**DEPARTMENT OF CIVIL, MIT Manipal**

# M.Tech. STRUCTURAL ENGINEERING

**Program Structure (Applicable to 2019 admission onwards)**

| YEAR | FIRST SEMESTER | | | | | | SECOND SEMESTER | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **SUB CODE** | **SUBJECT NAME** | **L** | **T** | **P** | **C** | **SUB CODE** | **SUBJECT NAME** | **L** | **T** | **P** | **C** |
| I | MAT 5154 | OPTIMIZATION TECHNIQUES | 4 | 0 | 0 | 4 | CIE 5271 | DESIGN OF PRE-STRESSED CONCRETE STRUCTURES | 3 | 1 | 0 | 4 |
| | HUM 5151 | RESEARCH METHODOLOGY AND TECHNICAL COMMUNICATION | 1 | 0 | 3 | 2 | CIE 5272 | EARTHQUAKE RESISTANT DESIGN OF STRUCTURES | 3 | 1 | 0 | 4 |
| | CIE 5171 | ADVANCED MECHANICS OF SOLIDS | 3 | 1 | 0 | 4 | CIE **** | ELECTIVE I | 3 | 1 | 0 | 4 |
| | CIE 5172 | ANALYSIS AND DESIGN OF TALL STRUCTURES | 3 | 1 | 0 | 4 | CIE **** | ELECTIVE II | 3 | 1 | 0 | 4 |
| | CIE 5173 | FINITE ELEMENT METHOD | 3 | 1 | 0 | 4 | CIE **** | ELECTIVE III | 3 | 1 | 0 | 4 |
| | CIE 5174 | STRUCTURAL DYNAMICS | 3 | 1 | 0 | 4 | *** **** | OPEN ELECTIVE | 3 | 0 | 0 | 3 |
| | CIE 5162 | COMPUTATIONAL AND STRUCTURAL ENGINEERING LAB | 0 | 0 | 6 | 2 | CIE 5264 | COMPUTER APPLICATION LAB | 0 | 0 | 6 | 2 |
| | | | | | | | CIE 5265 | PROFESSIONAL PRACTICE IN STRUCTURAL ENGINEERING | 0 | 0 | 3 | 1 |
| | **Total** | | **17** | **4** | **9** | **24** | | | **18** | **5** | **9** | **26** |
| | **THIRD AND FOURTH SEMESTER** | | | | | | | | | | | |
| **II** | CIE 6098 | PROJECT WORK | | | | | | | **0** | **0** | **0** | **25** |

| PROGRAM ELECTIVES | | OPEN ELECTIVES | |
|---|---|---|---|
| CIE 5012 | ADVANCED DESIGN OF RCC STRUCTURES | CIE 5051 | ADVANCED STRENGTH OF MATERIALS |
| CIE 5013 | ADVANCED DESIGN OF STEEL STRUCTURES | CIE 5052 | ENERGY AND ENVIRONMENT |
| CIE 5014 | ADVANCED FOUNDATION ENGINEERING | CIE 5053 | NON - DESTRUCTIVE TESTING OF MATERIALS |
| CIE 5015 | ANALYSIS, DESIGN AND CONSTRUCTION OF SHELL STRUCTURES | | |
| CIE 5016 | APPLICATIONS OF FINITE ELEMENT METHOD FOR STRUCTURAL ENGINEERING | | |
| CIE 5017 | DESIGN OF BRIDGES AND FLYOVERS | | |
| CIE 5018 | DESIGN OF PRECAST CONCRETE STRUCTURES | | |
| CIE 5019 | MASONRY STRUCTURES | | |
| CIE 5020 | OFFSHORE STRUCTURAL ENGINEERING | | |
| CIE 5021 | RELIABILITY ANALYSIS AND DESIGN OF STRUCTURES | | |
| CIE 5022 | SOIL STRUCTURE INTERACTIONS | | |
| CIE 5023 | STRUCTURAL STABILITY | | |

# Program outcomes

| | |
|---|---|
| **PO1:** | An ability to independently carry out research /investigation and development work to solve practical problems |
| **PO2:** | An ability to write and present a substantial technical report/document |
| **PO3:** | Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program |
| **PO4:** | Able to analyze and design civil engineering structures and components utilizing computer simulation techniques and advanced engineering tools by integrating the structural engineering tenets to meet the present and future demands of society at large. |
| **PO5:** | Able to conduct systematic research, draw up appropriate experimental procedures and setup, analyze and interpret the research outcomes to further the frontiers of structural engineering domain. |
| **PO6:** | Able to apply modern structural engineering developments, including latest codal provisions through lifelong learning |

**MAT 5154 OPTIMIZATION TECHNIQUES [4 0 0 4]**

**Student should be able:**

| | |
|---|---|
| **CO1** | To develop the knowledge in the basic theory and algorithms for nonlinear optimization (unconstrained and constrained). |
| **CO2** | To develop a linear programming model and to obtain solution using Simplex, two-phase, Big-M and dual simplex method. |
| **CO3** | To learn different methods of finding eigenvalues and eigenvectors and study their properties. |
| **CO4** | To study the different concept of linear and nonlinear regression |

**Solution of Eigen Value Problems**: Forward and inverse iteration, Simultaneous iteration, Jacobi – Application to Structural Engg. **Method of Regression:** Linear and non-linear regression – Application to Structural Engg. (20)
**Introduction to optimization -** Engineering applications of optimization - classification of optimization problems. **Classical Optimization Techniques** - Single variable, multivariable optimization with and without constraints. Kuhn-Tucker conditions. Linear programming - Standard form of LP problems - graphical methods. (20)
**Linear and Non Linear Programming -** One dimensional minimization - Elimination methods - Interpolation methods - unconstrained optimisation techniques - direct search methods - Descent methods - constrained optimisation - Direct and indirect methods. (12)

**References :**


1. Rao S.S. (2005), 'Optimization: theory and Practice', Wiley Eastern Limited.
2. Fox, R.L. (1971), 'Optimization methods for Engineering Design', Addison - Wesley, reading mass.
3. Arora, J.S., (1989), 'Introduction to optimum Design' McGraw Hill International editions, N.Y.
4. Goldberg, D.E., (2001), 'Genetic algorithms in search, optimization, and Machine learning', Addison Wesley, Reading Mass.
5. Deb, K., (2002), 'Optimization for Engineering Design, Algorithms and examples' Prentice - Hall of India private Ltd., New Delhi.

## Course Articulation Matrix

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| MAT 5154.1 | 3 | | 2 | 2 | 1 | |
| MAT 5154.2 | 3 | | 2 | 2 | | |
| MAT 5154.3 | 3 | | 2 | | | |
| MAT 5154.4 | 3 | | 2 | | 1 | |
| **Average correlation levels** | **3** | | **2** | **2** | **1** | |

## HUM 5151 RESEARCH METHODOLOGY AND TECHNICAL PRESENTATION [1 0 3 2]

**Student should be able to:**

| | |
|---|---|
| **CO1** | Define concepts of research and recall types of research |
| **CO2** | Define the problem, and develop the research design to solve the identified problem |
| **CO3** | Organise the thesis report, journal paper |
| **CO4** | Develop effective technical oral presentation |
| **CO5** | Develop a good research proposal |

**Mechanics of Research Methodology**: Types of research, Significance of research, Research framework, Case study method, Experimental method, Sources of data, Data collection using questionnaire, Interviewing, and experimentation. **(08)**

**Research formulation**: Components, selection and formulation of a research problem, Objectives of formulation, and Criteria of a good research problem. **(08)**

**Research hypothesis:** Criterion for hypothesis construction, Nature of hypothesis, Need for having a working hypothesis, Characteristics and Types of hypothesis, Procedure for hypothesis testing. **(08)**

**Sampling Methods**: Introduction to various sampling methods and their applications. Data Analysis- Sources of data, Collection of data, Measurement and scaling technique, and Different techniques of Data analysis. **(12)**

**Thesis Writing and Journal Publication**:Writing thesis, Writing journal and conference papers, IEEE and Harvard styles of referencing, Effective presentation, Copyrights, and avoiding plagiarism. **(12)**

