ACADEMIC REGULATIONS, POGRAMME STRUCTURE AND SYLLABI

(Effective from 2021-2022)

MASTER OF TECHNOLOGY
IN
STRUCTURAL ENGINEERING

RVR& JC COLLEGE OF ENGINEERING
(Autonomous)
CHOWDAVARAM
GUNTUR DISTRICT
ANDHRA PRADESH

R.V.R. & J.C. COLLEGE OF ENGINEERING :: GUNTUR

(Autonomous)

CHOICE BASED CREDIT SYSTEM REGULATIONS (R-21) for 2-YEAR MASTER OF TECHNOLOGY (M.Tech.) Degree Program

(w.e.f. the batch of students admitted into First Year M.Tech.
from the academic year 2021-22)

1 MINIMUM QUALIFICATIONS FOR ADMISSION

The eligibility criteria for admission into M.Tech. programme is as per the guidelines of Andhra Pradesh State Council of Higher Education (APSCHE), Amaravati.

1.1 **Category – A Seats :** The seats under this category shall be filled by the Convener, PGCET Admissions.

1.2 **Category – B Seats :** The seats under this category shall be filled by the College as per the guidelines of APSCHE.

2 COURSES OF STUDY

M.Tech. Courses are offered in the following branches of study:

Branch of Engineering	Specialisation Offered
Civil Engineering	Structural Engineering
Computer Science & Engineering	Computer Science and Engineering.
Electrical & Electronics Engineering	Power Systems Engineering.
Electronics & Communication Engineering	Communication Engineering & Signal Processing
Information Technology	Computer Science & Technology
Mechanical Engineering	Machine Design

3 DURATION OF THE COURSE AND MEDIUM OF INSTRUCTION

3.1 The duration of the course is two academic years consisting of two semesters in each academic year.

3.2 The medium of instruction and examination is English.

4 MINIMUM INSTRUCTION DAYS

Each semester shall consist of a minimum number of 90 days of instruction excluding the days allotted for tests, examinations and preparation holidays.

5 REGISTERING THE COURSES OFFERED

5.1 A candidate has to register and secure 68 credits out of which 30 credits from laboratory courses including project work.

5.2 The structure of the M.Tech. Programme comprises of two semesters of course work consisting of 6 Core subjects + 6 Elective subjects + 4 Labs (or) 3 Labs + 1 Seminar (or) 2 Labs + 2 Seminars, followed by two semesters of Dissertation.

5.3 A candidate has to register and secure at least minimum pass grade in Research Methodology & IPR Course in I Year II Semester, for which no credit is awarded.

5.4 MOOCS (Massive Open Online Courses) Requirements.

- Enrolment of MOOCS Course will be initiated from the date of commencement of class work for I Year I Semester.
- MOOCS course completion certificate of duration not less than 8 weeks, must be submitted on or before the last instruction day of II Year I Semester, for which 2 Credits will be awarded. The Grade is awarded based on the marks obtained in the MOOCS performance.
- List of organizations offering MOOCS course(s) will be announced by the respective Board of Studies at the time of commencement of class work for I Year I Semester.

5.5 Internship / Industrial Training / Professional Certification:

- Internship / Industrial Training / Professional Certification should be taken up during the summer holidays for a period of 4-8 weeks.
- Internship / Industrial Training / Professional Certification completion certificate must be submitted along with a report and presentation during the II Year I Semester Internal evaluation.

5.6 Dissertation shall be carried out under the Supervision of a Faculty Member in the concerned department.

- A student may, however, in certain cases, be permitted to work on his/her 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 / Industry. In such cases, the dissertation shall be jointly supervised by a member of the faculty and a person from the Organization / Industry.
- The student is eligible for submission of M.Tech., dissertation report at the end of the II Year II Semester if he/she passed all the credit courses in the previous semesters.
- In a special case, if any student unable to submit his/her dissertation report at the end of II Year II Semester due to any other reason permitted by the head of the institution, he/she will be allowed to submit at a later date and the viva-voce examination will be conducted separately.

5.7 The student has to publish (or) get acknowledgement for acceptance of publication in at least one paper in a Conference / peer reviewed Journal related to his / her work to get eligibility to submit the Dissertation.

6 EVALUATION

6.1 The performance of the student in each semester is evaluated subject wise. In each Semester, there shall be two Internal Examinations consists of a Sessional Test for 30 Marks and an Assignment for 10 Marks. The semester end examination is conducted for 60 marks. The Internal Evaluation for Theory subjects is based on the 80% (24 out of 30 marks) weightage

given to the best of the performances and the remaining 20% (6 out of 30 marks) for the least performance, in the two midterm examinations one held in the middle of the semester and the other held immediately after the completion of the instruction. The internal evaluation for practical subjects is based on the day to day performance and semester end internal practical Examination.

6.2 The marks for Seminar will be awarded by internal evaluation by a panel of the department.

6.3 For taking the Semester end examination in any theory or practical subject, students shall be required to obtain a minimum of 50% marks in Internal evaluation in that subject failing which he / she is required to repeat the subject when next offered.

6.4 For each theory subject, there is a comprehensive Semester End Examination at the end of each Semester. In addition to the reguar semester end examinations held at the end of each semester, supplementary examinations will also be conducted during the academic year. Such candidates taking the Regular/ Supplementary examinations as supplementary candidates may have to take more tahn one examination per day.

6.5 For each Practical course the Semester End Examination is conducted by one internal and one external examiner appointed by the Principal of the College. The duration of the examination is specified in the detailed Schemes of Instruction & Examination.

6.6 Examination in Dissertation (Phse-II) is conducted by one internal examiner and one external examiner appointed by the Principal.

6.7 The performance of the students in each semester is evaluated subject wise. The distribution of marks between internal assessment and Semester End Examination is as follows:

Nature of the subject	Sessional Marks	Semester End Exam. Marks
Theory subjects	40	60
Practical's	40	60
Seminar / Internship / Mini Project / Professional Certification / Dissertation (Phase-I)	100	–
Dissertation (Phase-II)	40	60

7 LABORATORY / PRACTICAL COURSES

In any semester, a minimum of 10 experiments / exercises specified in the syllabus for laboratory course shall be completed by the student and get the record certified by the concerned Head of the Department, to be eligible to appear for the Semester End Examination in that Practical course.

