COURSE STRUCTURE

AND

DETAILED SYLLABUS

FOR

M.TECH

(STRUCTURAL ENGINEERING)

REGULAR

2015 – Regulations

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY

COLLEGE OF ENGINEERING (AUTONOMOUS)

ANANTAPUR – 515 002 (A.P.)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY
COLLEGE OF ENGINEERING :: (AUTONOMOUS)
ANANTAPUR
CIVIL ENGINEERING DEPARTMENT
Curriculum & Course Structure
For M.Tech Course (Structural Engineering)
For the batches admitted from 2015

I SEMESTER:

Code	Subject	L	P	C
15D10101	Advanced Mathematical Methods	4	0	4
15D11101	Matrix Methods of Structural Analysis	4	0	4
15D11102	Theory of Elasticity	4	0	4
15D11103	Theory and Analysis of Plates	4	0	4
	Elective – I	4	0	4
15D11104	Experimental Stress Analysis			
15D11105	Advanced Reinforced Concrete Design			
15D11106	Cost Effective Housing Techniques			
	Elective – II	4	4	2
15D11107	Prestressed concrete			
15D11108	Maintenance and Rehabilitation of Structures			
15D11109	Advanced Foundation Engineering			
15D11110	Advanced Concrete Laboratory	0	4	26

II SEMESTER:

Code	Subject	L	P	C
15D11201	Structural Dynamics	4	0	4
15D11202	Finite Element Analysis of Structures	4	0	4
15D11203	Stability of Structures	4	0	4
15D11204	Analysis of shells and folded plates	4	0	4
	Elective – III	4	0	4
15D11205	1. Design of Bridges			
15D11206	2. Advanced Concrete Technology			
15D11207	3. Earthquake Resistant Structures			
	Elective – IV	4	0	4
15D11208	1. Advanced structural Steel Design			
15D11209	2. Building Construction Management			
15D11210	3. Fracture Mechanics			
15D54201	Research Methodology (Audit Course)	2	0	0
15D11211	CAD Laboratory	0	4	2

III & IV SEMESTERS:

Code	Subject	L	P	C
15D11301	III Semester Seminar – I	0	4	2
15D11401	IV Semester Seminar – II	0	4	2
15D11302	III & IV Semester Project work	--	--	44
		0	8	48

Note :All End Examinations (Theory and Practical)are of three hours duration.

T-Tutorial L-Theory P-Practical/Drawing C-Credits

L	P	C
4	0	4

Subject Code:15D10101

M.Tech
(STRUCTURAL ENGINEERING)
ADVANCED MATHEMATICAL METHODS

First Semester

UNIT-I

Calculus of variation-Concepts of maxima and minima of functions-constraints and Lagrange's multipliers-Extreme value of functional-Euler's equations – solutions of Euler's equation. Hamilton principal- Lagrange equations generalized dynamic excitations – constraints in dynamical systems.

UNIT-II

Numerical solution of ordinary differential equations Taylor series method, Picard's method, Euler's method modified Euler's method & R.K.method. Eigen values and Eigen vectors – general method – Power method, spectral method.

UNIT-III

Numerical solution of partial differential equations –Elliptical equations standard five points formula, diagonal five point formula –solution of Laplace equation by Leibmann's iteration method, Poisson's equation and its applications.

UNIT-IV

.Numerical solution of partial differential equations – Parabolic equations bender –Schmidt method-bender - Schmidt recurrence equation, crank-Nicholson difference method.

UNIT-V

Finite element method – weighted Residual methods, least square method Gelarkin's method – finite elements – Interpolating over the whole domain – one dimensional case, two dimensional case – application to boundary value problems.

TEXT/REFERENCE BOOKS:

1. Numerical methods for Engineers by Steven C.Chapra and Raymond P.Canale – Mc Graw Hill Book Company.
2. Applied numerical analysis by Curtis. F.Gerald- Addeson Wesely Publishing Company.
3. Higher Engineering mathematics by B.S. Grewal Khanna Publishers.
4. C-Language and numerical methods by C-Xavier. New Age International publishers.
5. Computational methods for partial differential equations by M.K.Jain, SKR Lyengar, R.K.Jain.

L	P	C
4	0	4

Subject Code:15D11101

M.Tech
(STRUCTURAL ENGINEERING)
MATRIX METHODS OF STRUCTURAL ANALYSIS

First Semester

1. **INTRODUCTION:-**Indeterminacy-Determination of static and kinematic indeterminacies of two-dimensional and three-dimensional portal frames, pin jointed trusses and hybrid frames-coordinate systems –structural idealization. Introduction To Matrix Methods Of Analysis-Flexibility and stiffness matrices-Force displacement relationships for axial force, couple, torsional moments – stiffness method of analysis and flexibility method of analysis.

2. **ANALYSIS OF CONTINUOUS BEAMS**- stiffness method and flexibility method of analysis –continuous beams of two and three spans with different end conditions-internal hinges.

3. **ANALYSIS OF TWO DIMENSIONAL PORTAL FRAMES & PINJOINTED TRUSSES** – stiffness and flexibility method of analysis of 2D portal frames with different end conditions-plotting of bending moment diagrams. Computation of joint displacement and member forces for pinjointed trusses.

4. **TRANSFORMATION OF CO-ORDINATES** - Local and Global co-ordinate systems-transformation of matrices from local to global coordinates of element stiffness matrix-direct stiffness method of analysis-assembly of global stiffness matrix from element stiffness matrices –static condensation-sub-structuring.

5. **EQUATION SOLVERS-**solution of system of linear algebraic equations-direct inversion method-gauss elimination method-Cholesky method-banded equation solvers-frontal solution technique.

TEXT/REFERENCE BOOKS :

1. Structural Analysis by Pundit & Gupta, Tata MC Graw Hill Book company.
2. Structural Analysis by C.S.Reddy, Tata MC Graw Hill Book company
3. Cotes, R.C., Couties, M.G., and Kong, F.K., Structural Analysis, ELBS.
4. MC.Guire, W.,and Gallagher, R.H., Matrix Structural analysis, John Wiley and sons.
5. John L.Meek., Matrix Strucstural Analysis, MC Graw Hill Book company.
6. Structural Analysis – R.C.Hibbeler, Pearson Education

L	P	C
4	0	4

Subject Code: 15D11102

M.Tech
(STRUCTURAL ENGINEERING)
First Semester

THEORY OF ELASTICITY

1. **INTRODUCTION TO PLANE STRESS AND PLANE STRAIN ANALYSIS:** Elasticity –Notation for forces and stresses-Components of stresses –components of strain –Hooke's law.Plane stress-plane strain-Differential equations of equilibrium-Boundary conditions- Compatability equations-stress function-Boundary conditions.

2. **TWO DIMENSIONAL PROBLEMS IN RECTANGULAR COORDINATES:** Solution by polynomials-Saint Venant's principle-Determination of displacements-bending of simple beams-application of Fourier series for two dimensional problems - gravity loading.

3. **TWO DIMENSIONAL PROBLEMS IN POLAR COORDINATES :** General Equation in polar co-ordinates - stress distribution symmetrical about an axis –Pure bending of curved bars- strain components in polar coordinates-Displacements for symmetrical stress distributions-simple symmetric and asymmetric problems-General solution of two dimensional problem in polar coordinates-Application of the general solution of two dimensional problem in polar coordinates-Application of the general solution in polar coordinates.

4. **ANALYSIS OF STRESS AND STRAIN IN THREE DIMENSIONS:** Principle stress - ellipsoid and stress-director surface-Determination of principle stresses-Maximum shear stresses-Homogeneous deformation-principle axis of strain rotation.**GENERAL THEOREMS:**
   Balance laws - Differential equations of equilibrium- conditions of compatibility - Determination of displacement-Equations of equilibrium in terms of displacements-principle of superposition-Uniqueness of solution –the Reciprocal theorem.

5. **TORSION OF PRISMATICAL BARS:**
   Torsion of prismatic bars- Elliptical cross section-other elementary solutions-membrane anology-Torsion of rectangular bars-solution of torsional problems by energy method-use of soap films in solving torsionol problems-hydra dyanmical analogies-Torsion of shafts, tubes, bars etc.

TEXT/REFERENCE BOOKS :

1. Theory of Elasticity and Plasticity by Timoshenko, S., MC Graw Hill Book company.
2. Advnced Strength of materials by Papoov, MC Graw Hill Book company.
3. Theory of Elasticity and Plasticity by Sadhu Singh. Khanna Publishers.
4. Chen, W.F. and Han, D.J.Plasticity for structural Engineers, Springer – Verlag, New York.
5. Lubliner, J., Plasticity theory, Mac Millan Publishing Co., New York.
6. Foundations of Solid Mechanics by Y.C.Fung, PHI Publications.
7. Advanced Mechanics of Solids by L.S. Srinath, Tata MC Graw Hill Book company.

L	P	C
4	0	4

Subject Code:15D11103

M.Tech (Structural Engineering)

THEORY AND ANALYSIS OF PLATES
First Semester

1. **DERIVATION OF PLATE EQUATIONS FOR RECTANGULAR PLATES –**In plane bending and transverse bending effects.Plates under various loading conditions like concentrated, U.D.L and hydrostatic pressure- Navier and Levy's type of solutions for various boundary conditions.

2. **CIRCULAR PLATES:** Symmetrically loaded, circular plates under various loading conditions, annular plates.

3. **PLATES UNDER SIMULTANEOUS BENDING AND STRECTHING:** Derivation of the governing equation and application to simple cases.

4. **ORTHOTROPIC PLATES:** Derivation of the governing equation, applications to grillage problems as equivalent orthotropic plates.

5. **NUMERICAL AND APPROXIMATE METHODS: E**nergy solutions by variational methods, finite difference and finite element methods of analysis for plate problems.Study of few simple cases for large deflection theory of plates .

REFERENCE BOOKS:

1. Timoshenko, S., and Krieger, S.W., Theory of plates and shells, Mc Graw Hill Book company.
2. Theory of plates by Chandrashekhara, K, Universities Press ltd
3. Szilard, R., Theory and Analysis of Plates, Prentice Hall Inc.
4. N.K.Bairagi, Plate analysis, Khanna Publishers, Delhi, 1986.

L	P	C
4	0	4

Subject Code:15D11104

M.Tech(STRUCTURAL ENGINEERING)
EXPERIMENTAL STRESS ANALYSIS
(Elective-I)
First Semester

1. **PRINCIPLES OF EXPERIMENTAL APPROACH :-**
   Merits of Experimental Analysis Introduction, uses of experimental stress analysis advantages of experimental stress analysis, Different methods –Simplification of problems.
2. **STRAIN MEASUREMENT USING STRAIN GAUGES :-**
   Definition of strain and its relation of experimental Determinations Properties of Strain-Gauge Systems-Types of Strain Gauges –Mechanical, Acoustic and Optical Strain Gauges. Introduction to Electrical strain gauges - Inductance strain gauges – LVDT – Resistance strain gauges – various types –Gauge factor – Materials of adhesion base..
3. **STRAIN ROSSETTES AND NON – DESTRUCTIVE TESTING OF CONCRETE:-**
   Introduction – the three elements Rectangular Rosette – The Delta Rosette Corrections for Transverse Strain Gauge.
   Ultrasonic Pulse Velocity method –Application to Concrete. Hammer Test – Application to Concrete.
4. **THEORY OF PHOTOELASTICITY** :-
   Introduction –Temporary Double refraction – The stress Optic Law –Effects of stressed model in a polariscope for various arrangements – Fringe Sharpening. Brewster's Stress Optic law.
5. **TWO DIMENSIONAL PHOTOELASTICITY :-**
   Introduction – Isochramic Fringe patterns- Isoclinic Fringe patterns passage of light through plane Polariscope and Circular polariscope Isoclinic Fringe patterns – Compensation techniques – Calibration methods – Separation methods – Scaling Model to prototype Stresses – Materials for photo – Elasticity Properties of Photoelastic Materials.

Reference Books :-

1.Experimental stress analysis by J.W.Dally and W.F.Riley, College House Enterprises
2. Experimental stress analysis by Dr.Sadhu Singh.khanna Publishers
3.Experimental Stress analysis by U.C.Jindal, Pearson Pubilications.
4. Experimental Stress Analysis by L.S.Srinath, MC.Graw Hill Company Publishers.

