File Ref.No.35323/GA- IV - E2/2013/CU

UNIVERSITY OF CALICUT

Abstract

Faculty of Engineering - M.Tech Structural Engineering (Civil Engineering)- Syllabus - with effect from 2012 -13 admission onwards - Sanctioned - Orders issued.

UNIVERSITY OF CALICUT (G & A - IV - E)

U.O.No. 4474/2013/CU Dated, Calicut University.P.O, 03.10.2013

Read:-1. Item No. I)-b- of the Minutes of the meeting of the Board of Studies in Engineering -PG- held on 12-10-2012.

2. Item No. 6 of the Minutes of the meeting of the Faculty of Engineering held on 05-11-2012.

3. Minutes of the meeting of the Academic Council held on 15-01-2013.

4. Item No. E under the title " Items deferred by the meeting of the Academic Council held on 15-01-2013" of the Minutes of the meeting of the Academic Council held on 31-07-2013.

ORDER

Vide paper read as 1st above, the Board of Studies in Engineering (PG) held on 12-10-2012 has considered the draft scheme and syllabi for the M.Tech course in Structural Engineering (Civil Engineering) and resolved to approve the same with effect from 2012 admission onwards.

Vide paper read as 2nd above, the Faculty of Engineering held on 05-11-2012 resolved to approve item No. I-b of the minutes of the meeting of the Board of Studies in Engineering(PG) held on 12-10-2012.

Vide paper read as 4th above, the Academic Council at its meeting held on 31-07-2013 has approved the minutes of the meeting of the Faculty of Engineering held on 05-11-12 and the minutes of various Boards of Studies under the Faculty.

Sanction has therefore been accorded for implementing the scheme and syllabi for M.Tech course in Structural Engineering (Civil Engineering) with effect from 2012 admission onwards.

Orders are issued accordingly. Scheme and Syllabi for M.Tech in Structural Engineering (Civil Engineering) is appended.

Prof.Raveendranath K

Registrar

To

The Principals of all Engineering Colleges offering M.Tech Course.

Copy to : - PS to VC/ PA to PVC/ PA to Registrar/ CDC/ M.Tech Branch, PB/

System Administrator(with a request to upload the syllabus in the website)

SF/DF/FC

Forwarded / By Order

Section Officer

UNIVERSITY OF CALICUT

M.Tech. DEGREE COURSE

STRUCTURAL ENGINEERING
(CIVIL ENGINEERING)

Curricula, Scheme of Examinations and Syllabi
(with effect from 2012 admissions as per 2010 scheme)

CURRICULUM OF M. TECH. PROGRAMME IN STRUCTURAL ENGINEERING

SEMESTER 1

Sl No	Course Code	Subject	Hours/week			ICA	ESE	Total	Credits
			L	T	P				
1	CES10 101	Numerical methods in structural engineering	3	1	0	100	100	200	4
2	CES10 102	Theory of Elasticity and Plasticity	3	1	0	100	100	200	4
3	CES10 103	Advanced Theory and Design of concrete structures	3	1	0	100	100	200	4
4	CES10 104	Structural Dynamics	3	1	0	100	100	200	4
5	CES10 105	Elective -1	3	1	0	100	100	200	4
6	CES10 106(P)	Concrete technology & structural Engineering lab	0	0	2	100		100	2
7	CES10 107(P)	Seminar-1	0	0	2	100		100	2
Total			15	5	4	700	500	1200	24

L-Lecture T-Tutorial P-Practical ICA-Internal Continuous Assessment ESE-End Semester Examination

ELECTIVE 1

CES10 105 (A) Advanced Foundation Engineering

CES10 105 (B) Experimental stress analysis and instrumentation

CES10 105 (C) Construction and maintenance management

Note: 6 hours/week is meant for departmental assistance by students. Each student has to undertake the departmental work assigned by HOD.

SEMESTER 2

Sl No	Course Code	Subject	Hours/week			ICA	ESE	Total	Credits
			L	T	P				
1	CES10 201	Finite Element Analysis	3	1	0	100	100	200	4
2	CES10 202	Analysis and Design of Earthquake Resistant Structures	3	1	0	100	100	200	4
3	CES10 203	Advanced Design of Metal Structures	3	1	0	100	100	200	4
4	CES10 204	Elective- 2	3	1	0	100	100	200	4
5	CES10 205	Elective- 3	3	1	0	100	100	200	4
6	CES10 206(P)	Structural Engineering Design studio	0	0	2	100		100	2
7	CES10 207(P)	Seminar-2	0	0	2	100		100	2
Total			15	5	4	700	500	1200	24

L-Lecture T-Tutorial P-Practical ICA-Internal Continuous Assessment ESE-End Semester Examination

ELECTIVE 2

CES10 204 (A) Marine Structures
CES10 204 (B) Pavement Analysis and Design
CES10 204 (C) Analysis and Design of Plates and Shells

ELECTIVE 3

CES10 205 (A) Soil Structure Interaction
CES10 205 (B) Advanced Concrete Technology
CES10 205 (C) Design of Bridges and Tower Structures

Note: 6 hours / week is meant for departmental assistance by students. Each student has to undertake the departmental work assigned by HOD.