8 ATTENDANCE

8.1 The student shall put up a minimum of 75% attendance in each subject.

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

8.3 If the student does not satisfy the attendance requirement in any subject he or she shall not be permitted to appear for the Semester End examination in that subject and has to repeat that subject when next offered.

9 CONDITION(S) FOR PROMOTION

A student is eligible for promotion to next semester, if he / she satisfies the minimum requirements of attendance and sessional marks in 50% of the Theory Subjects, as stipulated in **Clauses 6 and 8**.

10 CONDITIONS FOR PASS

A student is declared to have passed in individual subject if he / she secures a minimum of 40% marks in theory and 50% marks in Laboratory / Project Work in Semester End Examination and a minimum of 50% marks in both Sessional & Semester End Examination put together.

11 AWARD OF CREDITS

Credits are awarded for each Theory / Practical / Intership / Professional Certification / Seminar / Dissertation / MOOCS. Each theory subject is awarded 3 credits and each practical / Intership / Professional Certification Seminar / MOOCS subjects are awarded 2 credits. Dissertation (Phase-I) in II Year I Semester is awarded 6 credits and Dissertation (Phase-II) at the end of II Year II Semester is awarded 14 credits.

11.1 AWARD OF GRADES

S.No.	Range of marks	Grade	Grade Points
1.	$\geq 90\%$	A^+	10.0
2.	$> 80\%$ - $< 90\%$	A	9.0
3.	$> 70\%$ - $< 80\%$	B^+	8.0
4.	$> 60\%$ - $< 70\%$	B	7.0
5.	$> 55\%$ - $< 60\%$	C	6.0
6.	$> 50\%$ - $< 55\%$	D	5.0
7.	$\leq 49\%$	F	0.0
8.	The grade 'W' represents withdrawal /absent (subsequently changed into pass or C to O or F grade in the same semester)	W	0.0

11.2 A candidate securing 'F' grade in any course there by securing zero grade points has to reappear and secure at least 'C' grade in the subsequent examinations for that course.

11.3 After each semester, Grade sheet will be issued which will contain the following details:

- The list of courses for each semester and corresponding credits and grades obtained
- The Semester Grade Point Average (SGPA) for each Semester and
- The Cumulative Grade Point Average (CGPA) of all courses put together up to that semester.

SGPA is calculated based on the following formula:

$$\frac{\sum[No.of credits \times Gradepoints]}{\sum No.of credits}$$

CGPA will be calculated in a similar manner, considering all the courses up to that semester.

11.4 A consolidated Grade Sheet shall be issued to the candidate, after completing all, indicating the CGPA of all the Two years put together.

11.5 Conversion of CGPA into equivalent Percentage of marks:

Percentage of Marks = (CGPA-0.50)x10.

12 ELIGIBILITY FOR AWARD OF M.TECH. DEGREE

The M.Tech. Degree shall be conferred on a student who satisfies the following requirements:

12.1 The student who satisfies the conditions for pass in all the subjects including labs of all the years as stipulated in **Clauses 10**.

12.2 **Maximum Time Limit for completion of M.Tech Degree:** A candidate, who fails to fulfil all the academic requirements for the award of the degree within four academic years from the year of admission, shall forefeit his/her seat in M.Tech. Degree.

13 AWARD OF CLASS

A student who becomes eligible for the award of M.Tech. Degree as stipulated in **Clause 11** shall be placed in one of the following Classes.

S.No	Class	CGPA
1	First Class With Distinction	7.5 or more
2	First Class	6.5 or more but less than 7.5
2	Second Class	5.5 or more but less than 6.5
3	Pass Class	5.0 or more but less than 5.5

14 AWARD OF RANK

The rank shall be awarded based on the following:

14.1 Ranks shall be awarded in each branch of study for the top ten percent of the students appearing for the Regular Semester End Examinations or the top two students whichever is minimum.

14.2 The Rank shall be awarded only to those students who completes their degree within two academic years.

14.3 For the purpose of awarding rank in each branch, only such students who passed all subjects in the first attempt shall be considered.

15 TRANSITORY REGULATIONS

15.1 A student, studied under R-17 regulations of RVR & JCCE (Autonomous) curriculum and discontinued the I Year I Semester course, shall join in I Year I Semester of R-21 regulations.

15.2 A student, studied under R-17 regulations of RVR & JCCE (Autonomous) curriculum and discontinued the I year II Semester course and also at the subsequent semesters will follow the same R-17 regulations/ curriculum and he / she has to complete the subject by appearing the examinations conducted by the college under R-17 curriculum.

16 CONDUCT AND DISCIPLINE

16.1 Candidates shall conduct themselves within and outside the premises of the institute in a manner befitting the candidates of our institution.

16.2 As per the order of Hon'ble Supreme Court of India, ragging in any form is considered as a criminal offence and is banned. Any form of ragging will be severely dealt with.

16.3 The following acts of omission and / or commission shall constitute gross violation of the code of conduct and are liable to invoke disciplinary measures with regard to ragging.

a) Lack of courtesy and decorum, indecent behavior anywhere within or outside the campus.

b) Willful damage of college / individual property.

c) Possession, consumption or distribution of alcoholic drinks or any kind of narcotics or hallucinogenic drugs.

d) Mutilation or unauthorized possession of library books.

e) Noisy and unseemly behavior, disturbing studies of fellow candidates.

f) Hacking of computer systems (such as entering into other person's areas without prior permission, manipulation and / or damage of computer hardware and software or any other cybercrime etc.)

g) Usage of camera / cell phone in the campus

h) Plagiarism of any nature

i) Any other acts of gross indiscipline as decided by the academic council from time to time.

16.4 Commensurate with the gravity of offense, the punishment may be reprimand, fine, expulsion from the institute / hostel, debar from examination, disallowing the use of certain facilities of the institute, rustication for a specified period or even outright expulsion from the institute or even handing over the case to appropriate law enforcement or the judiciary.

