparation and presentation.*
- *Research proposals, publications and ethics*
- *Important research methods in engineering*

As a tutorial type course, this course is expected to be more learner centric and active involvement from the learners are expected which encourages self-study and group discussions. The faculty mainly performs a facilitator's role.

Syllabus

Overview of research methodology - Research process, scientific method, research design process. Research Problem and Design - Formulation of research task, literature review and web as a source, problem solving approaches, experimental research, and ex post facto research. Thesis writing, reporting and presentation -Interpretation and report writing, principles of thesis writing- format of reporting, oral presentation. Research proposals, publications and ethics - Research proposals, research paper writing, considerations in publishing, citation, plagiarism and intellectual property rights. Research methods – Modelling and Simulation, mathematical modeling, graphs, heuristic optimization, simulation modeling, measurement design, validity, reliability, scaling, sample design, data collection methods and data analysis

Course Outcome

At the end of course, the student will be able to:

- Discuss research methodology concepts, research problems, research designs, thesis preparations, publications and research methods.
- Analyse and evaluate research works and to formulate a research problem to pursue research
- Prepare a thesis or a technical paper, and present or publish them
- Apply the various research methods followed in engineering research for formulation and design of own research problems and to utilize them in their research project.

References

- C. R. Kothari, "*Research Methodology, Methods and Techniques"*, New Age International Publishers
- K. N. Krishnaswamy, Appa Iyer Sivakumar, M. Mathirajan, "*Management Research Methodology, Integration of principles", Methods and Techniques*, Pearson Education
- R. Panneerselvam, *"Research Methodology"*, PHI Learning
- Deepak Chawla, Meena Sondhi, "*Research Methodology–concepts & cases"*, Vikas Publg House
- J.W Bames, *"Statistical Analysis for Engineers and Scientists"*, McGraw Hill, N.York
- Schank Fr., "*Theories of Engineering Experiments"*, Tata Mc Graw Hill Publication.
- Willktnsion K. L, Bhandarkar P. L, "*Formulation of Hypothesis"*, Himalaya Publication.
- Fred M Kerlinger , *"Research Methodology"*

- Ranjit Kumar, "*Research Methodology, A step by step guide for beginners",* Pearson Education
- John W Best, James V Kahan, "*Research in Education"*, PHI Learning
- Donald R. Cooper, Pamela S. Schindler, "*Business Research Methods"*, 8/e, Tata McGraw-Hill Co Ltd
- Sinha, S.C. and Dhiman, A.K., 2002. "*Research Methodology"*, Ess Publications. 2 volumes
- Trochim, W.M.K., 2005. "*Research Methods: the concise knowledge base"*, Atomic Dog Publishing. 270p.
- Coley, S.M. and Scheinberg, C. A., 1990, "*Proposal Writing*", Sage Publications.
- Day, R.A., 1992. "*How to Write and Publish a Scientific Paper"*, Cambridge University Press.
- Fink, A., 2009. "*Conducting Research Literature Reviews: From the Internet to Paper"*. Sage Publications
- Donald H.McBurney, "*Research Methods"*, 5th Edition, Thomson Learning, ISBN:81-315-0047- 0,2006
- Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. "*An introduction to Research Methodology"*, RBSA Publishers..
- Wadehra, B.L. 2000. "*Law relating to patents, trademarks, copyright designs and geographical indications"*. Universal Law Publishing
- Carlos, C.M., 2000. "*Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options"*. Zed Books, New York.
- Additional suitable web resources
- Guidelines related to conference and journal publications

COURSE PLAN

Module	Contents	Contact Hours	Sem.Exam Marks ;%
I	**Overview of Research Methodology** Research concepts – meaning – objectives – motivation - types of research –research process – criteria for good research – problems encountered by Indian researchers - scientific method - research design process – decisional	5	15
II	**Research Problem and Design** Formulation of research task – literature review – methods – primary and secondary sources – web as a source – browsing tools -formulation of research problems – exploration - hypothesis generation - problem solving approaches-introduction to TRIZ(TIPS)-experimental research – principles -Laboratory experiment - experimental designs - ex post facto research - qualitative research	5	15
FIRST INTERNAL EXAM			
III	**Thesis writing, reporting and presentation** Interpretation and report writing – techniques of	4	15

	interpretation – precautions in interpretation – significance of report writing – principles of thesis writing- format of reporting - different steps in report writing – layout and mechanics of research report - references – tables – figures – conclusions. oral presentation – preparation - making presentation – use of visual aids - effective communication		
IV	**Research proposals, publications, ethics and IPR** Research proposals - development and evaluation – research paper writing – layout of a research paper - journals in engineering – considerations in publishing – scientometry-impact factor- other indexing like h-index – citations - open access publication -ethical issues - plagiarism –software for plagiarism checking- intellectual property right- patenting case studies .	5	15
SECOND INTERNAL EXAM			
V	**Research methods – Modelling and Simulation** Modelling and Simulation – concepts of modelling – mathematical modelling - composite modelling – modelling with – ordinary differential equations – partial differential equations – graphs heuristics and heuristic optimization - simulation modelling	5	20
VI	**Research Methods – Measurement, sampling and Data acquisition** Measurement design – errors -validity and reliability in measurement - scaling and scale construction - sample design - sample size determination - sampling errors - data collection procedures - sources of data - data collection methods - data preparation and data analysis	4	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
07 CE 6307	COMPUTATIONAL LAB	0-0-2-1	2015

Course Objectives

To provide practical knowledge in computation.

List of Excercises/ Experiments

1. To prepare a technical document in LaTeX
2. To prepare slides using Beamer (LaTeX)
3. To learn MATLAB and to work out simple problems using MATLAB
4. Familiarize with a computer algebra system (CAS), and apply the CAS to solve simple instances of the following problems.

   Solutions of algebraic equations

   Solutions of differential equations

   Finding the Fourier series expansions of periodic functions

   Finding Laplace/Fourier transforms and their inverses of elementary functions
5. To solve a large number of algebraic equations using Linear Algebra [Actual equations to obtain the moments in a multi-storeyed (say 5 storeyed) building]
6. To change the 'right hand side' of the above equations and study the corresponding errors in the solution (To study well and ill conditioned equations)
7. To find the eigenvalues and the eigenvectors of a large matrix
8. Orthogonal functions and expansion in infinite series
9. Different types of orthogonal functions, Gibbs phenomenon
10. Gaussian quadrature (different types)
11. Interpolation and curve fitting
12. Approximate methods: Rayleigh; Ritz; Galerkin; least square, etc.
13. Approximate methods:Rayleigh; Ritz; Galerkin; least square, etc. (contd).

(Out of the above, a minimum of Ten Excercises/ Experiments should be done.)

Course No.	Course Name	L-T-P-Credits	Year of Introduction
07 CE 6309	INTRODUCTION TO SEMINAR	0-0-1-0	2015

Course Objectives

This is to improve the oral communication skill of the students.

Syllabus

Individual students are required to choose a topic (need not be engineering) of their interest in consultation with faculty and present for about 30 minutes. They will be guided about sound modulation, sequence of presentation, eye contact and writing on the black board.

SEMESTER 2

Course No.	Course Name	L-T-P-Credits	Year of Introduction
07 CE 6302	FINITE ELEMENT ANALYSIS	3-1-0-4	2015

Course Objectives

To build up the back ground, basic concepts and basic formulation of finite element method to enable the students to understand various element formulations and use them for analysis, including programming.

Syllabus

Introduction to finite element method – general description of the method - basic equations of elasticity - theories of stress and strain – plane stress – plane strain conditions, direct stiffness method – Gauss elimination solution of equations , calculus of variations – variational principles of solid mechanics – principles of virtual work – Rayleigh-Ritz, Weighted residual (Galerkin) and finite difference method. Concept of elements – displacement model – shape functions – C^0 and C^1 elements – numerical integration – Gauss quadrature method - analysis of framed structure – 2D and 3D truss and frame elements, CST and LST elements – rectangular elements – Isoparametric elements axisymmetric solid elements, analysis of plate bending - analysis of shells – analysis using recent softwares.

