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| **KERALA TECHNOLOGICAL UNIVERSITY**  http://ktu.edu.in/images/logo_final.png  **SCHEME AND SYLLABUS**  **FOR**  **M. Tech. DEGREE PROGRAMME**  **IN**  **CIVIL ENGINEERING**  **WITH SPECIALIZATION**  **COMPUTER AIDED STRUCTURAL ENGINEERING**  **CLUSTER 05 (ERNAKULAM II)**  **KERALA TECHNOLOGICAL UNIVERSITY CET Campus, Thiruvananthapuram Kerala, India -695016**  **(2015 ADMISSION ONWARDS)** |

**KERALA TECHNOLOGICAL UNIVERSITY**

**SCHEME AND SYLLABUS FOR M. Tech. DEGREE PROGRAMME**

**Branch: CIVIL ENGINEERING**

**Specialization: COMPUTER AIDED STRUCTURAL ENGINEERING**

**SEMESTER - I**

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| **ExamSlot.** | **Course No.** | **Subject** | **Hrs / Week** | | | **Internal Marks** | **End Semester Exam** | | **Credits** |
| **L** | **T** | **P** | **Marks** | **Duration (Hrs)** |
| A | **05CE6001** | **Advanced Design of Concrete Structures** | **3** | **1** | **0** | **40** | **60** | **3** | **4** |
| B | **05CE6003** | **Theory of Elasticity** | **3** | **1** | **0** | **40** | **60** | **3** | **4** |
| C | **05CE6005** | **Structural Dynamics** | **3** | **1** | **0** | **40** | **60** | **3** | **4** |
| D | **05CE6007** | Prestressed Concrete | **2** | **1** | **0** | **40** | **60** | **3** | **3** |
| E | **05CE601X** | **Elective - I** | **2** | **1** | **0** | **40** | **60** | **3** | **3** |
|  | **05CE6077** | **Research Methodology** | **1** | **1** | **0** | **100** | **0** | **0** | **2** |
|  | **05CE6091** | **Structural Engineering Design Studio** | **0** | **0** | **2** | **100** | **0** | **0** | **1** |
| **Total** | | | **14** | **6** | **2** |  |  |  | **21** |

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| **Elective-I** | |
| **05CE6011** | Advanced Analysis of Structures |
| **05CE6013** | Computer Aided Design |
| **05CE6015** | Design of Offshore Structures |

**SEMESTER -II**

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| **ExamSlot.** | **Course No.** | **Subject** | **Hrs / Week** | | | **Internal Marks** | **End Semester Exam** | | **Credits** |
| **L** | **T** | **P** | **Marks** | **Duration (Hrs)** |
| A | **05CE 6002** | **Finite Element Analysis** | **3** | **1** | **0** | **40** | **60** | **3** | **4** |
| B | **05CE 6004** | **Bridge Engineering** | **2** | **1** | **0** | **40** | **60** | **3** | **3** |
| C | **05CE 6006** | **Theory of Plates and Shells** | **2** | **1** | **0** | **40** | **60** | **3** | **3** |
| D | **05CE 602X** | Elective II | **2** | **1** | **0** | **40** | **60** | **3** | **3** |
| E | **05CE 603X** | **Elective - III** | **2** | **1** | **0** | **40** | **60** | **3** | **3** |
|  | **05CE 6066** | **Seminar - I** | **0** | **0** | **2** | **100** | **0** | **0** | **2** |
|  | **05CE 6088** | **Mini Project** | **0** | **0** | **4** | **100** | **0** | **0** | **2** |
|  | **05CE 6092** | **Computer Application Lab** | **0** | **0** | **2** | **100** | **0** | **0** | **1** |
| **Total** | | | **11** | **5** | **8** |  |  |  | **21** |

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| **Elective-II** | | **Elective-III** | |
| **05CE 6022** | Earthquake Resistant Design of Structures | **05CE 6032** | Microstructure and Innovations in Structural Concrete |
| **05CE 6024** | Structural Reliability | **05CE 6034** | Engineering Fracture Mechanics |
| **05CE 6026** | Design of Substructures | **05CE 6036** | Structural Optimization |

**SEMESTER – III**

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| **ExamSlot.** | **Course No.** | **Subject** | **Hrs / Week** | | | **Internal Marks** | **End Semester Exam. valuation Scheme (Marks)** | | **Credits** |
| **L** | **T** | **P** | **Marks** | **Duration (Hrs)** |
| A | **05CE 704X** | **Elective IV** | **2** | **1** | **0** | **40** | **60** | **3** | **3** |
| B | **05CE 705X** | **Elective V** | **2** | **1** | **0** | **40** | **60** | **3** | **3** |
|  | **05CE 7067** | **Seminar - II** | **0** | **0** | **2** | **100** | **0** | **0** | **2** |
|  | **05CE 7087** | **Project (Phase 1)** | **0** | **0** | **8** | **50** | **0** | **0** | **6** |
| **Total** | | | **4** | **2** | **10** |  |  |  | **14** |

**SEMESTER – IV**

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| **ExamSlot.** | **Course No.** | **Subject** | **Hrs / Week** | | | **Internal Marks** | **End Semester Exam. valuation Scheme (Marks)** | | **Credits** |
| **L** | **T** | **P** | **Marks** | **Duration (Hrs)** |
|  | **05CE 7088** | **Project (Phase II)** | **0** | **0** | **21** | **Internal-70** | **0** | **0** | **12** |
| **External-30** |
| **Total** | | | **0** | **0** | **21** | **100** |  |  | **12** |

TOTAL: 68

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE 6001** | | **ADVANCED DESIGNS OF CONCRETE STRUCTURES** | 3-1-0-4 | 2015 | |
| COURSE OBJECTIVES:  The objective of this course is to make students to learn principles of Structural Design, to design different types of structures and to detail the structures. To evaluate performance of the structures  **COURSE OUTCOMES:**  On successful completion of this course, students are able to   * Understand the principles of Structural Design * Design and develop analytical skills. * Summarize the principles of Structural Design and detailing * Understands the structural performance. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Yield line method of analysis of slabs:– Characteristic features of yield lines– analysis by virtual work method – Yield line analysis by equilibrium method, Design of grid floor –Approximate method (IS code method). | | | | 9 |
| **INTERNAL TEST 1(Module 1)** | | | | | |
| **II** | Design of continuous beams:- Redistribution of moments, Design of portal frames. Design of building frames, Design of Pile foundation: Pile and Pile cap- single and group with friction and end bearing. | | | | 9 |
| **INTERNAL TEST 2(Module 2)** | | | | | |
| **III** | Design of special RC elements: – Design of slender columns, Design of shear walls (with and without boundary elements), Design of Deep beams, Design of corbels | | | | 10 |
| **IV** | Design of flat slabs:– Introduction–components–IS Code recommendations– IS code method of design- with and without drop- interior and exterior panels. | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**   1. Pippard A J S, “The Analysis of Engineering Structures”, Edward Arnold Publishers Ltd. 2. Krishna Raju N., “Advanced Reinforced Concrete Design”, CBS Publishers and distributers, New Delhi. 3. Krishna Raju., “Design of Reinforced Concrete Structures” 4. Punmia,Ashok K Jain,Arun K Jain,”Reinforced Concrete Vol:II”. 5. P C Varghese, “Limit State Design of concrete structures”. 6. P C Varghese, “Foundation engineering”. 7. S Ramamrutham, R Narayan., “Design of Reinforced Concrete Structures” 8. S S Bhavikatti , "Advance R.C.C Design Vol II". 9. Rajagopalan, “Design of Storage structures” 10. Reynolds Handbook. 11. Relevant IS Codes. 12. Menon & Pillai – “Design of R.C.C. Structures” 13. Bikash Chandra chattophadhyay, Joyanta maity, “Foundation engineering”. 14. N P Kurian, “Design of Foundation Systems”. | | | | | |
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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE 6003** | | **THEORY OF ELASTICITY** | 3-1-0-4 | 2015 | |
| COURSE OBJECTIVES:   1. To introduce concept of stress and strain in three dimensional bodies along with compatibility, equilibrium and boundary conditions. 2. To introduce the concept of plane stress, plane strain and stress function for actual continuum problems. 3. To introduce the concept of warping and torsion in non-circular and thin-walled sections incorporating classical theories. 4. To introduce concept of plastic stage, plastic flow and elasto-plastic analysis in continuum problems. 5. To acquire knowledge of various failure criteria for general stress states.   **COURSE OUTCOMES:**  On successful completion of this course, students are able to   * Develop the concept of stress-strain tensors and their relationships in 3D continuum problems. * Idealize physical problems into plane stress and plane strain problems and solve them using stress functions. * Identify the effect of torsion in thin-walled and irregular closed/open sections. * Apply various failure criteria for general stress states at points. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | **Elasticity**  Basic concepts– Body force–Surface traction–Stresses and strains–Three dimensional stresses and strains–analysis–transformation equations of 3D stresses & strains–principal stresses & strains–States of stresses & strain–Equilibrium equations–generalised Hooke’s Law–Compatibility Conditions–Boundary conditions. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | **Two dimensional stress–strain problems**  Plane stress and plain strain– Analysis–transformation equations–stress–strain relations–equilibrium equations in Cartesian and polar co ordinates Airy’s stress function– Biharmonic Equilibrium–St Venant’s principle–2D problems in Cartesian coordinate–cantilever with concentrated load at free end–Cantilever with moment at free end. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | **Torsion**  Torsion of prismatic bar– General solution–Warping function approaches – St. Venant’s theory– Membrane analogy– Sand heap analogy– Torsion of Non Circular sections – Torsion of multi celled thin wall open and closed sections. | | | | 10 |
| **IV** | **Plasticity**  Introduction to plasticity – General concepts – Stress – Strain curves – Ideal plastic body – Plastic flow conditions – theories of failure – plastic work – Plastic potential – Yield criteria – Simple applications – Elasto – plastic analysis for bending and torsion of bars – Residual stresses. | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**   1. Timoshenko S P and Goodier J. N, “Theory of Elasticity”, Tata Mcgraw Hill International Student Edition. 2. Johnson W and Mellor P. B, “Plasticity for mechanical engineers”, Van Nostrand Company Ltd. 3. Sadhu Singh, “Theory of elasticity”, Khanna Publishers, Delhi. 4. Sadhu Singh, “Theory of Plasticity”, Khanna Publishers, Delhi. 5. Srinath L. S, “Advanced mechanics of solids”, Tata McGraw– Hill Publishing Company Ltd., New Delhi. 6. Arthur P Boresi & Omar M SideBottom, “Advanced Mechanics of Materials”, John Wiley & Sons. 7. Sokolnikoff, “Mathematical Theory of Elasticity”. 8. T. G. Seetharam, L. Govinda Raju, “ Applied Elasticity”. | | | | | |
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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE 6005** | | **STRUCTURAL DYNAMICS** | 3-1-0-4 | 2015 | |
| COURSE OBJECTIVES:  To provide a good understanding of the basic principles of structural dynamics. To formulate equations of motion for continuous structures, single and multiple-degree of freedom structures subjected to various dynamic loads. Emphasizing the relevance of damping, resonance and lumping of mass in vibration problems. Solving dynamic problems using analytical and approximate methods and evaluate the dynamic characteristics of the structures.  **COURSE OUTCOMES:**  On successful completion of this course, students are able to  • To understand the basic concepts of structural dynamics and relevance modeling structures as continuous system, single or multiple degree-of-freedom systems.  • To apply the principles of structural dynamics to practical problems.  • Express structural dynamics problem as equivalent problems of statics.  • Understand the significance of damping and resonance in structures. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | **Introduction**  Objectives - types of dynamic problems - degree of freedom - D’ Alemberts Principle - principle of virtual displacement- Hamilton’s principle. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | **Single Degree of Freedom System**  Undamped and damped free and forced vibrations −critical damping − over damping − under damping − logarithmic decrement. response to harmonic loading − evaluation of damping − vibration isolation − transmissibility − response to periodic forces- vibration measuring equipments. Duhamel integral for undamped system - Response to impulsive loads. | | | | 9 |