16.5 For an offence committed in (i) a hostel (ii) a department or in a class room and (iii) elsewhere, the chief warden, the head of the department and the principal respectively, shall have the authority to reprimand or impose fine.

16.6 Cases of adoption of unfair means and / or any malpractice in an examination shall be reported to the principal for taking appropriate action.

16.7 All cases of serious offence, possibly requiring punishment other than reprimand, shall be reported to the academic council.

16.8 The institute level standing disciplinary action committee constituted by the academic council shall be the authority to investigate the details of the offence, and recommend disciplinary action based on the nature and extent of the offence committed.

16.9 The principal shall deal with any academic problem, which is not covered under these rules and regulations, in consultation with the programmes committee in an appropriate manner, and subsequently such actions shall be placed before the academic council for ratification. Any emergency modification of regulation, approved by the appropriate authority, shall be reported to the academic council for ratification.

16.10 "Grievance and Redressal Committee" (General) constituted by the Principal shall deal with all grievances pertaining to the academic / administrative / disciplinary matters.

17 MALPRACTICES

17.1 The Principal shall refer the cases of malpractices in internal assessment tests and semester-end examinations to a malpractice enquiry committee constituted by him / her for the purpose. Such committee shall follow the approved scales of punishment. The principal shall take necessary action, against the erring candidates basing on the recommendations of the committee.

17.2 Any action on the part of a candidate during an examination trying to get undue advantage or trying to help another, or drive the same through unfair means is punishable according to the provisions contained hereunder. The involvement of the staff, who are in-charge of conducting examinations, valuing examination papers and preparing / keeping records of documents relating to the examinations in such acts (inclusive of providing incorrect or misleading information) that infringe upon the course of natural justice to one and all concerned in the examination shall be viewed seriously and recommended for award of appropriate punishment after thorough enquiry.

18 AMENDMENTS TO REGULATIONS

The College may, from time to time, revise, amend, or change the Regulations, Schemes of Examinations, and / or Syllabus.

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DEPARTMENT OF CIVIL ENGINEERING

M.Tech. :: Structural Engineering

PROGRAMME STRUCTUE AND SCHEME OF EVALUATION

(w.e.f. the batch of students admitted from the academic year 2021-2022)

I M.Tech. I Semester

S.No.	Subject Code & Title	Hours/Week		Evaluation of Marks			Credits
		L	P	Int.	Ext.	Total	
1.	SE511 Theory of Elasticity and Plasticity	3	--	40	60	100	3
2.	SE512 Dynamics of Structures	3	--	40	60	100	3
3.	SE513 Matrix methods of Structural Analysis	3	--	40	60	100	3
4.	Elective-I	3	--	40	60	100	3
5.	Elective-II	3	--	40	60	100	3
6.	Elective-III	3	--	40	60	100	3
7.	SE551 Structural Engineering Laboratory	--	4	40	60	100	2
8.	SE552 Seminar	--	4	100	--	100	2
Total :		18	8	380	420	800	22

I M.Tech. II Semester

S.No.	Subject Code & Title	Hours/Week		Evaluation of Marks			Credits
		L	P	Int.	Ext.	Total	
1.	SE521 Finite Element Analysis of Structures	3	--	40	60	100	3
2.	SE522 Stability of Structures	3	--	40	60	100	3
3.	SE523 Theory of Plates and Shells	3	--	40	60	100	3
4.	Elective-IV	3	--	40	60	100	3
5.	Elective-V	3	--	40	60	100	3
6.	Elective-VI	3	--	40	60	100	3
7.	SE561 Computer Aided Design Laboratory	--	4	40	60	100	2
8.	SE562 Seminar	--	4	100	--	100	2
9.	MC01 Research Methodology & IPR	2	--	100	--	100	--
Total :		20	8	480	420	900	22

II M.Tech. I Semester

S.No.	Subject Code & Title	Hours/Week		Evaluation of Marks			Credits
		L	P	Int.	Ext.	Total	
1.	SE611 MOOC's	--	--	--	100	100	2
2.	SE651 Internship	--	--	100	--	100	2
3.	SE652 Dissertation (Phase-I)	--	--	100	--	100	6
Total :		--	--	200	100	300	10

II M.Tech. II Semester

S.No.	Subject Code & Title	Hours/Week		Evaluation of Marks			Credits
		L	P	Int.	Ext.	Total	
1.	SE661 Dissertation (Phase-II)	--	--	40	60	100	14

ELECTIVE SUBJECTS

SE571 Advanced Theory and Design of RCC Structures
SE572 Design of Reinforced Concrete Foundations
SE573 Structural Optimization
SE574 Fracture Mechanics of Concrete
SE575 Fibre Reinforced Plastic Composites
SE576 Experimental Stress Analysis and Motion Measurement
SE577 Health Monitoring of Structures
SE578 Design of Tall Buildings
SE579 Advanced Foundation Engineering
SE580 Earthquake Resistant Design of Structures
SE581 Disaster Management
SE582 Ground Improvement Techniques
SE583 Advanced Design of Steel Structures
SE584 Composite Construction
SE585 Design of Prestressed Concrete Structures
SE586 Repair and Rehabilitation of Structures
SE587 Advanced Bridge Engineering
SE588 Fibre Reinforced Concrete
SE589 Precast Concrete Structures
SE590 Formwork for Concrete Structures
SE591 Advanced Concrete Technology

SE 511 THEORY OF ELASTICITY AND PLASTICITY

Course Outcomes:

1. Analyse the stress and strain in three dimensions.
2. Solve two-dimensional problems in rectangular coordinates.
3. Solve two-dimensional problems in polar coordinates.
4. Analyse the stresses due to torsion of bars having different cross sections.
5. Understand the basic concepts of plasticity.

UNIT-I

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

UNIT-II

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

UNIT-III

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

UNIT-IV

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 rolledprofile sections; Torsion of thin tubes

UNIT-V

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

Learning resources:

1. Theory of elasticity by S.P.Timoshenko & J.N.Goodier, McGraw-Hill,1982.
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, 2009.
4. Computational elasticity by M. Ameen, Narosa Publishing House,2008.
5. Introduction to Engineering plasticity by GK Lal and NV Reddy, Narosa Publishing House,2009.
6. Plasticity for structural engineers by Chen and Han, Cengage Learning India , 2009.
7. Theory of elasticity and plasticity by H.J.Helena, PHI Learning, 2017.