**References:**


1. Dr Ranjit Kumar(2005) "Research Methodology: A Step-by-Step Guide for Beginners", SAGE.
2. Geoffrey R. Marczyk, David DeMatteo & David Festinger(2004), "Essentials of Research Design and Methodology", John Wiley & Sons.
3. John W. Creswel(2004) , "Research Design: Qualitative, Quantitative, and Mixed Methods Approaches", SAGE.
4. Suresh C. Sinha and Anil K. Dhiman(2006), "Research Methodology (2 Vols-Set), Vedam Books.C. R. Kothari(2008), "Research Methodology: Methods and Techniques", New Age International Publisher.
5. Donald R Cooper & Pamela S Schindler(2007), "Business Research Methods", McGraw Hill International.
6. R. Pannershelvam(2006), "Research Methodology", Prentice Hall, India.
7. Manfred Max Bergman(2006), "Mixed Methods Research", SAGE Books.
8. Paul S. Gray, John B. Williamson, David A. Karp, John R. Dalphin(2007), "The Research Imagination", Cambridge University press.
9. Cochrain **& Cox**(2006), "Experimental Designs", II Edn. Wiley Publishers**.**

## Course Articulation Matrix

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| HUM 5151.1 | 3 | 2 | | | 3 | 2 |
| HUM 5151.2 | 3 | 2 | | 1 | 3 | 2 |
| HUM 5151.3 | 3 | 3 | | | 1 | 1 |
| HUM 5151.4 | 3 | 2 | | | | |
| HUM 5151.5 | 3 | 3 | | 1 | 2 | 1 |
| **Average correlation levels** | **3** | **2.4** | | **1** | **2.25** | **1.5** |

## CIE 5171 ADVANCED MECHANICS OF SOLIDS [3 1 0 4]

| | |
|---|---|
| **CO1** | Graduates of the program will be able to evaluate the stress – strain relationships, equilibrium conditions, strain – displacement relationships, and principal stresses & strains in cartesian co-ordinate system. |
| **CO2** | Graduates of the program will be able to evaluate stress – strain compatibility conditions and Airy's stress function in Cartesian co-ordinate system |
| **CO3** | Graduates of the program will be able to analyze the stress strain relationships, compatibility conditions using Polar co-ordinates for problems involving pure bending of curved bars and stress concentration around holes |
| **CO4** | Graduates of the program will be able to outline the classical plate theory, the equilibrium equations, governing equations & relationships of rectangular and circular plates; |
| **CO5** | Graduates of the program will be able to illustrate the geometry, classification of shells, relation between stress resultants, strain, & curvature, along with the membrane & bending action of shells. |

**Syllabus:**

**Theory of Elasticity:** Cartesian co-ordinates; concepts of stress and strain at a point - generalized Hooke's law- homogeneity, Isotropy, Orthotropy, stress - strain relations - plane stress - plane strain. Equilibrium equations - boundary conditions, strain - displacement relations - compatibility equations in terms of strains and stresses. Analysis of stress and strain at a point in any direction - principal stresses and strains and their directions. (24)

**Polar Coordinates:** Equilibrium equations - strain displacement relations - compatibility equations (in terms stresses). Stress function - solution of simple axi-symmetric problems - stress - concentration around a hole in a plate under the action of in - plane stresses. (10)

**Theory of Plates:** Slopes and curvatures of slightly bent plates - principal curvatures - moment - curvature relationships - small deflections of laterally loaded plates - boundary conditions - strain energy of bending of plates - bending of orthotropic plates. (08)

**Theory of Shells:** Differential geometry of curves and surfaces - classification of shells - Membrane action and bending action - Force resultants and moment resultants in terms of mid-surface strains and changes in curvatures - analysis of simple shells of revolution subjected to symmetrical loading. (06)

**References:**


1. Stephen P. Timoshenko and J.N. Goodier, (2008), “Theory of Elasticity”, 3rd Edition, Auckland: McGraw Hill Book Company.
2. R. T. Fenner, (1986), “Engineering Elasticity: Application of numerical and analytical techniques”, Chichester: Horwood, England..
3. L.S. Srinath, (2009), “Advanced Mechanics of Solids”, Tata McGraw Hill, Delhi.
4. S.P. Timoshenko and S.W. Kriegar, (2015), “Theory of plates and shells”, II Edition, 13th Reprint, McGraw Hill Book Company, New York.
5. A.C. Ugural, (2018), “Plates and Shells: theory and analysis”, Fourth Edition, Boca Raton: CRC Press, Taylor & Francis Group.
6. K. Chandrashekhara, (2008), “Analysis of Thin Concrete Shells”, 2nd Revised Edition, New Age International Publishers, New Delhi.
7. G.S. Ramaswamy, (2005), “Design and Construction of Concrete shell roofs”, Revised Edition, Malabar, Fla. : R.E. Krieger.


## Course Articulation Matrix

| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
|---|---|---|---|---|---|---|
| CIE 5171.1 | 1 | | 2 | 1 | | |
| CIE 5171.2 | 1 | | 2 | 1 | | |
| CIE 5171.3 | 1 | | 3 | 2 | | |
| CIE 5171.4 | 1 | | 3 | 2 | 2 | |
| CIE 5171.5 | 1 | | 2 | 1 | | |
| **Average correlation levels** | **1** | | **2.4** | **1.4** | **2** | |

## CIE 5172 ANALYSIS AND DESIGN OF TALL STRUCTURES [3 1 0 4]

| | |
|---|---|
| **CO1** | Graduates of the program will be able to select the design criteria, design philosophies and materials |
| **CO2** | Graduates of the program will be able to assess the type of loading and concrete, different forms for tall buildings to resist lateral loads. |
| **CO3** | Graduates of the program will be able to apply the principles of structural analysis by approximate methods to simple frame, braced frame and shear wall structures. |
| **CO4** | Graduates of the program will be able to illustrate the principle of structural analysis to outrigger and wall-frame structure. stability and P-delta effects for tall structures |
| **CO5** | Graduates of the program will be able to evaluate differential shortening, design principles in chimney shells, foundations and the behaviour of transmission line towers. |

**Syllabus:**

**Introduction**: Briefn history, demand and factors affecting design of Tall structures (01)

**Analysis and design of Tall structures:** Design criteria, Design philosophy, wind loading, seismic loading, sequential loading, Human discomfort, Fire and Temperature. Codal provisions in IS 16700. (06)
**Materials:** high performance concrete, fiber reinforced concrete, light weight concrete and High strength steel. (08)

**Structural planning of tall buildings and Forms:** floor systems, building rigid jointed frames, Braced frames, Shear walls, Frame-shear wall structures, Tubular structures, coupled tubes, Outriggers braced structures and hybrid structures. (08)

**Approximate analysis:**Framed structure, Wall-Frame structures, Outrigger braced structures for lateral loads on buildings. (15)

**Chimneys/Hollow shafts subjected to lateral loads**: Design of Chimney shaft and foundations. Analysis of Transmission line towers. Foundations for Tall structure – Raft and pile foundation general principles (10)

**References:**


1. Bungale S. Taranath, Structural Analysis and Design of Tall Buildings, McGraw
2. Hill. G.M. Pinfold, Reinforced Concrete Chimneys and Towers, View point publisher.
3. Byran Statford Smith and Alex Coull, Tall building structures-
4. Analysis and Design, John Wiley and Sons.