L	P	C
4	0	4

Subject Code:15D11105

M.Tech (STRUCTURAL ENGINEERING)
(ELECTIVE – I)
ADVANCED REINFORCED CONCRETE DESIGN

1. **Deflection of Reinforced concrete beams and Slabs**:
   Introduction -Short-term Deflection of beams and Slabs -Deflection due to -Imposed loads - Short- term deflection of beams due to applied loads- Calculation of deflection by IS 456 - Calculation of deflection by BS 8110 - Deflection calculation by Eurocode - ACI Simplified Method - Deflection of continues beams by IS 456 - Deflection of Cantilevers - Deflection of Slabs.**Estimation of Crackwidth in Reinforced Concrete Members:**Introduction - Factors affecting Crackwidth in beams - Mechanism of Flexural cracking Calculation of crack widths - Simple Empirical method - Estimation of Crackwidth in -beams by IS 456 of BS 8110 - Shrinkage and Thermal Cracking
2. **Design of Reinforced Concrete Deep Beams:**
   Introduction - Minimum Thickness - Steps of Designing deep beams - Design by IS 456 - Design according to British Practice - ACI Procedure for design of deep beams - Checking for local failures - Detailing of deep beams
3. **Shear in Flat Slabs and Flat Plates:**
   Introduction - Checking for One-way (wide beam) shear - Two-way (Punching) shear Permissible punching shear - Shear due to Unbalanced Moment (Torsional moments) Calculation of j values - Strengthening of column areas for moment transfer by torsion which produces shear - Shear Reinforcement Design - Effect of openings in Flat slabs - Recent Revisions in ACI 318 - Shear in Two – way Slabs with beams.
4. **Design of plain concrete walls & Shear walls:**
   Introduction - Braced and Unbraced walls - Slenderness of walls- Eccentricities of vertical loads at Right angles to wall - Empirical design method for plane concrete walls carrying axial load - Design of walls for In-plane Horizontal forces - Rules for detailing of steel in concrete wallsIntroduction - Classification of shear walls - Classification according to behavior - Loads in shear walls - Design of Rectangular and flanged shear walls - Derivation of formula for moment of Resistance of Rectangular shear walls
5. **Design of Reinforced Concrete Members for Fire Resistance:**
   Introduction - ISO 834 standard heating conditions- Grading or classifications - Effect of High temperature on steel and concrete - Effect of high temperatures on different types of structural members - Fire resistance by structural detailing from Tabulated data - Analystical determination of the ultimate bending moment capacity of reinforced concrete beams under fire - Other considerations

TEXT/REFERENCE BOOKS :

1. P.Purushothaman, Reinforced concrete Structural Elements: Behaviour, analysis and Design, TATA MC Graw Hill.
2. C.E. Reynolds and J.C. Steedman, Reinforced Concrete Desigers Hand bood, A view point publication.

3. Limit State Design of Reinforced Concrete Structures by P.Dayaratnam, Oxford & IBH Publishers, 2004 edition.
4. Advanced RCC by N.Krishna Raju, CBS Publishers & Distributors.
5. Reinforced cement concrete Structures – Devadas Menon, TATA MC Graw Hill.
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L	P	C
4	0	4

Subject Code:15D11106

M.Tech(STRUCTURAL ENGINEERING)

ELECTIVE –1

COST EFFECTIVE HOUSING TECHNIQUES

1. a) **Housing Scenario**

Introducing - Status of urban housing - Status of Rural Housing

b) Housing Finance:

Introducing - Existing finance system in India - Government role as facilitator - Status at Rural Housing Finance - Impedimently in housing finance and related issues

a**) Land use and physical planning for housing**

introduction - Planning of urban land - Urban land ceiling and regulation act - Efficiency of building bye lass - Residential Densities

b) Housing the urban poor

Introduction - Living conditions in slums - Approaches and strategies for housing urban poor

2. Development and adoption of low cost housing technology

Introduction - Adoption of innovative cost effective construction techniques - Adoption of precast elements in partial prefatroices - Adopting of total prefactcation of mass housing in India- General remarks on pre cast rooting/flooring systems - Economical wall system - Single Brick thick loading bearing wall - 19cm thick load bearing masonery walls - Half brick thick load bearing wall - Flyash grypsym thick for masonry - Stone Block masonery - Adoption of precast R.C. plank and join system for roof/floor in the building

3. Alternative building materials for low cost housing

Introduction - Substitute for scarce materials – Ferrocement - Gypsum boards - Timber substitutions - Industrial wastes - Agricultural wastes - Fitire starateru; for ,p,topm of alternative building maintenance

Low cost Infrastructure services:

Introduce - Present status - Technological options - Low cost sanitation - Domestic wall - Water supply, energy

4. Rural Housing:

Introduction traditional practice of rural housing continuous - Mud Housing technology- Mud roofs - Characteristics of mud - Fire treatment for thatch roof - Soil stabilization - Rural Housing programs

5. Housing in Disaster prone areas:

Introduction – Earthquake - Damages to houses - Traditional prone areas - Type of Damages and Railways of non-engineered buildings - Repair and restore action of earthquake Damaged non-engineered buildings recommendations for future constructions. Requirement’s of structural safety of thin precost roofing units against

Earthquake forcesStatus of R& D in earthquake strengthening measures - Floods, cyclone, future safety

TEXT BOOKS

1. Building materials for low –income houses – International council for building research studies and documentation.
2. Hand book of low cost housing by A.K.Lal – Newage international publishers.
3. Properties of concrete – Neville A.m. Pitman Publishing Limited, London.
4. Light weight concrete, Academic Kiado, Rudhai.G – Publishing home of Hungarian Academy of Sciences 1963.
5. Low cost Housing – G.C. Mathur.
6. Modern trends in housing in developing countries – A.G. Madhava Rao, D.S. Ramachandra Murthy & G.Annamalai.

L	P	C
4	0	4

Subject Code:15D11107

M.Tech(STRUCTURAL ENGINEERING)

PRESTRESSED CONCRETE
(ELECTIVE – II)
First Semester

1. **INTRODUCTION:**Development of prestressed concrete –Advantages and Disadvantages of PSC over RCC –General principles of pre-stressing-pre tensioning and post tensioning –Materials used in PSC-high strength concrete –High tension steel-Different types /methods/systems of prestressing.

2. **Losses of prestress**: Estimation of the loss of prestress due to various causes like elastic shortening of concrete ,creep of concrete, shrinkage of concrete, relaxation of steel, slip in anchorage, friction etc.

3. **Flexure & Deflections:** Analysis of sections for flexure in accordance with elastic theory-Allowable stresses-Design criteria as per I.S code of practice –Elastic design of Beams (rectangular, I and T sections) for Flexure –Introduction to partial prestressing. Introduction-Factors influencing deflections-short term and long term deflections of uncracked and cracked members.

4. **Shear, bond, Bearing and Anchorage:** shear in PSC beams –Principal stresses –Conventional elastic design for shear-transfer of prestress in pretensioned members-transmission length –Bond stresses-bearing at anchorage –Anchorage zone stresses in post-tensioned members-Analysis and design of end blocks by Guyon, Magnel and approximate methods –Anchorage zone reinforcements.

5. **Statistically indeterminate structures**: Introduction –advantages and disadvantages of continuity –Layouts for continuous beams-primary and secondary moments –Elastic analysis of continuous beams-Linear transformation-Concordant cable profile-Design of continuous beams.**Circular prestressing**: Introduction –Circumferential prestressing Design of Prestressed concrete tanks –vertical prestressing in tanks-Dome prestressing.

REFERENCE BOOKS:

1. Prestressed Concrete by S. Krishna raju, TMH Pubilishers.
2. Prestressed Concrete by S. Ramamrutham, Dhanpati Rai Pubilicartions.
3. Prestressed concrete design by Praveen Nagarajan, Pearson Pubilications.
4. T.Y.Lin, Design of Prestressed Concrete Structures, Asian Publishing house, Bombay, 1953.
5. Y.Guyon, Prestressed Concrete, Vol.I&II, Wiley and Sons, 1960.
6. F.Leohhardt, Prestressed concrete Design and construction, Wilhelm Ernst and shon, Berlin, 1964.
7. C.E.Reynolds and J.C. Steedman, Reinforced concrete designers hand bood, A view point publication, 1989.
8. Edward P.Nawy, Prentice Hall – Prestressed Concrete.
9. Prestressed Concrete – by Raj Gopal, Narsoa Pubilications.

L	P	C
4	0	4

Subject Code:15D11108

M.Tech (Structural Engineering)

MAINTENANCE AND REHABILITATION OF STRUCTURES

ELECTIVE – II
First Semester

1. **Influence on serviceability and Durability**:- General : Quality assurance for concrete construction, As built concrete properties, strength, permeability, volume changes, thermal properties, cracking. Effects due to climate, temperature, chemicals, wear and erosion, design and construction errors, corrosion mechanism, Effects of cover thickness and cracking methods of corrosion protection, inhibitors, resistant steels, coatings cathodic protection.

2. **Maintenance and Repair Strategies** :- Inspection, Structural Appraisal, Economic appraisal, components of equality assurance, conceptual bases for quality assurance schemes.

3. **Materials for Repair :-** Special concretes and mortar, concrete chemicals, special elements for accelerated strength gain, Expansive cement, polymer concrete, sulphur infiltrated concrete, ferro cement, Fibre reinforced concrete.

4. **Techniques for Repair :-** Rust eliminators and polymers coating for rebars during repair, foamed concrete, mortar and dry pack, vacuum concrete, Gunite and shotcrete Epoxy injection, Mortar repair for cracks, shoring and underpinning.

5. **Case Studies :-** Repairs to overcome low member strength, Deflection, cracking, chemical disruption, weathering, wear, fire, leakage, marine exposure.

TEXT/REFERENCE BOOKS:

1. Dension Campbell, Allen and Harold Roper, Concrete Structures, Materials, Maintenance and Repair, Longman Scientific and Technical, U.K. 1991.
2. RT.Allen and S.C. Edwards, Repair of concrete Structures, Blakie and sons, UK, 1987.
3. MS. Shetty, Concrete Technology – Theory and practice, S.Chand and company, New Delhi, 1992.
4. Santhakumar, A.R.Training Course notes on damage assessment and Repair in low cost housing RHDC-NBO Anna University, Madras, July, 1992.
5. Raikar, R.N.learning from failures – deficiencies in Design, construction and service – R&D centre (SDCPL), Raikar Bhavan, Bombay, 1987.
6. N.Palaniappan, Estate Management, Anna Institute of Management, Madras Sep. 1992.
7. F.K.Garas, J.L.Clarke, GST Armer, Structural Assessment, Butterworths, UK Aporil 1987.
8. A.R. Santhakumar, Concrete chemicals – Theory and applications, Indian society for construction Engineering and Technology, Madras. 1993 (In press)

L	P	C
4	0	4

Subject Code:15D11109

M.Tech (Structural Engineering)

ADVANCED FOUNDATION ENGINEERING
ELECTIVE – II
First Semester

1. **SHALLOW FOUNDATIONS-I:** General requirements of foundations. types of shallow foundations and the factors governing the selection of type of shallow foundation. Bearing capacity of shallow foundations by Terzaghi's theory and Meyerhof's theory (derivation of expressions and solution to problems based on these theories). Local shear and general shear failure and their identification

2. **SHALLOW FOUNDATIONS-II:** Bearing capacity of isolated footing subjected to eccentric and inclined loads. bearing capacity of isolated footing resting on stratified soils- Button's theory and Siva reddy analysis. Analysis and structural design of R.C.C isolated, combined and strap footings.

3. **DEEP FOUNDATIONS-I:** Pile foundations-types of pile foundations. estimation of bearing capacity of pile foundation by dynamic and static formulae. Bearing capacity and settlement analysis of pile groups. Negative skin Friction, Pile load tests.Sheet Pile Walls.Cantilever sheet piles and anchored bulkheads, Earth Pressure diagram,Determination of depth of embedment in sands and clays-Timbering of trenches-Earth Pressure diagrams-forces in struts.

4. **DEEP FOUNDATIONS-II:** Well foundations-Elements of well foundation. forces acting on a well foundation. Depth and bearing capacity of well foundation. Design of individual components of well foundation (only forces acting and principles of design). Problems associated with well sinking.

5. **FOUNDATIONS IN PROBLEMATIC SOILS:** Foundations in black cotton soils-basic foundation problems associated with black cotton soils. Lime column techniques-principles and execution. Under reamed piles-principle of functioning of under reamed pile-Analysis and structural design of under reamed pile. Use of Cohesive Non Swelling (CNS) layer below shallow foundations.

TEXT BOOKS:
- Analysis and Design of Foundations and Retaining Structures-Shamsher Prakash,Gopal Ranjan and Swami Saran.

Reference Books:
- **Analysis and Design of Foundations-J.E.Bowles**
- **Foundation Design and Construction-Tomlinson**
- **Foundation Design-Teng.**
- **Geotechnical Engg – C.Venkatramaiah**

L	P	C
0	4	2

Subject Code:15D11110

M.Tech(Structural Engineering)

ADVANCED CONCRETE LABORATORY
First Semester

List of Experiments:

1. Mix Design of Concrete and Casting of Specimen.
2. Young's Modulus of Concrete
3. Accelerated curing test on Concrete cubes.
4. Non destructive tests on concrete.
5. Mix design of high strength concrete including casting and testing of specimens.
6. Mix design of fly ash concrete including casting and testing of specimens.
7. Bending test on a RCC beam under.

a) single point load
b) Three point load

L	P	C
4	0	4

Subject Code:15D11201

M.Tech (STRUCTURAL ENGINEERING)

STRUCTURAL DYNAMICS
Second Semester

1. **Theory of Vibrations:** Introduction –Elements of a vibratory system – degrees of freedom-continuous systems –lumped mass idealization –Oscillatory motion –Simple harmonic motion –pictorial representation of S.H.M - free vibrations of single degree of Freedom (SDOF) systems –undamped and Damped –Critical damping – Logarithmic decrement –Forced vibrations of SDOF systems-Harmonic excitation – Dynamic magnification factor- Bandwidth.Fundamental objective of dynamic analysis-types of prescribed loading- Methods of discretization- Formulation of the equations of motion.