SE 512 DYNAMICS OF STRCUTURES

Course Outcomes:

1. Understand fundamental concepts of structural dynamics
2. Evaluate the response of single degree of freedom systems
3. Evaluate the earthquake response of single degree of freedom systems
4. Evaluate the response of multi degree of freedom systems
5. Determine the natural frequencies and mode shapes of systems with distributed mass and elasticity

UNIT-I

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

UNIT-II

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.

UNIT-III

3. Earthquake response of Single Degree of Freedom Systems

Earthquake response of linear systems – Earthquake excitation , Equation of motion, Response quantities, Response spectrum concept , Pseudo acceleration response spectrum, Peak structural response from the response spectrum, Elastic design spectrum

UNIT-IV

4. 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). Numerical evaluation of dynamic response - Newmark's method

UNIT-V

5. Systems with Distributed Mass And Elasticity

Undamped free vibration of simply supported and cantilever beams

Learning resources :

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 .
5. Dynamics of structures by A.K. Jain, Pearson Education India ,2016.
6. Structural dynamics of earthquake engineering by S.Rajasekaran, CRC Press,2009.
7. Theory of vibrations with applications by W.T.Thomson, M.D. Dahleh and C.Padmanabhan, Pearson Education India ,2008.

SE 513 MATRIX METHODS OF STRUCTURAL ANALYSIS

Course Outcomes :

1. Determine and formulate the degree of static and kinematic indeterminacy of the structures
2. Analyze structures like continuous beams and single bay, single story rigid jointed and pin jointed frames for internal forces using flexibility matrix and stiffness matrix methods.
3. Analyze structures like continuous beams and single bay, single story rigid jointed frames for internal forces using stifness matrix methods
4. Analyze structures like continuous beams, pin jointed plane frames for internal forces using member stifness matrix methods
5. Develop flow charts for analysis of continuous beams and pin jointed plane frames

Unit-I

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.

Unit-II

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.

Unit-III

Fundamentals of the Stiffness Method :

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

Unit-IV

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.

Unit-V

Computer Programs for Framed structures:

Flow Chart for the analysis of the following structures:

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

Learning resources :

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.
5) Matrix analysis of structures by P.K.Singh, Cengage Learning India , 2013.
6) Matrix methods of structural analysis by SS Bhavikatti, IK International Publishing House Pvt.Ltd.,2011.

SE 521 FINITE ELEMENT ANALYSIS OF STRUCTURES

Course Outcomes:

1. Illustrate the relation between stress and strain
2. Determine element stiffness matrix and load vector
3. Determine global stiffness matrix and solve governing equations
4. Solve plane stress and plane strain problems
5. Solve plate bending problems

Unit - I

Basic Principles

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

Unit - II

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

Unit - III

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

Unit - IV

Plane-stress and Plane-strain analysis

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

Unit -V

Analysis of plate bending

Basic theory of plate bending; Shear deformation plates; Plate bending analysis using four nodded 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. Finite element method in Structural analysis by AS Meghre and KN Kadam, Khanna Publishers, 2014.
6. Concepts and applications of finite element analysis by R.D.Cook et.al., John Wiley and Sons, 1989.

SE 522 STABILITY OF STRUCTURES

Course Outcomes:

1. Determine the critical loads of columns subjected to flexural buckling
2. Determine the critical loads of columns subjected to torsional buckling
3. Determine the critical moment of a beam subjected to pure bending
4. Determine the critical loads of a plate subjected to normal and shear stresses
5. Determine the critical load of a cylindrical shell subjected to axial compression and evaluate the critical loads of discrete systems

Unit - I

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 bars with sudden change in cross section; Inelastic buckling of bars

Unit II

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.

Unit III

3. **Lateral Buckling of Beams :**
   Differential equations for lateral buckling; Lateral buckling of I beam and narrow rectangular beam in pure bending

Unit -IV

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 rectangular plates under the action of shear stresses .

Unit -V

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

Learning resources :

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.

SE 523 THEORY OF PLATES AND SHELLS

Course Outcomes :

1. Analyse bending of long rectangular plates.
2. Investigate the stresses due to symmetrical bending of circular plates.
3. Explore the stresses in laterally loaded plates having small deflection.
4. Understand the classification of shells and membrane theory.
5. Analyse the cylindrical shells using bending theory.

UNIT-I

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

UNIT-II

3. Symmetrical bending of circular plates

Differential equation for symmetrical bending of laterally loaded circular plates; Uniformly loaded circular plates

UNIT-III

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

UNIT-IV

5. Introduction to Shells

Parametric representation of a surface; The first quadratic form; Equation to the normal of asurface; 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

UNIT-V

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

Learning Resources:

1. Theory of plates and shells by S.P.Timoshenko and S.Woinowsky-Krieger, McGrawHill, 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.

SE 551 STRUCTURAL ENGINEERING LABORATORY

Course Outcomes :

1. Evaluate the effects of water-cement ratio and aggregate- cement ratio onstrength of concrete
2. Design concrete mix by IS code method or ACI method and correlate cube strength, cylinder strength, split tensile strength and modulus of rupture
3. Compare the failure of under reinforced and over reinforced beams and examine span to depth ratio on failure pattern of RC beams
4. Determine the strength of concrete by using Rebound Hammer and Ultrasonic PulseVelocity Meter
5. Determine the measurement of static strain by electrical resistance strain gauges
6. Determine principal stress difference using photoel;asticity
7. Illustrate dynamics of three storey frame and buckling of column
8. Demonstrate self compacting concrete

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 ofConcrete.
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 PulseVelocity 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 todiametrical 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

SE 561 COMPUTER AIDED DESIGN LABORATORY

Course Outcomes :

1. Design multi-storey RC building , one storey trussed roof steel building, one storey gable frame (Pre-engineered) building, steel multistory pin-jointed building with braces,simple tower
2. Analyse a beam and plate with a hole for plane stress condition using FEM
3. Analyse a plate for using FEM
4. Analyse a cylindrical shell roof using FEM

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 RC 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

SE 571 ADVANCED THEORY AND DESIGN OF RCC STRUCTURES

Course Outcomes:

1. Design beams subjected to combined shear, bending and torsion
2. Draw reinforcement details in RC joints
3. Design shear walls
4. Design flat slabs
5. Analyse RC slabs using yield line theory

UNIT – I

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

UNIT – II

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

UNIT – III

Design of shear walls:

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

UNIT – IV

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

UNIT – V

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

Learning resources :

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, 2009.
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.