SEMESTER 3

Sl No	Course Code	Subject	Hours /week			ICA		ESE	Total	Credits
			L	T	P					
1	CES10 301	Elective 4	3	1	0	100		100	200	4
2	CES10 302	Elective 5	3	1	0	100		100	200	4
3	CES10 303(P)	Industrial Training	0	0		0		50	50	1
4	CES10 304(P)	Master Research Project Phase I	0	0	22	Guide 150	EC 150		300	6
Total			6	2	22	500		250	750	15

**Industrial Training is for a minimum period of two weeks*

L-Lecture T-Tutorial P-Practical ICA-Internal Continuous Assessment ESE-End Semester Examination

ELECTIVE 4

CES10 301 (A) Design of Pre-stressed Concrete Structures
CES10 301 (B) Mechanics of Composite Materials
CES10 301 (C) High Rise buildings

ELECTIVE 5

CES10 302 (A) Design of Industrial Structures
CES10 302 (B) Probability Methods in Civil Engineering
CES10 302 (C) Structural Optimization and Reliability Analysis
CES10 302 (D) Forensic Engineering and Rehabilitation of Structures

Note: 6 hours / week is meant for departmental assistance by students. Each student has to undertake the departmental work assigned by HOD

SEMESTER 4

Sl No	Course Code	Subject	Hours /week			ICA		ESE		Total	Credits
			L	T	P	Guide	Evaluation Committee	External Examiner	Viva voce		
1	CES10 401(P)	Master Research Project Phase II	0	0	30	150	150	150	150	600	12

L-Lecture T-Tutorial P-Practical ICA-Internal Continuous Assessment ESE-End Semester Examination.

Note: 6 hours / week is meant for departmental assistance by students. Each *student has to undertake the departmental work assigned by HOD.*

Total credits for all semesters: 75

Total marks for all semesters: 3750

SYLLABI OF M.TECH PROGRAMME IN STRUCTURAL ENGINEERING

SEMESTER 1

CES10 101 NUMERICAL METHODS IN STRUCTURAL ENGINEERING

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

Objective: *To impart in depth knowledge of various mathematical tools applied to diversified problems in structural engineering*

Module I (14 Hours)

Systems of linear algebraic equations:

Elimination and factorization methods: Gauss, Cholesky and Crout's methods – Ill-conditioned systems – Symmetric and Banded systems – Gauss Siedel iteration - Relaxation method-condition of convergence of iterative methods.

Systems of non-linear equations – Newton-Raphson Method.

Module II (16 Hours)

Partial differential equations:

Ordinary differential equations in more than two variables – first order P.D.E-integral surface passing through a given curve-surfaces orthogonal to given system-compatible systems of first order P.D.E-charpits method -solution satisfying the given conditions-linear P .D.E with constant coefficients

Module III (12 Hours)

Interpolation and integration

Lagrange – Hermitian and cubic spline methods – Isoparametric style of interpolation

Numerical Integration using Gaussian quadrature - One and Two Dimensions

Gauss Hermite Quadrature Method - Newton–Cotes open quadrature - Monte Carlo Method - Application to deflection of beams and plates

Module IV (12 Hours)

Eigen Value Problems

Introduction – Methods of solutions: method of characteristic polynomial – Faddeev-Leverrier Method - Approximate Methods:- Forward iteration, inverse iteration – (Vianello-Stoodala method)Power Method with deflation - Rayleigh – Ritz Method.

Text Books:

1. B.S Grewal, "Numerical Methods in Engineering and Science", Khanna Publications.
2. Rajasekaran S, "Numerical Methods in Science and Engineering – A practical approach", AH Wheeler & Co.
3. P Kandasamy, "Numerical Methods", S Chand and company.
4. Stevan C. Chapra and Raymond P. Canale, "Numerical Methods for Engineers", McGraw Hill
5. Erwin Kreyszig ., "Advanced Engineering Mathematics", 5th Edition, Weiley Eastern Ltd., 1989.

References:

6. Michael D Greenberg, "Advanced Engineering Mathematics", Pearson education.
7. Ian Sneddon, "Elements of Partial Differential Equations", McGraw Hill, International Editions.
8. Balagurusamy , "Numerical Methods", Tata McGraw Hill
9. Carrier, G.F. and Pearson, C.E., "Partial Differential Equations", Academic Press, New York, 1976
10. Carl de Boor Verlog, "A practical guide to splines", Springer-Verlag

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 100 marks
Question pattern
Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES10 102 THEORY OF ELASTICITY AND PLASTICITY

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

Objective: *To equip students with concepts of elasticity and plasticity applied to structural engineering*

Module I (14 Hours)

Introduction: State of stress at a point in three dimensional elasticity - Principal stresses - Octahedral stresses - Strain at a point - Equilibrium and compatibility conditions - Generalised Hooke's law.

Plane Cartesian Elasticity: Plane stress - Plane strain - Equations of equilibrium in two dimensions - Compatibility of strain - Boundary conditions - Governing differential equation in Cartesian co-ordinates - stress functions Airy's stress function - Two dimensional problems in rectangular co-ordinates - Method of solution by Polynomials.

Module II (12 Hours)

Plane Problem in Polar Co-ordinates: Solution of two dimensional problem in Polar co-ordinates – axi-symmetric Stress distribution – thick cylinder, rotating disc, curved beam- Effect of circular holes on stress distribution in plates - Loads on straight boundaries - Concentrated force acting on a beam-stress on a circular disc under diametric compression.

Module III (14 Hours)

Strain Energy Methods: Total strain energy- complementary energy - Principle of virtual work and total potential energy- Theorem of minimum potential energy, Betti's reciprocal theorem, principle of linear superposition, uniqueness of elasticity solution. Theorem of minimum complementary energy- Griffith's theory of rupture - Castigliano's theorem - Principle of least work.

Torsion: Torsion of straight bars – elliptic cross section - Saint Venant's theory - Membrane analogy – narrow rectangular cross section - Torsion of thin-walled open sections - Torsional stress concentration.

Module IV (14 Hours)

Introduction to plasticity: One-dimensional elastic-plastic relations, isotropic and kinematic hardening, yield function, flow rule, hardening rule, incremental stress-strain relationship, governing equations of elastoplasticity.

Yield and failure criteria-Stress strain relations for perfect elasto-plastic materials-Von Mises, Tresca and Mohr-Coulomb stress functions-simple elastic plastic problem-Expansion of a thick walled cylinder – incremental stress-strain relationship

Implementation of plasticity in metals and concrete – principles only – metals - plastic stress strain matrix for metals- nonlinear stress strain relation in concrete.