2. **Single degree of Freedom System**: Formulation and solutions of the equation of motion - free Vibration response –response to harmonic, periodic, Impulsive and general Dynamic loading –Duhamel integral

3. **Multi Degree of Freedom System:** selection of the degree of freedom –Evaluation of structural property matrices-Formulation of the MDOF equations of motion – Undamped free vibrations-Solution of Eigen value problem for natural frequencies and mode shapes- Analysis of dynamic response –Normal coordinates –Uncoupled equations of motion –Orthogonal properties of normal modes-mode superposition procedure

4. **Practical vibration analysis:** Stodola method- Fundamental mode analysis –analysis of second and higher modes –Holzer's method –basic procedure –transfer matrix procedure

5. **Introduction to Earthquake analysis:** Introduction –Excitation by rigid base translation –Lumped mass approach -SDOF and MDOF system- I.S code methods of analysis.**Continuous system:** Introduction –Flexural vibrations of beams- Elementary case-Equation of motion –Analysis of undamped free shapes of simple beams with different end conditions-principles of application to continuous beams.

REFERENCE BOOKS:

- A.K.Chopra, "Structural Dynamics for Earthquake Engineering",Pearson Pubilications
- Dynamics of structures by Clough & Penziem
- Structural dynamics by Mario Paz
- I.S:1893(latest)" code of practice for earthquakes resistant design of stuctures"
- Anderson R.A fundamentals of vibration, Amerind Pulblishing Co.,1972.

L	P	C
4	0	4

Subject Code:15D11202

M.Tech(STRUCTURAL ENGINEERING) II- SEMESTER

FINITE ELEMENT ANALYSIS OF STRUCTURES

1. **Introduction-**Concepts of FEM –steps involved –merits &demerits –energy principles –Discretization –Rayleigh –Ritz method of functional approximation.**Elastic formulations:** Stress equations-strain displacement relationships in matrix form-plane stress, plane strain and Axi-symmetric bodies of revolution with axi symmetric loading

2. **One Dimensional FEM-**Stiffness Matrix for Beam and Bar elements shape functions for ID elements –static condensation of global stiffness matrix-solution –Initial strain and temperature effects.

3. **Two Dimensional FEM-**Different types of elements for plane stress and plane strain analysis –Displacement models –generalized coordinates-shape functions-convergent and compatibility requirements –Geometric Invariance –Natural coordinate system-area and volume coordinates-Generation of element stiffness and nodal load matrices –static condensation.

4. **Isoparametric formulation**-Concept, Different isoparametric elements for 2d analysis-Formulation of 4-noded and 8-noded isoparametric quadrilateral elements – Lagrangian elements-serendipity elements. **Axi symmetric analysis** –bodies of revolution-axi symmetric modelling –strain displacement relationship-formulation of axi symmetric elements.

5. **Three Dimensional FEM-**Different 3-D elements, 3D strain –displacement relationship- formulation of hexahedral and isoparametric solid element.

REFERENCE BOOKS:

1. Finite Elements Methods in Engineering by Tirupati. R. Chandrnpatla and Ashok D. Belegundu – Pearson Education Publications.
2. Finite Element analysis – Theory & Programming by C.S.Krishna Murthy- Tata Mc.Graw Hill Publishers Finite Elements Methods in Engineering by Tirupati. R. Chandrnpatla, Universities Press India Ltd. Hyderabad.
3. Finite element method and its application by Desai ,2012, Pearson Pubilications.
4. Finite element methods by Darrel W.Pepper, Vikas Pubilishers
5. Finite element analysis and procedures in engineering by H.V.Lakshminaryana, 3rd edition, universities press, Hyderabad.
6. Finite element analysis in Engineering Design by S.Rajasekharan, S.Chand Publications, New Delhi.
7. Finite element analysis by S.S. Bhavakatti-New age international publishers

L	P	C
4	0	4

Subject Code:15D11203

M.Tech(STRUCTURAL ENGINEERING)II-SEMESTER

STABILITY OF STRUCTURES

1. **Formulations related to beam columns :** Concept of Stability, Differential equation for beam columns –Beam column with concentrated loads –continuous lateral load – couples -beam column with built in ends –continuous beams with axial load – application of Trignometric series –Determination of allowable stresses.

2. **Elastic Buckling of Bars:** Elastic buckling of straight columns –Effect of shear stress on buckling-Eccentrically and laterally loaded columns –energy methods – Buckling of a bar on elastic foundation, Buckling of a bar with intermediate compressive forces and distributed axial loads –Buckling of bars with change in cross section –Effect of shear force on critical load –Built up columns

3. **Inelastic Buckling and Torsional Buckling :** Buckling of straight bars-Double modulus theory –Tangent modulus theory. Pure torsion of thin walled bar of open cross section-Non –Uniform torsion of thin walled bars of open cross section-Torsional buckling –Buckling under Torsion and Flexure.

4. **Mathematical Treatment of Stability Problems:** Buckling problem orthogonality realation –Ritz method-Timoshenko method, Galerkin method

5. **Lateral Buckling of simply supported Beams and rectangular plates :** Beams of rectangular cross section subjected for pure bending. Derivation of equation of rectangular plate subjected to constant compression in two directions and one direction.

REFERNCE BOOKS:

1. Stability of metalic structure by Bleich –Mc Graw hill
2. Theory of Beam columns Vol I by chen & Atsuta Mc.Graw Hill
3. Smitses,Elastic stability of structures, Prentice Hall,1973.
4. Timoshenko, S., and Gere., theory of Elastic stability, Mc Graw Hill Book company, 1973.
5. Brush and Almorth., Buckling of bars plates and shells, Mc Graw Hill book company ,1975.
6. Chajes, A., Principles of Structural Stability Theory, Prentice Hall,1974
7. Ashwini Kumar, stability theory of structures, TATA Mc Graw Hill publishing company Ltd, New Delhi,1985.

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Subject Code:15D11204

M.Tech (STRUCTURAL ENGINEERING)
II- SEMESTER

ANALYSIS OF SHELLS AND FOLDED PLATES

1. **Equations of equilibrium :** Introduction, classification, derivation of stress Resultants, Principles of membrane theory and bending theory.

2. **Cylindrical shells:** Derivation of governing DKJ equation for bending theory, details of Schorer's theory, Applications to the analysis and design of short shells and long shells. Introduction of ASCE manual co-efficients for design.

3. **Introduction to shells of double curvature**: (other than shells of revolution:) Geometry and analysis of elliptic paraboloid, rotational paraboloid and hyperbolic paraboloid shapes by membrane theory.

4. **Folded Plates:** Folded plate theory, plate and slab action, Whitney's theory, Simpson's theory for the analysis of different types of folded plates (Design is not included)

5. **Shells of double Curvature**-Surfaces of revolution .Derivation of equilibrium equations by membrane theory, Applications to spherical shell and rotational Hyperboloid

TEXT / REFERENCE BOOKS:

1. Design and construction of concrete shell roofs by G.S. Rama Swamy – CBS Publishers & Distributors, 485, Jain Bhawan Bhola Nath Nagar, shahotra, Delhi.
2. Fundamentals of the analysis and design of shell structures by Vasant S.kelkar Robert T.Swell – Prentice hall, Inc., Englewood cliffs, new Jersy -02632.
3. N.k.Bairagi, Shell analysis, Khanna Publishers, Delhi, 1990.
4. Billington, Ithin shell concrete structures, Mc Graw Hill Book company, New york, St. Louis, Sand Francisco, Toronto, London.
5. ASCE Manual of Engineering practice No.31, design of cylindrical concrete shell roofs ASC, Newyork.

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Subject Code:15D11205

M.Tech (STRUCTURAL ENGINEERING) II- SEMESTER

DESIGN OF BRIDGES
ELECTIVE-III

1. Introduction – Classification, investigations and planning, choice of type – economic span length – IRC specifications for road bridges, standard live loads, other forces acting on bridges, general design considerations.

2. Design of box culverts – General aspects – Design loads – Design moments, shears and thrusts – Design of critical section. Design of slab bridges – Effective width of analysis – workings stress design and detailing of slab bridges for IRC loading.

3. T-Beam bridges – Introduction – wheel load analysis – B.M. in slab – Pigaud's theory – analysis of longitudinal girders by Courbon's theory working stress design and detailing of reinforced concrete T-beam bridges for IRC loading.

4. Prestressed Concrete Bridges – General features – Advantages of Prestressed concrete bridges – pretensioned Prestressed concrete bridges – post tensioned Prestressed concrete Bridge decks. Design of post tensioned Prestressed concrete slab bridge deck.Bridge Bearings – General features – Types of bearings – forces on bearings basis for selection of bearings – Design principles of steel rocker and roller bearings and its design – Design of elastometric pad bearing detailing of elastometric pot bearings.

5. Piers and abutments – General features – Bed block – Materials for piers and abutments – typies of piers – forces acting on piers – Design of pier – stability analysis of piers – general features of abutments – forces acting on abutments – stability analysis of abutments.Bridge foundations – General Aspects – Types of foundations – Pile foundations – well foundations – caisson foundations.

TEXT/REFERENCES :

1. Essentials of bridges engineering – D.Hohnson Victor oxford & IBH publishers co-Private Ltd.
2. Design of concrete bridges MC aswanin VN Vazrani, MM Ratwani, Khanna publishers.
3. Bridge Engineering – S.Ponnuswamy.
4. BRowe, R.E., Concrete Bridge Design, C.R.Books Ltd., London, 1962.
5. Taylor F.W., Thomson, S.E., and Smulski E., Reinforced concrete Bridges, John wiley and sons, New york, 1955.
6. Derrick Beckett, an Introduction to Structural Design of concrete bridges, surrey University; press, Henlely – thomes, oxford shire, 1973
7. Bakht.B.and Jaegar, L.G. bridge Analysis simplified, Mc Graw Hill, 1985.
8. Design of Bridges – N.Krishna Raju – Oxford & IBH
9. Design of Bridge structures – FR Jagadeesh, M.A. jaya Ram – Eastern Economy edition.

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Subject Code:15D11206

M.Tech (STRUCTURAL ENGINEERING) II- SEMESTER

ADVANCED CONCRETE TECHNOLOGY
ELECTIVE-III

1. **Cements and Admixtures**: Portland cement – Chemical composition - Hydration, setting and finenesses of cement – structures of hydrated cement – mechanical strength of cement gel - water held in hydrate cement paste – Heat of hydration of cement – Influence of compound composition on properties of cement – tests on physical properties of cement – I.S. specifications – Different types of cements – Admixtures.

2. **Aggregates**: Classification of aggregate – particle shape and texture – Bond strength and other mechanical properties of aggregate specific gravity, Bulk density, porosity, absorption and moisture in aggregate – soundness of aggregate – Alkali – aggregate reaction, Thermal properties – sieve analysis – Fineness modulus – grading curves – grading requirements – practical grading – Road note No.4 grading of fine and coarse aggregates gap graded aggregate – maximum aggregate size.

3. **Fresh concrete**: Workability – factors affecting workability – measurement of workability by different tests – Effect of time and temperature on workability – segregation and bleeding – mixing and vibration of concrete – quality of mixing water.
   Hardened Concrete: Water/cement ratio-Abram's law – Gel space ratio – effective water in mix – Nature of strength of concrete – strength in tension and compression-Griffith's hypothesis – factors affecting strength – autogeneous healing –Relation between compression and tensile strength – curing and maturity of concrete Influence of temperature on strength – Steam curing – testing of Hardened concrete – compression tests – tension tests – factors affecting strength – flexure tests – splitting tests – Non destructive testing methods.

4. **Elasticity, Shrinkage and Creep**: Modulus of elasticity – dynamic modulus of elasticity – poisson's ratio – Early volume changes – swelling – Draying shrinkage - Mechanism of shrinkage – factors affecting shrinkage – Differential shrinkage – moisture movement carbonation shrinkage-creep of concrete – factors influencing creep – relation between creep and time – Nature of creep – Effect of creep.