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| **INTERNAL TEST 2 (Module 2)** | | |
| **III** | **Multidegree Freedom Systems and Continuous systems**  Natural modes − orthogonality conditions − free and harmonic vibration − Free longitudinal vibration of bars and flexural vibration of beams with different end conditions . Forced vibration:- mode superposition method- mode acceleration method | 10 |
| **IV** | **Approximate methods for Multidegree Freedom Systems (free vibration)**Rayleigh’s method − Dunkerley’s method − Stodola’s method − Rayleigh –Ritz method − Matrix method. | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | |
| **REFERENCES:**   1. Clough & Penzien, “Dynamics of Structures”. 2. Meirovitch.L, “Elements of Vibration Analysis”. 3. W.T. Thomson , “Vibration Theory and Applications”. 4. M.Mukhopadhyay , “Vibrations, Dynamics & Structural systems”. 5. Paz Mario, “Structural Dynamics–Theory and Computation”. 6. Denhartog, “Mechanical vibrations”. 7. Timoshenko, “Vibration Problems in Engineering”. 8. Anil K Chopra, “Dynamics of structures”, Pearson Education. | | |
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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE 6007** | | **PRESTRESSED CONCRETE** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:   * To introduce the need for prestressing as well as the methods, types and advantages of  prestressing to the students. * To understand the basic concepts of Prestressed Concrete. * To study various devices used for Prestressing. * Students will be introduced to the behavior of prestressed concrete structures subjected to flexure and shear. * To analysis and design the basic structural members in Prestressed concrete based on relevant codal provisions. * To analysis and design the special structures like Prestressed Concrete Pipes, Liquid Storage Tanks and Concrete Poles.   **COURSE OUTCOMES:**  On successful completion of this course, students are able to   * *Understand the basic concepts of Prestressed Concrete, methods and its use.* * *Analyse, Comprehend the design and detailing of Prestressed concrete structures used in practice* | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | **Introduction: -** Basic concept of Prestressing, Analysis of prestress and bending stress: - Stress concept, Strength concept: - Pressure line and internal resisting couple and Load balancing concept for extreme fiber stresses for various tendon profile. Systems of Prestressing: - Pre tensioning and Post tensioning, Thermo elastic and Chemical prestressing. Tensioning devises and Systems, Materials for Prestressed concrete: - Need of high strength concrete and steel, Advantages of prestressed concrete over reinforced concrete.  **Losses of Prestress: -** Losses of Prestress:- Stages of losses, Types of losses in pre-tensioning and post-tensioning due to Elastic shortening, Shrinkage, Creep, Relaxation, Anchorage Slip, Friction and Sudden changes in temperature. Graphical method for friction loss, Methods of overcoming friction losses. Concept of reduction factor.  **Deflection of beams: -** Short term, Load deflection curve, Importance of control of deflections, factors influencing deflections, Pre- cracking and Post- cracking, Effect of tendon profile on deflections, Prediction of long term (Concept only,) | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | **Cracking and Failure: -** Micro and visible cracking, Stresses in steel due to loads. Failure: - Flexural failure, Shear failure, other modes of failure.  **Elastic Design**: - Shear and Torsional Resistance of PSC members: - shear and Principal stresses, Ultimate shear resistance of PSC members: - Section cracked and uncracked, Design for shear using IS code. PSC members in torsion:-Pure torsion, Combined bending moment and torsion, Combined bending moment, shear and torsion: - Codified procedures, Design of reinforcement using IS code provision. Flexuralstrength: - Simplified code procedure for bonded and unbonded symmetrical and unsymmetrical sections. Behavior under flexure: - Codel provision for Limit state design:-Design stress strain curve for concrete. Design of sections for flexure: - Expressions for minimum section modulus, Prestressing force and Eccentricity. Design: - Analytical and Graphical. Limiting zone for prestressing force.  **End blocks: -** Anchorage zoneStresses, Stress distribution in end block,Methods of investigation, Anchorage zone reinforcements, Design (IS Code method only) | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | **Design of Pretensioned and Post-Tensioned Flexural Members: -** Dimensioning of Flexural members, Estimation of Self Weight of Beams, Design of Pre tensioned and Post tensioned members symmetrical about vertical axis.  **Design of Compression members (Concepts only, no design expected) :-**Design ofcompression members, with and without flexure, its application in the design of Piles, Flag masts and similar structures.  **Prestressing of statically indeterminate structures: -** Advantages, Effect, Method of achieving continuity, Primary, Secondary and Resultant moments, Pressure line, Concept of Linear transformation, Guyon’s theorem, Concordant cable profile. | | | | 10 |
| **IV** | **Composite construction of Prestressed and in situ Concrete: -** Types, Analysis of stresses, Differential shrinkage, Flexural strength, Shear strength, Design of composite section.  **Tension members: -** Load factor, Limit state of cracking, Collapse, Design of sections for axial tension.  **Design of Special Structures (concept only, no design expected):-** Prestressed Folded plates, Cylindrical Shells, Pipes, Circular water tanks | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**   1. T.Y. Lin and H. Burns Ned., “Design of prestressed concrete structures”, John Wiley and sons, New York. 2. N. Krishna Raju, “Prestressed concrete”, Tata McGraw Hill Publishing Co.Ltd. 3. BIS, IS: 1343-1980, “Code of Practice for Prestressed Concrete”, Bureau of Indian standards, India. 4. R. H. Evans and E. W. Bennet, “Prestressed Concrete Theory and Design”, Chapman and Hall, London. 5. N. Rajagopal, “Prestressed Concrete”, Narosa Publishing House, New Delhi. 6. S. Ramamrutham, “Prestressed Concrete”, Dhanpat Rai Publishing Company (P) Ltd., New Delhi. 7. Y. Guyon, “Prestressed Concrete”, C. R. Books Ltd., London. 8. P.W. Abeles, “An Introduction to prestressed Concrete”, Vol. I & II, Concrete Publications Ltd., London. 9. H. Nilson Arthur, “Design of Prestressed Concrete”, 2nd edn. John Wiley and Sons, New York. 10. F. Leonhardt, “Prestressed Concrete and Construction2nd edn.” Wilhelm Ernst and Sohn, Berlin,Munich | | | | | |
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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE 6011** | | **ADVANCED ANALYSIS OF STRUCTURES** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:  To familiarise and review the basic concepts of structural analysis and focus on analysis of statically and kinematically determinate and indeterminate structures especially skeletal structures like plane trusses, beams and grids and plane frames using flexibility and stiffness method.  **COURSE OUTCOMES:**  On successful completion of this course, students are able to   * Appreciate significance of matrix method (flexibility and stiffness methods) as a tool foranalysing structural forms with far less computational effort. * Enable a good understanding of stiffness method and its application in commercial softwarepackages | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | **Matrix methods**  Review of work and energy principles **-** Maxwell, Betti, Castigliano theorems- principles virtual work-Classification of structures–discrete structures–elements–nodes–degrees of freedom–static& kinematic indeterminacy Stiffness method–coordinate systems–element stiffness matrix. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | **Element approach**  Stiffness method – analysis of pin jointed frames (temperature effect, lack of fit), continuous beams (settlement of supports), rigid jointed frames and grids. | | | | 9 |

