ACADEMIC REGULATIONS, COURSE STRUCTURE AND SYLLABI

(To be effective from 2015-2016)

MASTER OF TECHNOLOGY
IN
STRUCTURAL ENGINEERING

ACHARYA NAGARJUNA UNIVERSITY
NAGARJUNA NAGAR
GUNTUR DISTRICT
ANDHRA PRADESH

ACHARYA NAGARJUNA UNIVERSITY :: NAGARJUNA NAGAR

REVISED REGULATIONS FOR
TWO - YEAR M.TECH. DEGREE COURSE
(CHOICE BASED CREDIT SYSTEM)

(With effect from the batch of students admitted during the academic year 2015-2016)

1.0 ELIGIBILITY FOR ADMISSION

1.1 The candidates, both non-sponsored and sponsored, for Admission into M.Tech programme shall have one of the following qualifications.

S.No.	Programme	Qualifications
1.	Chemical Engineering	Bachelor Degree in Chemical Engineering / Chemical Technology / Biotechnology or its equivalent Degree recognized by Acharya Nagarjuna University
2.	Civil Engineering	Bachelor Degree in Civil Engineering or its equivalent Degree recognized by Acharya Nagarjuna University
3.	Computer Science & Engineering	B.Tech / B.E Computer Science and Engineering / Information Technology / M.C.A / M.Sc., Computers / M.Sc., Electronics / M.Sc., Mathematics or its equivalent Degree recognized by Acharya Nagarjuna University.
4.	Electrical and Electronics Engineering	Bachelor Degree in Electrical & Electronics Engineering / Electrical Engineering / Electrical Power Engineering / AMIE (Electrical Engineering) or its equivalent Degree recognized by Acharya Nagarjuna University.
5.	Electronics and Communication Engineering	Bachelor Degree in Electronics & Communication / Electronic & Instrumentation Engineering / AMIE or its equivalent Degree recognized by Acharya Nagarjuna University.
6.	Mechanical Engineering	Bachelor Degree in Mechanical Engineering or its equivalent Degree recognized by Acharya Nagarjuna University.

1.2 Admission of Non-sponsored category students: Admission of non-sponsored category students is made on the basis of GATE/PGECET rank. When GATE/PGECET qualified candidates are not available, admission will be on the basis of merit in the qualifying examination. Students with or without GATE/PGECET rank should have obtained a minimum of 50% marks in the qualifying examination to become eligible for admission.

Reservation of seats to the candidates belonging to Scheduled Castes and Scheduled Tribes is as prescribed by the State Govt./University from time to time. If suitable candidates are not available to fill all the seats reserved for S.T category, they shall be filled by students S.C. Category and vice-versa.

If suitable candidates are not available for reserved seats, they shall be filled by the general category candidates.

1.3 Admission of Sponsored Category students: Sponsored category students should have at least 50% marks in the qualifying examination to become eligible for admission to the Post Graduate Programme. Preference will be given to those candidates who are GATE/PGECET qualified.

The candidates must have a minimum of two years of full time work experience in a registered firm / company/ industry / educational and research institutions / any government department or government autonomous organizations in the relevant field in which the admission is being sought.

A letter from the employer must be furnished stating that the candidate is being sponsored to get admission. The employer should also indicate that the candidate will not be withdrawn midway till the completion of course. The rule of reservation shall not apply to the admission of sponsored category students.

1.4 The total number of full time candidates admitted into a course with or without GATE/PGECET rank should not exceed the sanctioned strength.

2.0 MEDIUM OF INSTRUCTION, DURATION AND STRUCTURE

2.1. The medium of instruction shall be in English.

2.2. The minimum and maximum period for completion of the P.G. Programme is 4 Semesters for full time students.

2.3. Each Semester shall normally spread over sixteen weeks.

(a) The Programme may consist of
   i. Core Courses
   ii. Elective Courses
   iii. Seminars
   iv. Internship
   v. Project Work

(b) The structure of the Programme comprises of two semesters of course work consisting of 6 Core subjects + 6 Elective subjects and 3 Lab courses + 1 Mini Project / Seminar (or) 2 Lab courses + 2 Seminars / Mini Project, followed by two semesters of Project work. In summer break, the student should undergo internship for four weeks duration. The student should present a seminar on the project work done at the end of the third semester. At the end of fourth semester the students should submit Project Thesis.

(c) Core subjects are fixed in each semester and a student must opt them without any choice. Whereas electives can be chosen by a student from the list of electives given (minimum 18 and maximum 24) according to his choice.

2.4. Project work shall be carried out under the Supervision of a Faculty Member in the concerned department.

2.5. A candidate may, however, in certain cases, be permitted to work on his Project/Dissertation at the place of employment, any recognized Institution/R&D Organization/Industry with the approval of the Head of the Department concerned and Head of the Organization. In such cases, the Project Work shall be jointly supervised by a member of the faculty and a person from the Organization holding a minimum of P.G. Degree in the concerned area of specialization.

2.6. Five copies of the Project Report certified by the Supervisor(s) and the Head of the Department concerned shall be submitted within one Calendar Year after completion of the second semester.

2.7. The student is eligible for the submission of M.Tech. Project Report at the end of fourth semester if he/she passed all the course work in the first & second semesters.

2.8. In a special case, if any candidate unable submit his/her Project Report at the end of fourth semester due to ill health or any other reason permitted by the head of the institution, he/she will be allowed submit at a later date and the viva-voce examination will be conducted, if clause 2.7 is satisfied.

3.0. ATTENDANCE

3.1 The candidate shall put up a minimum of 75% attendance in each subject.

3.2. Condonation of shortage in attendance up to 10% in any subject may be condoned by the University on the recommendations of the Principal of the concerned College for reasons of ill health and the application is submitted at the time of actual illness and is supported by a certificate from the authorized Medical Officer approved by the Principal.

3.3. If the candidate does not satisfy the attendance requirement in any subject he or she shall not be permitted to appear for the University examination in that subject and has to repeat that subject when next offered or study any other specified subject as may be required. In case of repetition the new internal marks will be taken into amount.

3.4. Failure in securing minimum prescribed attendance in any subject of previous Semester (s) is no bar for enrollment to the next semester.

4.0. EVALUATION

4.1 The performance of the candidate in each semester shall be evaluated subject wise. The maximum marks for each subject, seminar etc, will be as prescribed in the curriculum. The Internal Evaluation for Theory subjects shall be based on two mid-term examinations and two assignments. In every theory subject, out of 40 sessional marks, 30 marks are allotted to mid-term examination and 10 marks for assignments. The best of the performances in the two midterm examinations, one held in the middle of the semester and another held immediately after the completion of the instruction, will be considered. The internal evaluation for practical subjects is based on the day-to-day performance and semester end internal practical Examination.

4.2 The marks for Seminar will be awarded by internal evaluation made by two staff members of the faculty of the department concerned.

4.3 For taking the University examination in any theory or practical subject, candidates shall be required to obtain a minimum of 50% marks in Internal evaluation in that subject failing which he/she shall be required to repeat the course in that subject when next offered or study any other specified subject as may be required. In case of repetition the new internal marks will be taken into amount.

4.4 A candidate shall be deemed to have secured the minimum academic requirement in a subject if he or she secures a minimum of 50% marks in internal evaluation.

4.5 In case the candidate does not secure the minimum academic requirement in any subject he/she has to reappear in the University examination in that subject or any equivalent subject prescribed.

4.6 Failure to attain the minimum academic requirement in any subject of previous semester (s) is no bar for enrollment to the next semester.

4.7 The performance of the students in each semester shall be evaluated subject wise The distribution of marks between sessional work (based on internal assessment) and University Examination will be as follows:

Nature of the subject	Sessional Marks	University Exam. Marks
Theory subjects	40	60
Practical's	40	60
Seminar / Internship / Project Seminar	100	--
Project work	50	150 iva voce)

5.0 AWARD OF CREDITS

Credits are awarded for each Theory/Practical/Seminar/Project Subjects. Each theory subject is awarded 4 credits and each practical/Seminar subjects is awarded 2 credits. Project seminar in III Semester is awarded 8 credits and Project Viva-voce at the end of IV Semester is awarded 16 credits.