Course Outcome

Students after the completion of the course, are able to understand finite element and knowledge in structural engineering problems

References

1. Krishnamoorthy C. S., *"Finite Element Analysis - Theory and Programming"*, Tata McGraw Hill
2. Bathe K.J., "*Finite Element Procedures in Engineering Analysis"*, Prentice Hall of India
3. Desai C.S., "*Elementary Finite Element Method"*, Prentice Hall of India
4. Cook R.D., Malkus D.S. & Plesha M.F., "*Concepts & Applications of Finite Element Analysis"*, John Wiley
5. Chandrupatla T.R. & Belegundu A.D., "*Introduction to Finite Elements in Engineering"*, Prentice Hall of India
6. Cook, R.D., "*Finite Element Modelling for Structural Analysis'*, John Wiley and sons. 3.
7. Gallaghar R.H., "*Finite Element Analysis: Fundamentals"*, Prentice Hall Inc.
8. Rajasekaran S., "*Finite Element Analysis in Engineering Design"*, Wheeler Pub.
9. Zienkiewics O.C. & Taylor R.L., "*The Finite Element Method"*, Vol I & II, McGraw Hill
10. Reddy, J.N., "*An Introduction to the Finite Element Method"*, McGraw Hill, 2006

COURSE PLAN

Module	Contents	Contact Hours	Sem.Exam Marks ;%
I	Introduction to Finite Element Method – History of development – Advantages – Disadvantages - General description of the method -Basic equations of elasticity- Strain – Displacement relations – Theories of stress and strain – Stress-Strain relations – Plane stress – Plane strain conditions	8	15
II	Direct stiffness method – Review of basic concepts of matrix displacement analysis – Complete stiffness matrices – Co-ordinate transformation – Global stiffness matrices – Formulation of load vector – Direct stiffness method – Assembly of elements- Displacement boundary conditions – Gauss elimination solution of equations	10	15
FIRST INTERNAL EXAM			
III	Calculus of variations – Variational principles of solid mechanics – Principles of virtual work – Approximate methods – Rayleigh-Ritz, Weighted residual (Galerkin) and Finite Difference Method. Concept of elements – Displacement model – Shape functions – General coordinates – Natural coordinates – Convergence and Compatibility conditions	10	15
IV	C^0 and C^1 elements – Conforming and non conforming elements – Numerical integration – Gauss quadrature method- Summary of finite element procedure. Analysis of framed structure – 2D and 3D truss and frame elements – applications – Plane stress and plane strain analysis	10	15
SECOND INTERNAL EXAM			
V	Triangular elements – CST and LST elements – Rectangular elements – Isoparametric elements – Incompatible models – 8 noded and 20 noded isoparametric solid elements – Axisymmetric solid elements (for solid elements principles of formulations only).	10	20
VI	Analysis of plate bending – Basic equation of thin plate theory- Reissner-Mindlin theory – plate elements and applications – Analysis of shells – generated shell elements Programming concepts – Assembling – Boundary conditions – Solution techniques – Band width minimization – Gauss elimination. Modelling and analysis using recent softwares	8	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
07 CE 6304	EARTHQUAKE RESISTANT DESIGN OF STRUCTURES	3-0-0-3	2015

Course Objectives

To make students capable of analyzing and designing various types of structures exhibiting ample safety under probable earthquakes

Syllabus

Introduction to engineering seismology, base-excited SDOF system formulation of basic equation, base-excited MDOF system, earthquake analysis of linear systems-response history analysis - modal anlysis - modal response – total response - multistorey building with symmetric plan-torsional response - modal mass and height unsymmetric plan - response spectrum analysis of linear system - peak modal responses - effect of appendages, earthquake response of inelastic systems, effects of earthquake on - tower structures, power plants, switch yards, equipments or other life line structures, soil liquefaction, philosophy and principles of earthquake.-resistant design- Strength and stiffness- ductility-based design and detailing– analysis and design as per IS 1893:2002

Course Outcome

- Students after the completion of the course, are able to estimate forces acting on a structure due to earthquake.
- They are able to design structures to resist the forces due to earthquake.

References

1. Anil.K.Chopra, "*Dynamics of Structures (Theory and Applications to Earthquake Engineering)"*, 2nd Edition, Prentice Hall of India Private Limited. New Delhi, 2003
2. Jaykrishna, "*Elements of earthquake engineering"*, Saritha Prakasan, Naunchandi, Meerut
3. Mukhopadhyay, M., "*Structural Dynamics*", Ane Books, India, 2006
4. R W Clough and J Penzien, "*Dynamics of structures"*, McGraw Hill
5. Pankaj Agarwal and Manish Shrikandhe, "*Earthquake Resistant Design of Structures"*, PHI
6. Park & Paulay, "R*einforced concrete"*, McGrawHill

IS Codes: IS:1893 - (Part I), Criteria for Earthquake Resistant structures-General Provisions and Buildings IS:13935 – Repair and Seismic strengthening of buildings IS:4326 - Earthquake Resistant Design and Constructions of buildings IS:13827 – Improving Earthquake Resistance of Earthen buildings IS:13828 - Improving Earthquake Resistance of Low strength Masonry buildings IS:13920 – Ductile detailing of RC Structures subject to Seismic forces.

COURSE PLAN			
Module	**Contents**	**Contact Hours**	**Sem.Exam Marks ;%**
I	Introduction to engineering seismology – plate tectonics-faults- causes of earthquake-energy release Seismic waves -primary and secondary waves – Raleigh wave - Love wave – Magnitude of earthquake – Intensity-measurement – seismographs – seismic zoning of India.	7	15
II	Base-excited SDOF system formulation of basic equation – elastic response to pulse and harmonic excitations-– concepts of pseudo acceleration, velocity and displacement – four way logarithmic graph – response to arbitrary excitations- peak response values - response spectra-DVA Spectrum.	7	15
FIRST INTERNAL EXAM			
III	Base-excited MDOF system- (review: lumped mass system- natural frequencies-mode shapes- Modal combination - SRSS - CQC) – Lumped mass modeling of multi-storey shear building and modes of vibration – response quantities- response spectra –modal contribution factors-influence of higher modes-effect of damping on responses.	7	15
IV	Earthquake analysis of linear systems-response history analysis-modal anlysis-modal response – total response-multistorey building with symmetric plan- torsional response-modal mass and height unsymmetric plan-response spectrum analysis of linear system-peak modal responses-effect of appendages.	7	15
SECOND INTERNAL EXAM			
V	Earthquake response of inelastic systems-hysterisis loop and energy dissipation- elasto-plastic idealizations-concept of equivalent linear system – ductility factor-ductility demand- elastic and inelastic design spectra Performance of building and structures under earthquakes- Main Causes of Damage- Intensity of earthquake forces, lack of strength and integrity of buildings, quasi resonance – lack of ductility, lack of detailing. Effects of Earthquake on - tower structures, power plants, switch yards, equipments or other life line structures, soil liquefaction- Assessment of damage, concepts of seismic isolation and seismic active control (Numerical exercises not expected)	7	20
VI	Philosophy and Principles of earthquake.-resistant design-Strength and stiffness- ductility-based design and	7	20

	detailing– analysis and design as per IS 1893:2002 – Buildings- Seismic zones and coefficients – response reduction factors -Estimations of fundamental time period -Design spectrums – equivalent static analysis – Vertical distribution of seismic forces and horizontal shears – Dynamic analysis –Seismic weights – Building forms and architectural design concepts- Horizontal and vertical eccentricities due to mass and stiffness distribution-limits on drifts. Load combinations and permissible stresses as per IS. Use of codes like IS: 4326, IS: 13828, IS: 13827, IS13920, SP:22 with reference to masonry, RCC and steel building -Detailing of reinforcement and joints.		
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
07 CE 6306	ADVANCED DESIGN OF STEEL STRUCTURES	3-0-0-3	2015

Course Objectives

To introduce plastic analysis and design of steel structures

Syllabus

Elastic analysis, inelastic analysis, bolted Connections, welded connections, forms of light gauge sections, design of compression members, design of members under flexure, braced and unbraced beams, design of members subjected to lateral loads and axial loads, Crane gantry girders and crane columns, design of tubular structures, design of aluminum structures

Course Outcome

- Students after the completion of the course, are able to understand the behaviour of steel in inelastic range
- They are able to design and detail structures for various types of loadings

References:

1. Gaylord & Gaylrod, *"Design of Steel Structures"*, Mc Graw Hill
2. Duggal, S.K., "*Limit State Design of Steel Structures*", Tata mcGrawHill
3. Subramanian, N., "*Design of Steel Structures*", Oxford University Press.
4. Salmon C.G & Johns J.E, "*Steel Structures- Design and Behaviour"*, Harper and Row, 1980..
5. John Baker & Jacques Hayman, "*Plastic Design of Frames"*, University – Printing House, CambridgeDr. Ramachandra, "*Design of Steel Structures"* – Vol II. Standard Book House, Delhi.
6. Krishnamchar B.S. & Ajith Sinha, D . "*Design of steel structures"*, TMH Publishing Co.
7. Horne, M.R., and Morris, L.J., "*Plastic Design of Low -rise frames"*, Granada Publishing Ltd., 1981.
8. Wie - Wen Yu., "*Cold-formed Steel Structures"*, McGraw Hill Book Company, 1973. 10. William McGuire, Steel Structures, Prentice Hall, Inc., Englewood Cliffs, N.J.1986.
9. Subramanian N. ,"*Principles of Space Structures*", Wheeler Publishing Co

16. Santhakumar A.R and Senthil.R, "*Proceedings of International Conference on Space Structures*", Anna University, Chennai

COURSE PLAN

Module	Contents	Contact Hours	Sem.Exam Marks ;%
I	Methods of Analysis- Elastic Analysis – Inelastic Analysis – Plastic hinge concept – Methods of Plastic Analysis- Plastic design of continuous beams and frames – Effect of axial and shear force on plastic	7	15

	moment capacity.		
II	Bolted Connections- High Strength Friction Grip Bolts . Welded Connections – Moment Resistant Connections- Beam to beam connections – Beam Column connections – Splices	7	15
FIRST INTERNAL EXAM			
III	Forms of light gauge sections – Effective Area – Basic design stresses – Design of compression members – Design of members under flexure – Braced and unbraced beams	7	15
IV	Design of members subjected to lateral loads and axial loads – Principles of analysis and design of Industrial buildings and bents. Crane gantry girders and crane columns – Bracing of industrial buildings and bents.	7	15
SECOND INTERNAL EXAM			
V	Design of tubular structures - Design of tension and compression members, Connections, truss configurations, space structures.	7	20
VI	Design of Aluminum structures – Design of tension and compression members, beams and columns	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
07 CE 6316	ANALYSIS OF PLATES AND SHELLS	3-0-0-3	2015

Course Objectives

To familiarize students to study the analysis and design of shells and folded plates.

Syllabus

Review of the theory of bending of beams, pure bending of plates, symmetrical bending of circular plates, small deflection of laterally loaded plates, formulation and solution of some problems in rectangular plates, simply supported edges, other edge conditions, membrane theory of shells, introduction to the middle surface theory and bending theory of shells .

Course Outcome

- Students after the completion of the course, are able to understand the behaviour of plates under loads
- They are able to apply the knowledge to design plates and shells.

References

1. S.P. Timoshenko, and Woinowsky-Krieger, S.: "*Theory of Plates and Shells"*, 2nd ed., McGraw-Hill Book Company, (1959).
2. J.P. Den Hartog: "*Advanced Strength of Material"*, McGraw-Hill Book company, Inc., New York, (1952).
3. W. Flugge: "*Stresses in Shells"*, Springer-Verlag, Berlin, (1970).
4. V.V. Novozhilov: "*Thin Shell Theory"*, 2nd Russian ed., augmented and revised, translated from Russian by P.G. Lowe and edited by J.R.M. Radok, WoltersNoordorff , Groningen, (1970).
5. E. Ventsel & Th. Krauthammer, "*Thin Plates and Shells: Theory, Analysis and Applications"*, Marcel Dekker, Inc., New York, (2001)

COURSE PLAN

Module	Contents	Contact Hours	Sem.Exam Marks ;%
I	Review of the theory of bending of beams Pure bending of plates Love-Kirchhoff assumption and its consequences; slopes and curvature; relations between bending moments and curvatures; some particular cases of pure bending; strain energy in pure bending of plates.	7	15
II	Symmetrical bending of circular plates Differential equation for symmetrical bending of circular plates; uniformly loaded circular plates; some special cases (with a circular hole; concentrically loaded; loaded at the	7	15

	centre); corrections to the elementary theory.		
FIRST INTERNAL EXAM			
III	Small deflection of laterally loaded plates Differential equation of the deflection surface; boundary conditions; boundary conditions by variational methods; developable and non-developable surfaces and the consequences; exact theory of plates.	7	15
IV	Formulation and solution of some problems in rectangular plates Simply supported edges; other edge conditions. A brief mention of advanced topics Higher order theories; Karman theory, anisotropic plates, thermal stresses; buckling of plates. (Not included for examinations.)	7	15
SECOND INTERNAL EXAM			
V	Membrane theory of shells General theory; governing equation; simple applications (as in J.P. Den Hartog: Advanced Strength of Materials, chapter on Membrane Stresses in Shells.)	7	20
VI	Introduction to the middle surface theory and bending theory of shells Differential geometry of curved surfaces; first and second fundamental forms; metric tensor; Love-Kirchhoff assumption and its consequences; Gauss-Codazzi equations; indicate how the bending theory develops from the Love-Kirchhoff assumption.	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
07 CE 6318	MARINE STRUCTURES	3-0-0-3	2015

Course Objectives

To equip the students with basic concepts of analysis and design of most common coastal and offshore structures

Syllabus

Waves - wave theories, introduction to random and directional waves, design criteria, scour and other effects of currents, wave structure interaction, diffraction theory., wave loads on vertical walls and caissons, coastal Structures - breakwaters - seawalls - bulkheads- fenders and mooring facilities- jetties- wharves- quays- diaphragm walls- piles, offshore structures- analysis of jacket structures - design of tubular members and joints

Course Outcome

- Students after the completion of the course, are able to understand the forces coming on marine structures and their effect on it.
- Students are able to apply the knowledge for design of marine structures.

References

1. Sarpkaya, T. and Isaacson, M., "*Mechanics of Wave Forces on Offshore Structures"*, Van Nostrand Reinhold Co., NewYork, 1981
2. Ippen, A.T., *"Estuary and Coastline Hydrodynamics"*, McGraw-Hill Book Company, Inc., NewYork, 1978
3. Chakrabarti,S.K., "*Hydrodynamics of Offshore Structures"*, Computational Mechanics Publications, Southampton, Boston
4. Chakrabarti,S.K., "*Handbook of Offshore Engineering Vol.1&II"*, by S.K. Chakrabarti, Elseviers,2005.
5. *"Offshore pipelines"* by B. Gou, S. Song, J. Chacko and A. Ghalambor, GPP Publishers,2006
6. *"Structural Stability – Theory and Implementation"* by W.F.Chen and E.M.Lui by Elsevier
7. Thomas.H.Dawson, "*Offshore Structural Engineering"*, Prentice –Hall
8. Young Bai, "*Marine Structural Design"*, Elsevier 2003
9. Coastal Engineering Manual (CEM-Department of Army-US Army Corps of Engineers- latest revision)
10. API-Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms.API-RP2A-WSD (2000)-API-RP2A-LRFD (1993)

COURSE PLAN			
Module	**Contents**	**Contact Hours**	**Sem.Exam Marks ;%**
I	Waves : Classification of water waves - Two dimensional wave equation and wave characteristics - wave theories - Small amplitude waves - Finite amplitude waves - Stokian, Solitary and Conical wave theories - Water particle kinematics - wave energy, power (Numerical exercises to be done) - wave deformation - Reflection, Refraction, Diffraction- Breaking of waves .	7	15
II	Mass transport velocity. Introduction to Random and directional waves. Wave spectrum-Currents - Classification - Behaviour - Design Criteria, Scour and other effects of currents.	7	15
FIRST INTERNAL EXAM			
III	Wave Structure interaction- Non breaking wave forces on slender structures - Morison equation; (Numerical exercises to be done). Wave loads on large Bodies - Diffraction theory.	7	15
IV	Wave loads on vertical walls and Caissons: Non breaking loads - Sainflou method; Breaking forces - Minikin method; Goda method-(Numerical exercises to be done)- forces due to broken waves.	7	15
SECOND INTERNAL EXAM			
V	Coastal Structures- Breakwaters- Seawalls- Bulkheads- fenders and Mooring Facilities- Jetties- Wharves- Quays- Diaphragm Walls- Piles -Partial safety Factors.-Codal Requirements. - Submarine Pipelines -thickness calculations (detailed design not expected)	7	20
VI	Offshore structures- Types of Offshore Structures - Loads on Offshore Structures Wind Loads; Wave and Current Loads; Analysis of jacket structures-Static method of analysis-Cyclic loads for fatigue analysis-Design of tubular members and joints- (Simple design problems).	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
07 CE 6322	SOIL STRUCTURE INTERACTION	3-0-0-3	2015

Course Objectives

To make students understand the basics of soil structure interaction Also to impart knowledge about various linear and non-linear, isotropic and anisotropic models for soil structure interaction problems.