Text Books:

1. C.T.Wang, "Applied Elasticity", Wiley International
2. Timoshenko, S.P. and Goodier T.N. "Theory of Elasticity", McGraw Hill.
3. Chenn, W.P. and Henry D.J. "Plasticity for Structural Engineers", Springer Verlag Newyork
4. Sadhu Singh, "Theory of Plasticity", Khanna Publishers, New Delhi 1988.
5. Verma, P.D.S., "Theory of Elasticity", Vikas Publishing Pvt. Ltd. New Delhi -1997.

References:

1. Filenenko & Boridith, “Theory of Elasticity”, Mir publisher
2. Chwo P.C. and Pagano, N.J. "Elasticity Tensor, Dyadic and Engineering applications", D.Van Nestrand Co., 1988.
3. Sadhu Singh, "Theory of Elasticity", Khanna Publishers, New Delhi 1988.
4. Ernest E Sechler, “Elasticity in Engineering”
5. Xu, Z., Applied Elasticity, Wiley Eastern Ltd, India, 1992.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students’ right at the beginning of the semester by the teacher.

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES10 103 ADVANCED THEORY AND DESIGN OF CONCRETE STRUCTURES

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

Objective: *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*

Module 1 (12 hrs)

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 with tension - Control of deflections- immediate and long term deflections.

Module 2 (14 hrs)

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.

Module 3 (14 hrs)

Biaxial bending of columns- interaction diagrams-Analysis and Design of slender RCC columns- Control of cracking in beams and slabs – classical theory of cracking- codal procedures on crack-width computation as per IS-comparison with BS and ACI codes.

Module 4 (14 hrs)

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.

Text Books:

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)

References:

1. Arthur. H. Nilson, David Darwin and Charles W Dolan, “Design of Concrete Structures”, Tata McGraw Hill, 2004
2. Thomas T. C. Hsu, “Unified Theory of Reinforced Concrete”, CRC Press, London,1993.
3. IS 456 –2000, Indian Standard for Plain and Reinforced Concrete- Code of Practice, New Delhi
4. ACI – 318: 2002, Building Code Requirements for Structural Concrete and Commentary, ACI Michigan.
5. Pillai.S.V and Menon.D, "Reinforced Concrete Design", Tata McGraw Hill Book Co., first Edition, 2002

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students’ right at the beginning of the semester by the teacher.

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES 10-104 STRUCTURAL DYNAMICS

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

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

Module 1 (14 hrs)

Introduction: Fundamental objective of structural dynamic analysis – types of prescribed loadings – essential characteristics of a dynamic problem – method 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.

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.

Module 1I (14 hrs)

Single Degree of Freedom Systems: Response to harmonic loading, Undamped system- damped system, Response to periodic loading -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

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.

Module 1II (12 hrs)

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.

Module 1V (14 hrs)

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 excitation – central difference method – Newmark's method.

Text Books:

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

References:

1. Mario Paz, "Structural Dynamics - Theory and Computations", CBS Publications, New Delhi, 1983
2. Timoshenko, "Vibration problems in Engineering", Van Nostrand Co., Inc.
3. Biggs, "Introduction to Structural Dynamics", McGraw Hill Book Co. 1975
4. Hurty and Rubinsteian, "Dynamics of structures"
5. Short course on *Seismic Design of Reinforced Concrete Buildings*, CEP, IIT, Kanpur, Dec.1995
6. IS 1893 – Criteria for Earthquake Resistant Design of Structures.
7. SP 22: Explanatory Handbook on Codes for Earthquake Engineering.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES 10 105 (A) ADVANCED FOUNDATION ENGINEERING

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

Objective: *To equip the students to understand the analysis and design of various foundation systems required for various infrastructure projects*

Module I (12 hours)

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-Design principles and methodology of footings and raft.

Module II (14 hours)

Pile foundation-Introduction-Review of static and dynamic methods-load carrying capacity from SPT-Structural design of concrete piles and pile cap-Group action of piles.

Piled raft foundation-Introduction-Types-Design considerations

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.

Module III (14 hours)

Soil dynamics and Design of Machine foundations-Introuction-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-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.

Module IV (14 hours)

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.

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 Engg.,* Standard Publications

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES 10 105(B) EXPERIMENTAL STRESS ANALYSIS AND INSTRUMENTATION

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

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

Module I (14 hours)

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.

Strain gauges - definition of gauge length - sensitivity and range - characteristics of an ideal strain gauge - different 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.

Module II (14 hours)

Strain rosettes - determination of principal strains and stresses - construction of stress, strain circles - analytical solutions- Strain gauge circuits-characteristics- strain gauge bridges, temperature compensation- Force transducers, Load cells different types force balance pressure gauges.
Measurement of displacement by Linear variable displacement transducer (LVDT)

Module III (14 hours)

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

Module IV (12 hours)

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

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

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 100 marks
Question pattern
Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES10 105 (C) CONSTRUCTION AND MAINTENANCE MANAGEMENT

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

Objectives:

- *To equip the students to understand durability aspects of buildings, causes and process of failure and the methods of monitoring maintenance requirements and rehabilitation strategies of structures*
- *To study the various management techniques for successful completion of construction project*

Module I (14Hours)

Organising for Project management - Project Management – modern trends - Strategic Planning - Effects of Project Risks on Organization - Organization of Project Participants -Traditional Designer-Constructor Sequence - Professional Construction Management - Owner-Builder Operation - Turnkey Operation - Leadership and Motivation for the Project Team

Labour, Material and equipment utilisation - Historical Perspective - Labour Productivity - Factors Affecting Job-Site Productivity - Labour Relations in Construction - Problems in Collective Bargaining - Materials Management - Material Procurement and Delivery - Inventory Control - Tradeoffs of Costs in Materials Management.