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| **INTERNAL TEST 2 (Module 2)** | | |
| **III** | **Direct stiffness approach**  Structure stiffness matrix–assembly–equivalent joint load – incorporation of boundary conditions –solutions–Gauss elimination–matrix inversion–analysis of pin jointed frames, continuous beams. | 10 |
| **IV** | **Flexibility method**  ElementFlexibility matrix–truss element–beam element–force transformation matrix – equilibrium–compatibility–analysis of beams & frames (rigid and pin jointed), grids. | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | |
| **REFERENCES:**   1. Weaver & Gere, “Matrix Analysis of Structures”, East West Press. 2. Moshe F Rubinstein– “Matrix Computer Analysis of Structures”– Prentice Hall, 1969. 3. Meek J.L., “Matrix Structural Analysis”, McGraw Hill, 1971. 4. Reddy C.S., “Basic Structural Analysis”, Tata McGraw Hill Publishing Co.1996. 5. Smith J.C. “Structural Analysis”, Macmillian Pub.Co.1985. 6. Rajesekharan & Sankarasubramanian,G., “Computational Structural Mechanics”, Prentice Hall of India, 2001. 7. Mukhopadhyay M., “Matrix Finite Element Computer and Structural Analysis”, Oxford & IBH, 1984. 8. Wang C.K.& Solomon C.G.,” Introductory Structural Analysis”, McGraw Hill.1968. 9. Pezemieniecki, J.S, “Theory of Matrix Structural Analysis”, McGraw Hill Co.,1984. 10. Seeli F.B.& Smith J.P., “Advanced Mechanics of Materials”, John Wiley &Sons, 1993. 11. Norris & Wilbur, “Elementary Structural Analysis”, McGraw Hill. 12. Damodar Maity, “Computer Analysis of Framed Structures”, I K International. | | |
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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE 6013** | | **COMPUTER AIDED DESIGN** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:   * Calculation of distribution of forces within the structure and the displaced state of the system forms the crux of design process. * The objective of this course is to make students to learn computer aided methods of analysis adopted in industry for such purposes.   **COURSE OUTCOMES:**  On successful completion of this course, students are able to   * Idealize the actual structural systems, for the purpose of analysis, in the form of an acceptable simple frame work consisting of one dimensional elements being connected at joint locations. * Understand implementation procedures of such methods in computer programs. * Achieve Knowledge of problem solving skills using computer aided methods. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | History and overview of CAD– advantages of CAD over manual drafting and design – hardware requirements – computers and workstation, elements of interactive graphics, input/out put display, storage devices in CAD, and an overview of CAD software – 2D Graphics, 3D Graphics. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Popular CAD packages, Type of structure, Unit systems, structure geometry and Co-ordinate systems - global co- ordinate system, Local co-ordinate systems –Relationship between Global and Local co-ordinate systems Edit Input-Command Formats-Text Input. Graphical Input Generation-“Concurrent” Verifications- Library-Geometry-Generation–Dimensioning-loading- Analysis. | | | | 9 |

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| **INTERNAL TEST 2 (Module 2)** | | |
| **III** | Construction activities:- The critical path method- Definitions of terms and symbols- Steps in critical path scheduling- Developing a critical path schedule - Determining free float- Determining total cost of project - Manual versus Computer analysis of critical path methods­­–Popular packages in Construction Management and MIS. | 10 |
| **IV** | Information types and uses:- General application software’s- Civil engineering packages, Project management software, advanced structural engineering software’s, Expert systems for construction. | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | |
| **REFERENCES:**   1. Sujith Kumar Roy & Subrata Chakrabarty, “Fundamentals of Structural Analysis”, S Chand $ Company Ltd., New Delhi. 2. B.Sengupta & H. Guha, “Construction Management and Planning”, Tata Mc Graw Hill Publishing Co. Ltd, New Dehi. 3. R.L Peurifoy, “Constuction Planning, Equipment and methods”, Tata Mc Graw Hill Publishing Co. Ltd, Kogakusha. 4. Mikell P. Groover & Emroy W Zimmers,Jr, “CAD/CAM Computer Aided Design and Computer Aided Manufacturing” 5. Reference Manuals of Packages. 6. L S Sreenath, CPM – PERT. 7. C.S. Krishnamoorthy, S.Rajeev, A Rajaraman, “Computer Aided Design – Software and Analytical Tools”, Narosa Publishing House, New Delhi | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE6015** | | **DESIGNS OF OFFSHORE STRUCTURES** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:  To study the concept of wave theories, wave forces and design of jacket towers, marine pipes and cables.  **COURSE OUTCOMES:**  On successful completion of this course, students are able to   * Understand wave theory and estimate wave forces on structures * Create idealized models of different offshore structure * Do foundation analysis and dynamic analysis of offshore structures * Do the design of offshore structures | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | **Wave Theories:–**Wave generation process, small and finite amplitude wave theories.  **Forces of Offshore Structures:–**Wind forces, wave forces on vertical, inclined cylinders, structures – current forces and use of Morison equation. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | **Subsea Soil and Offshore Structure Modeling:–**Different types of offshore structures, foundation modeling, structural modeling of fixed offshore structures like jacket & jackups.  . | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | **Analysis of Offshore Structures:–**Static method of analysis, foundation analysis and dynamics of offshore structures – Numerical examples of jacket structures. | | | | 10 |
| **IV** | **Design of Offshore Structures:–**Design of platforms, helipads, Jacket tower and mooring cables and pipe lines. | | | | 8 |

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| **END SEMESTER EXAM (ALL Modules)** |
| **REFERENCES:**   1. Chakrabarti, S.K. ,”Hydrodynamics of Offshore Structures”, Computational Mechanics Publications, 1987. 2. Thomas H. Dawson, “Offshore Structural Engineering”, Prentice Hall Inc Englewood Cliffs, N.J. 1983 3. API, Recommended Practice for Planning, “Designing and Constructing Fixed Offshore Platforms”, American Petroleum Institute Publication, RP2A, Dalls, Tex. 4. Wiegel, R.L., “Oceanographical Engineering”, Prentice Hall Inc, Englewood Cliffs, N.J. 1964. 5. Brebia, C.A.Walker, S., “Dynamic Analysis of Offshore Structures”, New–nes Butterworths, U.K. 1979. 6. Reddy, D.V. and Arockiasamy, M., “Offshore Structures”, Vol.1, Krieger Publishing Company, Florida, 1991. |
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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE6077** | | **RESEARCH METHODOLOGY** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:  To generate awareness about the importance, types and stages of research along with different methods for data collection, analysis, interpretation and presentation of the results.  **COURSE OUTCOMES:**  On successful completion of this course, students are able to understand   * The significance of different types of research and its various stages. * The different methods of data collection. * Different methods for analyzing data and interpreting the results. * The proper way of reporting and presenting the outcome. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Introduction to research methodology. Types of research, research methods Vs methodology - stages of research process. Literature review – Problem definition- Research design for exploratory, descriptive and experimental research – Brief introduction to completely randomized design, randomized block design and Latin square designs (description only). | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Sampling fundamentals -Types of sampling: probability and non-probability sampling. Sampling theory, sampling distribution and sample size determination. Tools and techniques of data collection: Questionnaire and schedule for field surveys, interview, observation, simulation, experimental and case study methods. Collection, recording, editing, coding and scaling of data. Scale classification and types. Measurement of validity, reliability and practicality. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Descriptive and inferential statistics - Data analysis and interpretation –testing of hypothesis, testing of population mean, variance and proportion –Z test – t test – F test - chi square test. Test for correlation and regression –standard error of the estimate. Testing goodness of fit. | | | | 10 |
| **IV** | Meaning of interpretation and inference: importance and care for interpreting results. Presentation of reports: popular reports and technical reports - structure and style. Oral and written presentations: Parts of a research report. Guidelines for writing research papers and reports – Writing different sections of a research paper – Introduction, Methodology, Results, Discussion, Conclusion, Abstract – Writing the title. Methods of giving references and appendices: referencing styles. Ethics in research. Use of computers and internet in research. | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**   1. C. R. Kothari, Research Methodology, Methods and techniques (New Age International Publishers, New Delhi, 2004). 2. R. Panneerseklvam, Research Methodology (Prentice Hall of India, New Delhi, 2011). 3. Ranjit Kumar, Research Methodology, A step by step approach (Pearson Publishers, New Delhi, 2005. 4. Management Research Methodology : K. N. Krishnaswami, Appa Iyer and M Mathirajan, Pearson Education, Delhi, 2010 5. Hand Book of Research Methodology : M N Borse, Sree Nivas Publications, Jaipur, 2004 6. Business Research Methods: William G Zikmund, South – Western Ltd, 2003 7. Research Methods in Social Science: P K Majumdar, Viva Books Pvt Ltd, New Delhi, 2005 8. Analyzing Quantitative Data: Norman Blaikie, SAGE Publications , London, 2003 9. SPSS for Windows: Pearson Education New Delhi, 2007 | | | | | |
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| COURSE CODE | COURSE NAME | L-T-P-C | YEAR |
| **05CE 6091** | **STRUCTURAL ENGINEERING DESIGN STUDIO** | 0-0-2-1 | 2015 |
| COURSE OBJECTIVES:  The objective of this course is to make students to learn the softwares for structural analysis and design, To investigate the performance of structures for static and dynamic forces.  **COURSE OUTCOMES:**  On completion of this course, students are able to   * Achieve Knowledge of structural design * Understand the principles of structural analysis and design * Design and develop analytical skills. * Summerise the performance of structures for static and dynamic forces..   Application of Structural analysis & design software like STRAP and STAAD. The student has to practice the packages by working out different types of problems.  **STAAD & STRAP**  Linear Static Analysis, design & detailing of Continuous Beams, Portal Frames, Truss (2D and 3D), Multistoried Building.  Loading: Dead Load, Live Load, Wind Load ( IS: 875 Part 1 / Part 2 / Part 3), Earth Quake Load (IS: 1893 Part 1) and its Combinations as per codal Provisions | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE 6002** | | **FINITE ELEMENT ANALYSIS** | 3-1-0-4 | 2015 | |
| COURSE OBJECTIVES:   1. To provide the student with knowledge and analysis skills in applying basic laws and steps used in solving the problem by finite element method. 2. To develop ability to identify the physical problem and idealize into mathematical model and then to finite element model. 3. To provide knowledge of various interpolation functions to solve problems by finite element method. 4. To familiarize various finite elements existing in the finite element library. 5. To develop an ability to solve continuum problems in a realistic and effective manner using existing software package.   **COURSE OUTCOMES:**  On successful completion of this course, students are able to   * Tackle all engineering continuum problems. * Idealize actual physical problems into mathematical model and then to a finite element model. * Solve continuum mechanics problem using existing finite element method software packages. * Evaluate, interpret and assess the accuracy of finite element analysis results for design and evaluation purposes.   Extend the knowledge of the application of finite element to solve civil engineering problems | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | **Introduction to FEM** - Historical development - Idealization of structures -Mathematical model - General procedure of FEA - Displacement approach.  Variational principles weighted residual approach and method of virtual work. Derivation of equilibrium equations. | | | | 9 |