SE 572 DESIGN OF REINFORCED CONCRETE FOUNDATIONS

Course Outcomes:

1. Understand the fundamental provisions for design of footings.
2. Design combined footings.
3. Design flat slab rafts.
4. Design single pile, under-reamed piles and pile caps.
5. Design well foundations.

Unit –I

1. PROVISIONS FOR DESIGN OF FOOTINGS (as per IS456 : 2000)

Design loads for foundation design, basic structural design of RC footings, soilpressure 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.

Unit –II

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.

Unit –III

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,

Unit –IV

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.

Unit –V

5. WELL FOUNDATIONS

Types, components, stability analysis of well foundations, design of well foundation.

Learning resources:

1. Design of Reinforced concrete foundations by P.C.Varghese,PHI Learning,2009.
2. Essentials of Bridge Engineering by Dr. Johnson Victor; Oxford & IBH Publishing Co.Pvt. Ltd.,2007.
3. Advanced Foundation Engineering by V.N.S. Murthy, CBS Publishers and Distributors,2010.

SE 573 STRUCTURAL OPTIMIZATION

Course Outcomes:

1. Describe basic optimization concepts and optimization tools
2. Apply linear programming
3. Describe unconstrained optimization
4. Describe constrained optimization
5. Apply optimization process

Unit-I

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

Unit-II

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

Unit-III

4. Unconstrained optimization

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

Unit - IV

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

Unit - V

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

Learning resources :

1. Elements of structural optimization by Haftka and Gurdal ; Publisher : Springer, 1992.
2. Structural optimization: Fundamentals and applications by U. Kirsch; Publisher : Springer, 1993.
3. Optimization : Theory and Applications by SS Rao, Wiley Eastern Ltd.,1984.

SE 574 FRACTURE MECHANICS OF CONCRETE

Course Outcomes:

1. Develop basic fundamental understanding of structural failure and concepts of linear elastic fracture mechanics.
2. Analyze fracture mechanics problems using the principles of linear elastic fracture mechanics.
3. Understanding the principles of non-linear fracture mechanics.
4. Evaluate the structure and fracture process of concrete.
5. Apply different methods of non-linear fracture mechanics to calculate Mode I Quasi-Brittle fracture.

UNIT – I

Introduction to fracture mechanics of concrete

Structural failure based on material performance; Concepts of linear elastic fracture mechanics; Fracture mechanics of concrete

UNIT – II

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.

UNIT – III

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.

UNIT – IV

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.

UNIT – V

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 □
(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.

Learning resources :

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**:** outledge, 1990.
3. Fracture mechanics Applications in concrete, Edited by Christian Gaedicke, ACI SP 300, 2015.
4. Applications of fracture mechanics to reinforced concrete by A.Carpinteri, Taylor & Francis, 1992.

SE 575 FIBRE REINFORCED PLASTIC COMPOSITES

Course Outcomes:

1. Understand fundamental concepts of fibre reinforced plastic composites and their processing
2. Analyse macromechanical behavior of a lamina
3. Analyse macromechanical behavior of a laminate
4. Design fibre reinforced plastic composites
5. Design fibre reinforced plastic composite joints

Unit-I

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

Unit-II

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

Unit-III

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

Unit-IV

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

Unit-V

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

Learning resources :

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.

SE 576 EXPERIMENTAL STRESS ANALYSIS AND MOTION MEASUREMENT

Course Outcomes:

1. Describe strain gauges
2. Measure strain using electrical resistance strain gauges
3. Determine stresses using photoelasticity
4. Describe model analysis of structures
5. Describe motion measurement

Unit - I

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

Unit -II

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

Unit -III

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

Unit - IV

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

Unit - V

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

Learning resources :

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,

SE 577 HEALTH MONITORING OF STRUCTURES

Course Outcomes:

1. Describe various aspects of structural health monitoring
2. Apply basic vibration concepts for structural health monitoring
3. Apply fibre-optic sensors for structural health monitoring
4. Apply piezoelectric sensors for structural health monitoring
5. Review case studies of structural health monitoring

Unit - I

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

Unit - II

2. **Vibration based techniques**

Introduction; Basic vibration concepts for SHM

Unit -III

3. Fibre-optic sensors

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

Unit -IV

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

Unit -V

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

Learning resources :

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.
3. Health monitoring of structural materials and components-Methods with applications by DE Adams, John Wiley and Sons, 2007.
4. Structural health monitoring and intelligent infrastructure Vol.1 by JP Ou, H.Li and ZD Duan, Taylor & Francis , 2006.

SE 578 DESIGN OF TALL BUILDINGS

Course Outcomes:

1. Describe a tall building and design a tall building against wind
2. Design a tall building against an earthquake
3. Apply lateral systems for steel buildings
4. Apply lateral systems for concrete buildings
5. Apply lateral systems to composite buildings ; describe floor systems and analyse tall buildings

Unit - I

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

Unit -II

3. Seismic Design

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

Unit - III

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

Unit - IV

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

Unit-V

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

Learning resources :

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.

SE 579 ADVANCED FOUNDATION ENGINEERING

Course Outcomes :

1. Determine ultimate bearing capacity of shallow foundation for layered soils.
2. Determine allowable bearing capacity and settlement of shallow foundation for in-situ cohesive and cohesionless soils.
3. Design various types of mat foundations including settlements.
4. Understand the principle involved in sheet pile walls and coffer dams and design of various types of sheet pile walls.
5. Analyze and design of braced cuts.

Unit - I

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, Weakersoil underlain by Stronger soil; Closely spaced foundations-Effect on UltimateBearing Capacity; Bearing capacity of foundations on top of a slope; Upliftcapacity of foundations.