6.0 AWARD OF GRADES

S.No.	Range of Marks	Grade	Grade Points
1	≥85%	S	10.0
2	75%-84%	A	9.0
3	65%-74%	B	8.0
4	60%-64%	C	7.0
5	55%-59%	D	6.0
6	50%-54%	E	5.0
7	≤49%	F(Fail)	0.0
8	The grade 'W' represents withdrawal/absent (subsequently changed into pass or E toS or F grade in the same semester)	W	0.0

A Student securing 'F' grade in any subject there by securing 0 grade points has to reappear and secure at least 'E' grade at the subsequent examinations in that subject

'W' denotes withdrawal/absent for a subject:

- After results are declared and Grade sheets will be issued to each student which will contain the following details:
- The list of subjects in the semester and corresponding credits and Grade obtained
- The Grade point average(GPA) for the semester and
- The Cumulative Grade Point Average(CGPA) of all subjects put together up to that semester from first semester onwards

GPA is calculated based on the fallowing formula:

$$\frac{\text{Sum of [No.Credits X Grade Point]}}{\text{Sum of Credits}}$$

CGPA will be calculated in a similar manner, considering all the subjects enrolled from first semester onwards.

7.0 AWARD OF DEGREE AND CLASS

A candidate who becomes eligible for the award of the degree shall be placed in the following three divisions based on the CGPA secured by him/her for the entire Programme

S.No.	Class	CGPA
1	First Class With Distinction	8.0 or more
2	First Class	6.5 or more but less than 8.0
3	Second Class	5.0 or more but less than 6.5

8.0 WITH-HOLDING OF RESULTS

The result of a candidate may be withheld in the following cases

i. The candidate has not paid dues to the institution
ii. A case of indiscipline is pending against the candidate
iii. A case of malpractice in examination is pending against the candidate The issue of degree is liable to be withheld in such cases

9.0 GENERAL

8.1. The University reserves the right of altering the regulations as and when necessary.

8.2 The regulations altered will be applicable to all the candidates on the rolls Irrespective of the fact that the regulations at the time of admission of the student to the programme are different.

8.3 The Academic Regulations should be read as a whole for purpose of any Interpretation Whenever there is a dispute regarding interpretation of regulations, the decision of the Vice-Chancellor is final.

COURSE STRUCTURE AND SCHEME OF EVALUATION
M.Tech. (Structural Engineering)

I Semester

S. No	Subject Code & Title	Periods per week		Maximum Marks			Credits
		L	P	Int.	Ext.	Total	
1.	MCE /SE/511 Theory of Elasticity and Plasticity	4		40	60	100	4
2.	MCE/SE/512 Dynamics of structures	4		40	60	100	4
3.	MCE/SE/513 Matrix methods of structural analysis	4		40	60	100	4
4.	Elective - I	4		40	60	100	4
5.	Elective - II	4		40	60	100	4
6.	Elective -III	4		40	60	100	4
7.	MCE/SE/551 Structural Engineering Laboratory		3	40	60	100	2
8.	MCE/SE/552 Seminar		1	100	-	100	2
		24	3	380	420	800	28

L: Lecture, P: Practical

Duration of Internal Examination : 2 Hours Duration of External Examination : 3 Hours

II Semester

S. No	Subject Title	Periods per week		Maximum Marks			Credits
		L	P	Int.	Ext.	Total	
1.	MCE/SE/514 Finite Element Analysis of Structures	4		40	60	100	4
2.	MCE/SE/515 Stability of Structures	4		40	60	100	4
3.	MCE/SE/516 Theory of Plates and Shells	4		40	60	100	4
4.	Elective - IV	4		40	60	100	4
5.	Elective - V	4		40	60	100	4
6.	Elective - VI	4		40	60	100	4
7.	MCE/SE/553 Computer Aided Design Laboratory		3	40	60	100	2
8.	MCE/SE/554 Seminar		1	100	-	100	2
		24	4	380	420	800	28

L: Lecture, P: Practical

Duration of Internal Examination : 2 Hours Duration of External Examination : 3 Hours

III Semester

S.No.	Subject Code & Title	Maximum Marks (Internal)	Credits
1	MCE/SE/711 Internship	100	2
2	MCE/SE/712 Project (Phase-I)	100	6

IV Semester

S.No.	Subject Code & Title	Maximum Marks Int.	Ext (Viva-voce)	Credits
1	MCE/SE/713 Project (Phase-II)	50	150	16

ELECTIVE SUBJECTS

MCE/SE/611 Advanced Theory and Design of RCC Structures

MCE/SE/612 Design of reinforced concrete foundations

MCE/SE/613 Structural optimization

MCE/SE/614 Fracture Mechanics of concrete

MCE/SE/615 Fibre Reinforced Plastic Composites

MCE/SE/616 Experimental stress analysis and Motion measurement

MCE/SE/617 Health monitoring of structures

MCE/SE/618 Design of Tall Buildings

MCE/SE/619 Advanced Foundation Engineering

MCE/SE/620 Earthquake Resistant Design of Structures

MCE/SE/621 Disaster Management

MCE/SE/622 Ground Improvement Techniques

MCE/SE/623 Advanced Design of Steel Structures

MCE/SE/624 Composite Construction

MCE/SE/625 Design of Prestressed Concrete Structures

MCE/SE/626 Repair and Rehabilitation of Structures

MCE/SE/627 Advanced Bridge Engineering

MCE/SE/628 Fibre reinforced concrete

MCE/SE/511 THEORY OF ELASTICITY AND PLASTICITY

1. **Analysis of stress and strain in three dimensions**
   Stress at a point – components of stress; Principal stresses; Stress ellipsoid and stress director surface; Determination of principal stresses; Stress invariants; Determination of maximum shear stresses; Octahedral shear stress; strain at a point – Components of strain; Differential equations of equilibrium ; Conditions of compatibility; Generalised Hooke's law

2. **Two-dimensional problems in rectangular coordinates**
   Plane stress ; Plane strain; Differential equations of equilibrium; Boundary conditions; Compatibility equations; Stress function; Governing differential equation; Solution by polynomials; End effects – Saint-Venant's Principle; Determination of displacements; Bending of a cantilever loaded at the end; Bending of a beam by uniform load

3. **Two-dimensional problems in polar coordinates**
   General equations in polar coordinates; Stress distribution symmetrical about an axis; Effect of circular holes on stress distribution in plates; Concentrated force at a point of a straight boundary; Concentrated force acting on a beam; Stresses in a circular disc

4. **Torsion**
   Torsion of straight bars – Saint Venant's theory; Elliptic cross section; Membrane analogy; Torsion of a bar of narrow rectangular cross-section; Torsion of rolled profile sections; Torsion of thin tubes

5. **Plasticity**
   Yield criteria – Introduction, The Tresca yield criterion, The von Mises yield criterion; Stress-Strain relations – Introduction, Plastic potential and Plastic flow, Levy-Mises equations, Prandtl-Reuss equations

Text Books

1) Theory of elasticity by S.P.Timoshenko & J.N.Goodier, McGraw-Hill.
2) Applied elasticity for engineers by L.Govindaraju and T.G.Sitharam, Civil Engineering, www.nptel.ac.in
3) Advanced mechanics of solids by LS Srinath, TataMcGra-Hill
4) Computational elasticity by M. Ameen, Narosa Publishing House.
4) Introduction to Engineering plasticity by GK Lal and NV Reddy, Narosa Publishing House.
5) Plasticity for structural engineers by Chen and Han, Cengage Learning.