Module II (12 Hours)

Constructions Operations Management – Trends and methods in construction project scheduling – principles-use of bar charts and networks-CPM and PERT methods

Quality management-Features of Quality management systems – general principles-Total Quality Management-ISO systems- ISO 9000 certification process in construction-quality manuals-preparation-principles

Principles of Safety management

Module III (14 Hours)

Maintenance and repair strategies - Definitions: Maintenance, repair and rehabilitation- Life expectancy of different types of buildings- Facets of Maintenance- importance of Maintenance-Inspection-Assessment procedure for evaluating a damaged structure

Repair project management- principles- choice of materials and methods and equipment

Influence on serviceability and durability-–effect of environmental elements such as heat, dampness, frost and precipitation on buildings-effect of chemical agents on building materials-effect of pollution on buildings-effect of fire on building-damage by biological agents like plants, trees, algae, fungus, moss, insects, etc.

Module IV (14 Hours)

Failure and repair of buildings: Definition of building failure-types of failures-methodology for investigation of failures-diagnostic testing methods and equipments-repair of cracks in concrete and masonry-methods of repair-repair and strengthening of concrete buildings-foundation repair and strengthening-underpinning-leakage of roofs and repair methods

Special materials for repair - Special concretes and mortar, concrete chemicals, special elements for accelerated strength gain, Expansive cement, polymer concrete, sulphur infiltrated concrete, ferrocement, Fibre reinforced concrete. Rust eliminators and polymers coating for Rebars, foamed concrete- special equipment

Text books

1. R.T.Allen and S.C.Edwards, “Repair of Concrete Structures”, Blakie and Sons,
2. UK, 1987.
3. M.S.Shetty, “Concrete Technology - Theory and Practice”, S.Chand and
4. Company, New Delhi, 1992.
5. Santhakumar, A.R., “ Concrete Technology”,, Oxford University Press, NewDelhi, 2007.
6. S Champion “Failure and repair of concrete structures”
7. Chitkara, K.K. Construction Project Management: Planning, Scheduling and Control, Tata McGraw-Hill Publishing Company, New Delhi, 1998.
8. Choudhury, S , Project Management, Tata McGraw-Hill Publishing Company, New Delhi, 1988.
9. Kumar Neeraj Jha,Project management – Theory and practice, Pearson Education India, New Delhi,2011.

References

1. Raikar, R.N., “Learning from failures - Deficiencies in Design”, Construction and
2. Service - R & D Centre (SDCPL), Raikar Bhavan, Bombay, 1987
3. Denison Campbell, Allen and Harold Roper, “Concrete Structures”, Materials,
4. Maintenance and Repair, Longman Scientific and Technical UK, 1991.
5. Smith P & Julian W, “Building services”, Applied science publications
6. Peter H. Emmons, Concrete Repair and Maintenance, Galgotia Publishers
7. SP:25 BIS Causes and Prevention of Cracks in buildings
8. SP:62 (S&T)-1997, BIS, Hand Book on Building Construction Practice, pp. 457-765
9. Seetharaman S., “Construction Engineering and Management (fourth Revised and Enlarged Edition) ”, Umesh Publications, Delhi (2003).
10. Chitale A. K. and Gupta R. C., “Materials Management- Text and cases”, Prentice-Hall of India Private Limited, New Delhi (2006).
11. Gopalakrishnan P and Sundaresan M, “Materials Management an integrated approach”, PHI Learning Private Limited, New Delhi (2009)
12. Chris Hendrickson and Tung Au, Project Management for Construction – Fundamental Concepts for Owners, Engineers, Architects and Builders, Prentice Hall, Pittsburgh, 2000.
13. Frederick E. Gould, Construction Project Management, Wentworth Institute of Technology, Vary E. Joyce, Massachusetts Institute of Technology, 2000.
14. George J.Ritz , Total Construction Project Management - McGraw-Hill Inc, 1994.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students’ right at the beginning of the semester by the teacher.

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES 10 106(P) CONCRETE TECHNOLOGY & STRUCTURAL ENGINEERING LAB

Credits: 2

Teaching scheme: 2 hours practical per week

Objective:

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.

Pre-requisite: -Nil

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- Neveli – Pearson Publishers, 2000
2. Concrete Technology – M.S. Shetty – S. Chand and Co., 2001
3. Srinath L.S., “Experimental Stress Analysis”, Tata McGrawHill

Students are required to prepare a record of the experiments conducted in the laboratory and the same shall be certified by the faculty in charge of the lab class and the head of the department. There shall be a semester end examination conducted by the faculty in charge of the lab class. The internal assessment shall be based on the performance of the students in the lab and also based on marks awarded to the records.

Internal continuous assessment: 100 marks

Continuous evaluation (Assessment of individual experiments)	: 30 %
Fair Record of experiments	: 20 %
Test(s), Viva voce	: 50 %

CES 10 107(P) SEMINAR - 1

Credits: 2

Teaching Scheme: 2 hours per week

Objective:

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.

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.

Internal continuous assessment: 100 marks

Evaluation shall be based on the following pattern:

Report (Relevance, Literature content, organization)	: 50 marks
Presentation, Discussion	: 40 marks
Participation	: 10 marks
Total	: 100 marks

SEMESTER 2

CES10 201 FINITE ELEMENT ANALYSIS

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

Objective: *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.*

Module I (12 Hours)

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 – Plain stress – Plain strain conditions
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

Module II (14 Hours)

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 – C_0 and C_1 elements – Conforming and non conforming elements – Numerical integration – Gauss quadrature method- Summary of finite element procedure.

Module III (16 Hours)
Analysis of framed structure **– 2D** and **3D** truss and frame elements – applications – Plain stress and plain strain analysis – 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).

Module IV (12 Hours)

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

Text Books:

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. Reddy, J.N., An Introduction to the Finite Element Method, McGraw Hill, 2006.