Unit -II

2) Shallow Foundations: Allowable bearing capacity and settlement

Introduction, Elastic settlement of foundations on saturated clay; Settlement basedon the theory of elasticity; Improved equation for elastic settlement; Settlement ofsandy soil-Use of strain influence factor; Settlement of foundation on sand based on standard penetration resistance; Settlement in granular soil based on pressure meter test(PMT); Primary consolidation settlement relationships; Three-dimensional effect on primary consolidation settlement; Tolerable settlement of buildings.

Unit - III

3) Mat Foundations

Introduction, Combined footings-Rectangular combined footing, Trapezoidal combined footing, Cantilever footing; Common types of Mat foundations; Bearingcapacity of mat foundations; Differential settlement of mats ;Field settlement observations for mat foundations; Compensated foundation.

Unit - IV

4) Sheet Pile Walls and Coffer dams:

Introduction; Construction methods; Cantilever sheet pile walls; Cantilever sheetpiling 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 forpenetration of clay; Coffer dams-types with relative merits and demerits.

Unit -V

5) Braced cuts:

Introduction; Pressure envelope for braced cut design; Pressure envelope for cuts inlayered 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.

Learning resources :

1. Principles of Foundation Engineering, Braja M. Das.,Cengage Learning India, 2013.
2. Foundation Analysis & Design by Bowles, J.E., McGraw- Hill Book Company,2012.
3. Basic and Applied Soil Mechanics by Gopal Ranjan and ASR Rao, Wiley EasternLimited, New Delhi, 2007.
4. Geotechnical Engineering by SK Gulati & Manoj Datta, Tata McGraw- HillPublishing Company Limited,2005.

SE 580 EARTHQUAKE RESISTANT DESIGN OF STRUCTURES

Course Outcomes:

1. Calculate design forces for buildings
2. Design RC buildings for ductility
3. Analyse a long two-storey , two-bay RC building
4. Design earthquake resistant RC elements
5. Describe earthquake resistant steel buildings

UNIT-I

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.

UNIT-II

2. Ductility considerations in earthquake resistant design of RC 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.

UNIT-III

3. Analysis of a long two-storey , two-bay RC 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.

UNIT-IV

4. Earthquake resistant design of RC Elements

Design and detailing of typical flexural member ,typical column, footing and detailing of a exterior joint as per IS13920.

UNIT-V

5. Seismic design of Steel Buildings

Moment resisting frames – Design principles for special moment frame, Strong-column and weak beam concept, Provisions in IS800:2007 for special moment frame; Seismic moment connections-Toughened connections, Strengthened connections, Weakened connections; Concentrically braced frames ; Special concentrically braced frames; Eccentrically braced frames.

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. Design of steel structures –Limit state method by N.Subramanian, Oxford university press, 2016.
4. Seismic design of steel structures by Chia-Ming Uang et al., The seismic design handbook, Edited by F.Naeim, Kluwer Academic publications, 2001.

SE 581 DISASTER MANAGEMENT

Course Outcomes:

1. Understand the types of disasters and functions of disaster mitigating agencies at local, state and national levels.
2. Review the disaster profile and case studies in India.
3. Evaluate the seismic vulnerability of urban areas at different stages of disaster risk management.
4. Evaluate the landslide hazards at different geo-environmental conditions using scientific methods.
5. Acquire knowledge on cyclone and disaster resistant construction using knowledge based systems.

Unit - I

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

Unit - II

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

Unit - III

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.

Unit - IV

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.

Unit - V

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.

Learning resources :

1. Natural Hazards in the Urban Habitat by RN Iyengar, C.B.R.I., Tata McGraw Hill, 1997.
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 PublishingHouse, 2000.
6. Disaster Management Handbook, Edited by J.Pinkowski, CRC Press, 2008.

SE 582 GROUND IMPROVEMENT TECHNIQUES

Course Outcomes :

1. Understand the necessity of ground improvement techniques.
2. Apply suitable ground improvement technique for insitu treatment of cohesionless and cohesive soils.
3. Understand the concept of dewatering techniques, geotextiles and their functions.
4. Acquire knowledge on soil stabilization methods.
5. Design of earth reinforcement and Soil nailing.

Unit - I

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.

Unit -II

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.

Unit -III

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.

Unit -IV

4.Physical and chemical modification

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

Unit - V

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 geo textile reinforcement; Retaining walls with Geo grid reinforcement-General, design procedure for geo grid-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.

Learning resources :

1. Hausmann M.R(1990) Engineering Principles of ground modification, McGraw-Hill Education(India) Private Limited,1990.
2. Ground improvement Techniques, P.Purushothama Raj, Laxmi Publications Pvt. Ltd., 1999.
3. Robert M. Koerner, Designing with Geosynthatics, Vol.1, Xlibris,2012.
4. Construction and Geotechnical methods in Foundation Engineering, R.M.Koerner, McGraw-Hill Book Company,1984.
5. Current Practices in Geotechnical Engineering Vol.-I, Alam Singh and Joshi, International Book Traders,1987.
6. Geotechnical Engineering by SK Gulati & Manoj Datta, Tata McGraw- Hill Publishing Company Limited,2005.
7. Advanced Foundation Engineering by V.N.S. Murthy, CBS Publishers,2010.
   Principles of Foundation Engineering,by Braja M. Das, Cengage Learning,2013.

SE 583 ADVANCED DESIGN OF STEEL STRUCTURES

Course Outcomes:

1. Determine the wind loads on buildings
2. Design gable frames
3. Design low-rise multi-strorey pin-jointed braced buildings
4. Design light gauge steel sections
5. Design plate girder bridge for railway purpose

Unit - I

1. **Wind loads on buildings (as per IS875 Part 3 : 2016)**
   Wind load on pitched roofs; Wind loads on the walls of rectangular clad buildings

Unit - II

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

Unit - III

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

Unit-IV

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

Unit-V

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

Learning resources :

1. Design of steel structures by K.S.Sai Ram, Pearson Education, 2020.
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.