## Course Articulation Matrix

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CIE 5172.1 | 1 | | 1 | 1 | | 2 |
| CIE 5172.2 | 1 | | 2 | 1 | | 2 |
| CIE 5172.3 | 1 | | 3 | 2 | 1 | 2 |
| CIE 5172.4 | 1 | | 3 | 1 | 1 | 1 |
| CIE 5172.5 | 1 | | 3 | 1 | 1 | 3 |
| **Average correlation levels** | **1** | | **2.4** | **1.2** | **1** | **2** |

**CIE 5173 FINITE ELEMENT METHOD OF ANALYSIS [3 1 0 4]**

| | |
|---|---|
| **CO1** | Graduates of the program will be able to illustrate the basics of finite element method |
| **CO2** | Graduates of the program will be able to analyze pin jointed plane and space structures using finite element method |
| **CO3** | Graduates of the program will be able to analyze rigid jointed plane structures using finite element method |
| **CO4** | Graduates of the program will be able to evaluate the response of plane stress/plane strain problems using finite element method. |

**Syllabus:**

Brief general description of the method, theory of elasticity - constitutive relationships - plane stress and plane strain problems (02)
Concept of an element, types of elements, displacement models **-** displacement models by generalised coordinates, shape functions, shape functions for different types of elements based on generalized coordinates, Lagrangian polynomials and Hermitian polynomials. (08)
Minimization of potential energy approach, formulation of element stiffness and consistent load vector, application of boundary conditions (02)
Application of finite element method to analyse pin jointed and rigid jointed structures. (20)

Natural co-ordinates, Isoparametric elements, Numerical Integration. Application to plane stress and plane strain problems. (16)

**References:**

1. Desai C.S. and Abel J.E., (1987), 'Introduction to the Finite element method', CBS publications, New Delhi, 1st Indian edition.
2. Krishnamoorthy C.S., (1987), 'Finite element analysis', Tata McGraw Hill Publishing company Ltd., New Delhi, 2nd Edition.
3. Cook R.D., Malkas D.S. and Plesha, M.E., (1980).'Concepts and Applications of Finite element Analysis', Third Edition John Wiley and Sons, New York.
4. Bathe K.J., (1997), 'Finite element procedures in Engineering Analysis', Prentice Hall Engle Wood, Cliffs, NJ, III Edition.
5. Zinkiewicez O.C., (1979), 'The Finite element method', Third edition, Tata McGraw Hill Book Co, New Delhi, III Edition.

# Course Articulation Matrix

| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
|---|---|---|---|---|---|---|
| CIE 5173.1 | 3 | | 2 | 3 | 1 | |
| CIE 5173.2 | 3 | | 2 | 3 | 1 | |
| CIE 5173.3 | 3 | | 2 | 3 | 1 | |
| CIE 5173.4 | 3 | | 2 | 3 | 1 | |
| **Average correlation levels** | **3** | | **2** | **3** | **1** | |

## CIE 5174 STRUCTURAL DYNAMICS [3 1 0 4]

| | |
|---|---|
| **CO1** | Graduates of the program will be able to formulate the equation of motion |
| **CO2** | Graduates of the program will be able to assess the dynamic response of SDOF system subjected to the free and harmonic vibration |
| **CO3** | Graduates of the program will be able to assess the dynamic response of SDOF system subjected to periodic and blast loading |
| **CO4** | Graduates of the program will be able to evaluate the dynamic response of MDOF system |
| **CO5** | Graduates of the program will be able to evaluate the dynamic response of continuous system |

**Syllabus:**

**Introduction:** Objectives, dynamic loading, types of dynamic problems. Formulation of equations of motion: D'Alembert's principle, Principle of virtual work, Variational approach. (07)

**Single Degree of Freedom Systems:** Components of the system, un-damped and damped free vibrations, logarithmic decrement. Forced vibrations due to harmonic excitation – steady state and transient response, transmissibility, vibration isolation, evaluation of damping – half power band width method. Forced vibrations due to general dynamic loading – Duhamel's integral, response of SDOF system to impulsive loading, numerical methods – direct integration (constant and linear acceleration) of Duhamel's integral, trapezoidal rule and simpson's rule. Response to periodic loading – Fourier Analysis. (24)

**Multi-Degree of Freedom Systems:** Equations of motion, un-damped and damped free vibration, eigenvalues and eigen vectors, orthogonality conditions. Free vibration of shear buildings with and without damping. (Harmonic and impulse loads only). Approximate methods for the analysis of multi-degree of freedom un-damped systems – Raleigh's method, improved Raleigh's method, Dunkerley's method, Raleigh - Ritz method, matrix iteration method. (13)

**Continuous Systems:** Free longitudinal vibration of bars, flexural vibration of single span beams, forced vibration of beams. (04)

**References:**


1. Rao, S.D., (1995), 'Mechanical Vibrations',3rd ed., Addison Wesely, NewYork, 19.
2. Chopra A.K., (2001), 'Dynamics of structures – Theory and application to Earthquake Engg.' Prentice - Hall of India Pvt. Ltd. New Delhi
3. Seto, (1964), 'Mechanical vibrations, Schuam's Outline Series', McGraw Hill, Book Co., NewYork 19

4. Paz. M, (2004), 'Structural Dynamics', 2nd ed., C.B.S. Publishers and Distributors, New Delhi.
5. Mukhopadhay., (2000), 'Vibrations of structures and structural systems' Oxford and IBH, New Delhi.
6. Biggs J.M., 'Introduction to structural dynamics' ,McGraw Hill publications
7. Clough and Penzien, (1993), 'Dynamics of structures' – McGraw Hill publications
8. Humar, J.C., (2002), ‘Dynamics of structures’, Prentice hall, N.J.

## Course Articulation Matrix

| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
|---|---|---|---|---|---|---|
| CIE 5174.1 | 1 | | 2 | 3 | 1 | |
| CIE 5174.2 | 1 | | 2 | 3 | 1 | |
| CIE 5174.3 | 2 | | 3 | 3 | 1 | |
| CIE 5174.4 | 3 | | 3 | 3 | 1 | |
| CIE 5174.5 | 2 | | 3 | 3 | 1 | |
| **Average correlation levels** | **1.8** | | **2.6** | **3** | **1** | |

## CIE 5162 COMPUTATIONAL AND STRUCTURAL ENGINEERING LAB [0 0 6 2]

| | |
|---|---|
| **CO1** | Graduates of the program will be able to develop computer programs for axially loaded bar, plane and space trusses, continuous beams and plane frame structures using finite element method |
| **CO2** | Graduates of the program will be able to illustrate the principle of Clerk Maxwell's reciprocal theorem. |
| **CO3** | Graduates of the program will be able to evaluate models of two hinged arch, Cantilever beams, fixed, and the Influence Line diagram in frames and beams using Muller Breslau's principle |
| **CO4** | Graduates of the program will be able to design a concrete mix for desired grade of concrete. |
| **CO5** | Graduates of the program will be able to assess flexural behaviour of reinforced concrete, pre-tensioned pre-stressed rectangular concrete beams. |

**Syllabus:**

**Developing Computer Program for:**

1. Analysis of axially loaded bar (6x2)
2. Analysis of plane trusses (6)
3. Analysis of space trusses (6)
4. Analysis of plane rigid frame (6)
5. Analysis of Continuous beam (6)

**Structural Engineering Lab:**

1. Concrete mix design by IS Code and other methods. (9)
2. Study on flexural behaviour of reinforced concrete, pre-tensioned pre-stressed rectangular concrete beams. (3)
3. Study on structural behaviour of columns (3)
4. Non-destructive tests on concrete. (3)
5. Experimental study on models to verification of Clerks Maxwell's reciprocal Theorem (9)
6. Experimental study and analysis on models of;
   Two hinged arch, Buckling of columns, Cantilever beams,Fixed beams (6)
7. To study Influence Line diagram in frames and beams using Muller Breslau's principle. (3)

**References:**


1. IS:10262 "Indian Standard recommended guidelines for concrete mix design", (Latest)
2. SP: 23 –"Hand book of Concrete mixes", (Latest)

3. Krishna Raju N,"Design of reinforced Concrete Structures III Edition, CBS publishers, New Delhi.
4. Krishna Raju N, "Prestressed Concrete", III Edition, Tata McGraw Hill Publishing Co. New Delhi.
5. Lin T.Y., Burns N.H.,"Design of Prestressed Concrete Structures", III Edition, John Willey and Sons, New York.