Syllabus

Soil structure interaction and 'flexible' approach to the design of foundations, experimental determination of dub grade modulus, introduction to idealized soil response models for the analysis of soil, introduction to soil structure interaction models, beam on elastic foundation - soil models - infinite beam and finite beam, plate on elastic medium - infinite plate - analysis of finite plates, analysis and design of rafts and mats incorporating soil structure interaction, role of soil-structure interaction in earthquake resistant design, FEM Modeling, Elastic analysis of piles

Course Outcome

- Students after the completion of the course, understand behaviour of soil under loads transmitted by structures.
- They are able to apply the knowledge in designing various type of foundations.

References

1. *Soil mechanics* by TW Lambe & Whitmen.
2. Deb, D., "*Finite Element Methods- Concepts and Application in Geomechanics*", PHI Learning Pvt. Ltd.
3. Joseph E. Bowles, "*Foundation Analysis and Design*" McGraw-Hill.
4. *"Analytical and computer methods in foundation engineering"*, JE Bowles, McGraw Hill publications.
5. *"Foundation analysis"* by RF Scott, Printice Hall
6. Hytenyi, *"Beams on Elastic Foundations"* – university of Michigan Press.
7. *"Elastic Analysis of soil – Foundation Interaction"*. APS Selvadurai – Elsevier
8. *"Vibration Analysis and Foundation Dynamics"*, NSV Kameswara Rao, Wheeler Publishing, New Delhi.

COURSE PLAN

Module	Contents	Contact Hours	Sem.Exam Marks ;%
I	Soil structure interaction and 'flexible' approach to the design of foundations, Contact Pressure – from theory of Elasticity and Sub grade reaction, Concept of sub grade modulus, effects/parameters influencing sub grade	7	15

	modulus. Experimental Determination of Sub grade Modulus		
II	Introduction to Idealized Soil Response Models for the Analysis of Soil – Foundation Interaction – Time Dependent Behavior of Soil Masses. Introduction to Soil-structure interaction models - Winkler, Pasternak, Hetenyi and Filonenko-Borodich.	7	15
FIRST INTERNAL EXAM			
III	Beam on Elastic foundation-soil models: Infinite beam, two parameters, Isotropic elastic half space, analysis of beams of finite length, classification of finite beams in relation to their stiffness.	7	15
IV	Plate on Elastic medium: Infinite plate, Winkler, two parameters, isotropic elastic medium, thin and thick plates, analysis of finite plates: rectangular and circular plates.	7	15
SECOND INTERNAL EXAM			
V	Analysis and design of rafts and mats incorporating soil structure interaction Role of soil-structure interaction in earthquake resistant design, Finite difference solution to problems of beams on elastic foundation. Soil – structure Interaction in framed structure, FEM Modeling. Use of appropriate software packages.	7	20
VI	Modern concept of analysis of piles and pile groups. Elastic analysis of piles: Elastic analysis of single pile, theoretical solutions for settlement and load distributions, analysis of pile group, interaction analysis, load distribution in groups with rigid cap. Laterally loaded pile: Load deflection prediction for laterally loaded piles, sub-grade reaction and elastic analysis, interaction analysis, pile raft system.	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
07 CE 6324	DESIGN OF PRESTRESSED CONCRETE STRUCTURES	3-0-0-3	2015

Course Objectives

To make students familiar with the concepts of design of typical pre-stressed concrete structural elements

Syllabus

Basic concept and principles of pre-stressed concrete systems- loss of pre-stress, stresses at transfer and service loads, ultimate strength in flexure, code provisions for calculation of deflection (short & long term) in (IS, BS, ACI codes), complete design of post and pre-tensioned simply supported PSC beams, design and analysis of post and pre-tensioned PSC slabs - design of tension members – application in the design of prestressed cylindrical water tanks, analysis and design of statically indeterminate structures, PC poles, pipes and railway sleepers, composite beams – analysis and design, partial pre-stressing, definitions, principles and design approaches.

Course Outcome

- Students after the completion of the course, are able to understand the behaviour of pre-stressed concrete structures.
- They are able to apply the knowledge to anlayse and design of pre-stressed concrete structures.

References

1. Krishna Raju.N, "*Prestressed Concrete*", 4th Edition, Tata McGraw Hill Publishing Co. New Delhi 2000
2. Dayaratnam.P., "*Prestressed Concrete*", Tata McGraw Hill Publishing Co. New Delhi 2000
3. Sinha .N.C & S.K. Roy, "*Fundamentals of Prestressed Concrete*, S.Chand & Co., 1985
4. Rajagopalan.N. "*Prestressed Concrete*", Narosa Publishing House, New Delhi - 2002
5. Lin .T.Y. "*Design of Prestressed Concrete Structures*", John Wiley and Sons - Inc - 1960
6. Leonhardt.F. "*Prestressed Concrete Design and Construction*", - Second Edition Wilhelm Ernst & Sohn, Berlin, 1964
7. Guyon .V. "*Limit State Design of Prestressed Concrete*", - Vol - 1 & 2, Applied Science Publishers, London 1995
8. Mallick and Rangaswamy., "*Mechanics of Prestressed Concrete Design* ", Khanna Publishers.
9. Pandit & Gupta., " *Prestressed Concrete* ", CBS
10. F.K. Hong & R.H. Evans., *"Reinforced and Prestressed Concrete* " Tata McGraw Hill Co.

COURSE PLAN			
Module	**Contents**	**Contact Hours**	**Sem.Exam Marks ;%**
I	Review- Basic concept and principles of pre-stressed concrete systems- loss of pre-stress computation of losses. Stresses at transfer and service loads	7	15
II	Study of code provisions- ultimate strength in flexure. Code provisions for calculation of deflection (short & long term) in (IS, BS, ACI codes).	7	15
FIRST INTERNAL EXAM			
III	Complete design of post and pre-tensioned simply supported PSC beams -including end block design- cable profile- shear, bond, deflection. Serviceability requirements- deflection and cracking limit states.	7	15
IV	Design and analysis of post and pre-tensioned PSC slabs - Design of tension members – Application in the design of prestressed cylindrical water tanks.	7	15
SECOND INTERNAL EXAM			
V	Analysis and design of statically indeterminate structures- continuous beams- con-cordancy and linear transformation- simple cases of cantilever beams and slabs. Design criteria and manufacturing methods of uniformly pre-stressed members. PC poles, pipes and railway sleepers (detailed design not expected).	7	20
VI	Composite beams –Analysis and design – Ultimate strength – applications, Elementary idea of composite construction for tee beams in bridges. Partial pre-stressing- Definitions, principles and design approaches.	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
07 CE 6326	PAVEMENT ANALYSIS AND DESIGN	3-0-0-3	2015

Course Objectives

To impart the knowledge of principles and methodology of design of rigid and flexible pavements.

Syllabus

Comparison between flexible & rigid Pavements, bituminous mix design methods, specifications and testing, analysis & design of flexible pavement, analysis & design of rigid pavements, bituminous mix design methods, design of rigid pavement shoulders, drainage design, pavement structure & its evaluation - pavement performance, overlays & design - different types of overlays - design methodologies, pavement management system

Course Outcome

Students after the completion of the course, are able to design different types of pavements for different types of loadings.