MCE/SE/512 DYNAMICS OF STRCUTURES

1. Introduction

Fundamental objective of structural dynamics; Types of prescribed loadings ; Essential characteristics of a dynamic problem; Methods of descritisation – Lumped, Generalised displacements, Finite element concept; Formulation of equation of motion ; Dynamic equilibrium equation using D'Alembert's Principle

2. Single-Degree-of-Freedom Systems

Force-displacement relation – Linear elastic systems; Damping force; Equation of motion-external force; Mass-spring-damper system; Undamped free vibration; Viscously damped free vibration; Coulomb-damped free vibration; Harmonic vibration of undamped and viscously damped systems; Response to periodic excitation; Response to unit impulse; Response to arbitrary force; Response to step force; Response to rectangular pulse force; Numerical evaluation of dynamic response – Newmark's method

Earthquake response of linear systems – Earthquake excitation , Equation of motion, Response quantities, Time history analysis using Newmark's method for a particular ground motion (EL CENTRO), Response spectrum concept , Pseudo acceleration response spectrum, Peak structural response from the response spectrum, Elastic design spectrum

3. Multi-Degree-Of-Freedom Systems

Undamped free vibrations – Analysis of vibration frequencies, analysis of vibration mode shapes, orthogonality conditions

Analysis of dynamic response – Normal coordinates, Uncoupled equations of motion (undamped and viscously damped), Mode (displacement) superposition analysis – Viscously damped

Numerical evaluation of dynamic response - Newmark's method

4. Systems with Distributed Mass And Elasticity

Undamped free vibration of beams ; Analysis of dynamic response – Normal coordinates, uncoupled flexural equations of motion (undamped and viscously damped)

Text Books :

1) Dynamics of Structures by R.W. Clough and P.E. Penzien , McGraw-Hill, 1993.
2) Dynamics of Structures by A.K.Chopra , Prentice-Hall of India, 2001.
3) Structural Dynamics by Mario Paz, CBS Publishers, 1987.
4) Structural dynamics by M. Mukhopadhyay, Ane Books India .

MCE/SE/513 MATRIX METHODS OF STRUCTURAL ANALYSIS

(1) Basic Concepts of Structural Analysis :

Introduction; Types of Framed Structures; Deformations in Framed Structures; Actions and Displacements; Equilibrium; Compatibility; Static and Kinematic Indeterminacy; Structural Mobilities; Principle of Superposition; Action and Displacement Equations; Flexibility and Stiffness Matrices; Equivalent Joint Loads; Energy Concepts; Virtual Work.

(2) Fundamentals of the Flexibility Method:

Introduction; Flexibility Method; Temperature changes; Prestrains and Support Displacements; Joint Displacements; Member End Actions and support reactions; Flexibilities of prismatic members; Formalization of the Flexibility method.

(3) Fundamentals of the Stiffness Method :

Introduction; Stiffness Method; Temperature changes; Prestrains and Support Displacements; Stiffness of Prismatic Members; Formalization of the Stiffness Method.

(4) Computer Oriented Direct Stiffness Method :

Introduction; Direct Stiffness Method; Complete Member Stiffness Matrices; Formation of Joint Stiffness Matrix; Formation of Load Vector; Rearrangement of Stiffness and Load Arrays; Calculation of Results; Analysis of Continuous Beams; Plane Truss Member Stiffness; Analysis of Plane Trusses; Rotation of Axes in Two Dimensions; Application to Plane Truss Members; Rotation of Axes in Three Dimensions; Plane Frame Member Stiffness; Analysis of Plane Frames.

(5) Computer Programs for Framed Structures:

Flow Chart for the analysis of the following structures:

i) Continuous Beam
ii) Plane Truss
iii) Plane Frame

Text Books :

1. Matrix Analysis of Framed Structures by W. Weaver & J.M.Gere, CBS Publishers, 1986.
2. Matrix methods of structural analysis by PN Godbole, RS Sonparote, SU Dhote, PHI, 2014.
3. Matrix methods of structural analysis by AS Meghre and SK Deshmukh, Charotar Publishing House,2003.
4. Computer analysis of framed structures by Damoder Maity, IK International, 2007.

MCE/SE/551 STRUCTURAL ENGINEERING LABORATORY

A minimum of 10 of the following experiments are to be carried out :

1. Study of the effect of water/cement ratio on workability and strength of Concrete.
2. Study of the effect of aggregate /cement ratio on strength of concrete
3. Mix design methods using a) I.S. Code method b) ACI Code method
4. A study of correlation between cube strength, cylinder strength, split tensile strength and modulus of rupture
5. A study of behaviour of under-reinforced and over-reinforced beams
6. A study on the effect of span to depth ratio on the failure pattern of RC beams
7. Non-destructive testing of concrete using Rebound Hammer and Ultrasonic Pulse Velocity Meter
8. Measurement of static strain by electrical resistance strain gauges
9. Determination of the material fringe value of a given photo elastic material.
10. Determination of principal stress difference in a circular disc subjected to diametrical compression.
11. Determination of principal stresses in a bar subjected to axial tension.
12. Dynamics of a three storey building frame subjected to harmonic base motion
13. Test on buckling of column – Southwell Plot
14. Tests on self compacting concrete

MCE/SE/514 FINITE ELEMENT ANALYSIS OF STRUCTURES

1. Basic Principles

Equilibrium equations; Strain-displacement relations; Linear constitutive relations; Principle virtual work; Principle of stationary potential energy

2. Element Properties

Different types of elements; Displacement models; Relation between nodal degrees of freedom and generalized coordinates; Convergence requirements; Compatibility requirement; Geometric invariance; Natural coordinate systems; Shape functions; Element strains and stresses; Element stiffness matrix; Element nodal load vector

Isoparametric elements – Definition, Two-dimensional isoparametric elements – Jacobian transformation, Numerical integration

3. Direct Stiffness method and Solution Technique

Assemblage of elements–Obtaining Global stiffness matrix and Global load vector; Governing equilibrium equation for static problems; Storage of Global stiffness matrix in banded and skyline form; Incorporation of boundary conditions; Solution to resulting simultaneous equations by Gauss elimination method

4. Plane-stress and Plane-strain analysis

Solving plane stress and plane-strain problems using constant strain triangle and four nodded isoparametric element

5. Analysis of plate bending

Basic theory of plate bending; Shear deformation plates; Plate bending analysis using four noded isoparametric element

Text books :

1. Finite element analysis by C.S.Krishnamurthy, Tata-McGraw-Hill, 1994.
2. Introduction to finite element method by PN Godbole, IK International, 2013.
3. Finite element analysis by SS Bhavikatti, New Age International, 2010.
4. Matrix and finite element analyses of structures by M.Mukhopadhay and A.H.Sheikh, Ane Books, 2004.
5. Concepts and applications of finite element analysis by R.D.Cook et.al., John Wiley and Sons, 1989.

MCE/SE/515 STABILITY OF STRUCTURES

1. **Buckling of columns and frames :**
   Introduction; Euler's column formula; Alternate form of the differential equation for determining critical loads; The use of beam-column theory in calculating the critical loads; Buckling of frames; The energy method; Buckling of a bar under distributed axial load; Buckling of bars with sudden change in cross section; Inelastic buckling of bars

2. **Torsional buckling :**
   Pure torsion of thin-walled bars of open cross section; Non-uniform torsion of thin-walled bars of open cross section ; Torsional buckling under axial loading; Combined flexural and torsional buckling.

3. **Lateral Buckling of Beams :**
   Differential equations for lateral buckling; Lateral buckling of beams in pure bending; Lateral buckling of cantilever and simply supported beams of narrow rectangular and I sections subjected to concentrated load

4. **Buckling of Rectangular Plates:**
   Methods of calculation of critical loads; Buckling of simply supported rectangular plates uniformly compressed in one direction; Buckling of simply supported rectangular plates uniformly compressed in two perpendicular directions; Buckling of uniformly compressed rectangular plates simply supported along two opposite sides perpendicular to the direction of compression and having various edge conditions along the other two sides

5. **Buckling of Shells:**
   Introduction to buckling of axially compressed cylindrical shells.