5. **Mix Design**: Proportioning of concrete mixes by various methods – fineness modulus, trial and error, mix density, Road Note. No. 4, ACI and ISI code methods – factors in the choice of mix proportions – Durability of concrete – quality control of concrete – Statistical methods – High strength concrete mix design. **Special concrete's**: Light weight concretes –light weight aggregate concrete- Mix design – Cellular concrete - No fines concrete – High density concrete – Fiber reinforced concrete – Different types of fibers - factories affecting properties of FRC – Applications polymer concrete – types of polymer concrete properties of polymer concrete applications

TEXT/ REFERENCE BOOKS:

1. Properties of Concrete by A.M.Neville – Pearson publication – 4th edition
2. Concrete Technology by M.S.Shetty. – S.Chand & Co. ; 2004
3. Design of Concrete Mix by Krishna Raju, CBS pubilishers.
4. Concrete: Micro structure, Properties and Materials – P.K.Mehta and J.M.Monteiro, Mc-Graw Hill Publishers
5. Concrete Technology by A.R. Santha Kumar, Oxford university Press, New Delhi
6. Concrete Technology by A.M.Neville – Pearson publication
7. Concrete Technology by M.L. Gambhir. – Tata Mc. Graw Hill Publishers, New Delhi
8. Non-Destructive Test and Evaluation of materials by J.Prasad & C.G.K. Nair , Tata Mcgraw hill Publishers, New Delhi

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Subject Code:15D11207

M.Tech (STRUCTURAL ENGINEERING) II- SEMESTER
EARTHQUAKE RESISTANT STRUCTURES
ELECTIVE – III

1. **Engineering seismology :**
   Earthquake – causes of earthquake – earthquakes and seismic waves – scale and intensity of earthquakes – seismic activity – Measurements of earth quakes – seismometer- strong motion accelerograph / field observation of ground motion – analysis of earthquakes waves – earth quake motion – amplification of characteristics of surface layers – earthquake motion on the ground surface;
2. **Vibration of structures under ground motion:**
   Elastic vibration of simple structures – modelling of structures and equations of motion – freevibrations of simple structures – steady state forced vibrations – Non steady state forced vibrations – response spectrum representations; Relation between the nature of the ground motion and structural damage.
3. **Design approaches:** Methods of analysis – selection of analysis – equivalent lateral force procedure seismic base shear – seismic design co-efficient - vertical distribution of seismic forces and horizontal shear – twisting moment - Over turning moment – vertical seismic load and orthogonal effects lateral deflection – P- Δ characteristics effect – soil structure Interaction. Seismic – Graphs study, earthquake records for design – factors affecting Accelerogram characteristics - artificial Accelerogram – zoning map.Dynamic – analysis procedure: Model analysis – Inelastic – time history analysis Evaluation of the results.
4.. **Earthquake – Resistant design of structural Components and systems:**
   Introduction – monolithic reinforced – concrete structures – precast concrete structures – Prestressed concrete structures – steel structures – composite – structures, masonry structures – Timber structures.
5. Fundamentals of seismic planning: Selection of materials and types of construction form of superstructure – framing systems and seismic units – devices for reducing. Earthquake loads,

TEXT / REFERENCE BOOKS:

1. Design of earthquake resistant structures by Minoru Wakabayashi.
2. A.K.Chopra, Strucutural Dynamics for Earthquake Engineering", Pearson Pubilications.
3. R.W.Clough and 'Dynamics of structures'. Mc Graw – Hill, 2nd edition, 1992.
4. N.M Newmark and E.Rosenblueth, Fundamentals of Earthquake Engineering' prentice hall,1971.
5. David Key, Earthquake design practice for buildings." Thomas telford,London,1988
6. R.L. Wegel, Earthquake Engg; Prentice Hall 12nd edition 1989.
7. J.A. Blume, N.M. Newmark, L.H. Corning., Design of Multi –storied Buildings for Earthquake ground motions', Portland Cement Association, Chicago,1961
8. I.S.Codes No. 1893,4326,13920.
9. Earthquake Resistant Design by Pankaj Agarwal.

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Subject Code:15D11208

M.Tech (STRUCTURAL ENGINEERING) II- SEMESTER

ELECTIVE-IV
ADVANCED STRUCTURAL STEEL DESIGN

1. Design of self supporting stacks/chimneys – Considerations for preliminary design (industrial requirements – thermal requirement – mechanical force requirement – wind load and dead load estimation) – Detailed estimation of wind; dead-and other accidental – loads; Analysis; Detailed design including provision of stakes /spoilers – Design of super structure only.
2. Analysis of multi-storey frames using approximate methods and substitute frame method:
   a) Cantilever method &
   b) Portal method

3. Design of Gantry Girder – Introduction – Loads acting on the ganny girder – permissible stresses - types of gantry girders and crane sails – crane data – maximum moments and shears – design procedure (restricted to electrically operated cranes)
4. Theorems of plastic analysis, applications to the cases of rectangular portal frames. Principles of optimization in structural design – Application to simple – rectangular portal frame – minimum weight design.

5. General methods of plastic design: combining mechanics methods, plastic moment redistribution method; Application to few cases of simple two storied rectangular portal frames including estimation of deflection.

Books for reference:

1. Plastic analysis of structures by B.G.Neal
2. Steel Skeleton V.I and II by Baker
3. Design of steel structures by Vazarani and Ratwani
4. Strength of materials (Vol-II)) by Timoshenko.
5. Analysis of Steel Structure by Manohar.
6. Analysis of Steel Structure by Pinfold
7. Analysis of Steel Structure by Arya & Azmani
8. Analysis of Steel Structure by Relevant IS codes.
9. Analysis of Steel Structure by Punmia, B.C.

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Subject Code:15D11209

M.Tech (STRUCTURAL ENGINEERING) II- SEMESTER
BUILDING CONSTRUCTION MANAGEMENT
ELECTIVE-IV

1. Introduction – Types constructions public and private contract management – scrutinizing tenders and acceptance of tenders, contracted, changes and terminating of contract – subcontracts construction organizations – organizational chart- Decentralization payrolls and records – organization chart of a construction company.

2. Construction practices – Times Management – bar chart, CPM, PERT – Progress report

3. Resources management and inventor- Basic concepts equipment management, material management inventory control.

4. Accounts management – Basic concepts, Accounting system and book keeping, depreciation, Balance sheet, profit and loss account, internal auditing. Quality control by statistical methods, sampling plan and control charts, safety requirements.

5. Cost and Financial Management – Cost volume relationship, cost control system, budget concept of valuation, cost of equity capital management cash. Labor and industrial; laws – payment of wages act. Contract labor, workmen's compensation, insurance, industrial disputes act.

REFERENCE:

1. Construction project management by Jha ,Pearson pubilications,New Delhi.
2. Construction Technology by Subir K.Sarkar and Subhajit Saraswati – Oxford Higher Education- Univ.Press, Delhi.
3. Project Planning and Control with PERT and CPM by Dr.B.C.Punmia, K.K.Khandelwal, Lakshmi Publications New Delhi.
4. Optimal design of water distribution networks P.R.Bhave, Narosa Publishing house 2003.
5. Total Project management, the Indian context- by : P.K.JOY- Mac Millan Publishers India Limited.

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4	0	4

Subject Code:15D11210

M.Tech (STRUCTURAL ENGINEERING) II- SEMESTER
ELECTIVE-IV
Fracture Mechanics

1. **Summary of basic problems and concepts:**
Introduction - A crack in a structure - The stress at a crack tip - The Griffith criterion The crack opening displacement criterion - Crack Propagation - Closure

2. **The elastic crack – tip stress field :**
The Airy stress function - Complex stress functions - Solution to crack problems - The effect of finite size - Special cases - Elliptical cracks - Some useful expressions

3. **The crack tip plastic zone:**
The Irwin plastic zone correction - The Dugdale approach - The shape of the plastic zone - Plane stress versus plane strain - Plastic constraint factor - The thickness effect

4. **The energy principle:**
The energy release rate - The criterion for crack growth - The crack resistance (R curve) - Compliance , The J integral (Definitions only)
Plane strain fracture toughness:
The standard test - Size requirements - Non-Linearity – Applicability
Plane stress and transitional behaviour:
Introduction - An engineering concept of plane stress - The R curve concept

5. **The crack opening displacement criterion:**
Fracture beyond general yield - The crack tip opening displacement - The possible use of the CTOD criterion
Determination of stress intensity factors:
Introduction - Analytical and numerical methods - Finite element methods, Experimental methods (An Ariel views only)

REFERENCES;

1. Elementary engineering fracture mechanics - David Broek, Battelle, columbus laboratories, columbus, Ohieo, USA
2. Fracture and Fatigue Control in Structures - john M.Barsom, Senior consultant United states Steel corporation & Stanley T.Rolfe, Ross H.Forney Professor of Engineering University of Kansas. &Stanley T.Rolfe, Ross H.forney Professor of Engineering, University of Kansas

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Subject Code:15D54201

M.Tech (STRUCTURAL ENGINEERING) II- SEMESTER

RESEARCH METHODOLOGY

(Audit Course)

(Audit Course For M.Tech. –II Semester Program from 2015 admitted batches onwards)

UNIT I

Meaning of Research – Objectives of Research – Types of Research – Research Approaches – Guidelines for Selecting and Defining a Research Problem – research Design – Concepts related to Research Design – Basic Principles of Experimental Design.

UNIT II

Sampling Design – steps in Sampling Design –Characteristics of a Good Sample Design – Random Sampling Design.

Measurement and Scaling Techniques-Errors in Measurement – Tests of Sound Measurement – Scaling and Scale Construction Techniques – Time Series Analysis – Interpolation and Extrapolation.

Data Collection Methods – Primary Data – Secondary data – Questionnaire Survey and Interviews.

UNIT III

Correlation and Regression Analysis – Method of Least Squares – Regression vs Correlation – Correlation vs Determination – Types of Correlations and Their Applications

UNIT IV

Statistical Inference: Tests of Hypothesis – Parametric vs Non-parametric Tests – Hypothesis Testing Procedure – Sampling Theory – Sampling Distribution – Chi-square Test – Analysis of variance and Co-variance – Multi-variate Analysis.

UNIT V

Report Writing and Professional Ethics: Interpretation of Data – Report Writing – Layout of a Research Paper – Techniques of Interpretation- Making Scientific Presentations in Conferences and Seminars – Professional Ethics in Research.

Text books:

1. **Research Methodology:Methods and Techniques – C.R.Kothari, 2nd Edition,New Age International Publishers.**
2. **Research Methodology: A Step by Step Guide for Beginners- Ranjit Kumar, Sage Publications (Available as pdf on internet)**
3. **Research Methodology and Statistical Tools – P.Narayana Reddy and G.V.R.K.Acharyulu, 1st Edition,Excel Books,New Delhi.**

REFERENCES:

1. Scientists must Write - Robert Barrass (Available as pdf on internet)

2. Crafting Your Research Future –Charles X. Ling and Quiang Yang (Available as pdf on internet)

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Subject Code:15D11211

M.Tech
(STRUCTURAL ENGINEERING)
II- SEMESTER

CAD LABORATORY

1. Analysis of cantilever, simply supported beam, fixed beams, continuous beams for different loading conditions.
2. Design of R.C.C. beams, slabs, foundations.
3. Design of steel tension Members
4. Reinforcement detailing in beam using graphics.
5. Reinforcement detailing in slabs using graphics.
6. Reinforcement detailing in foundation using graphics.

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Ananthapuramu – 515 002, Andhra Pradesh, India

Course Structure of R21 Academic Regulations for M.Tech (Regular) Programs
with effect from AY 2021-2022

DEPARTMENT OF CIVIL ENGINEERING

STRUCTURAL ENGINEERING

I SEMESTER

S.No.	Course Code	Subject Name	Cate Gory	Hours Per Week			Credits
				L	T	P	
1	21D11101	Advanced Structural Analysis	PC	3	0	0	3
2	21D11102	Advanced Concrete Technology	PC	3	0	0	3
3	**Professional Elective - I**						
	21D11103	Advanced Mathematical Methods	PE	3	0	0	3
	21D11104	Theory and Analysis of Plates					
	21D11105	Theory of Elasticity					
4	**Professional Elective - II**						
	21D11106	Experimental Stress Analysis	PE	3	0	0	3
	21D11107	Maintenance and Rehabilitation of Structures					
	21D11108	Design of Bridges					
5	21D11109	Research Methodology and IPR	MC	2	0	0	2
6	21D11110	English for Research Paper Writing	AC	2	0	0	0
	21D11111	Value Education					
	21D11112	Pedagogy Studies					
7	21D11113	Advanced Concrete Laboratory – I	PC	0	0	4	2
8	21D11114	Computer Aided Design Laboratory – I	PC	0	0	4	2
Total				**16**	**00**	**08**	**18**

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Ananthapuramu – 515 002, Andhra Pradesh, India

Course Structure of R21 Academic Regulations for M.Tech (Regular) Programs
with effect from AY 2021-2022

DEPARTMENT OF CIVIL ENGINEERING

STRUCTURAL ENGINEERING

II SEMESTER

S.No.	Course Code	Subject Name	Category	Hours Per Week			Credits
				L	T	P	
1	21D11201	Structural Dynamics	PC	3	0	0	3
2	21D11202	Finite Element Methods for Structural Engineering	PC	3	0	0	3
3	**Professional Elective - III**						
	21D11203	Advanced Reinforced Concrete Design	PE	3	0	0	3
	21D11204	Design of Prestressed Concrete					
	21D11205	Analysis of Shells and Folded Plates					
4	**Professional Elective - IV**						
	21D11206	Stability of Structures	PE	3	0	0	3
	21D11207	Advanced Steel Design					
	21D11208	Fracture Mechanics					
5	21D11209	Technical Seminar	PR	2	0	0	2
6	21D11210	Disaster Management	AC	2	0	0	0
	21D11211	Constitution of India					
	21D11212	Stress Management by Yoga					
7	21D11213	Advanced Concrete Laboratory – II	PC	0	0	4	2
8	21D11214	Computer Aided Design Laboratory – II	PC	0	0	4	2
Total				**14**	**00**	**12**	**18**

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Course Structure of R21 Academic Regulations for M.Tech (Regular) Programs
with effect from AY 2021-2022

DEPARTMENT OF CIVIL ENGINEERING

STRUCTURAL ENGINEERING

III SEMESTER

S.No.	Course Code	Subject Name	Category	Hours Per Week			Credits
				L	T	P	
1	**Professional Elective – V**						
	21D11301	Earthquake Resistant Design of Buildings	PE	3	0	0	3
	21D11302	Cost Effective Housing Techniques					
	21D11303	Building Construction Management					
2	**Open Elective**						
	21D10301	Green Buildings -	OE	3	0	0	3
3	21D11304	Dissertation Phase – I	PR	0	0	20	10
4	21D00301	Co-Curricular Activities	PR				2
Total				**06**	**00**	**20**	**18**

IV SEMESTER

S.No.	Course Code	Subject Name	Category	Hours Per Week			Credits
				L	T	P	
1	21D11401	Dissertation Phase – II	PR	0	0	32	16
Total				**00**	**00**	**32**	**16**

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Ananthapuramu – 515 002, Andhra Pradesh, India

R21 COURSE STRUCTURE & SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF CIVIL ENGINEERING
(STRUCTURAL ENGINEERING)

Course Code	21D11101	ADVANCED STRUCTURAL ANALYSIS	L	T	P	C
Semester	I		3	0	0	3

Course Objectives: This Course Will Enable Students:

1.To understand the static and kinematic indeterminacy of the structures
2.To understand the concepts of matrix methods of analysis of structures
3.To understand the analysis of continuous beams.
4.To understand the analysis of rigid and pin jointed frames

Course Outcomes (CO): Student will be able to

1.Distinguish determinate and indeterminate structures.
2.Identify the method of analysis for indeterminate structures.
3.Apply matrix methods of analysis for continuous beams.
4.Apply matrix methods of analysis for rigid and pin jointed frames.