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| **INTERNAL TEST 1 (Module 1)** | | |
| **II** | **Shape functions** – Polynomials - Lagrangian and Hermition Interpolation – Generalised coordinates – Natural coordinates - Compatibility - C0 and C1 elements - Convergence criteria - Conforming & nonconforming elements – Patch test. | 9 |
| **INTERNAL TEST 2 (Module 2)** | | |
| **III** | **Stiffness matrix** - Bar element - Beam element - Plane stress and plane strain and axisymmetric problems -Triangular elements - Constant Strain Triangle - Linear Strain Triangle – Legrangian and Serendipity elements, static condensation - **Isoparametric elements** - Numerical Integration.- Gauss- Quadrature. | 10 |
| **IV** | **General plate bending elements** - Plate bending theory – Kirchhoff’s theory – Mindlin’s theory – locking problems - preventive measures – reduced integration – selective integration-spurious modes. | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | |
| **REFERENCES:**   1. O C Zienkiewicz,.”Finite Element Method”, fifth Edition,McGraw Hill, 2002 2. R.D.Cook, “Concepts and Applications of Finite Element Analysis”, John Wiley & Sons. 3. C.S.Krishnamoorthy, ”Finite Element Analysis”,Tata McGraw Hill .New Delhi,1987. 4. S.Rajasekharan, “Finite Element Analysis in Engineering Design”, S Chand & Co. Ltd.1999. 5. T.Kant, “Finite Element Methods in Computational Mechanics”,Pergamons Press. 6. K.J.Bathe, “Finite Element Procedures in Engineering Analysis”.,Prentice Hall, 7. Mukhopadhyay M.,Matrix “Finite Element Computer and Structural Analysis”,Oxford & IBH,1984. 8. Irving H.Shames,”Energy &Finite Element Methods in Structural Mechanics”. 9. Desai C.S. & Abel J.F., “Introduction to Finite Element Methods”, East West Press. | | |
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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE 6004** | | **BRIDGE ENGINEERING** | 3-1-0-4 | 2015 | |
| COURSE OBJECTIVES:  The objective of this course is to make students to learn principles of Structural Design,It provides the foundation for advanced design and bridge analysis and design. To evaluate performances of the structures.  **COURSE OUTCOMES:**  On completion of this course, students are able to   * Understand and use the basic concepts in proportioning and design of bridges in terms of aesthetics, geographical location and functionality. * Develop an intuitive feeling about the sizing of bridge elements and the conceptual design part * Assess the load flow mechanism and loads on bridges. * Design of bridge and its foundation starting from conceptual design, selecting suitable bridge, geometry to sizing of its elements | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | **Planning of bridges:**– Investigation for bridges– need for investigation– selection of site– economical span– subsoil exploration– investigation report– importance for proper investigation–Design of RCC bridges**–** IRC loading– types of bridges– components of bridges– analysis and design of slab bridges and box culvert. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | **Design of girder bridges:–** T-beam bridges– Analysis and design of deck slab,longitudinal girders and cross girders–Pigeaud’s method– Courbon’s method– Morice and Little method– Hendry–Jaegar method– prestressed concrete bridges( simply supported case only). | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | **Bearings:–** importance of bearings– bearings for slab bridges– bearings for girder bridges–Design of elastomeric bearings –Joints –Appurtenances. Substructure- different types- materials for piers and abutments- substructure design– piers and abutments – shallow footings – well foundation. | | | | 10 |
| **IV** | **Construction methods:**– Inspection and maintenance and construction of bridges–case studies of recently constructed major bridges–critical studies of failure of major bridges.  Features of suspension bridges and cable stay bridges. | | | | 8 |

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| **END SEMESTER EXAM (ALL Modules)** |
| **REFERENCES:**  1. Raina V.K (1991), “Concrete Bridge Practice– Analysis, design & economics”, Tata Mc–GrawHill, publishing company, New Delhi.  2. Raina V.K (1988), “Concrete Bridge Practice– Construction Maintenance & Rehabilitation”, Tata Mc–GrawHill, publishing company, New Delhi.  3. Victor D.J (19991), “Essentials of Bridge Engineering”, Oxford & IBH publishing company, New Delhi.  4. Ponnuswami S (1993), “Bridge Engineering”, Tata Mc–GrawHill, publishing company, New Delhi.  5. Krishna Raju N (1996), “Design of Bridges”, TataMcGrawHill, publishing company, New Delhi.  6. Relevant IS Codes, and IRC Codes. |
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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE 6006** | | **THEORIES OF PLATES AND SHELLS** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:   * To generate awareness about different types of plates and their solution strategy when subjected to different types of loads and boundary conditions. * To Generate awareness about different types (and behavior) of shells and their solution strategy when subjected to different types of loads   **COURSE OUTCOMES:**  On successful completion of this course, students are able to   * Classification of plates and relevant theory to be applied for their analysis * The classic theory of thin plates and apply Navier’s and Levy’s solution to analyse problems related to thin plates * Analysis of circular plates subjected to axis symmetric loads * The behavior of shells and apply classic theory (membrane theory and bending theory)  for analysis of simple shells. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | **Plates:-**Introduction- classification of plates- thin plates and thick plates – assumptions in the theory of thin plates- Differential equation for cylindrical bending of rectangular plates.  **Pure bending of plates:-** slope and curvature of slightly bent plates – relation between bending moment and curvature in pure bending – stresses acting on a plate inclined to x and y axes-Particular cases of pure bending of rectangular plates. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | **Laterally loaded rectangular plates:-** Small deflections of Laterally loaded thin plates-Differential equation of plates- derivation of fourth order differential equation -Solution techniques for fourth order differential equation– boundary conditions – simply supported, built- in and free edges.  **Simply Supported rectangular plates under sinusoidal Load:-** Navier solution for simply supported plates subjected to uniformly distributed - Levy’s solution for simply supported rectangular plates – uniformly distributed and concentrated load. | | | | 9 |