6. **Mathematical treatment of stability problems:**
   Discrete/Discontinuous systems; Eigen value problem; Converting continuous systems to discrete systems using the finite element method – Buckling of a column with sudden change in cross-section

Text books :

1. Theory of elastic stability by Timoshenko & Gere, McGraw Hill, 1961.
2. Background to buckling by Allen and Bulson, McGraw-Hill, 1980.
3. Structural stability – Theory and implementation by WF Chen and EM Lui, Elsevier, 1987.
4. Principles of elastic stability by A.Chajes, Prentice-Hall, 1974.
5. Stability of structures – Principles and applications by CH Yoo and SC Lee, Butterworth-Heinemann, 2011.

MCE/SE/516 THEORY OF PLATES AND SHELLS

1. **Bending of long rectangular plates to cylindrical surface**
   Differential equation for cylindrical bending of plates

2. **Pure bending of plates**
   Slope and curvature of slightly bent plates; Relations between bending moments and curvature in pure bending of plates; Particular cases of pure bending; Strain energy in pure bending of plates; Limitation on the application of the derived Formulae

3. **Symmetrical bending of circular plates**
   Differential equation for symmetrical bending of laterally loaded circular plates; Uniformly loaded circular plates

4. **Small deflections of laterally loaded plates**
   Differential equation of the deflection surface; Boundary conditions; Simply supported rectangular plates under sinusoidal load; Navier's solution for simply supported rectangular plates; Levy's solution for simply supported and uniformly loaded rectangular plates

5. **Introduction to Shells**
   Parametric representation of a surface; The first quadratic form; Equation to the normal of a surface; The second quadratic form; Principal curvatures, Gauss curvature, and lines of curvature; Surfaces of revolution; Some definitions; Classification of shell surfaces

6. **Membrane theory of Cylindrical shells**
   Thin shells; Parts of a cylindrical shell; Loads; Notes on the membrane theory; Equations of equilibrium; Stresses in simply supported cylindrical shell; Value of K for dead load; Cylindrical shell with circular directrix; Some comments on the membrane theory

7. **Bending theory of cylindrical shells**
   The need for a bending theory; Stress analysis of cylindrical shells; Expressions for strain and change in curvature – Strains in a circular cylindrical shell, Rotation of the tangent , Change in circumferential curvature, Stress-strain relations, Moment-curvature relation, Membrane displacements due to dead load; Beam theory of cylindrical shells – Advantages of the beam method, assumption , Range of validity, Beam analysis, Arch analysis

8. **Membrane theory of surfaces of revolution**
   Equations of equilibrium; Symmetrically loaded shells; The spherical shell- Stress under its own weight, Stresses with concentrated load at crown

Text books :

1. Theory of plates and shells by S.P.Timoshenko and S.Woinowsky-Krieger, McGraw-Hill, 1959.
2. Stresses in beams, plates and shells by A.C.Ugural, CRC Press, 2010.

3. Design and construction of concrete shell roofs by G.S.Ramaswamy, CBS Publishers& Distributors,1986.
4. Thin shell structures by JN Bandyopadhay, New Age International, 1998.

MCE/SE/553 COMPUTER AIDED DESIGN LABORATORY

A minimum of 6 of the following problems are to be solved using application software like STAAD PRO, ANSYS, SAP etc.

1. Design of multistory RCC building
2. Design of one storey trussed roof steel building
3. Design of one storey gable frame (Pre-engineered) building
4. Design of steel multistory pin-jointed building with braces
5. Design of a simple tower
6. Plane stress analysis of a beam using FEM
7. Plane stress of a plate with a circular hole using FEM
8. Plate bending analysis using FEM
9. Analysis of a cylindrical shell roof using FEM

MCE/SE/611 ADVANCED THEORY AND DESIGN OF RCC STRUCTURES

1. **Behaviour of RCC members in Shear and Torsion**
   Kani's theory for shear; Skew bending theory for torsion; Different modes of failure; Design of beams in combined shear, bending and torsion

2. **Detailing of RCC structures**
   Basic principles of detailing – Truss analogy, Directional changes, General layout of reinforcement; Beam-column joints – Strut- and-Tie model, Detailing ; Beam-to-girder joints; Corners and T-Joints; Brackets and corbels

3. **Design of shear walls**
   Introduction; Classification of shear walls; Classification according to behaviour; Loads on shear walls; Design of rectangular and flanged shear walls

4. **Flat slabs**
   Shear in flat slabs and flat plates – One-way shear, Two-way (punching) shear, Shear due to unbalanced moment, Shear reinforcement design; Equivalent frame analysis of flat slabs – Historical development and definition of equivalent frame, Moment of inertia of slab-beams, Theoretical column stiffnesses, Use of published data for flat \ slabs, equivalent column method, arrangement of live load, Reduction in negative moments, Design procedure

5. **Yield line analysis of slabs**
   Introduction; Upper and lower bound theorems; Rules for yield lines; Analysis by segment equilibrium; Analysis by virtual work; Orthotropic reinforcement and skewed yield lines; special conditions at edges and corners; Fan patterns at concentrated loads; Limitations of yield line theory

Text books :

1. Advanced reinforced concrete design by P.C.Varghese, Prentice-Hall of India, 2005.
2. Reinforced concrete structural elements by P.Purushothaman, Tata McGraw-Hill, 1984.
3. Reinforced concrete design by S.U. Pillai and D.Menon, Tata McGraw-Hill, 2003.
4. Design of reinforced concrete structures by N.Subramanian, Oxford University Press, 2013.
5. Design of concrete structures by A.H.Nilson, McGraw-Hill, 1997.
6. Reinforced concrete structures by R.Park and T.Paulay, John Wiley & Sons, 1975.

MCE/SE/612 DESIGN OF REINFORCED CONCRETE FOUNDATIONS

1. **PROVISIONS FOR DESIGN OF FOOTINGS (as per IS456 : 2000)**
   Design loads for foundation design, basic structural design of RC footings, soil pressure on foundations, Analysis of footings subjected to vertical loads and moments, Planning and design of independent footing, depth and detailing of steel requirements, development lengths of main bars in footing.

2. **COMBINED FOOTINGS:**
   Types of combined footings, action of combined footing, planning layout of combined footing, distribution of column loads in transverse direction, combined footing with transverse beams under column loads, design of combined footings.

3. **RAFT FOUNDATIONS:**
   Types of rafts, Deflection requirements of beams and slabs in rafts, General consideration in design of rigid rafts, Types of loading and choice of raft, Components of flat slabs, Analysis of flat slabs, design of flat slab rafts,

4. **PILE FOUNDATIONS**
   Estimation load carrying capacity of single and pile group under various loading conditions, Design of single pile, Design of under-reamed piles, Design of pile caps.

5. **WELL FOUNDATIONS**
   Types, components, stability analysis of well foundations, design of well foundation.

Text Books:

1. Design of Reinforced concrete foundations by P.C.Varghese,PHI Learning Pvt.Ltd, New Delhi.
2. Essentials of Bridge Engineering by Dr. Johnson Victor; Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
3. V.N.S. Murthy, "Advanced Foundation Engineering", CBS Publishers and Distributors.