## Course Articulation Matrix

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CIE 5162.1 | 3 | 2 | 2 | 3 | 1 | 1 |
| CIE 5162.2 | 2 | 2 | 1 | 1 | 1 | |
| CIE 5162.3 | 2 | 2 | 1 | 1 | 1 | |
| CIE 5162.4 | 3 | 2 | 1 | 2 | 2 | 3 |
| CIE 5162.5 | 3 | 2 | 2 | 2 | 2 | 3 |
| **Average correlation levels** | **2.6** | **2** | **1.4** | **1.8** | **1.4** | **2.3** |

## CIE 5271 DESIGN OF PRE-STRESSED CONCRETE STRUCTURES [3 1 0 4]

| | |
|---|---|
| **CO1** | Graduates of the program will be able to design the pre-stressed flexural members. |
| **CO2** | Graduates of the program will be able to evaluate the pre-stressed member for shear, torsion and transmission of pre-stress. |
| **CO3** | Graduates of the program will be able to evaluate composite sections and one way slab for flexure. |
| **CO4** | Graduates of the program will be able to design of continuous beams and portal frames |
| **CO5** | Graduates of the program will be able to design circular prestressing members and compression members. |

**Syllabus:**

**Introduction**: Code Provisions, Loses, Analysis of Type1 & Type2 members under Flexure at Transfer and at Service. (12)

**Analysis for Ultimate Strength**: Limiting Zone, Magnel's Graphical Method, Design of Sections for Tpye 1 & type 2 flexure members, Limit State of Collapse for Shear & Torsion, Calculation of Deflection, Crack Width, Transmission of Prestress. (12)

**Analysis of Continuous Beams:** Moment due to Reactions, Pressure Line due to Prestressing Force, Principle of Linear Transformation, Concordant Tendon Profile, Tendon Profiles, Analysis for Ultimate Strength, Moment Redistribution. (12)

**Analysis & Design**: Composite Sections, Design of One-way Slabs, Compression Members, Circular Prestressing members: Prestressed Concrete Pipes. (12)

**References:**


1. IS:1343 "Indian Standard code of practice for pre-stressed concrete" (Latest)
2. IS:1785 "Indian Standard Specification for plain hard drawn steel for pres-stressed concrete ", Second Revision (Latest)
3. IS 784 'Pre-stressed concrete pipes- specification'(Latest)
4. N Krishnraju, "Pre-stressed concrete", III Edition, Tata McGraw Hill publications, New Delhi.
5. Arthur H Nilson, "Design of pre-stressed concrete", II Edition, John Wiley & sons, publications, New York.
6. T Y Lin, N H Burns, "Design of pre-stressed concrete structures", III Edition, John Wiley & sons, publications, New York.
7. Dr. Amlan K Sengupta and Prof. Devdas Menon, "Prestressed Concrete Structures", NPTEL Notes

## Course Articulation Matrix

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CIE 5271.1 | 2 | | 3 | 2 | | 2 |
| CIE 5271.2 | 2 | | 3 | 2 | | 2 |
| CIE 5271.3 | 2 | | 3 | 2 | | 2 |
| CIE 5271.4 | 2 | | 3 | 2 | | 2 |
| CIE 5271.5 | 2 | | 3 | 2 | | 2 |
| **Average correlation levels** | **2** | | **3** | **2** | | **2** |

## CIE 5272 EARTHQUAKE RESISTANT DESIGN OF STRUCTURES [3 1 0 4]

| | |
|---|---|
| **CO1** | Graduates of the program will be able to outline the fundamentals of earthquake engineering |
| **CO2** | Graduates of the program will be able to evaluate the response of SDOF structure by response spectrum method |
| **CO3** | Graduates of the program will be able to evaluate the response of MDOF structure by response spectrum method |
| **CO4** | Graduates of the program will be able to evaluate the response of the in-elastic structure |
| **CO5** | Graduates of the program will be able to evaluate the lateral force generated in the structure due to earthquake, design criteria for earthquake resistant structure conforming to the codal provisions. |

**Syllabus:**

**Introduction :** Importance of earthquake resistant Design – ground motion in an earthquake – Types of seismic waves; Earth quake intensity – modified Mercalli scale – comprehensive intensity scale. (03)

**Review of dynamic response of MDOF systems :** Response to ground acceleration – response analysis by mode superposition - response spectrum analysis – selection of Design Earthquake – Earthquake response of in-elastic structures. (26)

**Earthquake Zones:** Codal provisions (I.S. 1893 - 1984, IS 1893-2002, IS 4326 -1993, IS 13920-1993). Terminology – Design criteria**:** multi-storey buildings, elevated structures like, elevated tanks and stack like structures. (Emphasis on Design of multi - storey buildings) (19)

**References:**


1. Chopra, A.K. (2001), 'Dynamics of Structures', Prentice Hall of India Pvt. Ltd. New Delhi.
2. Clough, R.W and Penzien J, (1993), 'Dynamics of Structures', McGraw Hill Book Co. New York.
3. Duggal S. K. (2007) “Earthquake Resistant Design of Structures” Oxford University Press, New Delhi
4. Pankaj Agarwal and Manish Shrikhande (2006), 'Earthquake resistant Design of structures', Prentice Hall of India Pvt. Ltd. New Delhi.
5. Jaikrishna (1994), 'Elements of Earthquake Engineering', South Asia Publishers, New Delhi.
6. Paz M, (2004), "Structural Dynamics", CBS Publishers, New Delhi.
7. IS:1893-1984, “Indian Standard Criteria for Earthquake Resistant Design of Structures” , Bureau of Indian Standards, New Delhi.

**8.** IS:1893(Part 1) -2016, "Indian Standard Criteria for Earthquake Resistant Design of Structures" , Bureau of Indian Standards, New Delhi.

## Course Articulation Matrix

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CIE 5272.1 | 1 | | 1 | | | 2 |
| CIE 5272.2 | 2 | | 3 | 2 | | 3 |
| CIE 5272.3 | 3 | | 3 | 2 | | 3 |
| CIE 5272.4 | 3 | | 3 | 2 | | 1 |
| CIE 5272.5 | 3 | | 3 | 3 | | 3 |
| **Average correlation levels** | **2.4** | | **2.6** | **2.25** | | **2.4** |

## CIE 5012 ADVANCED DESIGN OF RCC STRUCUTRES [3 1 0 4]

**Students should be able to:**

| | |
|---|---|
| **CO1** | Design Continuous beams, Multistorey frames |
| **CO2** | Design Bunkers and Silos |
| **CO3** | Design Rectangular and Intze type water tanks |
| **CO4** | Design deck and beams of T beam deck Slab Bridge |
| **CO5** | Design and erection of pre-fabricated members |

**Syllabus:**

**Analysis and Design:** Continuous Beams, Multistorey Frames, Bunkers and Silos (12)

**Overhead water tanks :** Rectangular and Intze type water tanks (12)

**Design of deck and beams of T beam deck Slab Bridge**. (12)

**Pre fabricated construction:** Requirements for pre-fabricated R.C. members – design and erection of pre-fabricated members – general erection principles – transportation and storage – joints in pre-fabricated structures – analysis and design of embedded parts. (12)

**References:**


8. V.N. Vazirani and M.M. Ratwani, (1995), "Concrete Structures", 16th Edition, Khanna Publishers, Delhi.
9. P.M. Ferguson, J. F. Breen and J.O. Jirsa, (1988), "Reinforced Concrete", John Wiley & Sons, New York.
10. A.H. Nilson and G Winter, (1991), "Design of Concrete Structures", McGraw Hill Publishing Company, Singapore.
11. N. Krishna Raju, (2005), "Advanced Reinforced Concrete Design", II Edition, CBS Publishers, New Delhi.
12. S.K. Mallick and A.P. Gupta, (1985), "Reinforced Concrete", II Edition, Oxford – IBH, New Dehi.
13. Cook John, (1977), "Composite Construction", John Wiley and sons New York.
14. V Ramakrishnan and P.D. Arthur, (1969), "Ultimate Strength Design for Structural Concrete", Pitman, London.
15. Cyril Bensen, (1964), "Advanced Structural Design", ELBS, London.
16. IS: 456 "Indian Standard Code of practice for plain and reinforced concrete", (Latest)
17. IS:3370(Part IV)"Indian Standard Code of practice for the storage of liquids (Latest)
18. SP:16 (S & T) "Design Aids for Reinforced Concrete to IS: 456-1978", Bureau of Indian Standards, New Delhi.