References:

1. Chandrupatla T.R. & Belegundu A.D., Introduction to Finite Elements in Engineering, Prentice Hall of India
2. Cook, R.D., Finite Element Modelling for Structural Analysis, John Wiley and sons.
3. Gallaghar R.H., Finite Element Analysis: Fundamentals, Prentice Hall Inc.
4. Rajasekaran S., Finite Element Analysis in Engineering Design, Wheeler Pub.
5. Zienkiewics O.C. & Taylor R.L., The Finite Element Method, Vol I & II, McGraw Hill
6. Segrelind., The Finite Element Method.

Internal continuous assessment: 100 marks
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 100 marks
Question pattern
Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES10 202 ANALYSIS AND DESIGN OF EARTHQUAKE RESISTANT STRUCTURES

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

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

Module I (12 HOURS)
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.

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.

Module II (14 HOURS)
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.
Earthquake analysis of linear systems-response history analysis-modal anlysis-modal response – total response- multistory building with symmetric plan- torsional response-modal mass and height-unsymmetric plan- response spectrum analysis of linear system-peak modal responses-effect of appendages.

Module III (14 HOURS)
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 earth quake forces, lack of strength and integrity of buildings, quasi resonance – lack of ductility, lack of detailing.
Effects of Earth quake 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)

Module IV (14 HOURS)
Philosophy and Principles of earthquake.-resistant design- Strength and stiffness- ductility-based design and 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.

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, Reinforced 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.

Internal continuous assessment: 100 marks
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 100 marks
Question pattern
Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES10 203 ADVANCED DESIGN OF METAL STRUCTURES

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

Objective:
To introduce students with plastic analysis and design methods of some important types of metal structures.

Module I (12 Hours)

Plastic method of analysis – Comparison between elastic and plastic analysis, Plastic behaviour under static and cyclic loading. Analysis of continuous beams, Portal and gable frames, method for plastic moment distribution, Effect of axial force and shear force on plastic moments and connections.

Module II (12 Hours)

Design of Connections - Types of connections - Design framed beam connections - Seated beam connections - Unstiffened, Stiffened seat connections, Continuous beam-to-beam connections and continuous beam-to-column connection both welded riveted.

Module III (14 Hours)

Design for light gauge steel structures – Types of cross sections - Local buckling and lateral buckling, post buckling strength, concepts of Effective width - Design of compression and tension members ,Design of beams, Columns. Combined stresses and connections, wall studs.

Module IV (16 Hours)

Design of tubular structures – Design of tension and compression members, Connections, truss configurations, space structures.
Design of Aluminum structures – Design of tension and compression members, beams and columns

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, Cambridge
6. Dr. Ramachandra, Design of Steel Structures – Vol II. Standard Book House, Delhi.
7. Krishnamchar B.S. & Ajith Sinha, D . Design of steel structures, TMH Publishing Co.
8. Horne, M.R., and Morris, L.J., Plastic Design of Low -rise frames, Granada Publishing Ltd., 1981.
9. 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.
11. Subramanian N. ,"Principles of Space Structures", Wheeler Publishing Co
12. Santhakumar A.R and Senthil.R, "Proceedings of International Conference on Space Structures", Anna University, Chennai

Internal continuous assessment: 100 marks
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 100 marks
Question pattern
Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES10 204 (A) MARINE STRUCTURES

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

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

Module I (14 hrs)
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 . Mass transport velocity. Introduction to Random and directional waves. Wave spectrum**-**Currents -Classification - Behaviour - Design Criteria, Scour and other effects of currents.

Module II (12 hrs)
Wave Structure interaction- Non breaking wave forces on slender structures - Morison equation; (Numerical exercises to be done). Wave loads on large Bodies - Diffraction theory. 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.

Module III (14 hrs)
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);

Module IV (14 hrs)
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).

Text Books:

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

References

1. Thomas.H.Dawson, Offshore Structural Engineering, Prentice –Hall
2. Young Bai, Marine Structural Design, Elsevier 2003
3. Coastal Engineering Manual (CEM-Department of Army-US Army Corps of Engineers- latest revision)
4. API-Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms.API-RP2A-WSD (2000)-API-RP2A-LRFD (1993)

Internal continuous assessment: 100 marks
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 100 marks
Question pattern
Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES 10 204 (B) PAVEMENT ANALYSIS AND DESIGN

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

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

Pre-requisite: Nil

Module I (14 Hours)

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 - Depth of Frost Penetration.

Bituminous mix design methods, specifications and testing.

Module II (14Hours)

Analysis & Design of Flexible Pavement: Stresses and 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

Module III (12 Hours)

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.

Module IV (14 Hours)

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 Deterioration; 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 Overlays & Design: Pavement Overlays, Design of Flexible Overlay over Flexible Pavement by Benkelman Beam Deflection and other Methods, Flexible Overlays and Rigid Overlays over Rigid Pavements, Use of Geo synthetics in Pavement Overlays

References:

1. Yoder and Witzack, Principles of Pavement Design, John Wiley and sons.
2. Yang, Design of functional pavements, McGraw-Hill.
3. Woods, K.B., Highway Engineering Hand Book, McGraw Hill Book Co.
4. David Croney, The Design and Performance of Road Pavements, HMSO Publications.
5. Haas and Hudson, Pavement Management System, McGraw Hill Book Co., New York.
6. Per Ullitz, Pavement Analysis, Elsevier, Amsterdam
7. Harold N. Atkins, Highway Materials, Soils, and Concrete, Prentice Hall, 1996.
8. Robert D. Krebs, Highway Materials, McGraw Hill Text, 1971
9. Asphalt Institute, The Asphalt Handbook, 1989
10. IRC: 37-2001, Guidelines for the Design of Flexible Pavements.
11. IRC: 58-2002, Guidelines for the Design of Rigid Pavements.
12. IRC: 81 -1981, Guidelines for the Design of overlay using Benkelman Beam Deflection Technique.
13. RRL, DSIR, Concrete Roads, HMSO, IRC Publications

Internal continuous assessment: 100 marks
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 100 marks
Question pattern
Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES10 204 (C) ANALYSIS AND DESIGN OF PLATES AND SHELLS

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

Objective: *To provide the students with the basic concepts of structural behaviour, analysis and design of shell and folded plate structures mostly used in Civil Engineering*

Module I (14 Hours)

Theory of Plates:
Introduction to thin plates under small deflection theory - Kirchoff's assumptions - Lame's parameters - Development of strain - Displacement relationships - stress-strain relationships - Force-displacement equations and equilibrium equations in curvilinear co-ordinates - Lame's parameters u,v,w equations - variational principles and its applications to plate problems - Study of various boundary conditions.