UNIT - I		Lecture Hrs:10

INTRODUCTION:-Indeterminacy-Determination of static and kinematic indeterminacies of two-dimensional and three-dimensional portal frames, pin jointed trusses and hybrid frames-coordinate systems –structural idealization. Introduction To Matrix Methods Of Analysis-Flexibility and stiffness matrices-Force displacement relationships for axial force, couple, torsional moments – stiffness method of analysis and flexibility method of analysis.

UNIT - II		Lecture Hrs:10

ANALYSIS OF CONTINUOUS BEAMS- stiffness method and flexibility method of analysis –continuous beams of two and three spans with different end conditions internal hinges.

UNIT - III		Lecture Hrs:10

ANALYSIS OF TWO DIMENSIONAL PORTAL FRAMES & PINJOINTED TRUSSES – stiffness and flexibility method of analysis of 2D portal frames with different end conditions-plotting of bending moment diagrams. Computation of joint displacement and member forces for pin jointed trusses.

UNIT - IV		Lecture Hrs:9

TRANSFORMATION OF CO-ORDINATES - Local and Global co-ordinate systems-transformation of matrices from local to global coordinates of element stiffness matrix-direct stiffness method of analysis-assembly of global stiffness matrix from element stiffness matrices –static condensation-sub-structuring.

UNIT - V		Lecture Hrs:9

EQUATION SOLVERS-solution of system of linear algebraic equations-direct inversion method-gauss elimination method-Cholesky method-banded equation solvers-frontal solution technique.

Textbooks:

1. Matrix Analysis of Frames structures by William Weaver J.R and James M.Gere, CBS publications.
2. Advanced Structural Analysis by Ashok.K.Jain, New Channel Brothers.
3. Matrix method of Structural Analysis by Pandit & Gupta

R21 COURSE STRUCTURE & SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF CIVIL ENGINEERING
(STRUCTURAL ENGINEERING)

Reference Books:

1. Matrix Structural Analysis by Madhu B. Kanchi.
2. Matrix Methods of Structural Analysis by J.Meek.
3. Structural Analysis by Ghali and Neyveli.
4. Structural Analysis by Devdas Menon, Narosa Publishing Housing Pvt Ltd.

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R21 COURSE STRUCTURE & SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF CIVIL ENGINEERING
(STRUCTURAL ENGINEERING)

Course Code	21D11102	ADVANCED CONCRETE TECHNOLOGY	L	T	P	C
Semester	I		3	0	0	3

Course Objectives: This Course Will Enable Students:

1.To study the properties of concrete making materials
2.To do mix design
3.Familiar with the methods of concrete
4.Knowledge about advance tests on concrete

Course Outcomes (CO): Student will be able to

1.To be familiar with the properties of concrete making materials
2.Identify the influence and compatibility of chemical , mineral admixtures in concrete
3.Update the knowledge on recent advances in special concretes.
4.Know about various methods of concrete
5.Analyse the performance of concrete structure through microstructure analysis

UNIT - I | Lecture Hrs:10

Cements and Admixtures: Portland Cement – Chemical Composition - Hydration, Setting and Finenesses of Cement – Structures of Hydrated Cement – Mechanical Strength of Cement Gel - Water Held in Hydrate Cement Paste – Heat of Hydration of Cement – Influence of Compound Composition on Properties of Cement – Tests on Physical Properties of Cement – I.S. Specifications – Different Types of Cements – Admixtures

UNIT - II | Lecture Hrs:10

Aggregates: Classification of Aggregate – Particle Shape and Texture – Bond Strength and Other Mechanical Properties of Aggregate Specific Gravity, Bulk Density, Porosity, Absorption and Moisture in Aggregate – Soundness of Aggregate – Alkali – Aggregate Reaction, Thermal Properties – Sieve Analysis – Fineness Modulus – Grading Curves – Grading Requirements – Practical Grading – Road Note No.4 Grading of Fine and Coarse Aggregates Gap Graded Aggregate – Maximum Aggregate Size.

UNIT - III | Lecture Hrs:10

Fresh Concrete: Workability – Factors Affecting Workability – Measurement of Workability by Different Tests – Effect of Time and Temperature on Workability – Segregation and Bleeding – Mixing and Vibration of Concrete – Quality of Mixing Water.
Hardened Concrete: Water/Cement Ratio-Abram's Law – Gel Space Ratio – Effective Water in Mix – Nature of Strength of Concrete – Strength in Tension and Compression-Griffith's Hypothesis – Factors Affecting Strength – Autogeneous Healing –Relation Between Compression and Tensile Strength – Curing and Maturity of Concrete Influence of Temperature on Strength – Steam Curing – Testing of Hardened Concrete – Compression Tests – Tension Tests – Factors Affecting Strength – Flexure Tests – Splitting Tests – Non Destructive Testing Methods.

UNIT - IV | Lecture Hrs:9

Elasticity, Shrinkage and Creep: Modulus of Elasticity – Dynamic Modulus of Elasticity – Poisson's Ratio – Early Volume Changes – Swelling – Drying Shrinkage - Mechanism of Shrinkage – Factors Affecting Shrinkage – Differential Shrinkage – Moisture Movement Carbonation Shrinkage-Creep of Concrete – Factors Influencing Creep – Relation Between Creep and Time – Nature of Creep – Effect of Creep

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UNIT - V		Lecture Hrs:9

Mix Design: Proportioning of Concrete Mixes by Various Methods – Fineness Modulus, Trial and Error, Mix Density, Road Note. No. 4, ACI and ISI Code Methods – Factors in The Choice of Mix Proportions – Quality Control of Concrete – Statistical Methods – High Strength Concrete Mix Design.

Special Concretes: Light Weight Concretes –Light Weight Aggregate Concrete- - No Fines Concrete – High Density Concrete – Fiber Reinforced Concrete – Different Types of Fibers - Factors Affecting Properties of FRC – Geo-polymer Concrete-Polymerization Process for strength gain-Applications of geo-polymer Concrete – Self Compacting Concrete- Mix design Philosophy- Slump Flow, V-Funnel, L-box and U-box tests-Advantages and disadvantages of SCC

Textbooks:

1. Properties of Concrete by A.M.Neville – Pearson Publication – 4th Edition
2. Concrete Technology by M.S.Shetty. – S.Chand & Co. ; 2004
3. Concrete Technology by A.R. Santhakumar, Oxford University Press, New Delhi

Reference Books:

1. Concrete: Micro Structure, Properties and Materials – P.K.Mehta and J.M.Monteiro, Mc-Graw Hill Publishers
2. Design of Concrete Mix by Krishna Raju, CBS Pubilishers.
3. Concrete Technology by A.M.Neville – Pearson Publication
4. Concrete Technology by M.L. Gambhir. – Tata Mc. Graw Hill Publishers, New Delhi
5. Non-Destructive Test and Evaluation of Materials by J.Prasad & C.G.K. Nair , Tata Mcgraw Hill Publishers, New Delhi

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Course Code	21D11103	ADVANCED MATHEMATICAL METHOD	L	T	P	C
Semester	I		3	0	0	3

Course Objectives:

Course Outcomes (CO): Student will be able to

UNIT - I	Lecture Hrs:

Calculus of variation-Concepts of maxima and minima of functions-constraints andLagrange's multipliers-Extreme value of functional-Euler's equations – solutions of Euler's equation. Hamilton principal- Lagrange equations generalized dynamic excitations – constraints in dynamical systems

UNIT - II	Lecture Hrs:

Numerical solution of ordinary differential equations Taylor series method, Picard's method, Euler's method modified Euler's method & R.K.method. Eigen values and Eigen vectors – general method – Power method, spectral method

UNIT - III	Lecture Hrs:

Numerical solution of partial differential equations –Elliptical equations standard five points formula, diagonal five-point formula –solution of Laplace equation by Leibmann's iteration method, Poisson's equation and its applications

UNIT - IV	Lecture Hrs:

Numerical solution of partial differential equations – Parabolic equations bender –Schmidt method-bender - Schmidt recurrence equation, crank-Nicholson difference method

UNIT - V	Lecture Hrs:

Finite element method – weighted Residual methods, least square method, Galerkin's method – finite elements – Interpolating over the whole domain – Finite element application to boundary value problems

Textbooks:

1. Numerical methods for Engineers by Steven C.Chapra and Raymond P.Canale – Mc Graw Hill Book Company.
2. Applied numerical analysis by Curtis. F.Gerald- Addeson Wesely Publishing Company.
3. Higher Engineering mathematics by B.S. Grewal Khanna Publishers.
4. C-Language and numerical methods by C-Xavier. New Age International publishers.
5. Computational methods for partial differential equations by M.K.Jain, S.R.K.Iyengar, R.K.Jain.
6. An Introduction to the finite element method, J.N.Reddy, McGraw. Hill, Inc

Reference Books:

Online Learning Resources:

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R21 COURSE STRUCTURE & SYLLABUS FOR M.TECH COURSES
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Course Code	21D11104	THEORY AND ANALYSIS OF PLATES (PE-I)	L	T	P	C
Semester	I		3	0	0	3

Course Objectives: This Course Will Enable Students:

1.To know the behaviour of plates for external loads.
2.To know the behaviour of circular plates for external loads.
3.To know the behaviour of plates for simultaneous bending and stretching.
4.To know the behaviour of orthotropic plates.
5.To know the numerical and approximate methods for the analysis of plates.

Course Outcomes (CO): Student will be able to

1.Analyse the plates for external loads.
2.Analyse the circular plates for external loads.
3.Analyse the plates for simultaneous bending and stretching.
4.Analyse the orthotropic plates.
5.Analyse the plates by numerical methods.

UNIT - I **Lecture Hrs:10**

DERIVATION OF PLATE EQUATIONS FOR RECTANGULAR PLATES –In plane bending and transverse bending effects.Plates under various loading conditions like concentrated, U.D.L and hydrostatic pressure- Navier and Levy's type of solutions for various boundary conditions.

UNIT - II **Lecture Hrs:10**

CIRCULAR PLATES: Symmetrically loaded, circular plates under various loading conditions, annular plates.

UNIT - III **Lecture Hrs:10**

PLATES UNDER SIMULTANEOUS BENDING AND STRECTHING: Derivation of the governing equation and application to simple cases

UNIT - IV **Lecture Hrs:9**

ORTHOTROPIC PLATES: Derivation of the governing equation, applications to grillage problems as equivalent orthotropic plates.

UNIT - V **Lecture Hrs:9**

NUMERICAL AND APPROXIMATE METHODS: Energy solutions by variational methods, finite difference and finite element methods of analysis for plate problems.Study of few simple cases for large deflection theory of plates .

Textbooks:

1. Theory of Plates & Shells –Stephen, P.Timoshenko, S.Woinowsky-Krieger – Tata MC Graw Hill Edition
2. Analysis and design of concrete shell roofs by G.S.Ramaswami. CBS publications.
3. Design of concrete shell roofs by Billington – Tata MC Graw Hill, New York

Reference Books:

1. Shell Analysis by N.K.Bairagi. Khanna Publishers, New Delhi.
2. Design of Shells and Folded Plates by P.C. Varghese, PHI Learning Pvt. Ltd
3. Design of concrete shell roofs by Chaterjee. Oxford and IBH.,

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R21 COURSE STRUCTURE & SYLLABUS FOR M.TECH COURSES
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(STRUCTURAL ENGINEERING)

Course Code	21D11105	THEORY OF ELASTICITY	L	T	P	C
Semester	I	(PE-I)	3	0	0	3

Course Objectives: This Course Will Enable Students:

1.To make students understand the principles of elasticity.
2.To familiarize students with basic equations of elasticity.
3.To expose students to two dimensional problems in Cartesian and polar coordinates.
4.To make students understand the principle of torsion of prismatic bars.

Course Outcomes (CO): Student will be able to

1.To apply elastic analysis to study the fracture mechanics.
2.To apply linear elasticity in the design and analysis of structures such as beams, plates, shells and sandwich composites.
3.To apply hyper elasticity to determine the response of elastomer-based objects.
4.To analyze the structural sections subjected to torsion.

UNIT - I		Lecture Hrs:10

INTRODUCTION TO PLANE STRESS and PLANE STRAIN ANALYSIS:
Elasticity –Notation for Forces and Stresses-Components of Stresses –Components of Strain –Hooke's Law. Plane Stress-Plane Strain-Differential Equations of Equilibrium- Boundary Conditions- Compatibility Equations-Stress Function-Boundary Conditions.