## CIE 5014 ADVANCED FOUNDATION ENGINEERING [3 1 0 4]

**Students should be able to:**

| | |
|---|---|
| **CO1** | Understand the procedure to determine the bearing capacity of shallow foundation using various formulas and the procedure to design combined footings and mats |
| **CO2** | Understand the analysis to determine ultimate load carrying capacity and settlement of single and group of piles |
| **CO3** | Understand the procedure to design and to check the stability of cofferdams and well foundations |
| **CO4** | Understand the procedure to analyse foundations subjected to vibration |
| **CO5** | Understand the procedure to design foundations used for tall structures, hyperbolic foundations and parabolic shell foundations |

**Syllabus:**

**SHALLOW FOUNDATION:** Bearing capacity of shallow foundations - modes of failure – computation of bearing capacity by bearing capacity equations, SPT, CPT and plate load test data, IS code recommendations. Effects of shape, inclination and eccentricity of the load, adjacent footings on bearing capacity. Design of combined footings, and mats by conventional method. Solution of beam on elastic foundation using finite difference approach. Analysis of mats and ring foundation using finite difference and finite element methods. (12)

**PILE FOUNDATIONS**: Types – Pile capacity by dynamic & Static formula – Analysis of pile resistance by wave equation – Pile load tests – settlement of single pile – Elastic solutions – Laterally loaded piles – Pile groups – Efficiency of pile groups – settlement of pile groups – Approximate analysis of pile groups – Under reamed piles – Structural design of pile caps. (08)

**COFFER DAMS:** Soil pressure on single wall coffer dams – Design of single wall coffer dams – Stability of coffer dams – TVA method and Cummings method. (04)

**WELL FOUNDATIONS:** Forces acting on well foundation – Analysis of well foundation using Terzaghi's method. (04)

**MACHINE FOUNDATIONS:** Machine foundations – Type of machine foundations – Methods of analysis of machine foundation – Mass spring model and constants – Elastic half space approach – Determination of soil constants – static and dynamic design of machine foundations – Modes of vibration of block foundation – Barkan's approach – Design of block foundation – vibration isolation techniques. (08)

**FOUNDATIONS FOR TALL STRUCTURES:** Water tanks, Chimneys, Antenna towers and Radar Units. (06)

**SPECIAL FOUNDATIONS:** Hyperbolic Parabolic shells etc. (06)

**References:**


1. Joseph E. Bowles, (1986) Foundation Analysis and Design, Second Edition – McGRAW Hill Book Co.
2. Winterkorn and Fang, (2001) Foundation Engineering Hand Book – Van Nostrand Reinhold.
3. Leonards, (1962), Foundation Engineering, McGraw Hill Book Co.
4. Poulos H.G. and Davis E.H., (1980) Pile Foundation Analysis and Design, John Wiley & sons.
5. Srinivasalu P., Vaidyanathan C.V., (1976) Hand Book of Machine Foundations, Tata McGraw Hill publishing Co. Ltd.
6. Major A., (1962), Vibration Analysis and Design for Foundation for machine and turbines, Calletts Holding Ltd. London.
7. Szechy K., (1963), Foundation Engineering, Springer Verlag.
8. Teng, (1981) Foundation Design, Practice Hall of India.
9. N.V. Nayak, (1979), Foundation Design Manual, First Edition, Dhanpat Rai and Sons.
10. Relevant IS codes

## CIE 5015 ANALYSIS, DESIGN AND CONSTRUCTION OF SHELL STRUCTURES [3 1 0 4]

**Students should be able to:**

| | |
|---|---|
| **CO1** | Understand classification of shells, properties of curves and polynomial equations. |
| **CO2** | Understand membrane theory, beam theory, bending theory and arch analysis of shells |
| **CO3** | Apply membrane theory for shells of revolutions. |
| **CO4** | Analyze synclastic shells and anticlastic shells. |
| **CO5** | Analyze folded plates and discuss the construction methods of concrete shell roofs. |

**Syllabus:**

**Classification of Shells** – Properties of curves – Polynomial equations – Cylindrical shell – **Membrane Theory** – Beam Theory – Arch analysis. (10)
**Cylindrical shells** – Bending Theory – North light shells. (08)
**Membrane Theory for shells of revolution** - Domes – Paraboloids – Conical shell – Rotational Hyperboloids (08)
**Synclastic shells** – Elliptic paraboloids (08)
**Anticlastic shells** – Hyperbolic paraboloid – umbrella roof.
**Conoids** - Folded plates. (08)
**Construction of concrete shell roofs** (06)

**References:**


1. Ramaswamy, G.S., (1999), 'Design and Construction of shell roofs', CBS Publications, New Delhi.
2. Chatterjee, B.K., (1971), 'Theory and Design of Concrete Shells', Oxford - IBH Publishing Co. New Delhi.
3. Timoshenko and Krieger, (1959), ‘Theory of Plates and Shells', McGraw Hill, New York.
4. Ugural, A.C. (1999), 'Stresses in Plates and Shells', McGraw Hill, New York.

**CIE 5016 APPLICATIONS OF FEM FOR STRUCTURAL ENGINEERING [3 1 0 4]**

**Students should be able to:**

| | |
|---|---|
| **CO1** | formulate the stiffness matrix and equivalent nodal load vector for three dimensional brick element and two dimensional plate bending elements |
| **CO2** | Analyse plane and space pin connected structures, continues beams, plane rigid jointed structures, plane stress /plane strain problems, plate bending problems and three dimensional problems subjected to dynamic loads |
| **CO3** | apply finite element method for nonlinear analysis of structures |
| **CO4** | analyse beam-column, plane pin connected and rigid jointed structures, plane stress/plane strain problems for critical load, apply finite element method for soil-structure interaction analysis |
| **CO5** | apply memory management techniques for finite element problems |

**Syllabus:**

Application of finite element method for three dimensional analysis. (04)

Application of finite element method for the analysis of plates. (04)

Application of finite element method for dynamic analysis of pin and rigid jointed structures, plane stress/strain and plate bending problems. (12)

Application of finite element method for non-linear analysis - techniques for problems involving material and geometric non-linearity - incremental and iterative methods. (06)

Application of finite element method for elastic stability problems. (07)

Application of finite element method for soil - structure interaction analysis. (05)

Memory management techniques, compatibility and convergence requirement of displacement models. (10)

**References:**

1. Desai C.S. and Abel J.E., (1987), 'Introduction to the Finite element method', CBS publications, New Delhi, 1st Indian edition.
2. Krishnamoorthy C.S., (1987), 'Finite element analysis', Tata McGraw Hill Publishing company Ltd., New Delhi, 2nd Edition.

3. Cook R.D., Malkas D.S. and Plesha, M.E., (1980).'Concepts and Applications of Finite element Analysis', Third Edition John Wiley and Sons, New York.
4. Bathe K.J., (1997), 'Finite element procedures in Engineering Analysis', Prentice Hall Engle Wood, Cliffs, NJ, III Edition.
5. Zinkiewicz O.C., (1979), 'The Finite element method', Third edition, Tata McGraw Hill Book Co, New Delhi, III Edition.

## Course Articulation Matrix

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CIE 5016.1 | 3 | | 2 | 3 | 1 | |
| CIE 5016.2 | 3 | | 2 | 3 | 1 | |
| CIE 5016.3 | 3 | | 2 | | | |
| CIE 5016.4 | 3 | | 2 | 3 | 1 | |
| CIE 5016.5 | 3 | | 2 | 3 | 1 | |
| **Average correlation levels** | **3** | | **2** | **3** | **1** | |

## CIE 5017 DESIGN OF BRIDGES AND FLYOVERS [3 1 0 4]

**Students should be able to:**

| | |
|---|---|
| **CO1** | Discuss the IRC standard live loads and design the deck slab |
| **CO2** | Demonstrate types of bridges, their components and selection of bridge site |
| **CO3** | Design superstructures for various types of RCC bridges |
| **CO4** | Design various types of substructures and foundations |

**Syllabus:**

**Introduction:** Historic developments-Importance of Bridges-Bridges Vs Buildings-Classifications-Steps involved in Bridge Projects- Typical forms of Reinforced Concrete Bridges. (04)
**Limit State Method of Design of Bridges:** IRC -06- Forces on Bridges- Vehicular Loading Classes- Class 70R, Class AA, Class A, Class B, Impact Allowances-Load Combinations- IRC 112- Basis of Design- Design for Bending ,Axial Forces and Shear- Detailing. (08)
**Design of Deck Slabs:** Rectangular Slabs supported on opposite ends- Partial loading-Effective Width and Dispersion- Design of Solid Slab Culverts (10)
**Slabs supported on all sides**- partial Symmetric loading- Pigeaud's Curves- Interior Slabs of T-Beam Bridges. (06)
**T- Beam Bridges:**Cross Beams- Importance, Analysis and Design – Courbon's Method-Principle- Assumptions- Limitations- - Analysis and Design- Detailing of Longitudinal Beams-Balanced Cantilever Bridge- Design of Cantilever Portion (08)
**Grade Separators**: Flyovers- Under Passes- Forms and Parts- Analysis Design of Single Cell Box type Under Passes- Analysis and Design of Single bay Portal type Under Passes- IRC SP 90- IRC -54 (06)
**Sub-Structures and Foundations:** Bearings, types-Stability Analysis of Piers and Abutments-Foundations- Well Foundations- Pile Foundations-Types- Pile Caps (06)