Rectangular plates - Differential equation - Solution of simply supported plates under various loading conditions - Uniformly distributed load - Hydrostatic pressure and a concentrated load - Navier and Levy types of solutions.

Module II (14 Hours)

Symmetrical bending of circular plates - Differential equations - Uniformly loaded and concentrically loaded plates with various simply supported and clamped boundary conditions.

Theory of Shells
Introduction - Review of basic theory of shells - Definition and assumptions –strain displacement relationships - Stress-strain relationships - Force displacement equations and equilibrium equation in curvilinear co-ordinates – Kirchoff's assumptions in thin shallow shell theory - Classification of shell systems - Principal curvatures - Lame's parameters.

Module III (14 Hours)

Membrane theory of shells- Application to various shapes - Shells of double curvature - Circular cylindrical shells - Membranes deformation of symmetrically loaded cylindrical and spherical shells.

Approximate methods of analysis - Design of cylindrical shells and H.P shells – by Beam theory - Membrane theory.
Detailing of reinforcement for circular cylindrical shells

Module IV (12 Hours)

Folded plates -- types- Structural Behavior of folded plates - Equation of three shears – Application- Whitney's method of analysis.

Design and detailing of folded plates- design by ACI-ASCE task committee method
Formwork for shells and folded plates

References

1. Timoshenko & Krierger, “Theory of plates and shells”, Tata McGraw Hill,
2. Szilard, “Theory and analysis of plates - classical and numerical methods”,
3. Ramaswamy, G.S., “Design and construction of concrete shell roofs”, CBS Publishers
4. Novozhilov, “Theory of thin shells”,
5. Giben, “Theory of cylindrical shell roofs”,
6. Lundgen, “Cylindrical shells“,

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students’ right at the beginning of the semester by the teacher.

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES 10 205 (A) SOIL STRUCTURE INTERACTION

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

Objective: *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.*

Module I (14 Hours)

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 modulus. Experimental Determination of Sub grade Modulus..

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.

Module II (14 Hours)

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.

Plate on Elastic medium: Infinite plate, Winkler, two parameters, isotropic elastic medium, thin and thick plates, analysis of finite plates: rectangular and circular plates.

Module III (12 Hours)

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.

Module IV (14 Hours)

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.

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.

Internal continuous assessment: 100 marks
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 100 marks
Question pattern
Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES10 205 (B) ADVANCED CONCRETE TECHNOLOGY

Credits: 4

Teaching scheme: 3 hours lecture and 1 hour tutorial per week

Objective: *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*

Module I (12 Hours)

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.

Module II (15 Hours)

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
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.

Proportioning of concrete mixtures – concepts- mixture design as per BIS, BS and ACI methods, statistical quality control, acceptance criteria as per BIS code.

Module III (15 Hours)

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

Module IV (12 Hours)

Special concretes - Lightweight concrete- description of various types - High strength concrete and mixture 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

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

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

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students’ right at the beginning of the semester by the teacher.

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES 10 205 (C) DESIGN OF BRIDGES AND TOWER STRUCTURES

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

Objective:
To impart the students with some 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. Students are equipped to analyze and design transmission towers.

Module I (12 HOURS)

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.

Design of skew slab culverts.

Module II (14 HOURS)

R.C. Bridges: - box culverts. T-beam bridges - Pigeaud curves - Courbon's theory - Hendry Jaegar method - 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.

Module III (14 HOURS)

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.

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.

Module IV (14 HOURS)

Steel Bridges: Design of Plate girder and Pratt truss bridges.

Analysis and design of Transmission Line Towers – classifications of towers- parts of tower -types of bracings, patterns - Sag and Tension calculations – loads and load combinations - tower testing – erection – tower foundations.

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Text Books

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.

Reference Books:

1. Rowe R.E. – Concrete Bridge Design.
2. Leon Hardit F. – Prestressed Concrete Design and Construction.
3. 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

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES 10 206(P) STRUCTURAL ENGINEERING DESIGN STUDIO

Credits: 2

Teaching scheme: 2 hours practical per week

Objective: *Students are expected to use important softwares used in the field of structural engineering for analysis, design and drafting.*

Exercises on Concrete Structures: -

Analysis, design and detailing of solid slabs in a typical floor for a residential building- Analysis, design and detailing of beams in a typical intermediate floor of a multi-storey building- Analysis, design and detailing of circular ring beam supporting an overhead water tank- Analysis, design and detailing of a ribbed slab floor system- Generation of interaction curves for RC rectangular columns- Design of slender columns subject to biaxial bending- Analysis, design and detailing of shear walls- considering shear wall-frame interaction in a tall RC structure subject to wind loading- Application of strut-and-tie method to design and detail various RC elements and junctions.

Exercises on Metal Structures: -

Design of Steel Industrial Building – Design of roof trusses - Design of Steel Multi-storey Building - Design of Material Handling system - Design of steel Bridge - Design of pre-engineered buildings. Design of storage structures - Design of towers

References

1. Arthur. H. Nilson, David Darwin and Charles W Dolan, Design of Concrete Structures, Tata McGraw Hill, 2004
2. Park,R and Paulay T, Reinforced Concrete Structures, John Wiley & Sons, New York
3. Macleod, I.A, Shear Wall Frame Interaction. A design aid with commentary Portland Cement Association.
4. IS 456 :2000, Indian Standard for Plain and Reinforced Concrete- Code of Practice, BIS, New Delhi
5. IS 13920 : 1993, Indian Standard for Ductile Detailing of Reinforced Concrete Structures subjected toSeismic Forces - Code of Practice, BIS, New Delhi
6. Gaylord ., Design of steel structures, McGraw Hill, New York.
7. Dayaratnam, P., Design of steel structures, Wheeler Pub.