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| **INTERNAL TEST 2 (Module 2)** | | |
| **III** | **Circular plates** – polar coordinates – differential equation of symmetrical bending of laterally loaded circular plates- uniformly loaded circular plates with clamped edges and simply supported edges– circular plates loaded at the centre. | 10 |
| **IV** | **Classical theory of Shells –** Structural behaviour of thin shells – Classification of shells – Singly and doubly curved shells with examples – Membrane theory and bending theory of doubly curved shells.-equilibrium equations.  Folded plates – Introduction, Classification, Structural action and analysis. | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | |
| **REFERENCES:**   1. Lloyd Hamilton Donnell, “Beams, plates and shells”, Mc Graw Hill, New York. 2. S.P Timoshenko, S.W Krieger, “Theory of plates and shells”, Mc Graw Hill. 3. Owen F Hughes, “Ship structural design”, John Wiley & Sons, New York, 1983. 4. William Muckle, “Strength of ship structures”, Edqward Arnold Ltd, London, 1967. 5. Gol’oenveizen, “Theory of elastic thin shells”, Pergaman press, 1961. 6. J Ramachandran, “Thin shell theory and problems”, Universities press. 7. Krishna Raju N., “Advanced Reinforced Concrete Design”, CBS Publishers and distributers, New Delhi. 8. G.S Ramaswamy, “Design and Construction of Concrete Shell Roofs”, Tata- McGraw Hill Book Co. Ltd., | | |
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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE 6022** | | **EARTHQUAKE RESISTANT DESIGN OF stRUCTURES** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:   * To understand the principles of engineering seismology. * To provide an idea about earthquakes and its effects on structures. * To introduce the basic concepts of earthquake resistant design. * To study IS code provisions for the analysis, design and detailing of earthquake resistant structures. * To study the methods for improving the performance of buildings during earthquakes. * To learn different techniques to reduce earthquake effects and damage to the structures. * The students will get an idea about the concepts of repair and rehabilitation of earthquake affected structures and apply practically.   **COURSE OUTCOMES:**  On successful completion of this course, students are able to   * The student will understand the basic concepts and its importance on the design of seismic resistant structures. * Select appropriate structural systems, configurations and proportions so as to resist earthquake effects. * Do the design and detailing of structures for seismic resistance as per Indian Standards and for ductile behavior as per codal provisions. * Understand detailing of RCC and steel members * Summarize the Seismic evaluation and retrofitting of structures. * Awareness about disaster management due to earthquakes. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | **Seismic Hazards**:-Need of special emphasis to earthquake engineering, Ground shaking, structural hazards, Liquefaction, Lateral spreading, Landslides, Life line hazards, Tsunami and Seiche hazards.  **The Earth And its Interior: -** The Circulation, Continental drift, Plate tectonics, Plate boundaries, Faults and its geometry.  **The Earthquake: -** Elastic rebound theory, Terminology like hypocenter, epicenter and related distances.  **Seismic Waves: -** Terminology, Body waves: - P- waves and S- waves, Surface waves: – Love waves and Rayleigh waves. Calculation of wave velocity, measuring instruments, locating epicenter of earthquakes numerically from traces and wave velocity.  **Earthquake Size: -** Intensity – RF, MMI, JMA and MSK. Comparison of above. Magnitude – Local magnitude, Calculation (Analytically and graphically), Limitations, Surface wave magnitudes, Moment magnitudes and its Calculation, Saturation of magnitude scales. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | **Earthquake Ground Motion**: - Parameters: - Amplitude, Frequency and duration. Calculation of duration from traces and energy.  **Response Spectra: -** Concept, Design Spectra and normalized spectra, Attenuation and Earthquake Occurrence. Guttenberg- Richter Law.  **Concept of Earthquake Resistant Design: -** Objectives, Design Philosophy, Limit states, Inertia forces in Structure. Response of Structures – Effect of deformations in structure, Lateral Strength, Stiffness, Damping and ductility.  **Floor diaphragms: -**Flexible and rigid, Effect of inplane and out of plane loading, Numerical example for lateral load distribution  **Torsion and Twists in Buildings: -** Causes, Effects, Centre of mass and rigidity.Torsionally coupled and uncoupled system, Lateral load distribution, Numerical example based on IS code recommendation.  **Building Configurations: -** Size of Building, Horizontal and Vertical layout, Vertical irregularities, Adjacency of Building, Open-ground storey and soft storey, short columns. Effect of shear wall on Buildings. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | **R.C.C for Earthquake Resistant Structures**: - How to make buildings ductile, Concept of capacity design, Strong Column weak beam. Ductile design and detailing of beams and shear walls. Calculation of Base shear and its distribution by using codel provision. Detailing of columns and Beam joints. Performance of R.C.C. Building. **Ductiledetailing:-**Study of IS: 13920-1993.  **Repair**: - Methods, Materials and retrofitting techniques. | | | | 10 |
| **IV** | **Earthquakes in India: -** Past earthquakes in India an overview, Behaviour of buildings and structures during past earthquakes and lessons learnt from that.  **Seismic Code: -** Provisions of IS: 1893-2002.  **Masonry Buildings**:- Performance during earthquakes, Methods of improving performance of masonry walls, box action, influence of openings, role of horizontal and vertical bands, rocking of masonry piers.  **Reduction of Earthquake Effects**: - Base Isolation and dampers; Do’s and Don’ts During and after Earthquake. | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**   1. Bruce A. Bolt, “Earth quakes”, W.H. Freeman and Company, New York 2. Pankaj Agarwal and Manish Shrikhande, “Earthquake Resistant Design of Structures”, Prentice Hall of India Private Limited, New Delhi, India. 3. Steven L. Kramer, “Geotechnical Earthquake Engineering”, Pearson Education, India. 4. S. K. Duggal, “Earthquake Resistant Design of Structures”, Oxford University Press, New Delhi. 5. Murthy C. V. R, “Earthquake tips, Building Materials and Technology Promotion Council”, NewDelhi, India. 6. Pauly. T and Priestley M.J.N , “Seismic Design of Reinforced Concrete and   Masonry Buildings”, John Wiley and sons Inc.   1. David A Fanella, “Seismic detailing of Concrete Buildings”, Portland Cement   Association, Illinois.   1. Repair and Strengthening of Reinforced Concrete, Stone and Brick Masonry   Buildings, United Nations Industrial Development Organization, Vienna.   1. BIS, IS: 1893(Part 1)-2002 and IS : 13920-1993, Bureau of Indian Standards. 2. Anil K. Chopra, “Dynamics of Structures”,. Pearson Education, India.   Kamalesh Kumar, “Basic Geotechnical Earthquake Engineering”, | | | | | |
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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE 6024** | | **STRUCTURAL RELIABILITY** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:   * Assessment of safety of structures is a very important task of structural engineers. * The action and response are subjected to statistical variations and are probabilistic. * The primary objective of this course is to learn different methods of evaluation of safety taking into account the variation of design parameters. * To familiarise the structure and properties of the individual components of concrete and their relationship to each other.   **COURSE OUTCOMES:**  On successful completion of this course, students are able to   * Understand the concepts and techniques of reliability and probability distributions. * Define safety format or failure surface for a given actions and response along with their statistics. * Compute reliability index, for the given design details * Arrive at mean value of a dominant design parameter for the target reliability index. * Use simulation techniques to arrive at the statistics of design variables * Identify the structure property relationships. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | **Concepts of structural safety**:-Basic statistics:-Introduction-data reduction-histograms-sample correlation. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | **Probability theory, resistance distribution and parameters:-** Introduction- statistics of properties of concrete and steel, statistics of strength of bricks and mortar, dimensional variations-characterisation of variables of compressive strength of concrete in structures and yield strength of concrete in structures and yield strength of steel – allowable stresses based on specified reliability. | | | | 9 |

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| **INTERNAL TEST 2 (Module 2)** | | |
| **III** | **Probabilistic analysis of loads: -** Gravity load-introduction-load as a stochastic process. Wind load-introduction-wind speed-return period-estimation of lifetime wind speed-probability model of wind load.  **Basic structural reliability**: - Introduction-computation of structural reliability. Monte carlo study of structural safety and applications. | 10 |
| **IV** | **Level-2 Reliability method: -** Introduction-basic variables and failure surface-first order second moment methods like Hasofer and Linds method-nonnormal distributions-determination of B for present design-correlated variables | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | |
| **REFERENCES:**   1. Nobrert Llyd Enrick, “Quality control and reliability”, Industrial press New York. 2. A K Govil, “Reliability engineering”, Tata Mc Graw Hill, New Delhi. 3. Alexander M Mood, “Introduction to the theory of statistics”, Mc Graw Hill, Kogakusha Ltd. 4. Ranganathan, “Reliability of structures”.   Kamalesh Kumar, “Basic Geotechnical Earthquake Engineering”, | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE 6026** | | **DESIGNS OF SUBSTRUCTURES** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:   * To make students to learn principles of subsoil exploration. * To design the sub structures. * To evaluate the soil shear strength parameters.   **COURSE OUTCOMES:**  On successful completion of this course, students are able to   * Achieve Knowledge of design and development of problem solving skills. * Understand the principles of subsoil exploration. * Design and develop analytical skills. * Identify and evaluate the soil shear strength parameter. * Understand the concepts of Settlement analysis. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | **Substructures**  Definition and Purpose – Design principles – Design loads – Permissible settlements – Considerations in seismic design of sub structures.  **Raft Foundations**  Types of raft – Bearing capacity and settlement of rafts – Beams on elastic foundation – Methods of design of rafts. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | **Pile Foundations**  Load capacity of single piles – Static and dynamic formulae – Pile load tests – Cyclic pile load tests – Laterally loaded piles.  Pile groups – Group Efficiency – Design of pile groups – Settlement of single and pile groups in clays and sands – Negative skin friction on single and pile groups. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | **Pier Foundations** ypes of piers and Uses – Allowable bearing capacity – Design and construction of Piers – Settlement of Piers.  **Well Foundations** Types – Construction of Wells – Failures and Remedies – Bearing capacity Design of well foundations – Lateral stability – sinking of wells. | | | | 10 |
| **IV** | **Substructures in Expansive soils**  Characteristics of Expansive soils – Foundation problems – Foundation alternatives – Methods of Foundations – Design and Construction of under reamed piles. | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**   1. 1. J.E.Bowles, “Foundation Analysis and Design”, Mc. Graw Hill Publishing Co., New York 2. 2. Tomlinson, “Pile Design and Construction Practice”, A View Point Publication. 3. 3. Swami Saran, “Design of Substructures”, Oxford & IBH publishers, New Delhi. 4. 4. W.C. Teng, “Foundation Design”, Prentice Hall of India, New Delhi . 5. 5. Ninan P. Kurian – “Modern Foundations”. 6. 6. Lamb & Whileman – “Soil Mechanics”. | | | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE 6032** | | **MICROSTRUCTURE AND INNOVATIONS IN STRUCTURAL CONCRETE** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:   * To familiarise the structure and properties of the individual components of concrete and their relationship to each other. * Attempt to overcome the deficiencies of normal concrete by introducing self compacting concrete. * To ascertain the performance of concrete subjected to elevated temperatures during a fire hazard. * Acquaint the role of supplementary cementitious material in the production of concrete. * Characterisation methods of cementitious compounds.   **COURSE OUTCOMES:**  On successful completion of this course, students are able to   * Identify the structure property relationships. * Perform mix design and specify the self-compacting concrete. * Predict the reduction in the properties of concrete exposed to higher temperatures. * Familiarise various supplementary cementitious materials, pozzolanic reactions, advantages and popularization. * Interpret XRD patterns, SEM images and TGA curves. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | **The Structure of Concrete: -** Significance and Complexities, Structure of aggregate phase, Structure of hydrated cement paste, Solids in hydrated cement paste, Voids in hydrated cement paste and Water in hydrated cement paste.  **Structure property relationships in hydrated cement paste:-**Strength, Dimensional stability and Durability.  **Transition zone in concrete: -** Significance oftransition zone, Structure of transition zone, Strength of transition zone and Influence of transition zone on properties of concrete. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | **Self-compacting Concrete:-** Introduction, Definition and terms like Addition, Admixture, Binder, Filling ability, Fines (Powder), Flowability, Fluidity, Passing ability, Robustness, Segregation resistance, Slump-flow, Thixotrophy, Viscosity modifying admixture, Constituent materials, Mix design, Test methods and Conformation.  **Engineering Properties:-** Compressive strength, Tensile strength, Modulus of elasticity, Creep, Shrinkage, Coefficient of thermal expansion, Bond to reinforcement, Shear force capacity, Fire resistance and durability.  **Requirements:-**Basic andAdditional requirements and Requirements in fresh state, Consistence classification, Slump flow, Viscosity, Passing ability and Segregation resistance. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | **Effect of Temperature on Properties of Concrete:-** Different approaches for testing-Stressed, Unstressed and Unstressed residual tests.  **Important material properties of concrete under temperature:-** Thermal Expansion, Thermal Conductivity, Thermal Capacity and Thermal Diffusivity, Modulus of Elasticity, Poisson’s Ratio, Stress-Strain Relationship, Creep Deformation and Strength; Spalling of concrete; Influence of aggregate type. | | | | 10 |
| **IV** | **Supplementary Cementitious Materials:-**Different materials, Pozzolanic reaction.  **Characterization of Concrete (Concept Only):- X-Ray Diffraction Analysis (XRD):**-Introduction, Basic Principle, Identification of Major Phases Present in Cement/Clinker, Sample Preparation and X-Ray Diffractometry in Concrete, Hydrated Cement Paste, Aggregate Interface.  **Scanning Electron Microscope (SEM) Analysis:** Introduction of Scanning Electron Microscopy, Specimen Preparation, Concrete under the SEM, Mineral Admixtures in Concrete.  **Thermo Gravimetric Analysis (TGA): -** Introduction, Interpreting TGA Curves related to Concrete. | | | | 8 |