MCE/SE/613 STRUCTURAL OPTIMIZATION

1. Introduction

Function optimization and parameter optimization; Elements of problem formulation; The solution process; Analysis and design formulations; Specific versus General methods

2. Classical Tools in Structural Optimization

Optimization using differential calculus; Optimization using variational calculus; Classical methods for constrained problems; Local constraints and the minmax approach; Necessary and sufficient conditions for optimality; Use of series of solutions in structural optimization

3. Linear Programming

Limit analysis and design of structures; Prestressed concrete design by linear programming; Minimum weight design of statically determinate trusses ; A linear program in a standard form; The simplex method; Duality in linear programming

4. Unconstrained optimization

Minimization of functions of one variable; Minimization of functions of several variables; Specialised quasi-Newton methods; Probabilistic search algorithms

5. Constrained optimization

The Kuhn-Tucker conditions; Quadratic programming problems; Computing the Lagrange multipliers; Sensitivity of optimum solution to problem parameters; Gradient projection and reduced gradient methods; The penalty function methods ; Multiplier methods

6. Aspects of optimization process in practice

Generic approximations; fast reanalysis techniques; Sequential linear programming; Sequential non-linear approximate optimization; Special problems asscociated with shape optimization ; Optimization packages; Test problems – Ten bar truss

Text books :

1. Elements of structural optimization by Haftka and Gurdal ; Publisher : Springer
2. Structural optimization : Fundamentals and applications by U. Kirsch; Publisher : Springer
3. Optimization : Theory and Applications by SS Rao, Wiley Eastern Ltd.

MCE/SE/614 FRACTURE MECHANICS OF CONCRETE

1. **Introduction to fracture mechanics of concrete**
   Structural failure based on material performance; Concepts of linear elastic fracture mechanics; Fracture mechanics of concrete

2. **Principles of linear elastic fracture mechanics**
   Airy stress functions for problems in elasticity; Complex stress function; Elastic stress and displacement fields at crack tip; Stress intensity factors and crack opening displacements for useful geometries; Superposition of stress intensity factors; Plastic zone at crack tip; Griffith's fracture theory; Strain energy release rate for crack propagation; Relationship between stress intensity factor and strain energy release rate; Design based on linear elastic fracture mechanics

3. **Principles of non-linear fracture mechanics**
   Energy principles for crack propagation in non-linear materials; J-integral for non-linear elastic materials; Fracture resistance (R curve); Crack tip opening displacement;

4. **Structure and fracture process of concrete**
   Constituents and microstructure of concrete; Fracture behaviour and strain localization of concrete; Fracture process zone and toughening mechanisms; Experimental determination of fracture zone; Influence of fracture process zone on fracture behaviour of concrete

5. **Non-linear fracture mechanics for Mode I Quasi-Brittle Fracture**
   General description of quasi-brittle fracture; Fictitious approach – Energy dissipation for fictitious crack, Fictitious crack model by Bazant and Oh, Determination and influence of σ (w) relationship, Some comments on fictitious crack approach; Effective elastic approach – Energy dissipation for effective-elastic crack, Two-parameter fracture model by Jenq and shah, Size effect model by Bazant and Kazemi, Effective crack model by Karihaloo and Nallathambi, Effective crack model by Refai and Swartz, Some comments on effective-elastic crack approach; Comparison between Fictitious and effective-elastic crack approaches; Finite element analysis – Discrete crack approach, Smeared crack approach , Software available

Text Books :

1. Fracture Mechanics of Concrete: Applications of Fracture Mechanics to Concrete, Rock and Other Quasi-Brittle Materials by Surendra P. Shah, Stuart E. Swartz, Chengsheng Ouyang, Publisher : Wiley , 1995.
2. Analysis of Concrete Structures by Fracture Mechanics by by L. Elfgren, Publisher**:** Routledge, 1990.
3. Fracture mechanics – Applications to concrete , Edited by Victor C.Li and Z.P.Bazant, ACI SP118.
5. Elements of fracture mechanics by Prashant Kumar, Wheeler Publishing, 1999.

MCE/SE/615 FIBRE REINFORCED PLASTIC COMPOSITES

1. **Introduction**
   Definition; History of fibre reinforced composites; Constituent materials – Fibres, Polymeric matrix, Prepregs; Lamina and Laminate; General characteristics of FRP; Micromechanics and macromechanics; Properties of typical composite materials; Applications of FRPs in Civil engineering

2. **Processing of FRP Composites**
   Contact moulding; Compression moulding methods ; Filament winding

3. **Macromechanical behaviour of a lamina**
   Introduction; Stress-strain relations of a lamina with respect to its principal axes; Stress-strain relations of an arbitrarily oriented lamina; Typical elastic properties of a unidirectional lamina

4. **Macromechanical behaviour of a laminate**
   Introduction; Classical lamination theory – Lamina stress strain behaviour, Strain and stress variation in a laminate, Resultant laminate forces and moments; Special cases of laminate stiffnesses

5. **Design of FRP structures**
   Introduction; Composite structural design; The design spiral; Design criteria; Design allowables; Material selection; Selection of configuration and manufacturing process; Laminate design – selection of laminate, laminate design problem, laminate design Procedure; Mathematical analysis of the laminate – estimation of shear force, estimation of deflection, mathematical algorithm; Design examples – design of tension member, laminate design for strength, laminate design for stiffness

6. **Composite Joints**
   Introduction; Classes of laminate joints; Bonded joints- stress distribution, modes of failure, Merits and demerits of adhesive bonded joints; Mechanical joints – failure modes, advantages and disadvantages

Text books :

1. Mechanics of composite materials and structures by Madhujit Mukhopadhay, Universities Press, 2004.
2. Mechanics of composite materials by R.M.Jones, Publisher : Taylor & Francis, 1998.

MCE/SE/616 EXPERIMENTAL STRESS ANALYSIS AND MOTION MEASUREMENT

1. **Introduction to Strain Measurements**
   Experimental determination of strain; Properties of strain gage systems; Types of strain gages

2. **Strain Measurement using Electrical Resistance Strain Gages**
   Introduction; Strain sensitivity in metallic alloys; Gage construction; Strain gage adhesives and moulding methods; Gage sensitivities and gauge factor; The Wheatstone bridge ; Wheatstone bridge sensitivity; Temperature compensation ; Static recording and data logging – Manual strain indicators, Automatic data acquisition systems, PC based data acquisition systems; Strain analysis methods – Three element rectangular rosette

3. **Stress analysis using Photoelasticity**
   Wave theory of light; Refraction of light; The Polariscope – Plane polarisers, wave plates; Plane polariscope; Circular polariscope; Diffused light polariscope; The stress optic law for two-dimensional plane-stress bodies; Two-dimensional photoelastic stress analysis – Isochromatic fringe patterns, Isoclinic fringe patterns, Calibration methods, Principal stress separation methods, Scaling model-to-prototype stresses; Materials for two dimensional photoelasticity; Three-dimensional photoelasticity – Stress freezing

4. **Model analysis of Structures**
   Introduction – Objectives of structural model studies, Some basic definitions, Types of similitude , Classification of model studies, Model materials, Size effects; Principles of similitude – Dimensional analysis, Buckingham π Theorem, Variables in structural behaviour; Requirements of similitude; Direct approach

5. **Motion Measurement**
   Introduction; Vibrometers and Accelerometers; The seismic instrument; General theory of the seismic instrument; The seismic accelerometer; Practical accelerometers

Text Books :

1. Experimental Stress Analysis by Dally and Riley, McGraw-Hill, 1991.
2. Model analysis of Structures by T.P.Ganesan, Universities Press, 2000.
3. Mechanical measurements by Bechwith, Merangoni & Lienhard, Pearson Education, 2003.
4. Experimental stress analysis by Sadhu Singh, Khanna Publishers, 2014.

MCE/SE/617 HEALTH MONITORING OF STRUCTURES

1. Introduction

Definition; Introduction for structural health monitoring (SHM); Smart materials and structures; Process and Pre-usage monitoring as a part of SHM; SHM as a part of system management; Passive and active SHM; NDE, SHM and NDECS; Variety and multi-disciplinary

2. **Vibration based techniques**

Introduction; Basic vibration concepts for SHM

3. Fibre-optic sensors

Introduction; Classification of fibre-optic sensors; Examples of applications in Civil Engineering

4. Piezoelectric sensors

Background and context; The use of embedded sensors as acoustic emission detectors; State-of-the art and main trends in piezoelectric transducer-based acousto-ultrasonic SHM research; Electrochemical impedance

5. Case studies for SHM

- Recent development of bridge health monitoring system in Korea
- Monitoring results of a self-anchored suspension bridge in Korea
- Long-term monitoring of a hybrid cable-stayed bridge in China

Text Books :

1. Structural health monitoring by Daniel Balageas, Claus-Peter Fritzen and Alfredo Guenes (Editors), Wiley-ISTE Ltd., 2006.