Students are required to prepare a record of the experiments conducted in the laboratory and the same shall be certified by the faculty in charge of the lab class and the head of the department. There

shall be a semester end examination conducted by the faculty in charge of the lab class. The internal assessment shall be based on the performance of the students in the lab and also based on marks awarded to the records.

Internal continuous assessment: 100 marks

Continuous evaluation (Assessment of individual experiments)	: 30 %
Fair Record of experiments	: 20 %
Test(s), Viva voce	: 50 %

CES10 207 (P) SEMINAR 2

Credits: 2

Teaching scheme: 2 hours per week

Objective: *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*

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.

Internal continuous assessment: 100 marks

Evaluation shall be based on the following pattern:

Report (Relevance, Literature content, organization)	: 50 marks
Presentation, Discussion	: 40 marks
Participation	: 10 marks
Total	: 100 marks

SEMESTER 3

CES10 301 (A) DESIGN OF PRESTRESSED CONCRETE STRUCTURES

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

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

Module I (12 hours)
Review- Basic concept and principles of pre-stressed concrete systems- loss of pre-stress- computation of losses. Design and analysis of pre-stressed section for flexure -Stresses at transfer and service loads - study of code provisions - ultimate strength in flexure - code provisions for calculation of deflection (short & long term) in (IS, BS, ACI codes).

Module II (14 hours)
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. Design and analysis of post and pre-tensioned PSC slabs
Design of tension members – Application in the design of prestressed cylindrical water tanks.

Module III (14 hours)
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).

Module IV (14 hours)
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.

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 PrestressedCocrete Design ", Khanna Publishers.
9. Pandit & Gupta., " Prestressed Concrete ", CBS
10. F.K. Hong & R.H. Evans., "Reinforced and Prestressed Concrete " Tata McGraw Hill Co.

IS 1343-1980, IS 456-2000 are permitted to use in the examination.

Internal continuous assessment: 100 marks
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 100 marks
Question pattern
Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES 10 301 (B) MECHANICS OF COMPOSITE MATERIALS

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

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

Prerequisite: -Nil

MODULE 1 (14 HOURS)

Introduction: - Composite beams- Elastic behaviour of composite beams- No interaction case-Full interaction case-Shear connectors-Characteristics of shear connectors-Ultimate load behaviour - Serviceability limits-Basic design considerations-Design of composite beams.

MODULE II (12 HOURS)

Composite floors: - Structural elements-Profiled sheet decking-Bending resistance-Serviceability criteria - Analysis for internal forces and moments.

MODULE III (14 HOURS)

Composite columns: - Materials-Structural steel - Concrete-Reinforced steel-Composite column design -Fire resistance - Combined compression and uniaxial bending

MODULE IV (14 HOURS)

Continuous beams and slab - hogging moment regions of composite beams-Vertical shear and moment- Shear interaction - Global analysis of continuous beams- Design strategies

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.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES 10 301 (C) HIGH RISE BUILDINGS

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

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

Module I (14HOURS)

Design philosophy- materials: RCC, steel, PSC - loading- Gravity loading- Wind loading- Earthquake loading-blast
Loading. 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.

Module II (16HOURS)

Behaviour of various structural systems- factors affecting growth, height and structural form- Temperature stress in buildings.
Analysis and design: modeling for approximate analysis, Accurate analysis and reduction techniques. Analysis of building as total structural systems considering overall integrity and major subsystem interaction, Analysis for member forces, drift and twist, computerised general three dimensional analysis. Structural elements: Sectional shapes, properties and resisting capacity, deflection, cracking.

Module III (12HOURS)

Shear wall frame interaction- basic design of shear walls- design of tall buildings for differential movement, creep, and shrinkage effects, temperature effects and fire resistance. Use of prestressing. Construction techniques - safety devices.

MODULE IV (12HOURS)

Stability of tall buildings - Overall buckling analysis of frames- P- Delta analysis- Translational, torsional instability, out of plumb effects, effect of foundation rotation.

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.
3. Lynn S. Beedle, Advances in Tall Buildings, CBS Publishers and Distributers, Delhi,
4. Brayan Stafford Smith, Alex coull, Tall Building Structures, Analysis and Design, John Wiley and Sons, 1991
5. M. Fintal, “Handbook of Concrete Structures”

Internal continuous assessment: 100 marks
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students’ right at the beginning of the semester by the teacher.

End semester Examination: 100 marks
Question pattern
Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES 10 302 (A) DESIGN OF INDUSTRIAL STRUCTURES

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

Objectives:

1. *To familiarize with the design of special structures widely used in industrial plants.*
2. *To reinforce the fundamental courses in structural design in the perspective of industrial applications.*

Module I (13 hours)

Functional design of industrial buildings:

Classification of industrial structures-layout planning requirements –Guidelines from factories act – Lighting- Illumination levels – Principles of day lighting /artificial lighting design – Natural / Mechanical ventilation – Fire safety requirements – Corrosion protection – Protection against noise – Cladding systems- vibration isolation techniques - Industrial floors.

Introduction to diverse types of industrial structures: General overview of Thermal power plant/Nuclear power plant structures / Process plant steelwork – conveyor structures – Boiler supporting structures-Substation structures.

Module II (15 hours)

Structural Design of Industrial Buildings:

Braced Industrial buildings – Unbraced Industrial frames – Gantry girders – analysis and design

Machine foundations – Strength and deformation of soil under dynamic loads; dynamic coefficients for soils, shear modulus and elastic constants of soil; Types-Design Requirements-Analysis and design of block type machine foundations (IS 2974 method) design of foundation for reciprocating and rotary machines, foundation for impact type loading-simple design exercises; vibration isolation technique.