UNIT - II		Lecture Hrs:10

TWO DIMENSIONAL PROBLEMS in RECTANGULAR COORDINATES:
Solution by Polynomials-Saint Venant's Principle-Determination of Displacements-Bending of Simple Beams-Application of Fourier Series for Two Dimensional Problems - Gravity Loading.

UNIT - III		Lecture Hrs:10

TWO DIMENSIONAL PROBLEMS in POLAR COORDINATES :
General Equation in Polar Co-Ordinates - Stress Distribution Symmetrical About An Axis – Pure Bending of Curved Bars- Strain Components in Polar Coordinates-Displacements for Symmetrical Stress Distributions-Simple Symmetric and Asymmetric Problems-General Solution of Two Dimensional Problem in Polar Coordinates-Application of The General Solution of Two Dimensional Problem in Polar Coordinates-Application of The General Solution in Polar Coordinates.

UNIT - IV		Lecture Hrs:9

ANALYSIS OF STRESS AND STRAIN IN THREE DIMENSIONS: Principle Stress - Ellipsoid and Stress-Director Surface-Determination of Principle Stresses- Maximum Shear Stresses-Homogeneous Deformation-Principle Axis of Strain Rotation.
General Theorems: Balance Laws - Differential Equations of Equilibrium- Conditions of Compatibility - Determination of Displacement-Equations of Equilibrium in Terms of Displacements-Principle of Superposition-Uniqueness of Solution –The Reciprocal Theorem.

UNIT - V		Lecture Hrs:9

TORSION OF PRISMATIC BARS:
Torsion of Prismatic Bars- Elliptical Cross Section-Other Elementary Solutions-Membrane Analogy-Torsion of Rectangular Bars-Solution of Torsional Problems by Energy Method-

Use of Soap Films in Solving Torsional Problems-Hydra Dynamical Analogies-Torsion of Shafts, Tubes and Bars.
Textbooks:
1. Theory of Elasticity and Plasticity by Timoshenko, S., MC Graw Hill Book company. 2. Advanced Strength of materials by Papoov, MC Graw Hill Book company. 3. Theory of Elasticity and Plasticity by Sadhu Singh. Khanna Publishers.
Reference Books:
1. Plasticity for structural Engineers- Chen, W.F. and Han, D.J., Springer – Verlag, New York. 2. Plasticity theory, Lubliner, J., Mc Millan Publishing Co., New York. 3. Foundations of Solid Mechanics by Y.C.Fung, PHI Publications. 4. Advanced Mechanics of Solids by L.S. Srinath, Tata MC Graw Hill Book company.

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Course Code	21D11106	EXPERIMENTAL STRESS ANALYSIS	L	T	P	C
Semester	I	(PE-II)	3	0	0	3

Course Objectives: This Course Will Enable Students:

1. To perform NDT test and interpret the results
2. To understand the science behind working of strain gauge
3. Understand the practical applications of strain gauge
4. To determine the stress distribution in anacrylic block using the concept of photoelasticity

Course Outcomes (CO): Student will be able to

1. To understand the mechanical properties of strain gauges and applications
2. To understand the design and performance of strain gauges
3. To understand the methods of Non-destructive testing
4. To understand the methods of photo elasticity and models

UNIT - I		Lecture Hrs:10

PRINCIPLES OF EXPERIMENTAL APPROACH
Merits of Experimental Analysis Introduction, Uses of Experimental Stress Analysis Advantages of Experimental Stress Analysis, Different Methods –Simplification of Problems.

UNIT - II		Lecture Hrs:10

STRAIN MEASUREMENT USING STRAIN GAUGES :-
Definition of Strain and Its Relation of Experimental Determinations Properties of Strain-Gauge Systems-Types of Strain Gauges –Mechanical, Acoustic and Optical Strain Gauges. Introduction To Electrical Strain Gauges - Inductance Strain Gauges – LVDT – Resistance Strain Gauges – Various Types –Gauge Factor – Materials of Adhesion Base.

UNIT - III		Lecture Hrs:10

STRAIN ROSSETTES and NON – DESTRUCTIVE TESTING of CONCRETE:-
Introduction – The Three Elements Rectangular Rosette – The Delta Rosette Corrections for Transverse Strain Gauge. Ultrasonic Pulse Velocity Method –Application To Concrete. Hammer Test – Application To Concrete.

UNIT - IV		Lecture Hrs:9

THEORY OF PHOTOELASTICITY :-
Introduction –Temporary Double Refraction – The Stress Optic Law –Effects of Stressed Model in A Polariscope for Various Arrangements – Fringe Sharpening. Brewster's Stress Optic Law.

UNIT - V		Lecture Hrs:9

TWO DIMENSIONAL PHOTOELASTICITY :-
Introduction – Isochromatic Fringe Patterns- Isoclinic Fringe Patterns Passage of Light Through Plane Polariscope and Circular Polariscope Isoclinic Fringe Patterns – Compensation Techniques – Calibration Methods – Separation Methods – Scaling Model To Prototype Stresses – Materials for Photoelasticity- Properties of Photoelastic Materials.

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Textbooks:
1. Experimental Stress Analysis by J.W.Dally and W.F.Riley, College House Enterprises 2. Experimental Stress Analysis by Dr.Sadhu Singh.Khanna Publishers 3. Abdul Mubeen, "Experimental Stress Analysis", DhanpatRai and Sons, 2001.
Reference Books:
1. Experimental Stress Analysis by U.C.Jindal, Pearson Pubilications. 2. Experimental Stress Analysis by L.S.Srinath, MC.Graw Hill Company Publishers. 3. Moire Fringes in Strain Analysis, PS Theocaris, Pergammon Press, 2002.

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R21 COURSE STRUCTURE & SYLLABUS FOR M.TECH COURSES
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(STRUCTURAL ENGINEERING)

Course Code	21D11107	MAINTENANCE AND REHABILITATION OF STRUCTURES (PE – II)	L	T	P	C
Semester	I		3	0	0	3

Course Objectives: This Course Will Enable Students:

1. To judge the rate of corrosion in various exposure conditions
2. To conduct nondestructive testing of structural elements
3. To select suitable bonding technique
4. To judge the effect of fire and earthquake loads on discontinuities

Course Outcomes (CO): Student will be able to

1.Estimate the causes for distress and deterioration of structures
2.Apply the NDT for condition assessment of structures, identify damages in RC structures
3.Select repair material and retrofitting strategy suitable for distress
4.Formulate guidelines for repair management of deteriorated structures
5.Strengthening of earthquake and fire damaged elements using various techniques.

UNIT - I		Lecture Hrs:10

Influence on Serviceability and Durability:- General : Quality Assurance for Concrete Construction, As Built Concrete Properties, Strength, Permeability, Volume Changes, Thermal Properties, Cracking. Effects Due To Climate, Temperature, Chemicals, Wear and Erosion, Design and Construction Errors, Corrosion Mechanism, Effects of Cover Thickness and Cracking Methods of Corrosion Protection, Inhibitors, Resistant Steels, Coatings Cathodic Protection.

UNIT - II		Lecture Hrs:10

Maintenance and Repair Strategies :- Inspection, Structural Appraisal, Economic Appraisal, Components of Equality Assurance, Conceptual Bases for Quality Assurance Schemes.

UNIT - III		Lecture Hrs:10

Materials for Repair :- Special Concretes and Mortar, Concrete Chemicals, Special Elements for Accelerated Strength Gain, Expansive Cement, Polymer Concrete, Sulphur Infiltrated Concrete, Ferro Cement, Fibre Reinforced Concrete.

UNIT - IV		Lecture Hrs:9

Techniques for Repair :- Rust Eliminators and Polymers Coating for Rebars During Repair, Foamed Concrete, Mortar and Dry Pack, Vacuum Concrete, Gunite and Shotcrete Epoxy Injection, Mortar Repair for Cracks, Shoring and Underpinning.

UNIT - V		Lecture Hrs:9

Case Studies :- Repairs To Overcome Low Member Strength, Deflection, Cracking, Chemical Disruption, Weathering, Wear, Fire, Leakage, Marine Exposure.

Textbooks:

1. Dension Campbell, Allen and Harold Roper, Concrete Structures, Materials, Maintenance and Repair, Longman Scientific and Technical, U.K. 1991.
2. RT.Allen and S.C. Edwards, Repair of Concrete Structures, Blakie and Sons, UK, 1987.
3. MS. Shetty, Concrete Technology – Theory and Practice, S.Chand and Company, New Delhi, 1992.

Reference Books:

R21 COURSE STRUCTURE & SYLLABUS FOR M.TECH COURSES
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1. Santhakumar, A.R.Training Course Notes on Damage Assessment and Repair in Low Cost Housing RHDC-NBO Anna University, Madras, July, 1992.
2. Raikar, R.N.Learning From Failures – Deficiencies in Design, Construction and Service – R&D Centre (SDCPL), Raikar Bhavan, Bombay, 1987.
3. N.Palaniappan, Estate Management, Anna Institute of Management, Madras Sep. 1992.
4. F.K.Garas, J.L.Clarke, GST Armer, Structural Assessment, Butterworths, UK Aporil 1987.

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R21 COURSE STRUCTURE & SYLLABUS FOR M.TECH COURSES
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(STRUCTURAL ENGINEERING)

Course Code	21D11108	DESIGN OF BRIDGES	L	T	P	C
Semester	I	(PE-II)	3	0	0	3

Course Objectives: This Course Will Enable Students:

1. To understand the various types of bridges
2. To understand the codal provisions for loading and design standards of bridges
3. To design the superstructure of bridge using different methods and loading conditions
4. To understand the design of bearings

Course Outcomes (CO): Student will be able to

1. Finalize with the usage of codal provisions in the design of bridges
2. Analyze and design substructure elements of bridges
3. Analyze and design various types of bridges like t-beam bridge,slab bridge ,box culvert.
4. To analyze and design of T beam bridge

UNIT - I		Lecture Hrs:10

Introduction – Classification, Investigations and Planning, Choice of Type – Economic Span Length – IRC Specifications for Road Bridges, Standard Live Loads, Other Forces Acting on Bridges, General Design Considerations.

UNIT - II		Lecture Hrs:10

Design of Box Culverts – General Aspects – Design Loads – Design Moments, Shears and Thrusts – Design of Critical Section.
Design of Slab Bridges – Effective Width of Analysis – Workings Stress Design and Detailing of Slab Bridges for IRC Loading.

UNIT - III		Lecture Hrs:10

T-Beam Bridges – Introduction – Wheel Load Analysis – B.M. in Slab – Pigaud's Theory – Analysis of Longitudinal Girders by Courbon's Theory Working Stress Design and Detailing of Reinforced Concrete T-Beam Bridges for IRC Loading.

UNIT - IV		Lecture Hrs:9

Prestressed Concrete Bridges – General Features – Advantages of Prestressed Concrete Bridges – Pre-tensioned Prestressed Concrete Bridges – Post Tensioned Prestressed Concrete Bridge Decks. Design of Post Tensioned Prestressed Concrete Slab Bridge Deck. Bridge Bearings – General Features – Types of Bearings – Forces on Bearings Basis for Selection of Bearings – Design Principles of Steel Rocker and Roller Bearings and Its Design – Design of Elastometric Pad Bearing Detailing of Elastomeric Pot Bearings.

UNIT - V		Lecture Hrs:9

Piers and Abutments – General Features – Bed Block – Materials for Piers and Abutments – Types of Piers – Forces Acting on Piers – Design of Pier – Stability Analysis of Piers – General Features of Abutments – Forces Acting on Abutments – Stability Analysis of Abutments.

Textbooks:

1. Essentials of Bridges Engineering – D.Hohnson Victor Oxford & IBH Publishers Co-Private Ltd.
2. Design of Concrete Bridges MC Aswanin VN Vazrani, MM Ratwani, Khanna Publishers.
3. Bridge Engineering – S.Ponnuswamy. Tata Mc Graw Hill

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Reference Books:

1. Concrete Bridge Design, Browe, R.E., C.R.Books Ltd., London, 1962.
2. Reinforced Concrete Bridges, Taylor F.W., Thomson, S.E., and Smulski E., John Wiley and Sons, New York, 1955.
3. An Introduction To Structural Design of Concrete Bridges, Derrick Beckett, Surrey University; Press, Henlely – Thomes, Oxford Shire, 1973
4. Bridge Analysis Simplified, Bakht.B.And Jaegar, L.G. Mc Graw Hill, 1985.
5. Design of Bridges – N.Krishna Raju – Oxford & IBH
6. Design of Bridge Structures – FR Jagadeesh, M.A. Jaya Ram – Eastern Economy Edition.

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Course Code	21D11109	RESEARCH METHODOLOGY AND IPR	L	T	P	C
Semester	I		2	0	0	2

Course Objectives: This Course Will Enable Students:

Course Outcomes (CO): Student will be able to

At the end of this course, students will be able to

1. Understand research problem formulation.
2. Analyze research related information
3. Follow research ethics
4. Understand that today's world is controlled by Computer, Information
5. Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
6. Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
7. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

UNIT - I		Lecture Hrs:

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		Lecture Hrs:

Effective literature studies approaches, analysis Plagiarism, Research ethics,

UNIT - III		Lecture Hrs:

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 - IV		Lecture Hrs:

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

UNIT - V		Lecture Hrs:

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Textbooks:

1. Structural Dynamics for Earthquake Engineering,A.K.Chopra,Pearson Pubilications
2. Dynamics of Structures by Clough & Penziem
3. Structural Dynamics by Roy. R. Craig John willy & fours.