SE 584 COMPOSITE CONSTRUCTION

Course Outcomes:

1. Understand composite structural elements and their design philosophy
2. Describe shear connectors
3. Design simply supported composite slabs and beams
4. Design continuous composite beams
5. Design composite columns

Unit - I

1. Introduction

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

Unit - II

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

Unit -III

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

Unit -IV

4. Continuous composite beams

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

Unit -V

5. Composite columns

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

Learning resources :

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.
4. Composite structures according to Eurocode 4 by D.Dujmovic, B.Anderoic and I.Lukacevic , Ernst &Sohn,2015.

SE 585 DESIGN OF PRESTRESSED CONCRETE STRUCTURES

Course Outcomes:

1. Design pre-tensioned and post-tensioned flexural members
2. Design continuous pre-stressed concrete beams
3. Design pre-stressed concrete pipes and poles
4. Design pre-stressed concrete piles and sleepers
5. Design prestressed concrete slabs

Unit - I

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

Unit - II

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

Unit -III

3. Prestressed concrete pipes and poles

Circular prestressing - Types of prestressed concrete pipes; Design of prestressed concrete pipes; Pre-stressed concrete poles – General features, Shapes of pre-stressed concrete poles, Design considerations, Partially prestressed pre-tensioned poles

Unit - IV

4.Pre-stressed concrete piles and sleepers

Pre-stressing of concrete piles- Advantages of prestressed concrete piles, Types of cross sections, Design considerations pile reinforcements, Pile shoes; Pre-stressed concrete sleepers—Early development, Types of prestressed sleepers, Design considerations of sleepers

Unit -V

5. 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

Learning resources :

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. Prestressed concrete design by Praveen Nagarajan, Pearson Education India, 2013.
4. Pre-stressed concrete by T.Y.Lin & N.H.Burns, John Wiley & Sons,1981

SE 586 REPAIR AND REHABILITATION OF STRUCTURES

Course Outcomes:

1. Understand the causes of deterioration and its relation to durability of structures.
2. Evaluate the damage in structure using destructive, non-destructive and semi-destructive methods.
3. Explore different concrete and construction repair chemicals.
4. Understand the repair and strengthening techniques used for different structural elements.
5. Understand the concepts of seismic retrofitting of reinforced concrete buildings.

UNIT – I

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, creepon 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 attackon concrete, Physical and chemical mechanisms, Acid attack on the concrete, Alkali reactionon 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.

UNIT - II

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.

UNIT - III

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 andmortar.

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).

UNIT - IV

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.

UNIT - V

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 ofdeformation, 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.

Learning Resources:

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).

SE 587 ADVANCED BRIDGE ENGINEERING

Course Outcomes :

1. Categorize various types of bridges and Loading standards.
2. Design reinforced concrete beam and slab bridge decks
3. Design a T-beam bridge.
4. Design prestressed Concrete Bridges
5. Design a steel-concrete composite plate girder bridge (as per Eurocode 4 Part 2)

UNIT-I

1. Types of bridges and Loading standards

Classification of bridges; IRC Loading standards; Design of reinforced concrete slab culvert

UNIT-II

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

UNIT-III

3. T-beam bridge

Analysis and design of reinforced concrete beam and slab bridge deck

UNIT-IV

4. 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

UNIT-V

5. 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

Learning resources :

1. Essentials of bridge engineering by D. Johnson 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.

SE 588 FIBRE REIFORCED CONCRETE

Course Outcomes :

1. Understand the basic concepts of fibre reinforced concrete.
2. Summarize the mechanical properties of fibre reinforced concrete.
3. Produce the fibre reinforced concrete.
4. Evaluate the properties of fresh fibre reinforced concrete.
5. Evaluate the properties of hardened fibre reinforced concrete.

UNIT-I

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 [CO:2]**
   Basic concepts; Strong brittle fibres in ductile matrix; Strong fibres in a brittle matrix; Tension behaviour of fibre 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

UNIT-II

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

UNIT-III

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

UNIT-IV

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

UNIT-V

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

Learning resources :

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.

SE589 PRECAST CONCRETE STRUCTURES

Course Outcomes :

1. Understand the basic concepts and materials used in precast concrete.
2. Analyze the precast frames.
3. Design the precast concrete floors.
4. Design of various precast elements like beam, column and shear wall.
5. Design of joints in precast construction.

UNIT-I

1. Understanding the precast concrete

Basic concepts of precast concrete, Precast concrete and in-situ concrete, Precast concrete structures; Advantages of precast structures.

2. Materials used in precast structures

Concrete; Steel reinforcement; Structural steel and bolts; Non-cementitious materials

UNIT-II

3. Precast frame analysis

Types of precast concrete structures; Simplified frame analysis; Substructuring methods; Connection design; Stabilising methods

UNIT-III

4. Precast concrete floors

Precast concrete flooring options; Flooring arrangements; Structural design of individual units

UNIT-IV

5. Precast concrete beams

General introduction; Non-composite reinforced concrete beams; Non-composite prestressed beams

6. Column and shear walls

Precast concrete columns; Column design; Precast concrete shear walls

UNIT-V

7. Joints and connections

Definitions; Basic mechanisms; Compression joints; Shear joints; Types of beam and column connections; Beam-to-column connections; Column foundation connections

Learning resources :

1. Precast concrete structures by Kim S.Elliott, Butterworth-Heinemann, 2002.

2. Multi-storey precast concrete framed structures by K.S.Elliott and C.K.Jolly, John Wiley & Sons ,2013.

SE 590 FORMWORK FOR CONCRETE STRUCTURES

Course Outcomes :

1. Understand the basics of formwork.
2. Summarize the design concepts of formwork.
3. Design wall and column formwork.
4. Design slab and beam formwork.
5. Design form work for special structures.