Module III (14 hours)

Design of Reinforced concrete bunkers and silos as per IS: 4995.

Tall Chimneys (RCC) –Types-Chimney sizing parameters- Overview of wind and temperature effects-Design principles of Reinforced concrete chimneys as per IS: 4998. principles of design for seismic loads.

Module IV (12 hours)

Cooling Towers –Types and functions- Design principles of RC natural draught cooling towers as per IS: 11504

Transmission line Towers- Types-Design loadings-Analysis and design concepts- Description of Tower construction- tower foundations.

Textbooks:

1. Proceedings of an advanced course on industrial structures, SERC – 1982.
2. S.N.Manohar, Tall Chimneys-Design and Construction, Tata Mc Graw Hill.
3. P.Dayaratnam, Design of steel structures, Wheeler Publishing Co.
4. Ramchandra, Design of steel structures, Vol. 1 and 2, Standard Book house Delhi.
5. Srivasulu and Vaidyanathan, Handbook of machine foundations-Tata McGraw Hill.
6. Murthy and Santhakumar, Transmission Line structures, McGraw Hill

References:

1. SP: 32–1986,Hand book on functional requirements of Industrial buildings (Lighting and ventilation).
2. G.W.Owens, P.R.Knowles and P.J.Dowling- Steel Designers' manual – 5th edition – Blackwell scientific publications.
3. V.Kalayanaraman, Advances in steel structures. Tata McGraw Hill
4. Krishnaraju N., Advanced Reinforced concrete design, CBS Publishers.
5. K.K.Mc Kelvey and Maxey Brooke, The Industrial Cooling Tower, Elsevier Publishing Co.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES10 302 (B) PROBABILITY METHODS IN CIVIL ENGINEERING

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

Objective: *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.*

Module I (16 Hours)

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 – Functions of two dimensional random variables – Regression Curve – Correlation, Analytical problems based on Civil Engineering context-eg. sampling and quality control.

Module II (16 Hours)

Estimation Theory - Unbiased Estimators – Method of Moments – Maximum Likelihood Estimation - Curve fitting by Principle of least squares – Regression Lines

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.

Module III (11 Hours)

Multivariate analysis - Covariance matrix – Correlation Matrix – Multivariate Normal density function – Principal components – Sample variation by principal components – Principal components by graphing- Analytical problems based on Civil Engineering context – eg. problems on reliability.

Module IV (11 Hours)

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.

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 Engineers, 3rd Edition, Wiley India, 2007.
4. A.H.S. Ang and W. H. Tang, "Probability Concepts in Engineering Planning and Design", Volume I and II.

Reference books

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

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES 10 302 (C) STRUCTURAL OPTIMIZATION AND RELIABILITY ANALYSIS

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

Objectives:

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

Module I (12 hours)

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.

Module II (14 hours)

Applications of linear programming problems in civil engineering - limit design of steel portal frames.
Introduction to Dynamic programming, Geometric programming.
Introduction to Genetic Algorithms- basic concept - problem formulation - operations-convergence criteria.

Module III (14 hours)

Concepts of structural safety- Probability theory:- Introduction, random events, random variables, functions of random variables, moments and expectation, common probability distributions. 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.

Module IV (14 hours)

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 partial safety factors, development of reliability based design criteria.

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, McGraw-Hill.
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.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES 10 302 (D) FORENSIC ENGINEERING AND REHABILITATION OF STRUCTURES

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

Objective: *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.*

Module I (12hours)

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

Module II (16hours)

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 optic method for prediction of structural weakness assessments

Module III (13hours)

Environmental Problems and Natural Hazards: Effect of corrosive environments, chemical and marine environments – pollution and carbonation problems – detection and measurement of corrosion, durability of RCC structures – damage due to earthquakes and strengthening of buildings – provisions of BIS 1893 and 4326

Module IV (13hours)

Modern Techniques of Retrofitting: Structural elements - first aid after a disaster – guniting, jacketing – 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.

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 –
6. Kenneth and Carper, Forensic Engineering.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES 10 303(P) INDUSTRIAL TRAINING

Credit: 1

Teaching Scheme: 1 hour per week

The students have to arrange and undergo an industrial training of minimum two weeks in an industry during the semester break after semester 2 and complete within 15 calendar days from the start of semester 3. (The venue of training may also be a construction site of any sizeable structure or design office or a combination of both, approved by the Head of the Department.). The students are required to submit a report of the training undergone and present the contents of the report before the evaluation committee constituted by the department. Evaluation committee will award the marks of end semester examination based on quality of training undergone, contents of the report and presentation.

End semester examination: Marks 50

CES 10 304(P) MASTERS RESEARCH PROJECT PHASE I

Credits: 6

Teaching scheme: 22 hours per week

Objective: *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*.

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.

Internal continuous assessment: 300 marks

The marks of internal continuous assessment will be based on interim reviews/evaluations by the guide along with evaluation committee consisting of two other internal faculty members.

	Guide :	Evaluation committee
First review	50	50
Second review	100	100

SEMESTER 4

CES 10 401(P) MASTERS RESEARCH PROJECT PHASE II

Credits: 12

Teaching scheme: 30 hours per week

Master Research project phase II is a continuation of project phase I started in the third semester. Towards the end of the semester there would be a pre-submission presentation to the evaluation committee to assess the quality and quantum of the work done. This would be a pre-qualifying exercise for the students for getting approval by the departmental committee for the submission of the thesis. At least one technical paper is to be prepared for possible publication in journal or conference. The technical paper is to be submitted along with the thesis. The final evaluation of the project will be external.

Internal Continuous assessment: 300 marks

	Guide	Evaluation committee
First review	50	50
Second review	100	100

Semester End Examination: 300 marks

Project Evaluation by external examiner: 150 marks

Viva Voce by external and internal examiner: 150 marks (75 marks each)

Total: 600 marks