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| **END SEMESTER EXAM (ALL Modules)** |
| **REFERENCES:**   1. 1. P. Kumar Mehta and Paulo J. M. Monteiro, “Concrete, Microstructure, Properties and Materials” Indian Concrete Institute, Chennai. 2. J. Thomas, "Concrete Technology", Cengage India, 2015. 3. J.A. Purkiss, “Fire Safety Engineering” Butterworth-Heinemann. 4. E.G. Butcher and A.C. Parnell, “Designing for Fire Safety” John Wiley and Sons. 5. E.E. Smith and T.Z. Harmathy, “Design Buildings for Fire Safety” ASTM Special Technical Publication 685, A Symposium Sponsored by ASTM Committee EQ5 on Fire Standards. 6. A.M. Neville, “Properties of Concrete” Addison Wesley Longman Limited, England. 7. A.M. Neville and J.J. Brooks, “Concrete Technology” Pearson Education, Asia. 8. P.C. Varghese, “Advanced Reinforced Concrete Design” PHI Learning Private Limited, New Delhi. 9. EFNARC, “The European Guidelines for Self-Compacting Concrete, Specification, Production and Use” EFNARC-2005, UK. 10. P.J.M. Bartos, M. Sonebi and A.K. Tamimi, “Workability and Rheology of Fresh Concrete: Compendium of Tests” RILEM Publications S.A.R.L,France. 11. V.S. Ramachandran and James J., “Handbook of Analytical Techniques in Concrete Science and Technology, Principles, Techniques and Applications” William Andrew Publishing, U.S.A. 12. George Widmann, “Interpreting TGA Curves” User Com. 13. Jain, V. K., “Fire Safety in Buildings”, New Age International (P) Ltd., New Delhi. |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE 6034** | | **ENGINEERING FRACTURE MECHANICS** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:  The objective of this course is to introduce the mathematical and physical principles of fracture mechanics and their applications to engineering design.  **COURSE OUTCOMES:**  On successful completion of this course, students are able to   * To compute the stress intensity factor, strain energy release rate, and the stress and strain fields around a crack tip for linear and non linear materials. * Know experimental methods to determine the fracture toughness * Use the design principle of materials and structures using fracture mechanics approaches | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | **Introduction:–** Significance of fracture mechanics, Griffith energy balance approach, Irwin’s modification to the Griffith theory, Stress intensity approach, Crack tip plasticity, Fracture toughness, sub–critical crack growth, Influence of material behaviour, I, II & III modes, Mixed mode problems. **Linear Elastic Fracture Mechanics (LEFM):–** Elastic stress field approach, Mode I elastic stress field equations, Expressions for stresses and strains in the crack tip region, Finite specimen width, Superposition of stress intensity factors (SIF), SIF solutions for wellknown problems such as centre cracked plate, single edge notched plate and embedded elliptical cracks. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | **Crack tip plasticity:–** Irwin plastic zone size, Dugdale approach, Shape of plastic zone, State of stress in the crack tip region, Influence of stress state on fracture behaviour. **Energy Balance Approach:–** Griffith energy balance approach, Relations for practical use, Determination of SIF from compliance, Slow stable crack growth and R–curve concept, Description of crack resistance. **LEFM Testing:–** Plane strain and plane stress fracture toughness testing, Determination of R–curves, Effects of yield strength and specimen thickness on fracture toughness, Practical use of fracture toughness and R–curve data. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | **Elastic plastic fracture mechanics (EPFM):–** Development of EPFM, J–integral, Crackopening displacement (COD) approach, COD design curve, Relation between J and COD, Tearing modulus concept, Standard JIc test and COD test. **Fatigue Crack Growth:–** Description of fatigue crack growth using stress intensity factor, Effects of stress ratio and crack tip plasticity – crack closure, Prediction of fatigue crackgrowth under constant amplitude and variable amplitude loading, Fatigue crack growth from notches – the short crack problem. | | | | 10 |
| **IV** | **Sustained load fracture:–** Time–to–failure (TTF) tests, Crack growth rate testing, Experimental problems, Method of predicting failure of a structural component, Practical significance of sustained load fracture testing. **Practical Problems:–** Through cracks emanating from holes, Corner cracks at holes, Cracks approaching holes, fracture toughness of weldments, Service failure analysis, applications in pressure vessels, pipelines and stiffened sheet structures. | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**  1. Ewalds, H.L. & Wanhill, R.J.H., “Fracture Mechanics” – Edward Arnold  2. David Broek, “Elementary Engineering Fracture Mechanics”, Sijthoff and Noordhaff, Alphen Aan Den Rijn, The Netherlands.  3. Ed L. Elfgren and S.P. Shah, “Analysis of Concrete Structure by Fracture Mechanics”, Proc of Rilem Workshop, Chapman and Hall, London. | | | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE 6036** | | **STRUCTURAL OPTIMIZATION** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:   * To provide an engineering view of optimization as a tool for design. * The course will also concentrate on the mathematical and numerical techniques of optimization as applied to structural engineering problems**.**   **COURSE OUTCOMES:**  On successful completion of this course, students are able to   * Understand the need and concepts of design optimization. * To use conventional and modern optimization methods in structural applications. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Introduction –Problem formulation with examples; Single Variable Unconstrained Optimisation Techniques – Optimality Criteria; Bracketing methods– Unrestricted search, Exhaustive search; Region Elimination methods:–Interval Halving methods, Dichotomous search, Fibonacci method, Golden section method; Interpolation methods–Quadratic Interpolation method, Cubic Interpolation method; Gradient Based methods– Newton–Raphson method, Secant method, Bisection method. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Multi Variable Unconstrained Optimisation Techniques – Optimality Criteria; Unidirectional Search ; Direct Search methods – Random search, Grid search, Univariate method, Hooke’s and Jeeves’ pattern search method, Powell’s conjugate direction method, Simplex method; Gradient based methods–Cauchy’s (Steepest descent) method, Conjugate gradient (Fletcher–Reeves) method, Newton’s method, Variable metric (DFP)method, BFGS method. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Constrained Optimisation Techniques;Classical methods – Direct substitution method, Constrained variation method, method of Lagrange multipliers, Kuhn–Tucker conditions. Linear programming problem: Standard form, Simplex method; Indirect methods –Elimination of constraints, Transformation techniques, and Penalty function method;Direct methods – Zoutendijk’s method of feasible direction, Rosen’s gradient Projection method. | | | | 10 |
| **IV** | Specialized Optimisation techniques – Dynamic programming, Geometric programming, Genetic Algorithms. | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**  1. Rao S. S., “Engineering Optimisation – Theory and Practice”, New Age International.  2. Deb, K., “Optimisation for Engineering Design – Algorithms and examples”, Prentice  Hall.  3. Kirsch U., “Optimum Structural Design”, McGraw Hill.  4. Arora J S. “Introduction to Optimum Design”, McGraw Hill  5. Rajeev S and Krishnamoorthy C. S., “Discrete Optimisation of Structures using  Genetic Algorithms”, Journal of Structural Engineering, Vol. 118, No. 5, 1992, 1223–  1250. | | | | | |

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| COURSE CODE | COURSE NAME | L-T-P-C | YEAR |
| **05CE 6066** | **SEMINAR - I** | 0-0-2-2 | 2015 |
| Each student is required to present a technical paper on a subject approved by the department. The paper should be on a recent advancement/trend in the field of structural engineering. He/she shall submit a report of the paper presented to the department. | | | |

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| COURSE CODE | COURSE NAME | L-T-P-C | YEAR |
| **05CE 6088** | **MINI PROJECT** | 0-0-4-2 | 2015 |
| The mini project is designed to develop practical ability and knowledge about practical problems related to the industry. Students can take up any structural project pertaining to relevance in the field of structural engineering. Projects can be chosen either from the list provided by the faculty or in the field of interest of the student. For external projects, students should obtain prior permission after submitting the details of the guide and synopsis of the work. The external project guide should have a minimum qualification of ME/M.Tech in structural or related fields. At the end of each phase, presentation of the project should be conducted, which will be evaluated by a panel of examiners. A detailed project report duly approved by the guide in the prescribed format should be submitted for end semester assessment. Marks will be awarded based on the report and their performance during presentations. | | | |