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Reference Books:

1. Stuart Melville and Wayne Goddard, "Research methodology: An introduction for science & engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide• for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
5. Mayall, "Industrial Design", McGraw Hill, 1992.
6. Niebel, "Product Design", McGraw Hill, 1974.
7. Asimov, "Introduction to Design", Prentice Hall, 1962.
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", 2016.
9. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

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Course Code	21D11110	ENGLISH FOR RESEARCH PAPER WRITING	L	T	P	C
Semester	I		2	0	0	0

Course Objectives: This Course Will Enable Students:

Course Outcomes (CO): Student will be able to

At the end of this course, students will be able to
1. Understand that how to improve your writing skills and level of readability
2. Learn about what to write in each section
3. Understand the skills needed when writing a Title Ensure the good quality of paper at very first-time submission

UNIT - I	Lecture Hrs:
Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness	
UNIT - II	**Lecture Hrs:**
Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction 4	
UNIT - III	**Lecture Hrs:**
Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.	
UNIT - IV	**Lecture Hrs:**
Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature	
UNIT - V	**Lecture Hrs:**
Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions. useful phrases, how to ensure paper is as good as it could possibly be the first- time submission	

Textbooks:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books) 2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
2. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook
3. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

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Course Code	21D11111	VALUE EDUCATION	L	T	P	C
Semester	I		2	0	0	0

Course Objectives: This Course Will Enable Students:

Course Outcomes (CO): Student will be able to

1. Understand value of education and self- development
2. Imbibe good values in students
3. Let the should know about the importance of character

UNIT - I	Lecture Hrs:

Values and self-development –Social values and individual attitudes, Work ethics, Indian vision of humanism. Moral and non- moral valuation. Standards and principles.,Value judgements

UNIT - II	Lecture Hrs:

Importance of cultivation of values., Sense of duty. Devotion, Self-reliance. Confidence, Concentration, Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity, Patriotism. Love for nature ,Discipline

UNIT - III	Lecture Hrs:

Personality and Behavior Development - Soul and Scientific attitude, Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour., Universal brotherhood and religious tolerance.

UNIT - IV	Lecture Hrs:

True friendship., Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

UNIT - V	Lecture Hrs:

Character and Competence –Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively

Textbooks:

1. Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi

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R21 COURSE STRUCTURE & SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF CIVIL ENGINEERING
(STRUCTURAL ENGINEERING)

Course Code	21D11112	PEDAGOGY STUDIES	L	T	P	C
Semester	I		2	0	0	0

Course Objectives: This Course Will Enable Students:

1. Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
2. Identify critical evidence gaps to guide the development

Course Outcomes (CO): Student will be able to

UNIT - I	Lecture Hrs:

Introduction and Methodology, Aims and rationale, Policy background, Conceptual framework and terminology Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions, Overview of methodology and Searching.

UNIT - II	Lecture Hrs:

Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education.

UNIT - III	Lecture Hrs:

Evidence on the effectiveness of pedagogical practices, Methodology for the in depth stage: quality assessment of included studies. How can teacher education (curriculum and practicum) and the school, curriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of the body of evidence for effective pedagogical, practices. Pedagogic theory and pedagogical approaches. Teachers' attitudes and beliefs and Pedagogic strategies

UNIT - IV	Lecture Hrs:

Professional development: alignment with classroom practices and followup support Peer support Support from the head teacher and the community. Curriculum and assessment Barriers to learning: limited resources and large class sizes

UNIT - V	Lecture Hrs:

Research gaps and future directions Research design Contexts Pedagogy Teacher education Curriculum and assessment Dissemination and research impact.

Textbooks:

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf.

R21 COURSE STRUCTURE & SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF CIVIL ENGINEERING
(STRUCTURAL ENGINEERING)

Course Code	21D11113	Advanced Concrete Laboratory – I	L	T	P	C
Semester	I		0	0	4	2

Course Objectives:

1.Mix design and Fresh Properties of Fly ash.
2. Compression Strength and Split Tensile Strength.
3. Mix design and Fresh Properties of GGBS.
4. Flexural Strength Properties of Metakaolin.

Course Outcomes (CO):

1. To gain knowledge Mix design and Fresh Properties of Fly ash.
2. To gain knowledge Compression Strength and Split Tensile Strength.
3. To gain knowledge Mix design and Fresh Properties of GGBS.
4. To gain knowledge Flexural Strength Properties of Metakaolin

List of Experiments:

1. Mix design and Fresh Properties of Fly ash based M40 Grade Concrete.
2. Compression Strength and Split Tensile Strength Properties of Fly ash based M40 Grade Concrete.
3. Flexural Strength Properties of Fly ash based M40 Grade Concrete.
4. Mix design and Fresh Properties of GGBS based M40 Grade Concrete.
5. Compression Strength and Split Tensile Strength Properties of GGBS based M40 Grade Concrete.
6. Flexural Strength Properties of GGBS based M40 Grade Concrete.
7. Mix design and Fresh Properties of Silica Fume based M40 Grade Concrete.
8. Compression Strength and Split Tensile Strength Properties of Silica Fume based M40 Grade Concrete.
9. Flexural Strength Properties of Silica Fume based M40 Grade Concrete.
10. Mix design and Fresh Properties of Metakaolin based M40 Grade Concrete.
11. Compression Strength and Split Tensile Strength Properties of Metakaolin based M40 Grade Concrete.
12. Flexural Strength Properties of Metakaolin based M40 Grade Concrete.

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R21 COURSE STRUCTURE & SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF CIVIL ENGINEERING
(STRUCTURAL ENGINEERING)

Course Code	21D11114	COMPUTER AIDED DESIGN LABORATORY–I	L	T	P	C
Semester	I		0	0	4	2

Course Objectives: The students will acquire knowledge about

1. Demonstrate the design of reinforced concrete structural elements.
2. Explain earthquake resistant design
3. Explain analysis of a building for wind loading.
4. Demonstrate the method of analysis of truss.

Course Outcomes (CO): At the end of the course, students will be able to:

2. Analyze and design the structural components like beams, slabs and columns,
3. Analyze and design retaining wall and shear wall.
4. Analyze for earthquake loading & wind loading of framed buildings.
5. Analyze and design pin jointed, rigid jointed plane structures.

List of Experiments:

1. Design of Singly reinforced concrete beam
2. Design of Doubly reinforced concrete beam
3. Design of reinforced concrete column subjected to biaxial bending
4. Design of One Way reinforced concrete slab
5. Design of Two Way reinforced concrete slab
6. Design of reinforced concrete retaining wall (cantilever type)
7. Design of reinforced concrete shear wall
8. Lateral forces on a building due to an earthquake using equivalent static method
9. Lateral forces on a building due to wind
10. Analysis of rigid jointed plane frames
11. Analysis of simply supported/cantilever beam
12. Analysis of plane truss and Design of Steel Tension Members.

References:

1. Staad Pro V8i for Beginners, T.S Sarma,Notion Press; (2014).
2. Learning Bentley Staad.Pro V8i for Structural Analysis, Sham Tickoo Dreamtech press (2015).
3. Technical Reference Manual for STAAD, Bentley

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R21 COURSE STRUCTURE & SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF CIVIL ENGINEERING
(STRUCTURAL ENGINEERING)

Course Code	21D11201	STRUCTURAL DYNAMICS	L	T	P	C
Semester	II		3	0	0	3

Course Objectives: This Course Will Enable Students:

1. Determine vibration characteristics of structures like frequency, amplitude, impedance and time period
2. Differentiate the response of single and multi-degree of freedom systems
3. Determine the response of structures for pulse excitation like blast load
4. Differentiate the response of Multi Degree of Freedom systems

Course Outcomes (CO): Student will be able to

1. Write equation of motion for single and multi-degree of freedom systems
2. Understand the impact of damping on charecterstics of vibrating system
3. Gain Knowledge about arbitrary and pulse excitation
4. Understand applications of Numerical methods in dynamics
5. Analyze in various theories of failure and plasticity

UNIT - I **Lecture Hrs:10**

Theory of Vibrations: Introduction –Elements of A Vibratory System – Degrees of Freedom-Continuous Systems –Lumped Mass Idealization –Oscillatory Motion –Simple Harmonic Motion –Pictorial Representation of S.H.M - Free Vibrations of Single Degree of Freedom (SDOF) Systems – Undamped and Damped –Critical Damping –Logarithmic Decrement –Forced Vibrations of SDOF Systems-Harmonic Excitation –Dynamic Magnification Factor- Bandwidth. Fundamental Objective of Dynamic Analysis-Types of Prescribed Loading- Methods of Discretization- Formulation of The Equations of Motion.

UNIT - II **Lecture Hrs:10**

Single Degree of Freedom System: Formulation and Solutions of The Equation of Motion - Free Vibration Response –Response To Harmonic, Periodic, Impulsive and General Dynamic Loading –Duhamel Integral

UNIT - III **Lecture Hrs:10**

Multi Degree of Freedom System: Selection of The Degree of Freedom –Evaluation of Structural Property Matrices-Formulation of The MDOF Equations of Motion –Undamped Free Vibrations-Solution of Eigen Value Problem for Natural Frequencies and Mode Shapes- Analysis of Dynamic Response –Normal Coordinates –Uncoupled Equations of Motion –Orthogonal Properties of Normal Modes-Mode Superposition Procedure

UNIT - IV **Lecture Hrs:9**

Practical Vibration Analysis: Stodola Method- Fundamental Mode Analysis –Analysis of Second and Higher Modes –Holzer's Method –Basic Procedure –Transfer Matrix Procedure

UNIT - V **Lecture Hrs: 9**

Introduction To Earthquake Analysis: Introduction –Excitation by Rigid Base Translation –Lumped Mass Approach -SDOF and MDOF System- I.S Code Methods of Analysis.

Continuous System: Introduction –Flexural Vibrations of Beams- Elementary Case-Equation of Motion –Analysis of Undamped Free Shapes of Simple Beams With Different End Conditions-Principles of Application To Continuous Beams.

R21 COURSE STRUCTURE & SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF CIVIL ENGINEERING
(STRUCTURAL ENGINEERING)

Textbooks:
1. Structural Dynamics for Earthquake Engineering,A.K.Chopra,Pearson Pubilications 2. Dynamics of Structures by Clough & Penziem 3. Structural Dynamics by Roy. R. Craig John willy & fours.
Reference Books:
1. Structural Dynamics by Mario Paz 2. I.S:1893(Part 1):2016 Code of Practice for Earthquakes Resistant Design of Stuctures. 3. Fundamentals of Vibration, Anderson R.A, Amerind Pulblishing Co., 1972.

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R21 COURSE STRUCTURE & SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF CIVIL ENGINEERING
(STRUCTURAL ENGINEERING)

Course Code	21D11202	FINITE ELEMENT METHODS FOR	L	T	P	C
Semester	II	STRUCTURAL ENGINEERING	3	0	0	3

Course Objectives: This Course Will Enable Students:

1 To provide an overview and basic fundamentals of Finite Element Analysis.
2 To introduce basic aspects of finite element theory, including domain discretization, interpolation, application of boundary conditions, assembly of global arrays, and solution of the resulting algebraic systems.
3 To explain the underlying concepts behind variational methods and weighted residual methods in FEM.
4 Formulate simple structural problems in to finite elements

Course Outcomes (CO): Student will be able to

1 Analyse and build FEA models for various Engineering problems.
2 Able to identify information requirements and sources for analysis, design and evaluation
3 Use professional-level finite element software to solve engineering problems.
4 Interpret results obtained from FEA software solutions, not only in terms of conclusions but also awareness of limitations.

UNIT - I		Lecture Hrs:10

Introduction-Concepts of FEM –Steps Involved –Merits &Demerits –Energy Principles – Discretization –Rayleigh –Ritz Method of Functional Approximation. **Elastic Formulations:** Stress Equations-Strain Displacement Relationships in Matrix Form-Plane Stress, Plane Strain and Axi-Symmetric Bodies of Revolution With Axi Symmetric Loading

UNIT - II		Lecture Hrs:10

One Dimensional FEM-Stiffness Matrix for Beam and Bar Elements Shape Functions for ID Elements –Static Condensation of Global Stiffness Matrix-Solution –Initial Strain and Temperature Effects.

UNIT - III		Lecture Hrs:10

Two Dimensional FEM-Different Types of Elements for Plane Stress and Plane Strain Analysis –Displacement Models –Generalized Coordinates-Shape Functions-Convergent and Compatibility Requirements –Geometric Invariance –Natural Coordinate System-Area and Volume Coordinates-Generation of Element Stiffness and Nodal Load Matrices –Static Condensation.

UNIT - IV		Lecture Hrs:9

Isoparametric Formulation-Concept, Different Isoparametric Elements for 2D Analysis-Formulation of 4-Noded and 8-Noded Isoparametric Quadrilateral Elements –Lagrangian Elements-Serendipity Elements. **Axi Symmetric Analysis** –Bodies of Revolution-Axi Symmetric Modelling –Strain Displacement Relationship-Formulation of Axi Symmetric Elements.

UNIT - V		Lecture Hrs:9

Three Dimensional FEM-Different 3-D Elements, 3D Strain –Displacement Relationship-Formulation of Hexahedral and Isoparametric Solid Element.