UNIT-I

1. Introduction

Formwork as a temporary structure; Requirements for formwork; Selection of formwork;Classification of formwork

2. Formwork materials

Introduction; Timber; Plywood; Steel;

UNIT-II

3. Formwork design concepts

Introduction; Loads on formwork; Dead or Permanent loads; Imposed loads;Environmental loads; The design basis; Estimating permissible stresses

4. Formwork for foundations

Introduction; Conventional formwork for foundation; Foundation formwork; Foundationformwork design; Illustration of foundation wall design

UNIT-III

5. Wall formwork

Introduction; Conventional wall formwork; Proprietary wall formwork system; Large areawall forms; Wall form design; Illustration of wall formwork design

6. Column formwork

Introduction; Conventional column formwork; Proprietary column formwork; All metalcolumn formwork; Design for column form; Illustration of column

formwork design

UNIT-IV

7. Slab and beam formwork

Introduction; Traditional slab and beam formwork; Design of slab and beam formwork; Illustration of slab and beam formwork design; Illustration of proprietary slab formwork design

UNIT-V

8. Formwork for special structures

Introduction; Shells; Domes; Folded plates; Overhead water tanks; Natural cooling tower;Nuclear reactor; Tunnel; Lift shaft

8. Formwork issues in Multi-storey building construction

Introduction; Techniques in multistorey RC construction; Distribution of loads on shoresand slabs in multistory construction- Simplified analysis

Learning resources :

1. Formwork for Concrete Structures by Kumar Neeraj Jha , Tata Mcgraw Hill EducationPvt.Ltd., 2012.
2. Formwork for concrete structures by RL Peurifoy and GD Oberlender, McGraw-Hill India,2015.

SE 591 ADVANCED CONCRETE TECHNOLOGY

Course Outcomes:

1. Understand the rheological models and dimensional stability of concrete.
2. Analyze the microstructure of concrete and admixtures.
3. Explore different types of aggregates used in concrete.
4. Evaluate the durability property of concrete.
5. Evaluate the quality, performance and maintenance parameters of concrete.

UNIT – I

Rheological Models of Fresh Concrete: Introduction, Simple flow test, Rheological models, Schematic differences in flow curves of different types of concrete, Rheological test models, factors affecting rheological properties, Effect of rheological properties on different types of concrete.

Dimensional Stability of Concrete: Dimensional stability of concrete, Modulus of Elasticity of concrete, Factors affecting the modulus of elasticity of concrete, Poisson's ratio, Mechanics of setting and hardening, Shrinkage, Creep and Thermal effects on concrete.

UNIT – II

Microstructure of Concrete: Definition, Significance, Complexities, Microstructure of the Aggregate Phase, Microstructure of the Hydrated Cement Paste, Interfacial Transition Zone in Concrete.

Admixtures: Significance, Surface-Active Chemicals, Set-Controlling Chemicals, Mineral Admixtures.

UNIT – III

Aggregates: Significance, Natural Mineral Aggregates, Lightweight Aggregate, Heavyweight Aggregate, Blast-Furnace Slag Aggregate, Aggregate from Fly Ash, Aggregates from Recycled Concrete and Municipal Waste, Aggregate Production, Aggregate Characteristics and Their Significance.

UNIT – IV

Durability: Definition, Significance, General Observations, Water as an Agent of Deterioration, Permeability, Classification of the Causes of Concrete Deterioration, Surface Wear, Crystallization of Salts in Pores, Frost Action, Effect of Fire, Deterioration of Concrete by Chemical Reactions, Reactions Involving the Formation of Expansive Products, Sulfate Attack, Alkali-Aggregate Reaction, Corrosion of Embedded Steel in Concrete, Concrete in the Marine Environment.

UNIT – V

Quality Control of Concrete Construction: Statistical Parameters and Variability, Recommendations of IS 456-2000, Errors in Concrete Construction, Tools for Quality Management, Analysis Techniques in Quality Management System, Quality Management System for Construction.

Performance and Maintenance of Concrete Structures: Factors Affecting Whole Life Performance, Measures to Improve Safe Life and Durability, Deterioration Model, Inspection, Tests and Monitoring, Critical Stages of a Structure, Maintenance Planning, Whole-Life Assessment.

Learning Resources:

1. Concrete Technology (Second Edition) by A.R.Santhakumar, Oxford University Press, 2018.
2. Concrete, Microstructure, Properties and Materials (Third Edition) by P.Kumar Mehta and Paulo J.M. Monteiro, McGraw-Hill, 2005.
3. Properties of Concrete (Fifth Edition) by A.M.Neville, Pearson, 2012.
4. Advanced Concrete Technology by Zongjin Li, John Wiley and Sons, Inc. New Jersey, 2011.
5. Handbook on Advanced Concrete Technology by N.V.Nayak and A.K.Jain, Alpha Science International Ltd, 2012.

MC01 RESEARCH METHODOLOGY AND IPR

Course Outcomes :

1. Define research problem and scope for solution
2. Implement effective literature studies approaches, analysis, Plagiarism.
3. Understand Intellectual Property rights and Procedure for grants of patents
4. Describe patent Rights, Scope of Patent Rights, Licensing and transfer of technology.
5. Describe developments in IPR

UNIT I *Text Book - 1,2,3* [CO:1]**(5)**

RESEARCH PROBLEM AND SCOPE FOR SOLUTION : Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.

UNIT II *Text Book - 1,2,3* [CO:2]**(5)**

FORMAT : Effective literature studies approaches, analysis, Plagiarism, Research ethics. Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

UNIT III *Text Book - 1,2,3* [CO:3]**(5)**

Nature of Intellectual Property : Patents, Designs, Trade and Copyright. Process of Patenting andDevelopment: technological research, innovation, patenting, development. International Scenario:International cooperation on Intellectual Property. Procedure for grants of patents, patenting under PCT.

UNIT IV *Text Book - 1,2,3* [CO:4] **(5)**

Patent Rights : Scope of Patent Rights, Licensing and transfer of technology, Patent information anddatabases, Geographical Indications.

UNIT V *Text Book - 1,2,3* [CO:5] **(5)**

DEVELOPMENTS IN IPR : New Developments in IPR, Administration of Patent System, IPR of Biological Systems, Computer Software etc, Traditional knowledge Case Studies, IPR and IITs.

Learning Resources :

TEXT BOOK(s):

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science &engineering students".

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2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, "Research Methodology: A Step by Step Guide for beginners", 2nd Edition.

REFERENCE BOOK(s):

1. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
2. Mayall, "Industrial Design", McGraw Hill, 1992.
3. Niebel, "Product Design", McGraw Hill, 1974.
4. Asimov, "Introduction to Design" Prentice Hall, 1962.
5. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
6. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008.