References

1. Yoder and Witzack, "*Principles of Pavement Design"*, John Wiley and sons.

2. Yang, "*Design of functional pavements"*, McGraw-Hill.

3. Yang. H. Huang, *"Pavement analysis and design"*, Prentice Hall, 2004.

4. Woods, K.B., *"Highway Engineering Hand Book"*, McGraw Hill Book Co.

5. David Croney, *"The Design and Performance of Road Pavements"*, HMSO Publications.

6. Haas and Hudson, "*Pavement Management System"*, McGraw Hill Book Co., New York.

7. Per Ullitz, *"Pavement Analysis"*, Elsevier, Amsterdam

8. Harold N. Atkins, "*Highway Materials, Soils, and Concrete",* Prentice Hall, 1996.

9. Robert D. Krebs, *"Highway Materials"*, McGraw Hill Text, 1971

10. Asphalt Institute, The Asphalt Handbook, 1989

11. IRC: 37-2001, Guidelines for the Design of Flexible Pavements.

12. IRC: 58-2002, Guidelines for the Design of Rigid Pavements.

13. IRC: 81 -1981, Guidelines for the Design of overlay using Benkelman Beam Deflection Technique.

13. RRL, DSIR, Concrete Roads, HMSO, IRC Publications

COURSE PLAN			
Module	**Contents**	**Contact Hours**	**Sem.Exam Marks ;%**
I	**Introduction** - Comparison between Flexible & Rigid Pavements -Highway and Airport pavements – Types and Component layers of Pavements – their functions - A brief study on aggregates, bitumen and modified bitumen like cutback, emulsion, polymer modified bitumen - Factors affecting Design and Performance of Pavements - Various Methods of Assessment of Subgrade Soil Strength for Pavement Design - Causes and Effects of variation in Moisture Content and Temperature. Bituminous mix design methods, specifications and testing.	7	15
II	**Analysis & Design of Flexible Pavement**: Stresses and strains of flexible pavements. Deflections in Homogeneous Masses - Burmister's 2-layer, 3- layer Theories - Wheel Load Stresses - ESWL of Multiple Wheels – Repeated Loads and EWLfactors - Sustained Loads and Pavement behaviour under Traffic Loads - Empirical, Semi-empirical and Theoretical Approaches. Development, Principle, Design steps, advantages and applications of different Pavement Design Methods such as AASHTO, Asphalt Institute and IRC method of pavement design.	7	15
FIRST INTERNAL EXAM			
III	**Analysis & Design of Rigid pavements**: Types of Stresses and Causes, Factors influencing the Stresses; General conditions in Rigid Pavement Analysis, ESWL, Wheel Load Stresses, Warping Stresses, Friction Stresses, Combined Stresses - Types of Joints in Cement Concrete Pavements and their Functions, Joint Spacing, Design of Slab Thickness, Design of Joint Details for Longitudinal Joints, Contraction Joints and Expansion Joints, IRC Method of Design.	7	15
IV	Bituminous mix design methods, specifications and testing. Material characterization- Resilient modulus, Dynamic modulus of bituminous mixtures and fatigue characteristics. Design of rigid pavement shoulders: Types of rigid pavement shoulders its advantages and disadvantages. Drainage design: general considerations and methods for controlling water in pavements	7	15

SECOND INTERNAL EXAM			
V	**Pavement Structure & Its Evaluation**: Factors affecting Structural Condition of Flexible and Rigid Pavements; Effects of Sub grade Soil, Moisture, Pavement Layers, Temperature, Environment and Traffic on Structural Stability. Pavement performance: Distress, serviceability, surface friction, roughness, Evaluation by Non-Destructive Tests such as FWD, Benkelman Beam Rebound Deflection, Plate Load Test, Wave Propagation and other methods of Load Tests; Evaluation by Destructive Test Methods, and Specimen Testing Pavement	7	20
VI	Overlays & Design: Different types of overlays, Design methodologies, Benkelman Beam Deflection and other Methods of overlay design, Use of Geo synthetics in Pavement Overlays. Soil stabilized roads: Mechanical stabilization, Soil-cement stabilization, soil-lime stabilization, special problems to be considered in stabilization works. Pavement management system- an overview.	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
07 CE 6328	STRUCTURAL OPTIMIZATION AND RELIABILITY ANALYSIS	3-0-0-3	2015

Course Objectives

To impart students with various techniques of structural optimization and to familiarize students with the applications of probability analysis and reliability techniques in structural engineering.

Syllabus

Optimisation methods in civil engineering - linear and nonlinear programming problems, applications of linear programming problems in civil engineering - limit design of steel portal frames. introduction to dynamic programming, geometric programming, introduction to genetic algorithms, concepts of structural safety, probability theory, random events, random variables, resistance distributions and parameters, basic structural reliability

Course Outcome

- Students after the completion of the course,are able to understand optmisation techniques and reliability analysis.
- They are able to apply the knowledge for structural optimisation.

References

1. Sastry S.S., *"Introductory Methods of Numerical Analysis"*, Prentice Hall of India
2. Scarborough J.B., "*Numerical Mathematical Analysis"*, Oxford and IBH
3. Rao S.S., "*Engineering Optimization-Theory and Applications"*, New Age International Publishers
4. Krishnamoorthy E.V. and Sen S.K., "*Numerical Algorithms"*, Affiliated East West Press
5. Kirsch U., "*Optimum Structural Design"*, McGraw Hill
6. Fox R.L., *"Optimization Methods for Engineering Design"*, Addison Wesley
7. Singiresu S. Rao, "*Engineering Optimization (Theory and Practice)"* 3rd Edition, New Age International (P) Ltd.
8. Press W.H., et al. "*Numerical Recipes in C – The art of Computation"*, Cambridge Press
9. Goldberg D.E., "*Genetic Algorithms in Search, Optimisation and Machine Learning"*, Addison Wesley Publishing Company.
10. R. Ranganathan., "*Reliability Analysis and Design of Structures"*, Tata McGraw Hill, 1990.
11. Ang, A. H. S & Tang, W. H., "*Probability Concepts in Engineering Planning and Design"*, Vol. I Basic Principles, John Wiley & Sons, 1975.
12. Ang, A. H. S & Tang, W. H., "*Probability Concepts in Engineering Planning and Design"*, Vol. II Decision, Risks and Reliability, John Wiley & Sons, 1984.

13. Jack R. Benjamin & C. Allin Cornell., "*Probability, Statistics and Decision for Engineers"*, McGrawHill.

14. H. O. Madsen, S. Krenk & N. C. Lind, "*Methods of Structural Safety"*, Prentice-Hall, 1986.

15. R. E. Melchers. "*Structural Reliability - Analysis and prediction"*, Ellis Horwood Ltd, 1987.

COURSE PLAN

Module	Contents	Contact Hours	Sem.Exam Marks ;%
I	Optimisation methods in civil engineering- Problem formulation with examples- Linear programming problems: statement of an optimisation problem - linear and nonlinear programming problems - standard form of linear programming problems - simplex algorithm - degeneracy, duality, transportation problem, assignment problem.	7	15
II	Applications of linear programming problems in civil engineering - limit design of steel portal frames. Introduction to Dynamic programming, Geometric programming.	7	15
	FIRST INTERNAL EXAM		
III	Applications of linear programming problems in civil engineering - limit design of steel portal frames. Introduction to Dynamic programming, Geometric programming.	7	15
IV	Concepts of structural safety- Probability theory:- Introduction, random events, random variables, functions of random variables, moments and expectation, common probability distributions.	7	15
	SECOND INTERNAL EXAM		
V	Resistance distributions and parameters: - Introduction, Statistics of properties of concrete, steel and other building materials, statistics of dimensional variations, characterization of variables, allowable stresses based on specified reliability.	7	20
VI	Basic structural reliability:- Introduction, computation of structural reliability. Level 2 Reliability methods: Introduction, basic variables and failure surface, first order second moment methods (FOSM). System reliability-series and parallel systems modeling. Reliability based design: Introduction, determination of	7	20

	partial safety factors, development of reliability based design criteria.		
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
07 CE 6308	SEMINAR I	0-0-2-2	2015

Course Objectives

To assess the debating capability of the student to present a technical topic. Also to impart training to a student to face audience and present his ideas and thus creating in him self-esteem and courage that are essential for an engineer.