2. Sensing issues in Civil Health monitoring by Farhad Ansari (Editor) , Springer, 2005.

MCE/SE/618 DESIGN OF TALL BUILDINGS

1. **General Considerations**
   Introduction; Definition of a tall building ; Lateral load design philosophy; Concept of premium for height; Factors responsible for slimming down the weight of structural frame; Development of high-rise architecture;

2. **Wind effects**
   Design considerations; Nature of wind; Extreme wind conditions; Characteristics of wind; Provisions of IS875(Part3); Wind tunnel engineering – Introduction, Description, of wind tunnels; Objectives of wind tunnel tests, Rigid model studies, Aeroelastic study

3. **Seismic Design**
   Introduction; Tall building behaviour during earthquakes ; Philosophy of earthquake design; Provisions of IS1893(Part1).

4. **Lateral Systems for Steel Buildings**
   Introduction; Rigid frames; Braced frames; Staggered truss system ; Eccentric bracing systems; Outrigger and belt systems; Framed tube systems; Interacting system of braced and rigid frames

5. **Lateral Systems for Concrete Buildings**
   Introduction; Frame action of column and slab systems; Flat slab and shear walls; Flat slab, shear walls and columns; Coupled shear walls; Rigid frame; Widely spaced perimeter tube; Core-supported structures; Shear-wall frame interaction

6. **Lateral Systems for Composite Construction**
   Introduction; Composite elements; Composite systems

7. **Gravity Systems**
   Concrete floor systems; Prestressed concrete systems; Composite metal decks

8. **Structural Analysis**
   Introduction; Preliminary hand calculations; General computer analysis techniques

Text Books :

1. Structural Analysis and design of tall buildings by B.S.Taranath, McGraw-Hill, 1988.
2. Reinforced concrete design of tall buildings by B.S. Taranath, CRC Press, 2010.
3. Structural analysis and design of tall buildings – Steel and Composite Construction, by B.S. Taranath ,CRC Press, 2012.
4. Tall building structures by B.S.Smith and A.Coull, John Wiley & Sons, 1991.

MCE/SE/619 ADVANCED FOUNDATION ENGINEERING

1) **Ultimate Bearing Capacity of Shallow Foundations:Special Cases**
Introduction, Foundation supported by a soil with a rigid base at shallow depth, Bearing capacity of layered soils-Stronger soil underlain by Weaker soil, Weaker soil underlain by Stronger soil; Closely spaced foundations-Effect on Ultimate Bearing Capacity; Bearing capacity of foundations on top of a slope; Uplift capacity of foundations.

2) **Shallow Foundations:Allowable bearing capacity and settlement**
Introduction,Elastic settlement of foundations on saturated clay;Settlement based on the theory of elasticity;Improved equation for elastic settlement;Settlement of sandy soil-Use of strain influence factor;Settlement of foundationon sand based on standard penetration resistance;Settlement in granular soil based on pressuremeter test(PMT); Primary consolidation settlement relationships;Three-dimensional effect on primary consolidation settlement;Tolerable settlement of buildings.

3) **Mat Foundations**
Introduction,Combined footings-Rectangular combined footing, Trapezoidal combined footing,Cantiver footing;Common types of Mat foundations;Bearing capacity of mat foundations;Differential settlement of mats;Field settlement observations for mat foundations;Compensated foundation.

4) **Sheet Pile Walls and Coffer dams**
Introduction;Construction methods;Cantilever sheet pile walls;Cantilever sheet piling penetrating sandy soils;Cantilever sheet piling penetrating clay;Anchored sheet pile walls;Free earth support method for penetration of sandy clay;Fixed earth support method for penetration into sandy soil;Free earth support method for penetration of clay;Coffer dams-types with relative merits and demerits.

5) **Braced cuts**
Introduction;Pressure envelope for braced cut design;Pressure envelope for cuts in layered soil;Design of various components of a braced cut;Bottom heave of a cut in clay;Stability of the bottom of a cut in sand.

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Text books :

1) Principles of Foundation Engineering, Braja M. Das.,Cengage Learning
2) Foundation Analysis & Design by Bowles, J.E., McGraw- Hill Book Company.
3) Basic and Applied Soil Mechanics by Gopal Ranjan and ASR Rao, Wiley Eastern Limited, New Delhi.
4) Geotechnical Engineering by SK Gulati & Manoj Datta, Tata McGraw- Hill Publishing Company Limited.

MCE/SE/620 EARTHQUAKE RESISTANT DESIGN OF STRUCTURES

1. **Design forces for buildings**
   Introduction; Equivalent static method; Mode superposition technique; Dynamic inelastic-time history analysis; Advantages and disadvantages of these methods; Determination of lateral forces as per IS1893(Part 1) – Equivalent static method, Model analysis using response spectrum

2. **Ductility considerations in earthquake resistant design of RCC buildings**
   Introduction; Impact of ductility; Requirements for ductility; Assessment of ductility– Member/element ductility, Structural ductility; Factor affecting ductility; Ductility factors; Ductility considerations as per IS13920

3. **Earthquake resistant design of a long two-storey , two-bay RCC building**
   Determination of lateral forces on an intermediate plane frame using Equivalent static method and Model analysis using response spectrum; Analysis of the intermediate frame for various load combinations as per IS1893(Part 1); Identification of design forces and moments in the members; Design and detailing of typical flexural member ,typical column, footing and detailing of a exterior joint as per IS13920.

4. **Seismic design of Steel Buildings**
   Behaviour and design of moment resisting frames – Introduction, Analysis and detailing of special moment frames, beam design, Beam-to-column connections; Beam-to-column panel zones, Column design;

   Behaviour and design of concentrically braced frames – Design philosophy, Hysteretic energy dissipation capacity of braces, Design requirements, Bracing connections design requirements, Columns and beams;

   Behaviour and design of eccentrically braced frames – Introduction, Basic concept and EBF behaviour, Link behaviour, Capacity design of other structural components;

   Design examples

Text books :

1. Earthquake resistant design of structures by Pankaj Agarwal and Manish Shrikhande, Prentice-Hall of India, 2006.
2. Seismic design of reinforced concrete and masonry buildings by T.Paulay and M.J.N.Priestley, John Wiley & Sons, 1991.
3. Seismic design of steel structures by Chia-Ming Uang et al., The seismic design handbook, Edited by F.Naeim, Kluwer Academic publishers, 2001.

MCE/SE/621 DISASTER MANAGEMENT

Concept of Disaster Management. Types of Disasters. Disaster mitigating agencies and their organizational structure at different levels.

Overview of Disaster situations in India: Vulnerability of profile of India and Vulnerability mapping including disaster – pone areas, communities, places. Disaster preparedness – ways and means; skills and strategies; rescue, relief reconstruction and rehabilitation. Case Studies: Lessons and Experiences from Various Important Disasters in India

Seismic vulnerability of urban areas. Seismic response of R.C frame buildings with soft first storey. Preparedness for natural disasters in urban areas. Urban earthquake disaster risk management. Using risks-time charts to plan for the future. Lateral strength of masonry walls. A numerical model for post earthquake fire response of structures.

Landslide hazards zonation mapping and geo-environmental problems associated with the occurrence of landslides. A statistical approach to study landslides. Landslide casual factors in urban areas. Roads and landslide hazards in Himalaya. The use of electrical resistivity method in the study of landslide. Studies in rock-mass classification and landslide management in a part of Garhwal-Himalaya, India.