**References:**


1. 'Essentials of Bridge Engineering'- Johnson Victor
2. 'Design of Bridges",incorporating IRC 112- N. Krishnaraju
3. 'Design of Bridge Structures'- Jagadeesh & Jayaram – PHI Learning
5. ' Concrete Bridge Practice' V K Raina- Tata McGraw Hill
5. 'IRC-6- Standard Specifications and Code of Practice for Road Bridges- Section II – Loads & Stresses' - Indian Roads Congress
6. 'IRC-112- Code of Practice for Concrete Bridges'- Indian Roads Congress
7. 'IRC-78 - Standard Specifications and Code of Practice for Road Bridges- Section VII– Foundations and Substructures' - Indian Roads Congress

## CIE 5018 DESIGN OF PRECAST CONCRETE STRUCTURES [3 1 0 4]

**Students should be able to:**

| | |
|---|---|
| **CO1** | Describe various precast structural systems, design principles, overall stability and analyse precast frames using various standard methods. |
| **CO2** | Design precast reinforced and prestressed concrete beams. |
| **CO3** | Design precast concrete columns and shear walls |
| **CO4** | Design precast horizontal floor diaphragms |
| **CO5** | Describe the behaviour of various joints in precast construction precast and design the joints and connections. |

**Syllabus:**

**Introduction:**

Suitability of precast construction, Advantage and Limitations, Materials Used.
Preliminary Design Consideration, General Design Principles, Structural System and Overall Stability, Structural Integrity, Earthquake Design, Modular Consideration and Standardization. (08)

**Precast Frame Analysis:**

Types of Precast Construction, Simplified Frame Analysis, Sub structuring Methods, Connection Design, Stabilizing Methods. (08)

**Precast Concrete Beams:**

Non-composite Reinforced Concrete Beams, Composite reinforced Beams, Non-composite Prestressed Beams, Composite Prestressed Beams, Propping, Horizontal Interface Shear. (08)

**Column and Shear Wall:**

Precast concrete Column, Column Design, Precast Concrete Shear Wall, Distribution of Horizontal Loading, Infill Shear Walls, Cantilever Walls. (08)

**Horizontal Floor Diaphragm:**

Shear Transfer Mechanism, Edge Profile and Tie Steel Details, Design of Floor Diaphragm, Shear Stiffness, Diaphragm Actions in Composite Floor with Structural Toppings. (06)

**Joint and Connections:**

Definitions, Basic Mechanism, Compression Joint, Tension Joint, Pinned Jointed Connections, Moment Resistance Connections, Beam-Column Connections, Column Foundation Connection, Ties in Precast Concrete Structures.
Design of precast truss elements and purlins (10)

**References:**


1. "Precast Concrete Structures", Kim S. Elliott, 2002, Butterworth- Heinemann, An imprint of Elsevier Science, www.bh.com
2. "FIP Planning and Design Handbook on Precast Building Structures", 1994, Published by SETO Ltd.
3. "Precast Concrete Structures", Hubert Bachmann & Alfred Steinle, , 2011, Published by Ernst &Sohn GmbH & Co. KG

**Course Articulation Matrix**

| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
|---|---|---|---|---|---|---|
| CIE 5018.1 | 1 | | 2 | | | 2 |
| CIE 5018.2 | 1 | 1 | 2 | 2 | | 2 |
| CIE 5018.3 | 1 | 1 | 2 | 2 | | 2 |
| CIE 5018.4 | 1 | 1 | 2 | 2 | | 2 |
| CIE 5018.5 | 1 | 1 | 2 | 2 | | 2 |
| **Average correlation levels** | **1** | **1** | **2** | **2** | | **2** |

## CIE 5019 MASONRY STRUCTURES [3 1 0 4]

**Students should be able to:**

| | |
|---|---|
| **CO1** | Analyze the material properties |
| **CO2** | Analyze the masonry structures for compression |
| **CO3** | Analyze the masonry structures for Shear and flexure, combined bending and axial loads |
| **CO4** | Analyze the masonry structures for working and ultimate strength design |
| **CO5** | Analyze the masonry structures for seismic evaluation and retrofit, in-situ and non-destructive tests |

**Syllabus:**

**Material properties**: Introduction to masonry construction, masonry units, clay and concrete blocks, mortar, grout and reinforcement, bonding patterns, shrinkage and differential movements; (8)
**Analysis of masonry structures:** Masonry in compression, prism strength, eccentric loading, kern distance; Masonry under lateral loads, in-plane and out-plane loads, analysis of perforated shear walls, lateral force distribution for flexible and rigid diaphragms; (12)

**Behaviour of masonry members**: Shear and flexure, combined bending and axial loads, reinforced vs. un-reinforced masonry, cyclic loading, ductility of masonry walls for seismic design, infill masonry; (8)
**Structural design of masonry**: Working and ultimate strength design, in-plane and out-plane design criteria infill, connecting elements and ties, consideration of seismic loads, code provision; (10)

Seismic evaluation and retrofit, in-situ and non-destructive tests for masonry; properties, repair and Strengthening of existing masonry structures for seismic loads ; (6)

Construction practices and new materials. (4)

**References:**


1. Hendry, A.W., Sinha B.P and Davies S.R., (1997), Design of Masonry Structures, E and F.N. Span, London.
2. Paulay T, Priestley MJN, (1992), Seismic Design of Reinforced Concrete and Masonry Buildings, John Wiley & Sons, INC.
3. Orton Andrew, (1986), Structural Design of Masonry, Longman London.
4. Sunset Books, (1995), Basic Masonry, Sunset Publishing Corporation.
5. IS:13828 – 1993, Improving Earthquake Resistance of Low Strength Masonry Buildings Guidelines IS:13828-1993.
6. Schneider Robert R., Dicky Walter L., (1987) Reinforced Masonry Design, Prentice Hall, New Jersey.
7. Tomazevie Miha, (2000), Earthquake Resistant Design of Masonry Building, Imperial College Press, London.
8. Beall C., (1987), Masonry Design and Detailing, McGraw Hill, New York.

## CIE 5020 OFFSHORE STRUCTURAL ENGINEERING [3 1 0 4]

**Students should be able to:**

| | |
|---|---|
| **CO1** | Identify different type of offshore structure |
| **CO2** | Asses the environmental loads on the offshore structure |
| **CO3** | Calculate the foundation response and its capacity |
| **CO4** | Calculate pressure Induced loads and related design criteria |
| **CO5** | Calculate effect of dynamic loads and effects due to earthquake loading |

**Syllabus:**

**Introduction**: Brief history, requirement and growth. (01)
**Common offshore structures:** Jacket/Template type offshore platform and its Construction aspects, Gravity type Offshore platform and its construction aspects, Hybrids platforms, Guyed-towers, Tension Legged Platform (TLP), Compliant structures. (11)
**Environmental loadings**: Wind loading, Wave loading using Airy's wave theory, Ice loading, Buoyant forces, Seismic loading and Mud loading. Morison equation approach for wave force on vertical and arbitrarily oriented piles. (12)
**Foundation analysis:** Pile axial capacity and its response, Pile lateral load capacity and its response. Bearing capacity of footings and its response, settlement of foundations. (12)
**Static analysis**: – Steel structures, Concrete platforms, Fatigue analysis and Design stress criteria. Examination for dynamic effects. (08)
**Dynamic analysis**:– governing equation for wave loadings, stress analysis, response to earthquake loadings. (04)

**References:**


1. Dawson, "Offshore structural Engineering" Prentice Hall.
2. Carneiro FL L B and Brebbia C A "Offshore structure Engineering, Gulf Publishing, Houston.
3. Design and Construction of Offshore Structures, Institution of Civil Engineers (ICE), London.