Syllabus

Individual students are required to choose a topic of their interest from Structural Engineering related topics preferably from outside the M.Tech syllabus. And give a seminar on that topic about 45 minutes. A committee consisting of at least three faculty members (preferably specialized in Structural Engineering) shall assess the presentation of the seminar and award marks to the students based on merits of topic of presentation. Each student shall submit two copies of a write up of his seminar topic. One copy shall be returned to the student after duly certifying it by the chairman of the assessing committee and the other will be kept in the departmental library. Internal continuous assessment marks are awarded based on the relevance of the topic, presentation skill, quality of the report and participation and Simulations.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
07 CE 6312	MINI PROJECT	0-0-4-2	2015

Course Objectives

To estimate the ability of the student in transforming the theoretical knowledge studied so far into a practical problem in structural engineering.
Students must be able to do a mini project – either actual design or rehabilitation, using hand computation and Softwares like ETABS / SAP and submit a report with relevant structural drawings.

Syllabus

Use of softwares like ETABS, SAP and also hand computation for analysis and design. Student has to analyse design, and detail structures. The basic concepts of design may be taken into consideration while designing the project.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
07 CE 6314	STRUCTURAL ENGINEERING LAB	0-0-2-1	2015

Course Objectives

To familiarize the students with the different sophisticated instrumentations used in the laboratory and field for measuring/monitoring stress, strain, deflection etc. in structures. New construction materials, their testing and construction practices are introduced.

Syllabus

Measurement of Strain: - Mechanical Strain Gauges- Electrical Strain gauges- Extensometers and Compressometers Measurement of Deflection:- Dial gauges - Linear Variable Differential Transducers

Principles of operations of UTM, hydraulic loading systems, force measuring devices etc. Concrete Mix design practices

Study of the behaviour of structural materials and structural members- Casting and testing of simple structural members. Under-reinforced and Over-reinforced RC beams in flexure. Effect of Shear span to depth ratio on the failure pattern of RC beams. Behaviour of steel beam under flexure. Hinge formation in two span RC continuous beam.

Introduction to Non Destructive Testing of RCC members - Rebound Hammer, Ultrasonic pulse devices, Core cut test.

New Reinforced Cement Composites:- Introduction to Steel fiber reinforced concrete – Ferrocement – Polymer concrete - Self Compacting Concrete – High Performance Concrete.

References:

1. *"Concrete Technology"*- Neville – Pearson Publishers, 2000

2. *"Concrete Technology"* – M.S. Shetty – S. Chand and Co., 2001

3. Srinath L.S., "*Experimental Stress Analysis*", Tata McGrawHill

SEMESTER 3

Course No.	Course Name	L-T-P-Credits	Year of Introduction
07 CE 7305	PROBABILITY METHODS IN CIVIL ENGINEERING	3-0-0-3	2015

Course Objectives

To provide the students the concept and an understanding of probability and random processes. It also helps to understand the Design of experiments. Emphasis shall be given to problems in Civil Engineering.

Syllabus

Random variables - random variables - probability function, functions of two dimensional random variables – regression curve – correlation, analytical problems based on civil engineering context, testing of hypothesis - sampling distributions - type I and type II errors, multivariate analysis - covariance matrix – correlation matrix, Ddsign of experiments- analysis of variance – one-way and two-way classifications – completely randomized design – randomized block design – Latin square design

Course Outcome

At the end of course, the student will be able to:

- *Familiarize with probabilist methods in civil engineering*
- *Apply the knowledge to interpret data and analyse results when they do experiments and* analyse

Text books

1. Richard Johnson. "*Miller & Freund's Probability and Statistics for Engineers*", Prentice – Hall of India, Private Ltd.,, New Delhi, 7th Edition, 2007.
2. Benjamin J R and Cornell C A, "*Probability, statics, and Decision for Civil Engineers*", McGraw Hill Book Company. New York, 1970
3. Douglas C., Montgomery and George C. Runger, "*Applied Statistics and Probability for Engineer"s*, 3rd Edition, Wiley India, 2007. 4
4. A.H.S. Ang and W. H. Tang, "*Probability Concepts in Engineering Planning and Design*", Volume I and II.

Reference books

5. Richard A. Johnson and Dean W. Wichern, "*Applied Multivariate Statistical Analysis*", Pearson Education, Asia, 5th Edition, 2002.
6. Gupta, S.C. and Kapoor, V.K. "*Fundamentals of Mathematical Statistics*", Sultan and Sons, New Delhi, 2001.
7. Jay L. Devore, "*Probability and statistics for Engineering and the Sciences*", Thomson and Duxbbury, Singapore, 2002.
8. Dallas E Johnson et al., "*Applied multivariate methods for data analysis*" Thomson and Duxbbury press, Singapore, 1998.

COURSE PLAN			
Module	**Contents**	**Contact Hours**	**Sem.Exam Marks ;%**
I	Random Variables - Random variables - Probability function – moments – moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Functions of a Random Variable. Joint distributions – Marginal and Conditional distributions	7	15
II	Functions of two dimensional random variables – Regression Curve – Correlation, Analytical problems based on Civil Engineering contexteg. sampling and quality control. Estimation Theory - Unbiased Estimators – Method of Moments – Maximum Likelihood Estimation - Curve fitting by Principle of least squares – Regression Lines	7	15
FIRST INTERNAL EXAM			
III	Testing of Hypothesis - Sampling distributions - Type I and Type II errors - Tests based on Normal, t, Chi-square and F distributions for testing of mean, variance and proportions – Tests for Independence of attributes and Goodness of fit. Analytical problems based on Civil Engineering context-eg. Characteristic strength, load.	7	15
IV	Multivariate analysis - Covariance matrix – Correlation Matrix – Multivariate Normal density function – Principal components – Sample variation by principal components –	7	15
SECOND INTERNAL EXAM			
V	Principal components by graphing- Analytical problems based on Civil Engineering context eg. problems on reliability.	7	20
VI	Design of experiments- Analysis of variance – One-way and two-way classifications – Completely randomized design – Randomized block design – Latin square design- Analytical problems based on Civil Engineering context.	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
07 CE 7307	FORENSIC ENGINEERING AND REHABILITATION OF STRUCTURES	3-0-0-3	2015

Course Objectives

To provide the students the concept and applications of forensic engineering to failure analysis and damage mitigation of structures. Structural retrofitting and rehabilitation techniques are also presented.

Syllabus

Failure of structures - review of the construction theory – performance problems – responsibility and accountability, diagnosis and assessment of distress - visual inspection – non destructive tests – ultrasonic pulse velocity method – rebound hammer technique, environmental problems and natural hazards, durability of RCC structures – damage due to earthquakes and strengthening of buildings – provisions of BIS 1893 and 4326, modern techniques of retrofitting, use of chemicals in repair – application of polymers – ferrocement, fiber composites and fiber reinforced concretes as rehabilitation materials – strengthening by pre-stressing

Course Outcome

At the end of course, the student will be able to:

- Understand the causes of failures
- Analyse the causes and suggest solutions like repair or strengthening

References

1. Dovkaminetzky, *"Design and Construction Failures"*, Galgotia Publication, New Delhi,2001
2. Jacob Feld and Kenneth L Carper, "*Structural Failures"*, Wiley Europe.
3. Raikar R.N., "*Diagnosis and treatment of Structures in Distress"*
4. Raina V.K., "*Bridge Rehabilitation"*
5. Ransom W.H., "*Building Failures – Diagnosis and Avoidance"*

COURSE PLAN

Module	Contents	Contact Hours	Sem.Exam Marks ;%
I	Failure of Structures: Review of the construction theory – performance problems – responsibility and accountability – case studies – learning from failures – causes of distress in structural members – design and material deficiencies – over loading	7	15
II	Diagnosis and Assessment of Distress: Visual inspection – non destructive tests – ultrasonic pulse velocity method – rebound hammer technique – ASTM classifications – pullout tests – Bremor test – Windsor probe test – crack patterns- crack detection techniques – case studies – single and multistorey buildings – Fibre	7	15

	optic method for prediction of structural weakness assessments		
FIRST INTERNAL EXAM			
III	Environmental Problems and Natural Hazards: Effect of corrosive environments, chemical and marine environments – pollution and carbonation problems – detection and measurement of corrosion.	7	15
IV	durability of RCC structures – damage due to earthquakes and strengthening of buildings – provisions of BIS 1893 and 4326	7	15
SECOND INTERNAL EXAM			
V	Modern Techniques of Retrofitting: Structural elements - first aid after a disaster – guniting, jacketing.	7	20
VI	Use of chemicals in repair – application of polymers – ferrocement, fiber composites and fiber reinforced concretes as rehabilitation materials – strengthening by pre-stressing – case studies – bridges – water tanks – cooling towers – heritage buildings – high rise buildings.	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
07 CE 7309	ELASTIC STABILITY	3-0-0-3	2015

Course Objectives

To provide a detailed treatment of buckling characteristics of various structural elements, and to present different methods to solve stability problems

Syllabus

Concepts of Stability, elastic instability of columns-Euler's theory-assumptions and limitations, compression members - Rayleigh Ritz , Galerkin methods - effect of shear on buckling – large deflection of columns, differential equation for beam-columns, buckling of frames, lateral stability of beams, buckling of thin-walled open sections, stability of Plates, buckling of Shells.