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| COURSE CODE | COURSE NAME | L-T-P-C | YEAR |
| **05CE 6092** | **COMPUTER APPLICATION LAB** | 0-0-2-1 | 2015 |
| COURSE OBJECTIVES:  *In professional design scenario, it is very important to use industry and research standard softwares in a proficient manner besides knowing the theoretical concepts of structural analysis.*  **COURSE OUTCOMES:**  On successful completion of this course, students are able to   * Achieve Knowledge of analysis and development of programming skills * Use industry and research standard software in a professional set up. * Understand the **elements of finite** element modelling, specification of loads and boundary condition, performing analysis and interpretation of results for final design | | | |
| Application of SAP 2000, ANSYS and NISA in modeling, simulation and analysis of structural components using the concepts given in theory papers. The student has to practice the packages by working out different types of problems mentioned below.  **SAP 2000**  Linear Static Analysis of Continuous Beams, Portal Frames, Truss (2D and 3D), Multistoried Building.  Loading : Dead Load, Live Load, Wind Load ( IS: 875 Part 1 / Part 2 / Part 3), Earth Quake Load (IS: 1893 Part 1) and its Combinations as per codal Provisions  **ANSYS and NISA**  Linear Static Analysis of Continuous Beams, Portal Frames, Truss (2D and 3D), Plates (Plane Stress and Plane Strain) | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE 7041** | | **STRUCTURAL STABILITY** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:  To impart a thorough foundation on the behaviour structural members undergoing form failure with emphasis on buckling in the elastic range. To give theoretical background on buckling of skeletal structures like columns, beam columns, portal frames and rigid members. Introduce the available analytical and numerical solution techniques to stability problems with variousgeometries, loading and boundary conditions. To provide an understanding of buckling phenomena in plates under inplane and transverse loading. Integration of finite element method for buckling analysis of beams and plates.  **COURSE OUTCOMES:**  On successful completion of this course, students are able to   * Appreciate and Understand the principles of strength and stability * To understand the behaviour of basic structural components and plates susceptible to instability and apply stability concepts for solving diverse problems in civil engineering. * Appreciate the relevance of the finite element approach in stability analysis | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | **Introduction to stability analysis:**–Stable, unstable and neutral equilibrium–Stability Criteria. Fourth order Elastica – large deflection of bars differential equation for generalized bending problems–elastic instability of columns–Euler’s theory–assumptions–limitations. Energy principles. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | **General treatment of column:-** Stability problem as an Eigen value problem–various modes of failure for various end conditions– both ends hinged–both ends fixed–one end fixed other end free– one end fixed other end hinged–Energy approach–Rayleigh Ritz–Galarkin’s method. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | **Beam column:**–beam column equation–solution of differential equation for various lateral loads–udl and concentrated loads– Energy method – solutions for various end conditions–bottom fixed– bottom hinged –horizontal compression members, buckling of frames. | | | | 10 |
| **IV** | **Stability of plates:–** inplane and lateral loads– boundary conditions–critical buckling pressure–aspect ratio  **Finite element application to stability analysis**– finite element stability analysis–element stiffness matrix –geometric stiffness matrix–derivation of element stiffness matrix and geometric stiffness matrix for a beam element. | | | | 8 |
| **END SEMESTER EXAM (All Modules)** | | | | | |
| **REFERENCES:**   1. Ziegler H, “Principles of structural stability”, Blarsdell, Wallham, Mass, 1963. 2. Thompson J M, G W Hunt, “General stability of elastic stability”, Wiley,New York. 3. Timoshenko, Gere, “Theory of elastic stability”, Mc Graw Hill, New York. 4. Don O Brush, B O O Almorth, Buckling of Bars, plates and shells, 5. Cox H L, The buckling of plates and shells, Macmillam, New York, 1963. 6. O C Zienkiewicz ,.Finite Element Method,fourth Edition,McGraw Hill, 7. R.D.Cook, Concepts and Applications of Finite Element Analysis, JohnWiley &Sons. | | | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE 7043** | | **ADVANCED STEEL STRUCTURES** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:   * This course covers the advanced principles of the design of hot-rolled and cold-formed steel structural members. * Reference is made to the IS 800 and 811 standards, explaining the underlying theory for the provisions in these standards. * The objectives are to provide students with advanced knowledge of steel structural design and confidence to apply the underlying principles to solve a wide range of structural steel problems. * To provide an engineering view of optimization as a tool for design*.*   **COURSE OUTCOMES:**  On successful completion of this course, students are able to   * Understand different types of loading with respect to structural parameters. * Analysis and design of different types of structures. * Application of IS code & SP code for detailing and drafting of different structural   components.   * Understand the background to the design provisions for hot-rolled and cold-formed steel   structures, including the main differences between them.   * Proficiency in applying the provisions for design of columns, beams, beam-columns. * Design structural sections for adequate fire resistance. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Design of members subjected to lateral loads and axial loads – Principles of analysis and design of Industrial buildings and bents – Crane gantry girders and crane columns – Bracing of industrial buildings and bents. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Analysis and design of steel towers, trestles and masts – Design of industrial stacks – Self supporting and guyed stacks lined and unlined – Stresses due to wind and earthquake forces – Design of foundations. | | | | 9 |

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| **INTERNAL TEST 2 (Module 2)** | | |
| **III** | Introduction – Shape factors – Moment redistribution Static, Kinematic and uniqueness theorems – Combined mechanisms – Analysis Portal frames. Method of plastic moment distribution – Connections, moment resisting connections. | 10 |
| **IV** | Design of light gauge sections – Types of cross sections – Local buckling and post buckling – Design of compression and Tension members – Beams – Deflection of beams – Combined stresses and connections.  Types of connections, Design of framed beam connections, Seated beam connection, Unstiffened, Stiffened Seat connections, Continuous beam – to – beam connections and continuous beam–to–column connection both welded and bolted. | 8 |
| **END SEMESTER EXAM (All Modules)** | | |
| **REFERENCES:**   1. Punmia B.C, “Comprehensive Deign of Steel structures”, Laxmi publications Ltd, 2000. 2. Arya, A.S, “Design of Steel Structures”, Newchand & bros, Roorkee, 1982 3. Ram Chandra, “Design of Steel Structures II”, Standard Book House, Delhi. 4. Dayaratnam, “Design of steel structures”. 5. Rajagopalan, “Design of Storage structures”. 6. Baker, “Steel skeleton”. 7. S.K.Duggal , “Design of Steel Structures”, McGraw Hill. 8. Lynn S.Beedle, “Plastic Analysis of steel frames”. 9. Relevant IS Codes. | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE 7045** | | **MAINTENANCE AND REHABILITATION OF STRUCTURES** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:   * This course is to make students to investigate the cause of deterioration of concrete structures. * To strategies different repair and rehabilitation of structures. * To evaluate the performance of the materials for repair.   **COURSE OUTCOMES:**  On successful completion of this course, students are able to   * Understand the cause of deterioration of concrete structures. * Design and develop analytical skills. * Summarize the principles of repair and rehabilitation of structures. * Understands the concept of Serviceability and Durability. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | **General:–**Quality assurance for concrete construction as built concrete properties strength, permeability, thermal properties and cracking.  **Influence on servicebility and durability:–**Effects due to climate, temperature, chemicals, wear and erosion, Design and construction errors, corrosion mechanism, Effects of cover thickness and cracking, methods of corrosion protection, corrosion inhibitors, corrosion resistant steels, coatings, cathodic protection. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | **Maintenance and repair strategies:–** Definitions : Maintenance, repair and rehabilitation, Facets of Maintenance importance of Maintenance, Preventive measures on various aspects Inspection, Assessment procedure for evaluating a damaged structure, causes of deterioration , testing techniques. | | | | 9 |