## Course Articulation Matrix

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CIE 5020.1 | 1 | 1 | | | | |
| CIE 5020.2 | 2 | 1 | 2 | 1 | | 2 |
| CIE 5020.3 | 1 | | 3 | 1 | | |
| CIE 5020.4 | 1 | | 3 | 1 | | 2 |
| CIE 5020.5 | 1 | | 3 | 1 | | 2 |
| **Average correlation levels** | **1.2** | **1** | **2.75** | **1** | | **2** |

## CIE 5021 RELIABILITY ANALYSIS AND DESIGN OF STRUCTURES [3 1 0 4]

**Students should be able to:**

| | |
|---|---|
| **CO1** | Understand use of general concepts of statistics for probabilistic analysis |
| **CO2** | Demonstrate various theories/methods regarding reliability analysis of structures |
| **CO3** | To apply the principles for reliability analysis of concrete structures safety |
| **CO4** | To apply Code provisions for reliability based design. |
| **CO5** | To correlate fundamentals of probability theory to structural reliability type bridges. |

**Syllabus:**

**Concepts of structural safety:** Basic concepts of statistics and Probability. Statistical properties of concrete, Steel Brick and Mortar. Characterization of variables. Probabilistic analysis of gravity loads and wind load, Monte Carlo-simulation. (24)

**Basic concept of structural systems:** System reliability, modeling of structural systems, bounds on system reliability. Automatic generation of mechanisms, generation of dominant mechanisms. Application to RCC, PSC and Steel structures. (24)

**References:**


1. Ranganathan R., (1990), "Reliability Analysis and Design of Structures", Tata - McGraw Hill Company Ltd., New Delhi.
2. Ang and Tang, (1995), "Probability concepts in Engineering Planning and Design", Vol. I and II, John Wiley and Sons, New York.
3. Kapoor R.C., (1999) "Reliability in Engineering designs", John Wiley and sons, New York.
4. Melechers R.E., (1999) "Structural Reliability Analysis and Predictions", John Wiley & Sons, New York.
5. Srinath L. S., (2001) "Reliability Engineering", East west Press, New Delhi.
6. Sidda, J.N., (1983) "Probabilistic Engineering Design", Marcel Dekker, New York.

## CIE 5022 SOIL-STRUCTURE INTERACTION [3 1 0 4]

**Students should be able to:**

| | |
|---|---|
| **CO1** | Understand soil- foundation interaction and its analysis |
| **CO2** | Understand the elasto-plastic and time dependent models to represent the behavior of soil |
| **CO3** | Understand the procedure to analyse beams on elastic foundation |
| **CO4** | Understand the analysis of thick and thin plates on elastic foundation |
| **CO5** | Understand the analysis of pile and pile groups considering soil-structure interaction |

**Syllabus:**

**Soil-Foundation Interaction**. (04)
**Soil response model**, Elasto-plastic behaviour, Time dependent behaviour. (12)
**Beams on Elastic foundations**, Analysis of beams of finite length. (14)
**Plates on elastic medium,** Infinite plates, thin and thick plates. (10)
**Elastic analysis of piles,** Analysis of pile groups, Interaction analysis. (08)

**References:**


1. A.P.S. Selvadurai, (1979), Elastic Analysis of Soil-Foundation Interaction.
2. H.G. Poulos and E.H. Devis, (1980), Pile-Foundation Analysis and Design, John Wiley & Sons.
3. R.F. Scott, (1968), Soil Mechanics and Engineering, McGraw Hill.

## CIE 5023 STRUCTURAL STABILITY [3 1 0 4]

**Students should be able to:**

| | |
|---|---|
| **CO1** | Understand elastic and inelastic analysis of the column stability criteria for various boundary conditions. |
| **CO2** | Analyze the lateral buckling of beams and frames with different support conditions |
| **CO3** | Evaluate Elastic buckling of plates and shell by different approaches |
| **CO4** | Evaluate Dynamic stability of different structural system and understand the post buckling behavior of plates and failure of shells |
| **CO5** | Evaluate stability problems for discrete and continuous systems by Finite element approach and discuss the code specifications for design of columns, beams and stiffeners |

**Syllabus:**

Buckling of Columns : Stability criteria by different approaches, Governing differential equation, Analysis for various boundary conditions, Energy method, Inelastic buckling of columns. (08)
Lateral Buckling of Beams: differential equation for lateral buckling, Lateral stability of different types of beams. (10)
Beam - Columns and Frames: Magnification factors for forces and displacements in beam columns subjected to different types of loads, Buckling of simple frames. (06)
Elastic Buckling of Plates and Shells: Equilibrium approach and energy approach for buckling of plates, post buckling behaviour of plates, failure of cylindrical shells. (06)
Dynamic Stability of Structures: Discrete systems, Lagrange Hamilton formulation for continuous systems, stability of continuous systems and energy approach for buckling of plates, post buckling behaviour of plates, Failure of cylindrical shells. Finite element formulation of stability problems for both discrete and continuous systems. (12)
Code specifications for design: Discussion on code provisions for the design of columns, beam columns, beams and stiffeners in girders. (06)

**References:**


1. Timoshenko and Gere. 'Stability of structures', McGraw Hill, New Delhi.
2. Chajes, 'Principles of structural stability theory', Prentice Hall, Englewood cliffs, New Jersey.
3. Iyengar, N.G.R., (1986), 'Structural stability of columns and plates', East-west Press, New Delhi.
4. Aswini Kumar, (1985), 'Stability Theory of structures', Tata Mc Graw Hill, New Delhi.

## CIE 5264 COMPUTER APPLICATIONS LAB [0 0 6 2]

| | |
|---|---|
| **CO1** | Graduates of the program will be able to develop a model to analyse plane/space trusses and frames using commercial softwares. |
| **CO2** | Graduates of the program will be able to develop a model to analyse grid floor and retaining wall using commercial softwares. |
| **CO3** | Graduates of the program will be able to develop a model to analyse structures subjected to moving loads using commercial softwares. |
| **CO4** | Graduates of the program will be able to develop a model to analyse structures subjected to dynamic loads. |
| **CO5** | Graduates of the program will be able to completely design real life structures by using commercial softwares. |

**Syllabus:**

1. Introduction to Software packages and analysis of plane truss
2. Problem related to plane frame
3. Analysis of Industrial truss of different configurations
4. Analysis of space truss of different configuration
5. Analysis of grid floor and retaining wall
6. Analysis of space frame
7. Analysis of frames for moving loads
8. Analysis of multi-storey building for lateral loads (Seismic and wind loads)
9. Free vibration and response spectrum analysis
10. Analyses of structural frames to dynamic loading (machine)
11. Demonstration of E-Tabs software
12. Mini project

(6x12=72)

**References:**

Relevant software reference Manuals.

## Course Articulation Matrix

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CIE 5264.1 | 3 | 2 | 2 | 3 | 2 | 3 |
| CIE 5264.2 | 3 | 2 | 2 | 3 | 2 | 3 |
| CIE 5264.3 | 3 | 2 | 2 | 3 | 2 | 3 |
| CIE 5264.4 | 3 | 2 | 2 | 3 | 2 | 3 |
| CIE 5264.5 | 3 | 3 | 2 | 3 | 2 | 3 |
| **Average correlation levels** | **3** | **2.2** | **2** | **3** | **2** | **3** |

## CIE 5265 PROFESSIONAL PRACTICE IN STRUCTURAL ENGINEERING [0 0 3 1]

| | |
|---|---|
| **CO1** | Graduates of the program will be able to outline the roles and responsibilities of a structural engineer as a professional team member and as a team leader. |
| **CO2** | Graduates of the program will be able to outline the various fundamental principles of structural engineering such as strength, stiffness, stability, serviceability and durability. |
| **CO3** | Graduates of the program will be able to illustrate the knowledge of various types of common construction materials, characterize practical loads and load paths in structure. |
| **CO4** | Graduates of the program will be able to outline various stages of a practical analysis and design projects which include, thumb rules, preliminary dimensioning, drawings, and bill of quantities. |
| **CO5** | Graduates of the program will be able to assess the risks involved in practice such, as legal disputes, criminal liabilities, contracts, professional bodies ethics and social responsibilities. |

**Syllabus:**

**The Structural Engineer**: Roles and Responsibilities- Professional Conduct-Qualities and Qualifications- Structural Engineer as a Team Member and a Team Leader - Entrepreneurship - Challenges of practicing- Essential Handbooks and Library (6)