Course Outcome

At the end of course, the student will be able to:

- Know about stability of structures and apply the knowledge in various types of structures

Text Books

1. Chajes, A., " *Principles of Structural Stability Theory*", Prentice Hall, 1974.
2. Iyengar, N.G.R., "*Elastic Stability of Structural Elements*", Macmillan India Ltd., Newdelhi,2007.

References

3. Ziegler H, "*Principles of structural stability"*, Blarsdell, Wallham, Mass, 1963.
4. Thompson J M, G W Hunt, "*General stability of elastic stability"*, Wiley,New York.
5. Timoshenko, Gere, "*Theory of elastic stability"*, Mc Graw Hill, New York.
6. Don O Brush, B O Almorth, "*Buckling of Bars, plates and shells"*, Mc Graw Hill,1975
7. Cox H L, "*The buckling of plates and shells"*, Macmillam, New York, 1963.
8. Ashwini Kukar, "*Stability of Structures* ", Allied Publishers LTD, New Delhi, 1998.
9. Murali L. Gambir," *Stability Analysis and Design of Strucures*", Springer-Verlog, Berlin, 2004

COURSE PLAN

Module	Contents	Contact Hours	Sem.Exam Marks ;%
I	Concepts of Stability Introduction - Stability Criteria – Stable, unstable and neutral Equilibrium - Fourth order Elastic- large deflection of bars - differential equation for generalized bending problems- elastic instability of columns-Euler's theory-assumptions and limitations-Energy principles	7	15

II	Compression Members Higher order Differential equations - analysis for various boundary conditions- behaviour of imperfect column - initially bent column - eccentrically loaded column- Energy method- Rayleigh Ritz , Galerkin methods - Effect of shear on buckling – Large deflection of columns.	7	15
FIRST INTERNAL EXAM			
III	Beam Columns: Introduction – Differential Equation for Beam-columns –Solution of differential equation for concentrated lateral loads - distributed loads – different end conditions Buckling of frames: Solutions for various end conditions- bottom fixed- bottom hinged – horizontal compression members.	7	15
IV	Lateral Stability of Beams: Differential equations for lateral buckling - lateral buckling of beams in pure bending - lateral buckling of cantilever and simply supported I beams Buckling of Thin-Walled Open Sections: Introduction - torsional buckling - torsional flexural buckling - Equilibrium and energy approaches.	7	15
SECOND INTERNAL EXAM			
V	Stability of Plates -Governing Differential equation- Equilibrium, energy concepts - Buckling of rectangular plates of various end conditions - Finite difference method - post-buckling strength	7	20
VI	Buckling of Shells -Donnel's Equation – Symmetrical Buckling of Cylinder under uniform axial Compression – Cylinder under uniform external lateral pressure – Cylinder subjected to torsion.	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
07 CE 7311	HIGH RISE BUILDINGS	3-0-0-3	2015

Course Objectives

To impart students with basic knowledge on analysis and design philosophy, structural systems and their structural behaviour applied to high rise buildings.

Syllabus

Design philosophy- materials: RCC, steel, PSC - loading - gravity loading - wind loading- earthquake loading - blast Loading, structural planning of tall building, behaviour of various structural systems - analysis and design, shear wall frame interaction - basic design of shear walls, stability of tall buildings - overall buckling analysis of frames - P- Delta analysis

Course Outcome

At the end of course, the student will be able to :

- Select suitable structural systems for tall buildings
- Analyse the forces coming on tall buildings

References

1. Taranath , B.S., "*Structural Analysis and design of Tall Building"*, Tata McGraw Hill., 2. Wilf gang Schuller, High Rise Building Structures, John Wiley and Sons.
2. Lynn S. Beedle, "*Advances in Tall Buildings"*, CBS Publishers and Distributers, Delhi,
3. Brayan Stafford Smith, Alex coull, "*Tall Building Structures, Analysis and Design"*, John Wiley and Sons, 1991
4. M. Fintal, "*Handbook of Concrete Structures*"

COURSE PLAN

Module	Contents	Contact Hours	Sem.Exam Marks ;%
I	Design philosophy- materials: RCC, steel, PSC - loading- Gravity loading- Wind loading- Earthquake loading-blast Loading.	7	15
II	Structural planning of tall building - Building frames- rigid frames, braced frames, infilled frames, shear walls, coupled shear walls; Frame-shear wall combo; other structural forms -tubular, cores, hybrid mega system.	7	15
	FIRST INTERNAL EXAM		
III	Analysis for member forces, drift and twist, computerised general three dimensional analysis. Structural elements: Sectional shapes, properties and resisting capacity, deflection, cracking.	7	15
IV	Analysis for member forces, drift and twist, computerised general three dimensional analysis. Structural elements: Sectional shapes, properties and resisting capacity,	7	15

	deflection, cracking.		
SECOND INTERNAL EXAM			
V	Stability of tall buildings - Overall buckling analysis of frames- P- Delta analysis- Translational, torsional instability, out of plumb effects, effect of foundation rotation.	7	20
VI	Stability of tall buildings - Overall buckling analysis of frames- P- Delta analysis- Translational, torsional instability, out of plumb effects, effect of foundation rotation.	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
07 CE 7313	ENGINEERING FRACTURE MECHANICS	3-0-0-3	2015

Course Objectives

To understand the principles of linear elastic and elastic-plastic fracture mechanics and their application to engineering design.

Syllabus

Significance of fracture mechanics, Griffith energy balance approach, Irwin's modification to the Griffith theory, stress intensity approach Linear Elastic Fracture Mechanics (LEFM), Crack Tip Plasticity, Energy Balance Approach, LEFM Testing, Elastic Plastic Fracture Mechanics (EPFM), sustained load fracture

Course Outcome

At the end of course, the student will be able to:

- Understand the principles of linear elastic and elastic-plastic fracture mechanics and their application in practical problems

Text Books

1. Ewalds, H.L. & Wanhill, R.J.H., *"Fracture Mechanics"*

References

2. Broek, D. "*Elementary Engineering Fracture Mechanics"* – Sijthoff & Noordhoff International Publishers.
3. Broek, D. *"The Practical Use of Fracture Mechanics"* – Kluwer Academic Publishers.
4. Hellan, D. "*Introduction to Fracture Mechanics"* – McGraw Hill Book Company.
5. Kumar, P. *"Elements of Fracture Mechanics"* – Wheeler Publishing.
6. Simha, K.R.Y. "*Fracture Mechanics for Modern Engineering Design",*

COURSE PLAN

Module	Contents	Contact Hours	Sem.Exam Marks ;%
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.	7	15
II	Linear Elastic Fracture Mechanics (LEFM):- Elastic stress field approach, Mode I elastic stress field equations, Expressions for stresses and strains in the crack tip region, Finite specimen width, Superposition of stress intensity factors (SIF), SIF solutions for well known problems such as centre cracked plate, single edge	7	15

	notched plate and embedded elliptical cracks.		
FIRST INTERNAL EXAM			
III	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.	7	15
IV	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.	7	15
SECOND INTERNAL EXAM			
V	Elastic Plastic Fracture Mechanics (EPFM):- Development of EPFM, J-integral, Crack opening displacement (COD) approach, COD design curve, Relation between J and OD, Tearing modulus concept, Standard J Ictest 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 crack growth under constant amplitude and variable amplitude loading, Fatigue crack growth from notches – the short crack problem.	7	20
VI	Sustained Load Fracture:- Time-to-failure (TTF) tests, Crack growth rate testing, Experimental problems, Method of predicting failure of a structural component, Practical significance of sustained load fracture testing. Practical Problems:- Through cracks emanating from holes, Corner cracks at holes, Cracks approaching holes, fracture toughness of weldments, Service failure analysis, applications in pressure vessels, pipelines and stiffened sheet structures.	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
07CE 7315	ADVANCED CONCRETE TECHNOLOGY	3-0-0-3	2015

Course Objectives

To equip the students to understand the properties of concrete and to familiarise the advances in concrete and concrete making so that the appropriate mixes and methods can be chosen according to the situation and to perform mix designs

Syllabus

Materials for concrete making - cement - aggregates, properties of fresh concrete, admixtures – mineral admixtures - chemical admixtures, proportioning of concrete mixtures – mixture design as per BIS, BS and ACI methods, statistical quality control, acceptance criteria as per BIS code, setting and hardening concrete, properties of hardened concrete, durability of concrete and concrete construction, lightweight concrete, high strength concrete, self compacting concrete, roller compacted concrete, ready mixed concrete, fibre reinforced concrete, polymer concrete, special processes and technology for particular types of structure.