Cyclone resistant house for coastal areas. Disaster resistant construction role of insurance sector. Response of buried steel pipelines carrying water subjected to earthquake ground motion. Preparedness and planning for an urban earthquake disaster. Urban settlements and natural hazards. Role of knowledge based expert system in hazard scenario.

Text books :

1. Natural Hazards in the Urban Habitat by Iyengar, C.B.R.I., Tata McGraw Hill.
2. Natural Disaster Management, Jon Ingleton (Ed), Tulor Rose, 1999.
3. Disaster Management, R.B.Singh (Ed),Rawat Publications, 2000.
4. Disaster Management by Ramakant Gaur , Authorpress, 2008.
5. Anthropology of Disaster Management, Sachindra Narayan, Gyan Publishing House, 2000.

MCE/SE/622 GROUND IMPROVEMENT TECHNIQUES

1.Introduction to Engineering ground modification

Need for engineered ground improvement, classification of ground modification techniques; suitability, feasibility and desirability of ground improvement technique; objectives of improving soil.

2.Mechanical Modification

Terminology and aims of mechanical modification,compaction purposes and strategies, Methods of compaction:Laboratory procedures-Dynamic compaction,kneading compaction,static compaction;shallow surface compaction-static rollers,impact and vibratory equipment,operational aspects of shallow compaction;Deep compaction techniques-precompression,explosion,heavy tamping,vibration,compaction grouting;Hydromechanical compaction-hydraulic fill,dry fill with subsequent spraying or flooding,compaction of rock fill with water jets.

3.Hydraulic Modification

Objectives and techniques, traditional dewatering methods-open sumps and ditches,vacuum dewatering wells; Filtration,drainage and seepage control with geosynthetics-Geotextiles-definition and types,geotextile applications,Basic functions of geotextiles;Preloading and use of vertical drains-Purpose of preloading and vertical drains,Methods of providing vertical drains-cylindrical sand drains,geosynthetic drains,Pre loading with vertical drains-radial consolidation,combined radial and vertical consolidation.

4.Physical and chemical modification

Terminology, construction techniques,and typical uses;Types of admixtures and their effect on soil properties-Granular admixtures, Cement stabilization and cement columns, Lime stabilization and lime columns, Stabilization using bitumen and emulsions, Stabilization using industrial wastes.

5.Modification by inclusions and confinement

Concept of soil reinforcement;Reinforced soil as a homogeneous composite material-Elastic theory,strength theories;Discrete soil-reinforcement action;Reinforced earth and other strip reinforcing methods-standard materials and dimensions,failure modes;Development of design procedures-Original standard analysis,Tieback analysis-Rankine type analysis,Coulomb type analysis.

Retaining walls with metallic strip reinforcement;step-by-step-design procedure using metallic strip reinforcement;Retaining walls with geotextile reinforcement;Retaining walls with Geogrid reinforcement-General,design procedure for geogrid-reinforced retaining wall.

Insitu Ground reinforcement:Ground Anchors-Typical applications,types and components; Rock bolts- Typical applications,types and components; Soil nailing-Different soil nailing systems and applications,The importance of construction sequence, Analysis of nailed soil,Special considerations for slope stabilization.

Text Books :

1. Hausmann M.R(1990) Engineering Principles of ground modification, McGraw-Hill Education(India) Private Limited,New Delhi.
2. Ground improvement Techniques, P.Purushothama Raju, Laxmi Publications Pvt. Ltd.,

New Delhi.
3. Robert M. Koerner, Designing with Geosynthatics, Prentice Hall New Jercy, USA.
4. Construction and Geotechnical methods in Foundation Engineering, R.M.Koerner, McGraw-Hill Book Company.
5. Current Practices in Geotechnical Engineering Vol.-I, Alam Singh and Joshi, International Book Traders, New Delhi.
6. Geotechnical Engineering by SK Gulati & Manoj Datta, Tata McGraw- Hill Publishing Company Limited.
7. Advanced Foundation Engineering by V.N.S. Murthy, CBS Publishers and Distributors.
8. Principles of Foundation Engineering, Braja M. Das.,Cengage Learning

MCE/SE/623 ADVANCED DESIGN OF STEEL STRUCTURES

1. **Wind loads on buildings (as per IS875 Part 3 : 1987)**
   Wind load on pitched roofs; Wind loads on the walls of rectangular clad buildings

2. **Analysis and design of gable frames**
   Elastic analysis and limit state design of gable frames subjected dead, live and wind loads; Plastic analysis and design of gable frames subjected to dead, live and wind loads

3. **Low-rise Multi-storey buildings**
   Limit state design of a three-storey braced (pin-jointed) building subjected to dead, live and wind loads –Design of composite beam, Design of column, Design of brace

4. **Design of light gauge steel structures (as per IS 801 : 1975)**
   Introduction; Types of sections; Design of compression members; Design of beams ; Design of beam-Columns

5. **Design of bridges :**
   Various types steel bridges; Design of a railway deck-type plate girder bridge using limit state method

Text books :

1. Design of steel structures by K.S.Sai Ram, Pearson Education, 2015.
2. Structural steel work – Design to limit state theory by Dennis Lam, Thien-Cheong Ang and Sing-Ping Chiw, Elsevier, 2004.
3. Steel Structures – Practical design studies by HK Al Nageim and TJ Macginley, Taylor & Francis, 2005.
4. Plastic design of steel frames by LS Beedle, John Wiley & Sons, 1958.

MCE/SE/624 COMPOSITE CONSTRUCTION

1. **Introduction**
   Composite beams and slabs; Composite columns and frames; Limit state design philosophy; Properties of materials ; Methods of analysis and design

2. **Shear Connection**
   Introduction; simply supported beam of rectangular cross section; Uplift; Methods of shear connection; Properties of shear connectors; Partial interaction; Longitudinal shear in composite slabs

3. **Simply supported composite slabs and beams**
   Introduction; Composite floor slabs; Design of composite slab; Composite beams – Sagging bending and vertical shear; Composite beams – Longitudinal shear; Stresses, deflections and cracking in service; Design of simply supported composite beam

4. **Continuous composite beams**
   Introduction; Hogging moment regions of continuous beams; Design of Continuous composite beam

5. **Composite columns**
   Introduction ; Composite columns; Beam-to-column joints; Simplified design method for columns; Design of composite column

Text books :

1. Composite structures of steel and concrete by R.P.Johnson,, Wiley India Pvt.Ltd., 2004.
2. Structural design of steelwork by L Martin and J Purkiss,Butterworth-Heinemann, 2008.
3. Analysis and design of steel and composite structures by QQ Liang, CRC Press, 2015.

MCE/SE/625 DESIGN OF PRESTRESSED CONCRETE STRUCTURES

1. **Design of Pre-tensioned and Post-tensioned Flexural members**
   Dimensioning of flexural members; Estimation of self weight of beams; Design of pre-tensioned beams; Design of post-tensioned beams

2. **Statically indeterminate pre-stressed concrete structures**
   Advantages of continuous members; Effect of prestressing indeterminate structures; Methods of achieving continuity; Concordant cable profile; Design of continuous prestressed concrete beams

3. **Prestressed concrete pipes and poles**
   Circular prestressing; Types of prestressed concrete pipes; Design of prestressed concrete pipes; Pre-stressed concrete poles

4. **Pre-stressed concrete slabs**
   Types of pre-stressed concrete floor slabs; Design of pre-stressed concrete one-way slabs; Design of pre-stressed concrete two-way slabs; Design of pre-stressed concrete simple flat slabs; Design of pre-stressed concrete continuous flat slab floors

Text Books:

1. Pre-stressed concrete by N.Krishna Raju, Tata-McGraw-Hill, 2012.
2. Pre-stressed concrete : Problems and solutions by N.Krishna Raju, CBS Publishers, 2015.
3. Pre-stressed concrete by T.Y.Lin & N.H.Burns, John Wiley & Sons,1981

MCE/SE/626 REPAIR AND REHABILITATION OF STRUCTURES

1. Durability and deterioration of structures:

Physical causes: Introduction, Durability of concrete, Causes of distress in concrete structures, shrinkage in concrete, Freeze and thaw on concrete, weathering on concrete, creep on concrete, Abrasion, Erosion and cavitations on concrete, Temperature changes, Construction errors, Accidental loadings, Design errors.