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| **INTERNAL TEST 2 (Module 2)** | | |
| **III** | **Materials for repair:–** Special concretes and mortar, concrete chemicals, special elements for accelerated strength gain, Expansive cement, polymer concrete, sulphur infiltrated concrete, ferro cement, Fibre reinforced concrete. | 10 |
| **IV** | **Techniques for repair:–** Rust eliminators and polymers coating for rebars during repair foamed concrete, mortar and dry pack, vacuum concrete, Gunite and Shotcrete Epoxy injection, Mortar repair for cracks, shoring and underpinning.  **Examples of repair to structures:–**Repairs to overcome low member strength, Deflection, Cracking, Chemical disruption, weathering wear, fire, leakage, marine exposure–case studies. | 8 |
| **END SEMESTER EXAM (All Modules)** | | |
| **REFERENCES:**   1. Denison Campbell, Allen and Harold Roper, “Concrete Structures , Materials, Maintenance and Repair”,Longman Scientific and Technical UK, 1991. 2. R.T.Allen and S.C.Edwards, “Repair of Concrete Structures” , Blakie and Sons, UK, 1987. 3. M.S.Shetty, “Concrete Technology – Theory and Practice” , S.Chand and Company, New Delhi, 1992. 4. Santhakumar, A.R., " Training Course notes on Damage Assessment and repair in Low Cost Housing "," RHDC–NBO " Anna University, July, 1992. 5. Raikar, R.N., “Learning from failures – Deficiencies in Design ", Construction and Service – R & D Centre (SDCPL), Raikar Bhavan, Bombay, 1987. | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE 7051** | | **NUMERICAL METHODS IN STRUCTURAL ENGINEERING** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:  The purpose of numerical analysis is two-fold:  (1) To find acceptable approximate solutions when exact solutions are either impossible or as arduous and time-consuming as to be impractical, and (2) To devise alternate methods of solution better suited to the capabilities of computers.   * Define and perform Gaussian elimination to solve a linear system and Identify pitfalls of Gaussian elimination. * Demonstrate the relative performance of Newton-Raphson and Modified Newton-Raphson’s methods. * Derive and apply the trapezoidal rule and Simpson’s rule of integration and Distinguish Simpson’s method from the trapezoidal rule. * Introduce students to the area of numerical methods and illustrate the far reaching nature and usefulness of these methods for structural engineering applications. * An appreciation of the application of numerical methods to "real world" problems in the analysis of structural engineering.   **COURSE OUTCOMES:**  On successful completion of this course, students are able to   * Understand various computational methods available to solve practical problems. * Enhance the capacity to select the most appropriate techniques for tackling problems in structural engineering. * Select from alternative methods the one method that is most appropriate for a specific problem. * Inculcate an ability to solve numerically many types of problems such as Roots of equations, Systems of linear simultaneous equations, Numerical Differentiation and integration, Eigen value problems etc., applied in structural engineering. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | **Solution of Linear and Non-linear equations:-**Linear system of equations:- Gaussian Elimination, Cholesky’s method and Cholesky’s Decomposition method-Numerical examples. Non linear system of equations:- Newton-Raphson’s method for single and multiples variables, Limitations. Modified-Newton Raphson’s methods-Numerical examples.  **Solution Techniques for Eigen Value Problems:-**Eigen value problems in structural engineering, Solution by characteristics polynomial-Numerical examples.  **Storage schemes -** Semi band and Skyline storage schemes, Sub-Structure Method of Analysis (Methods and Concept only). | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | **Numerical Integration:-**Trapezoidal and Simpson’s Rule for Areas, Trapezoidal Rule for Volumes- Related problems. Newmark’s Method: - Equivalent Loads, Newmark’s Procedure, Application of Newmark’s method for the, slope and deflection of beams (Simply supported, Cantilever and Over hanging) having uniform and varying flexural rigidity with different loading cases (Concentrated, Uniformly distributed and uniformly varying). Slope and deflection of propped cantilevers and fixed beams having uniform flexural rigidity with uniformly distributed loads.  Application of Newmark’s integration procedure for buckling of straight columns (ends hinged, one end fixed and other hinged) having uniform and non-uniform flexural rigidity. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | **Finite Difference Technique for Ordinary Differential Equations and its Applications in Structural Engineering:-**Forward, Backward and central difference. Initial and boundary value problems.  Application of finite difference method for statically determinate beam problems: - Calculation of bending moment and deflection of beams (simply supported and cantilever) having uniform and varying flexural rigidity subjected to loads (concentrated, uniformly distributed, uniformly varying and parabolic).  Application of finite difference method for statically indeterminate beam problems: - Calculation of bending moment and deflection of beams (propped cantilevers, fixed and two span continuous) having uniform and varying flexural rigidity subjected to loads (concentrated and uniformly distributed).  Application of finite difference method for buckling of columns: - Calculation of buckling load of columns (ends hinged, one end hinged and other fixed) with uniform and non uniform flexural rigidity.  Application of finite difference method for vibration of beams: - Calculation of natural frequency of beams (simply supported, propped cantilever and fixed) of uniform flexural rigidity subjected to concentrated load and uniformly distributed loads. | | | | 10 |
| **IV** | **Finite Difference Technique for Partial Differential Equations and its Applications in Structural Engineering:-** Application of finite difference technique for partial differential equation for membrane problems:- Derivation of module, Calculation of slope and deflection of laterally loaded square, triangular, L and T shaped membrane.  Application of finite difference technique for partial differential equation for bending of laterally loaded thin plates:- Derivation of module, Calculation of deflection of laterally loaded square, and rectangular plates with fixed and simply supported boundaries subjected to uniformly distributed and varying loads. | | | | 8 |
| **END SEMESTER EXAM (All Modules)** | | | | | |
| **REFERENCES:**   1. Rajasekaran S., “Numerical Methods in Science and Engineering-A practical approach”, A H Wheeler& Co. 2. Grewal B.S., “Numerical Methods in Engineering and Science”, Khanna Publishers. 3. Krishna Raju N., and Muthu K.U, ,“Numerical Methods for Engineering Problems”, Macmillan India Limited. 4. Bathe K.J., “Finite Element Proceedings in Engineering Analysis” Prentice Hall Inc. 5. James M.L. ,”Smith G.M. and Wolford J.C., “Applied Numerical Methods for Digital Computation”, Harper and Row Publishers. 6. Wang P.C., “Numerical and Matrix Methods in Structural Mechanics”, John Wiley & Sons. 7. Meghre A.S. and Deshmukh S.K.,”Matrix Methods of Structural Analysis (Theory, Examples and Programs), Charotar Publishing House. 8. James B. Scarborough, “Numerical Mathematical Analysis”, 9. Radha Kanta Sarkar, “Numerical Methods for Science and Engineering” Eswar Press, | | | | | |
| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE 7053** | | **THEORY OF PLASTICITY** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:   * This course covers the advanced principles of the design of hot-rolled and cold-formed steel structural members.   **COURSE OUTCOMES:**  On successful completion of this course, students are able to   * Understand different types of loading with respect to structural parameters. * The students learn the theory of plasticity as a background for nonlinear analysis (Material nonlinearity) by the Finite element method. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | **`**  **Preliminaries:** Basic equations of theory of elasticity:– Index notation, equations of equilibrium, constitutive relations for isotropic bodies, strain–displacement relations, compatibility, displacement and traction boundary conditions, admissibility of displacement and stress fields, plane stress and plane strain problems.  **Framework of plastic constitutive relations:–** Plastic behaviour in simple tension, generalisation of results in simple tension, yield surfaces, uniqueness and stability postulates, convexity of yield surface and normality rule, limit surfaces**.** | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | **Initial yield surfaces for polycrystalline metals:–** Summary of general form of plastic constitutive equations, hydrostatic stress states and plastic volume change in metals, shear stress on a plane, the von Mises initial yield condition, the Tresca initial yield condition, consequences of isotropy.  **Plastic behaviour under plane stress conditions:–** Initial and subsequent yield surfaces in tension–torsion, the isotropic hardening model, the kinematic hardening model, yield surfaces made of two or more yield functions, piecewise linear yield surfaces, elastic perfectly plastic materials. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | **Plastic behaviour of bar structures:–** Behaviour of a three bar truss, behaviour of a beam in pure bending, simply supported beam subjected to a central point load, fixed beams of an elastic perfectly plastic material, combined bending and axial force.  **The Theorems of Limit Analysis:–** Introduction, theorems of limit analysis, alternative statement of the limit theorems, the specific dissipation function. | | | | 10 |
| **IV** | **Limit analysis in plane stress and plane strain:–** Discontinuities in stress and velocity fields, the Tresca yield condition in plane stress and plane strain, symmetrical internal and external notches in a rectangular bar, the punch problem in plane strain, remarks on friction.  **Limit analysis as a programming problem:–** Restatement of limit theorems, application to trusses and beams, use of finite elements in programming problem, incremental methods of determining limit load. | | | | 8 |
| **END SEMESTER EXAM (All Modules)** | | | | | |
| **REFERENCES:**  1. Martin, J.B., “Plasticity: Fundamentals and General Results”, MIT Press, London.  2. Kachanov, L.M., “Fundamentals of the Theory of Plasticity”, Mir Publishers, Moscow.  3. Chakrabarty, J, “Theory of Plasticity”, McGraw Hill, New York.  4. Hill, R., “Mathematical Theory of Plasticity”, Oxford University Press.  5. Chen, W.F., and Han, D.J., “Plasticity for Structural Engineers”, Springer Verlag. | | | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE 7055** | | **EXPERIMENTAL STRESS ANALYSIS** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:   * To familiarize the student with state of the art experimental techniques namely strain gauges, photo elasticity, moiré interferometry, brittle coating, moiré fringes and holography. * Design experiments related to stress analysis problems. * Learn methodology for conducting laboratory and field experiments. * Analyse and interpret experimental observations and results.   **COURSE OUTCOMES:**  On successful completion of this course, students are able to   * Undertake experimental investigations to verify predictions by other methods. * To acquire skills for experimental investigations an accompanying laboratory course is desirable. * Capability to provide suitable instrumentation for conducting experiments. * Acquire capacity to organize laboratory experiments for project and thesis works. * Building capacity to conduct destructive and nondestructive experiments as a practicing engineer. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Strain measurement: mechanical, optical acoustical strain gauges. Electrical resistance strain gauges, strain rosettes. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Measurement of displacements – potentiometers – linear variable differential transformer (LDVT), Accelero meteres, Measurement of force : Load cells, Electrical resistance based: Ring type force transducer, pressure transducer. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Photo elasticity – Light and optics as related to photoelasticity, theory of photo elastic model materials, analysis techniques. Separation and compensation methods. Introduction to 3– dimensional photoelasticity. | | | | 10 |
| **IV** | Methods of measuring sensitivity like cantilever calibration, determination of ultimate strength, refrigeration techniques, relaxation techniques, double crack analysis of brittle coating data–Introduction to moiré fringe techniques of stress analysis. | | | | 8 |

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| **END SEMESTER EXAM (All Modules)** |
| **REFERENCES:**   1. Dalley and Rilley, “Experimental Stress Analysis”. 2. P.H. Adams & R.C. Dove, “Experimental Stress Analysis and motion Measurement”. 3. M. Hetney, Hand book of experimental stress analysis. |

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| COURSE CODE | COURSE NAME | L-T-P-C | YEAR |
| **05CE 7067** | **SEMINAR - II** | 2-1-0-3 | 2015 |
| Each student is required to present a technical paper on a subject approved by the department. The paper should be on a recent advancement/trend in the field of structural engineering. He/she shall submit a report of the paper presented to the department. | | | |

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| COURSE CODE | COURSE NAME | L-T-P-C | YEAR |
| **05CE 7087** | **PROJECT (PHASE-1)** | 2-1-0-3 | 2015 |
| The thesis (Phase-I) shall consist of research work done by the candidate or a comprehensive and critical review of any recent development in the subject or a detailed report of project work consisting of experimentation/numerical work, design and or development work that the candidate has executed.  In Phase-I of the thesis, it is expected that the student should decide a topic of thesis, which is useful in the field or practical life. The students should refer national and international journals, proceedings of national and international seminars and conferences. Emphasis should be given to the introduction to the topic, literature review, and scope of the proposed work along with some preliminary work / experimentation carried out on the thesis topic.  Student should submit Phase-I thesis report in two copies covering the content discussed above and highlighting the features of work to be carried out in part-I of the thesis. Student should follow standard practice of thesis writing.  The candidate will deliver a talk on the topic and the assessment will be made on the basis of the term work and talks there on by a panel of internal examiners one of which will be the internal guide. These examiners should give suggestions in writing to the student to be incorporated in thesis work Phase-II. | | | |

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| COURSE CODE | COURSE NAME | L-T-P-C | YEAR |
| **05CE 7088** | **PROJECT (PHASE II)** | 2-1-0-3 | 2015 |
| In the fourth semester the student has continue the thesis work and present the report. At the end of successfully finishing the work he / she has to submit a detailed report and has to present for a viva–voce. The work carried out should lead to a publication in a National / International Conference. They should submit the paper before the evaluation of the thesis and specific weightage will be given to accepted papers in reputed conferences. | | | |