Course Outcome

At the end of course, the student will be able to:

- Understand the advances in concrete technology for the design of various civil engineering structures.
- Apply the knowledge to design concrete of different strengths required for various structures.

Text books

1. Neville, A. M., "*Properties of Concrete*," 4th and final Edition, 2003.
2. Mehta, P. K. and Monteiro, P. J. M., "*Concrete: Microstructure, Properties, and Materials*," 3rd Edition, 2006.
3. Shetty M S, "*Concrete Technology, - Theory and Practice*", S.Chand and Company, New Delhi, 1992.

Reference books

4. Mindess S and Young JF, "*Concrete*", Prentice-Hall, USA,1981
5. H. Okamura and K. Ozawa, "*Mix Design for Self-Compacting Concrete*," Concrete Library of JSCE, No. 25, 1995, pp. 107 – 120
6. G. H. Tattersall, "*Workability and Quality Control of Concrete*," E&FN Spon, London, 1991
7. Hewlett P C, "*Concrete Admixtures use and applications"*, M R Rixom, The Concrete press, London, 1972

COURSE PLAN			
Module	**Contents**	**Contact Hours**	**Sem.Exam Marks ;%**
I	Materials for concrete making- Review of cements including blended cements, manufacture, chemical composition, chemical and physical processes of hydration, structure of hydration products- modern methods of analysis. Aggregates- Review of types; elementary mineralogy and petrology; Engineering considerations for use of various types- production of artificial aggregates; sampling and testing; effects on properties of concretes, mortars and grouts.	7	15
II	Properties of fresh concrete - basics regarding fresh concrete – mixing, workability, placement, consolidation, and curing - Rheological models to characterize concrete - Experimental methods to characterize rheology of concrete-Flowable and pumbable concrete	7	15
FIRST INTERNAL EXAM			
III	Admixtures –Mineral admixtures - Review of types, - pulverised fuel ash, ground granulated blast furnace slag and silica fume;; chemical and physical processes of hydration and interaction; effects on properties of concretes, mortars and grouts; Chemical Admixtures - Review of types and classification; chemical composition; actions and interactions; usage; effects on properties of concretes – on quality and costs.	7	15
IV	Proportioning of concrete mixtures – concepts- mixture design as per BIS, BS and ACI methods, statistical quality control, acceptance criteria as per BIS code.	7	15
SECOND INTERNAL EXAM			
V	Setting and hardening concrete - Plastic settlement and plastic shrinkage; early age thermal movements; strength development; maturity, accelerated curing Properties of hardened concrete- Strength; deformation under load; elasticity; creep; drying shrinkage and other volume changes -Thermal properties Durability of concrete and concrete construction - Durability concept; pore structure and transport processes; reinforcement corrosion; fire resistance; frost damage; sulfate attack; alkali silica reaction; delayed ettringite formation	7	20
VI	Special concretes - Lightweight concrete- description of various types - High strength concrete and mixture	7	20

	design; Self compacting concrete : Rheology and mixture design - Roller compacted concrete – Ready mixed concrete – Fibre reinforced concrete - polymer concrete Special processes and technology for particular types of structure - Sprayed concrete; underwater concrete, mass concrete; slipform construction, Prefabrication technology		
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
07CE 7317	MECHANICS OF COMPOSITE MATERIALS	3-0-0-3	2015

Course Objectives

To make students familiar with the concepts of analysis and design of composite structural elements.

Syllabus

Composite beams - elastic behaviour of composite beams, serviceability limits - basic design considerations - design of composite beams, composite floors - analysis for internal forces and moments, composite columns - reinforced steel-composite column design, combined compression and uniaxial bending, continuous beams and slab - design strategies distribution.

Course Outcome

At the end of course, the student will be able to:

- Understand the behaviour of composite materials.
- Apply the knowledge in designing various types of structural elements

References:

1. Johnson,R.P, "*Composite Structures of Steel and Concrete"*,Vol.1Beams,Slabs,Columns and Frames in Buildings, Oxford Blackwell Scientific Publications, London.
2. INSDAG teaching resource for structural steel design, Vol 2, INSDAG, Ispat Niketan, Calcutta.

COURSE PLAN

Module	Contents	Contact Hours	Sem.Exam Marks ;%
I	Introduction: - Composite beams- Elastic behaviour of composite beams- No interaction case-Full interaction case-Shear connectors-Characteristics of shear connectors-Ultimate load behavior.	7	15
II	Serviceability limits-Basic design considerations-Design of composite beams.	7	15
	FIRST INTERNAL EXAM		
III	Composite floors: - Structural elements-Profiled sheet decking-Bending resistance-Serviceability criteria - Analysis for internal forces and moments.	7	15
IV	Composite columns: - Materials-Structural steel - Concrete-Reinforced steel-Composite column design - Fire resistance.	7	15
	SECOND INTERNAL EXAM		
V	Combined compression and uniaxial bending	7	20

VI	Continuous beams and slab - hogging moment regions of composite beams-Vertical shear and moment- Shear interaction - Global analysis of continuous beams- Design strategies	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
07 CE 7301	SEMINAR II	0-0-2-2	2015

Course Objectives

To enhance the self-learning capacity of students and enable them to make a comprehensive approach to new and upcoming areas of technology. Also to impart training to students to face audience and present their ideas and thus creating in them self esteem and courage

Syllabus

Individual students are required to choose a topic of their interest from Structural Engineering related topics preferably from outside the M.Tech syllabus and give a seminar on that topic about 30 minutes. A committee consisting of at least three faculty members (preferably specialized in Structural Engineering) shall assess the presentation of the seminar and award marks to the students. Each student shall submit two copies of a write up of his/her seminar topic in a prescribed format. One copy shall be returned to the student after duly certifying it by the chairman of the assessing committee and the other will be kept in the departmental library. Internal continuous assessment marks are awarded based on the relevance of the topic, presentation skill, quality of the report and participation.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
07 CE 7303	MAIN PROJECT PHASE 1	0-0-12-6	2015

Course Objectives

To improve the professional competency and research aptitude by touching the specific areas which otherwise not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry/field and current research.

Syllabus

The project work can be analysis and design projects of innovative nature or experimental investigation or numerical simulations or a combination of these. Appropriate software developments with sufficient literature contributions can also be taken up. Each student will be allotted with a faculty as guide. In specific cases student may consult with an external guide with the prior consents of internal guide and head of the department. In this semester, students are expected to finalize appropriate topic of research, complete the required literature survey and about 25% of the objectives of their intended research.

SEMESTER 4

Course No.	Course Name	L-T-P-Credits	Year of Introduction
07 CE 7302	MAIN PROJECT PHASE II	0-0-21-12	2015

Course Objectives

To improve the professional competency and research aptitude by touching the areas which otherwise not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.

Syllabus

Main project phase II is a continuation of project phase I started in the third semester. There would be two reviews in the fourth semester, first in the middle of the semester and the second at the end of the semester. First review is to evaluate the progress of the work, presentation and discussion. Second review would be a pre-submission presentation before the evaluation committee to assess the quality and quantum of the work done. . At least one technical paper is to be prepared for possible publication in journal or conferences. The technical paper is to be submitted along with the thesis.