Chemical causes: Chemical attack on concrete, Carbonation attack on concrete, Sulfate attack on concrete, Physical and chemical mechanisms, Acid attack on the concrete, Alkali reaction on the concrete, Aggregate reaction and alkali silica reaction, Chloride attack on the concrete.

Corrosion: Basic principle of corrosion, Corrosion mechanisms of embedded metal, Corrosion process, Damages due to corrosion, Codal provisions for different exposure conditions, Corrosion protection techniques, Relative symptoms to causes of distress and deterioration.

2. Damage assessment:

Destructive testing systems: Introduction, Purpose of assessment, Rapid assessment, monitoring, Investigation of damage, observation, Damage assessment procedure, Visual inspection, Testing of hardened concrete.

Non – Destructive testing systems: Introduction, NDT methods, Surface hardness method, Ultra pulse velocity method, pulse echo method, radioactive method, Electromagnetic method, Electrical methods, Acoustic emission Techniques, Recent development on NDT instruments.

Semi – Destructive testing systems: Penetration techniques, Pullout test & Pull off test, Core sampling and testing, Permeability test, Carbonation pH value test, Chemical Testing of concrete, Diagnostic methods for corrosion damage.

3. Repair Materials:

Construction Chemicals: Introduction, Evolution of Portland cement concrete and concrete chemicals, Epoxy, Polymers and Latex, Acrylic Polymer, Polyester Resins, Applications of repair chemicals, Polymer modification on addition of polymer to cement concrete and mortar.

Concrete repair chemicals: Bonding coats, Steel corrosion inhibitor paint for steel in reinforced concrete construction, Rust remover paints. Ferro cement, Fibre reinforced concrete, Fibre reinforced polymer, Cementcrete, Geopolymer concrete, Portland pozzolana cement, silica fume concrete, self compacting concrete, Pre-placed aggregate concrete, Shotcrete/ Gunite, High performance concrete.

Examples of concrete chemicals for repair: Zentritix KMH (Corrosion protection and bonding coat), Nafufill BB2 (Bonding agent and polymer), Sika latex power (Water resistant bonding agent), Sunepoxy 358 (Epoxy bond coat), New coat (Roof waterproofing coating).

4. Repair and Rehabilitation:

Repair of Structural Elements: Repair of RC slabs, Repair of RC beams and columns damaged by steel corrosion, Repair of rising dampness in walls of ground floors in old buildings constructed without DPC, Efflorescence in buildings.

Repair of cracks in concrete members: Introduction, Investigations to find cause of cracks, Sealing of cracks by injection and crack filling, Blanketing inactive cracks by using elastic sealants, Repair of crack by stitching, Treatment of active structural cracks.

Strengthening Techniques: Introduction, Need for strengthening, Terms of repair, Structural concrete repair, Structural repair techniques for reinforced concrete, Structure concrete strengthening, Jacketing technique, externally bonding technique, externally bonded mild steel plats, strengthening with external reinforcement.

5. Seismic Retrofitting of reinforced concrete buildings:
Introduction, Considerations in retrofitting of structures, Source of weakness in RC frame buildings- Structure damage due to discontinuous load path, Structural damage due to lack of deformation, Quality of workmanship and materials, Classification of retrofitting techniques, Retrofitting strategies for RC buildings, Structural level (global) retrofit methods, Member level (local) retrofit methods, Comparative analysis of methods of retrofitting.

Text books:
1. Rehabilitation of concrete structures by B.Vidivelli, Published by Standard Publications-New Delhi, 2009.
2. Maintenance Repair & Rehabilitation & Minor works of Buildings by P.C.Varghese, Published by PHI Learning Pvt, Ltd, Delhi-2014.
3. Earthquake resistant design of structures by Pankaj Agarwal and Manish Shrikhande, Prentice-Hall of India, 2006.
4. Handbook on Repair and Rehabilitation of RCC buildings, Published by CPWD, Delhi, 2002 (freely available through Internet).

MCE/SE/627 ADVANCED BRIDGE ENGINEERING

1. Types of bridges and Loading standards

Classification of bridges; IRC Loading standards

2. Reinforced concrete beam and slab bridge decks

Courbon's method of analysis; Reaction factors for longitudinal girders; Local wheel load effects – Slab supported on two opposite sides; Cantilever slab; Dispersion along the span – Slab spanning in two directions – Pigeaud's method; Limitations of Pigeaud's method; Analysis and design of reinforced concrete beam and slab bridge deck

3. Prestressed Concrete Bridges

Genera aspects; Advantages of prestressed concrete bridges; Pre-tensioned prestressed concrete bridge decks; Post-tensioned prestressed concrete bridge decks; Design of post-tensioned prestressed concrete beam and slab bridge deck

4. Steel-concrete composite plate girder bridge (as per Eurocode 4 Part 2)

Behaviour of steel-concrete composite plate girders – Effective width of flanges for shear lag, Bending resistance of composite plate girders, Resistance to vertical shear, shear connection, Design equations for the evaluation of headed stud capacities; Design of a two-lane highway steel-concrete composite plate girder bridge deck

Text books :

1. Essentials of bridge engineering by D. John Victor, Oxford & IBH, 2001.
2. Pre-stressed concrete bridges by N.Krishna Raju , CBS Publishers, 2009.
3. Finite element analysis and design of steel and steel-concrete composite bridges by E.Ellobody, Butterworth-Heinemann, 2014.

MCE/SE/628 FIBRE REIFORCED CONCRETE

1. **Introduction**
   Historical development; Specifications and recommended procedures

2. **Interaction between fibres and matrix**
   Fibre interaction with homogeneous uncracked matrix; Fibre interaction in cracked matrix; Interpretation of test data and analytical models; Composition of the matrix

3. **Basic concepts and mechanical properties : Tension**
   Basic concepts; Strong brittle fibres in ductile matrix; Strong fibres in a brittle matrix; Tension behaviour of fobre cement composites; Experimental evaluation of conventional fibre-cement composites; Elastic response in tension; Prediction of composite strength based on empirical approaches; Experimental evaluation of high-volume fraction fibre composites; Fracture mechanics approach; Apllications based on linear elastic fracture mechanics

4. **Basic concepts and mechanical properties : Bending**
   Mechanism of fibre contribution to bending; Flexural toughness; Prediction of load-deflection response

5. **Properties of constituent materials**
   Cement; aggregates; water and water-reducing admixtures; Mineral admixtures; Other chemical admixtures; Special cements; Metallic fibres; Polymeric fibres; Carbon fibres; Glass fibres

6. **Mixture Proportioning , Mixing and Casting procedures**
   Mix proportions for FRC containing coarse aggregates; Mixing and casting procedures

7. **Properties of freshly mixed FRC Containing coarse aggregates**
   Workability tests; Tests for air content; Yield and unit weight; Steel fibre-reinforced concrete; Polmeric fibre-reinforced concrete; Other fibres

8. **Properties of Hardened FRC**
   Behaviour under compression –FRC with steel fibres and FRC with polymeric fibres; Behaviour under tension – FRC with steel fibres and FRC with polymeric fibres; Behaviour under flexure – FRC with steel fibres and FRC with polymeric fibres; Behaviour under shear, torsion and bending – FRC with steel fibres and FRC with polymeric fibres

Text books :

1. Fibre reinforced cement composites by P.N.Balaguru and S.P.Shah, McGraw-Hill, 1992.
2. Fibre reinforced cementious composites by A. Benturand and S.Mindess, Taylor & Francis, 1990.
3. Structural applications of fibre reinforced concrete , SP-182, ACI, 1998.