**Principles of Structural Engineering:** Concepts of Stability, Strength, Stiffness, Ductility, Safety, Serviceability, and Durability- Load Transfer –Load Paths- Assumptions (6)

**Practical Loads and Materials:** Magnitude-Direction-Position-Intensity-Occurrence-Dependence-Dead Load-Imposed load-Wind Load-Seismic Load-Snow Load- Hydrostatic Load- Loads due to Retention-Temperature Effects-Secondary Loads- Common Materials, Availability, Suitability- Concrete, Steel, Aluminium Composites- (6)

**Practical Analysis, Design and Detailing of Structures:** Suitability of Structural Systems-Preliminary Dimensioning- Thumb rules- Preferred dimensions- tools- Approximate Methods for review of results- Essentials of Drawings-Specifications- Bill of Quantities (6)

**Essentials of Implementation:** Field Skills-Construction Safety-Quality Assurance and Quality Control- Field Tests- Measurements- Instrumentation -Recording- Reporting (6)

**Structural Engineer and Society:** Risks – Law -Accreditations and licences - Civil and Criminal Implications in Practice- Agreements- Disputes-Arbitration- Ethical Practices- Social Responsibility -Continuing Professional Development - Association- Professional Bodies (6)

**References:**


1. 'Professional Practice'- KG Krishnamurthy & SV Ravindra PHI Learning
2. 'Civil Engineer's Handbook of Professional Practice'- KL Hansen & KE Zenobia- ASCE Press
3. 'What Every Engineer Should know about Enthics' – KK Humphreys - Marce Dekker New York
5. ' Risk Management in Civil, Mechanical & Structural Engineering'- Edited by M James- Thomas Telford


**Course Articulation Matrix**

| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
|---|---|---|---|---|---|---|
| CIE 5265.1 | | 1 | | 2 | | 1 |
| CIE 5265.2 | 1 | 1 | 1 | 2 | | 2 |
| CIE 5265.3 | 1 | 1 | 1 | 1 | | 2 |
| CIE 5265.4 | 1 | 2 | 1 | 1 | 1 | 2 |
| CIE 5265.5 | 1 | 2 | 1 | | | 2 |
| **Average correlation levels** | **1** | **1.4** | **1** | **1.5** | **1** | **1.8** |

## CIE 5051 ADVANCED STRENGTH OF MATERIALS [3 0 0 3]

| | |
|---|---|
| **CO1** | Able to analyze torsion in non-circular thin wall section, |
| **CO2** | Able to describe the stress distribution in unsymmetrical bending of straight beams |
| **CO3** | Able to Identify and describe shear centre, shear floe in thin walled sections |
| **CO4** | Able to Identify the design forces beams curved in plan, rings and hooks. |
| **CO5** | Able to describe the behavior and analyze the forces arising due to beams on elastic foundation. |

**Torsion :** Torsion of non-circular sections - Torsion of thin walled sections. (06)
**Unsymmetrical bending of straight beams** - stress distribution - shear centre - shear flow in thin walled beam cross sections - shear centre for thin walled sections. (10)
**Bending of Curved Beams:** Crane hooks, closed rings - correction factor for flanged cross sections. Bending of beams curved in plan. (10)
Beams on Elastic foundation - Infinite beams - Semi - infinite beams - short beams. (10)

**References:**


1. Srinath L.S (2000), Advanced Solid Mechanics TMH., New Delhi.
2. Boresi A.P., and Sidebottom O.M., (1985), Advanced Mechanics of Materials, John Wiley and sons in N.Y.
3. Den Hartog, (1952), Advanced Strength of Materials, McGraw Hill, N.Y.
4. N.Krishnaraju and D.R. Gururaja, (1997), Advanced Mechanics of solids and structures, Narosa Publishing House, New Delhi.
5. William F. Riley, Leroy D. Sturges and Don H. Morris, (2001), Mechanics of Materials, John Wiley & Sons, New Delhi.

## CIE 5052 ENERGY AND ENVIRONMENT [3 0 0 3]

**Students should be able to:**

| | |
|---|---|
| **CO1** | Discuss the environmental aspects of coal based energy production and their mitigation measures. |
| **CO2** | Discuss the environmental aspects of oil and natural gas based energy sources and nuclear energy. |
| **CO3** | Discuss the environmental aspects of renewable energy sources. |
| **CO4** | Discuss the environmental aspects of energy consumption for road transport and application of energy audit for energy conservation in buildings. |
| **CO5** | Discuss the design for environmentally responsible and resource efficient green buildings. |

**Introduction:** Global energy, Environmental resources, energy needs, Indian scenario - Energy consumption, needs and crisis. Energy production, utilization, Laws and Principles (06)

**Renewable sources of energy and Environmental aspects** - Bio gas, Bio- Mass,Hydro power, ocean energy, solar energy, geothermal energy, wind energy Urban waste derived energy, agricultural waste derived energy. (16)

**Non-renewable sources of energy and Environmental aspects** – energy norm, coal, oil , natural gas, Nuclear energy. (08)

**Regional impacts of temperature change:** Global temperature, Green house effects, global warming. Acid rain - Causes, effects and control methods. (06)

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**References:**


6. G.D.Rai. “Non-Conventional energy sources” Khanna publishers.
7. D P Kothari, et.al., “Renewable energy sources and Emerging Technologies”.
8. Wilber L.C. "Hand book of Energy Systems" Engg Wiley and Sons 1989.
9. Rao and Parulekar B.B. Energy Technology- Non-conventional Renewable and Conventional, Second Edition Khanna Publication 1977.

## CIE 5053 NON- DESTRUCTIVE TESTING OF MATERIALS [3 0 0 3]

**Students should be able to:**

| | |
|---|---|
| **CO1** | Judge the appropriateness of Nondestructive testing. |
| **CO2** | Evaluate the structure/system using Nondestructive techniques |
| **CO3** | Carry out the quality inspection of materials. |

**Introduction:** Importance and need of non-destructive testing, Basic methods for NDT of concrete structures, Qualification and certification, Testing of concrete, Comparison of NDT methods, Quality control. (**03)**

**Liquid Penetrant Tests:** Introduction, Processing, Test Equipment, Penetrant Materials, Test Methods, Advantages and Disadvantages, Applications, Case studies. **(03)**

**Magnetic particle testing:** Defects and discontinuities, Selection of Magnetizing Method, Selection of Magnetizing Method, Types of Magnetic Particles Inspection, Merits and demerits, Application, Case studies.c **(03)**

**Acoustic Emission Test:** Introduction, Principles and Theory, Signal Propagation, The AE Process Chain, AE Parameters, AE Sensors, Advantages and Limitations of AE Testing, Case studies. **(06)**

**Ultrasonic test:** Introduction, Definition of Acoustic Parameters, Ultrasonic Wave Propagation, Acoustic Impedance, Diffraction, Dispersion, Ultrasonic Testing Equipment, Detection of flaws, Merits and demerits, Application, Case studies. **(08)**

**Electromagnetic Testing Method:** Introduction, Eddy Current Theory, Eddy Current Sensing Probes, Eddy Current Techniques, Merits and demerits, Application, Case studies, Magnetic Flux Leakage Theory, Flux Leakage Sensing Probes, Magnetization for Flux Leakage Testing, Magnetic Flux Leakage Testing, Case Studies. **(05)**

**Leak Testing Methods:** Introduction, Fundamentals, Ultrasonic Leak Testing, Bubble Leak Testing, Dye Penetrant Leak Testing, Helium Mass Spectrometer Leak Testing, Vacuum Testing Method, Pressure Test Method, Merits and demerits, Case studies. **(03)**

**Radiographic Testing Method:** Introduction, Fundamental Properties of Matter, Radioactive Materials, Radiation Hazards and Personal Protection, Merits and demerits, Case studies. **(05)**

**References**


1. Barry Hull & Vernon John, Non-destructive Testing, 1st edition, Macmillan, London, 1988.
2. R. Halmshaw, Non-destructive Testing, 2nd edition, Edward Arnold, London, 1991.
3. McGonnagle W. J., Non-destructive testing, Gordon & Beach Science, New York, 1983.
4. Nondestructive Evaluation and Quality Control, Volume 17, 9th edition Metals Handbook, 1989.
5. Paul E. Mix**,** Introduction to Nondestructive Testing: A Training Guide, 2nd edition, John Wiley & Sons, Inc., Publication, 2005.