R21 COURSE STRUCTURE & SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF CIVIL ENGINEERING
(STRUCTURAL ENGINEERING)

Textbooks:

1. Finite Elements Methods in Engineering by Tirupati. R. Chandrnpatla and Ashok D. Belegundu – Pearson Education Publications.
2. Finite Element Analysis – Theory & Programming by C.S.Krishna Murthy- Tata Mc.Graw Hill Publishers
3. Finite Element Analysis by S.S. Bhavakatti-New Age International Publishers

Reference Books:

1. Finite Element Method and Its Application by Desai ,2012, Pearson Pubilications.
2. finite Element Methods by Darrel W.Pepper, Vikas Pubilishers
3. Finite Element Analysis and Procedures in Engineering by H.V.Lakshminaryana, 3rd Edition, Universities Press, Hyderabad.
4. Finite Element Analysis in Engineering Design by S.Rajasekharan, S.Chand Publications, New Delhi.
5. Finite Element Analysis by P Seshu-PHI Learning Publications.

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R21 COURSE STRUCTURE & SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF CIVIL ENGINEERING
(STRUCTURAL ENGINEERING)

Course Code	21D11203	ADVANCED REINFORCED CONCRETE DESIGN (PE-III)	L	T	P	C
Semester	II		3	0	0	3

Course Objectives: This course will enable students:

1. To design of reinforced concrete beam
2. To design of reinforced concrete slab
3. To analyze and design of multi storey building and Industrial Building
4. To design special structures such as Deep beams, Corbels and Grid Floors

Course Outcomes (CO): Student will be able to

1. Design the strength and serviceability of reinforced concrete elements
2. Design special reinforced concrete elements
3. Analyse and design of slabs and grid floor
4. Design the inelastic behaviour of concrete beams

UNIT - I **Lecture Hrs:10**

Deflection of Reinforced Concrete Beams and Slabs:
Introduction -Short-Term Deflection of Beams and Slabs -Deflection Due To -Imposed Loads - Short- Term Deflection of Beams Due To Applied Loads- Calculation of Deflection by IS 456 - Calculation of Deflection by BS 8110 - Deflection Calculation by Eurocode – ACI Simplified Method - Deflection of Continuous Beams by IS 456 - Deflection of Cantilevers - Deflection of Slabs

Estimation of Crack Width in Reinforced Concrete Members: Introduction - Factors Affecting Crack width in Beams - Mechanism of Flexural Cracking Calculation of Crack Widths - Simple Empirical Method - Estimation of Crack width in -Beams by IS 456 of BS 8110 - Shrinkage and Thermal Cracking.

UNIT - II **Lecture Hrs:10**

UNIT - III **Lecture Hrs:10**

Shear in Flat Slabs and Flat Plates:
Introduction - Checking for One-Way (Wide Beam) Shear - Two-Way (Punching) Shear Permissible Punching Shear - Shear Due To Unbalanced Moment (Torsional Moments) Calculation of J Values - Strengthening of Column Areas for Moment Transfer by Torsion Which Produces Shear - Shear Reinforcement Design - Effect of Openings in Flat Slabs - Recent Revisions in ACI 318 - Shear in Two – Way Slabs With Beams.

UNIT - IV **Lecture Hrs:9**

Design of Plain Concrete Walls and Shear Walls:
Introduction - Braced and Unbraced Walls - Slenderness of Walls- Eccentricities of Vertical Loads At Right Angles To Wall - Empirical Design Method for Plane Concrete Walls Carrying Axial Load - Design of Walls for In-Plane Horizontal Forces - Rules for Detailing of Steel in Concrete Walls

Design of Shear Walls:
Introduction - Classification of Shear Walls - Classification According To Behavior - Loads in Shear Walls - Design of Rectangular and Flanged Shear Walls - Derivation of Formula for Moment of Resistance of Rectangular Shear Walls

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UNIT - V		**Lecture Hrs:9**
Design of Reinforced Concrete Members for Fire Resistance : Introduction - ISO 834 Standard Heating Conditions- Grading Or Classification - Effect of High Temperature on Steel and Concrete - Effect of High Temperatures on Different Types of Structural Members - Fire Resistance by Structural Detailing From Tabulated Data - Analystical Determination of The Ultimate Bending Moment Capacity of Reinforced Concrete Beams Under Fire - Other Considerations		
Textbooks:		
1. Reinforced Concrete Structural Elements: Behaviour, Analysis and Design, P.Purushothaman, Tata Mcgraw Hill. 2. Reinforced Concrete Desigers Hand Bood, C.E. Reynolds and J.C. Steedman, A View Point Publication. 3. Advanced Reinforced Concrete Design , Varghese PC, Prentice Hall of India,2008		
Reference Books:		
1. Limit State Design of Reinforced Concrete Structures by P.Dayaratnam, Oxford & Ibh Publishers. 2. Advanced RCC by N.Krishna Raju, Cbs Publishers & Distributors. 3. Reinforced Cement Concrete Structures – Devdas Menon & Unnikrishna Pillai, Tata Mcgraw Hill		

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R21 COURSE STRUCTURE & SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF CIVIL ENGINEERING
(STRUCTURAL ENGINEERING)

Course Code	21D11204	DESIGN OF PRESTRESSED CONCRETE (PE-III)	L	T	P	C
Semester	II		3	0	0	3

Course Objectives: This Course Will Enable Students:

1. Familiarize students with concret of prestressing and analysis of prestress
2. Design and analysis of pretension and post tensioned concrete memebers
3. Determination of deflections of prestressed members
4. To calculate the losses of prestress,creep and shrinkage.

Course Outcomes (CO): Student will be able to

1. To understand the basic concepts about prestressed concrete and analysis of prestress
2. Estimate the effective losses in prestress
3. Analyse the effect of prestressing force in the beahviour of beams in flexure
4. To design shear, torsion and transmission length in prestressed concrete members
5. Design of compression and tension members as per codes of practice

UNIT - I **Lecture Hrs:10**

Introduction: Development of Prestressed Concrete –Advantages and Disadvantages of PSC Over RCC –General Principles of Pre-Stressing-Pre Tensioning and Post Tensioning – Materials Used in PSC-High Strength Concrete –High Tension Steel-Different Types /Methods/Systems of Prestressing. Analysis of Sections for Flexure in Accordance With Elastic Theory-Allowable Stresses-Design Criteria As Per I.S Code of Practice –Elastic Design of Beams (Rectangular, I and T Sections) for Flexure –Introduction To Partial Prestressing

UNIT - II **Lecture Hrs:10**

Losses of Prestress: Estimation of The Loss of Prestress Due To Various Causes Like Elastic Shortening of Concrete ,Creep of Concrete, Shrinkage of Concrete, Relaxation of Steel, Slip in Anchorage and Friction

UNIT - III **Lecture Hrs:10**

Deflections: Introduction-Factors Influencing Deflections-Short Term and Long Term Deflections of Un-cracked members- Short Term and Long Term Deflections of Cracked Members.

Shear: Shear in PSC Beams –Principal Stresses –Conventional Elastic Design for Shear-Transfer of Prestress in Pre-tensioned Members

UNIT - IV **Lecture Hrs:10**

End blocks: Transmission length –Bond stresses-bearing at anchorage –Anchorage zone stresses in post-tensioned members-Analysis and design of end blocks by Guyon, Magnel and approximate methods –Anchorage zone reinforcements.

UNIT - V **Lecture Hrs:10**

Statically Indeterminate Structures: Introduction –Advantages and Disadvantages of Continuity –Layouts for Continuous Beams-Primary
and Secondary Moments –Elastic Analysis of Continuous Beams-Linear Transformation-Concordant Cable Profile-Design of Continuous Beams

R21 COURSE STRUCTURE & SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF CIVIL ENGINEERING
(STRUCTURAL ENGINEERING)

Textbooks:
1. Prestressed Concrete by N. Krishna Raju, 6th Edition, TMH Pubilishers. 2. Prestressed Concrete by K.U.Muthu, PHI Learning Private Limited. 3. Prestressed Concrete Design by Praveen Nagarajan, Pearson Pubilications.
Reference Books:
1. Design of Prestressed Concrete Structures, T.Y.Lin and Ned H. Burns, Wiley Publishing House. 2. Prestressed Concrete, Vol.I&II, Y.Guyon, Wiley and Sons, 1960. 3. Prestressed Concrete, Edward P.Nawy, Prentice Hall –. 4. Prestressed Concrete – by N. Rajagopalan, Narosa Pubilishing House

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R21 COURSE STRUCTURE & SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF CIVIL ENGINEERING
(STRUCTURAL ENGINEERING)

Course Code	21D11205	ANALYSIS OF SHELLS AND FOLDED PLATES	L	T	P	C
Semester	II	(PE-III)	3	0	0	3

Course Objectives: This Course Will Enable Students:

1. To know the principles of membrane theory and bending theory.
2. To know the principles of cylindrical shells.
3. To know the principles of shells of double curvature other than shells of revolution.
4. To know the principles of folded plates
5. To know the principles of shells of double curvature shells of revolution

Course Outcomes (CO): Student will be able to

1. To derive stress resultants.
2. To derive the governing differential equations for cylindrical shells.
3. To derive the governing differential equations for shells of double curvature other than shells of revolution.
4. To analyse the folded plates.
5. To analyse the shells of double curvature for shells of revolution.

UNIT - I **Lecture Hrs:10**

Equations of equilibrium : Introduction, classification, derivation of stress Resultants, Principles of membrane theory and bending theory.

UNIT - II **Lecture Hrs:10**

Cylindrical shells: Derivation of governing DKJ equation for bending theory, details of Schorer's theory, Applications to the analysis and design of short shells and long shells. Introduction of ASCE manual co-efficients for design.

UNIT - III **Lecture Hrs:10**

Introduction to shells of double curvature: (other than shells of revolution:) Geometry and analysis of elliptic paraboloid, rotational paraboloid and hyperbolic paraboloid shapes by membrane theory.

UNIT - IV **Lecture Hrs:9**

Folded Plates: Folded plate theory, plate and slab action, Whitney's theory, Simpson's theory for the analysis of different types of folded plates (Design is not included)

UNIT - V **Lecture Hrs:9**

Shells of double Curvature-Surfaces of revolution .Derivation of equilibrium equations by membrane theory, Applications to spherical shell and rotational Hyperboloid

Textbooks:

1. Design and construction of concrete shell roofs by G.S. Rama Swamy – CBS Publishers & Distributors, 485, Jain Bhawan Bhola Nath Nagar, shahotra, Delhi.
2. Fundamentals of the analysis and design of shell structures by Vasant S.kelkar Robert T.Swell – Prentice hall, Inc., Englewood cliffs, new Jersy -02632.
3. N.k.Bairagi, Shell analysis, Khanna Publishers, Delhi, 1990.

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Reference Books:

1. Billington, Ithin shell concrete structures, Mc Graw Hill Book company, New york, St. Louis, Sand Francisco, Toronto, London.
2. ASCE Manual of Engineering practice No.31, design of cylindrical concrete shell roofs ASC, Newyork
3. Theory of Plates & Shells –Stephen, P.Timoshenko, S.Woinowsky-Krieger – Tata MC Graw Hill Edition
4. Analysis and design of concrete shell roofs by G.S.Ramaswami. CBS publications.
5. Shell Analysis by N.K.Bairagi. Khanna Publishers, New Delhi.

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R21 COURSE STRUCTURE & SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF CIVIL ENGINEERING
(STRUCTURAL ENGINEERING)

Course Code	21D11206	STABILITY OF STRUCTURES	L	T	P	C
Semester	II	(PE-IV)	3	0	0	3

Course Objectives: This Course Will Enable Students:

1. Determine stability of columns and frames
2. Determine stability of beams and plates
3. Use stability criteria and concepts for analyzing discrete and continuous systems,
4. To form differential equations for plate buckling

Course Outcomes (CO): Student will be able to

1. Apply the torisonal buckling and plates for buckling concept
2. Apply the inelastic behaviour of materials and analyse the inelastic character of column
3. Analyse the frame structures
4. Analyse the plate structures

UNIT - I — **Lecture Hrs:10**

Formulations Related To Beam Columns : Concept of Stability, Differential Equation for Beam Columns –Beam Column With Concentrated Loads –Continuous Lateral Load – Couples -Beam Column With Built in Ends –Continuous Beams With Axial Load – Application of Trignometric Series –Determination of Allowable Stresses.

UNIT - II — **Lecture Hrs:10**

Elastic Buckling of Bars: Elastic Buckling of Straight Columns –Effect of Shear Stress on Buckling-Eccentrically and Laterally Loaded Columns –Energy Methods –Buckling of A Bar on Elastic Foundation, Buckling of A Bar With Intermediate Compressive Forces and Distributed Axial Loads –Buckling of Bars With Change in Cross Section –Effect of Shear Force on Critical Load –Built Up Columns

UNIT - III — **Lecture Hrs:10**

Inelastic Buckling and Torsional Buckling : Buckling of Straight Bars-Double Modulus Theory –Tangent Modulus Theory. Pure Torsion of Thin Walled Bar of Open Cross Section-Non –Uniform Torsion of Thin Walled Bars of Open Cross Section-Torsional Buckling – Buckling Under Torsion and Flexure.

UNIT - IV — **Lecture Hrs:9**

Mathematical Treatment of Stability Problems: Buckling Problem Orthogonality Relation –Ritz Method-Timoshenko Method, Galerkin Method

UNIT - V — **Lecture Hrs:9**

Lateral Buckling of Simply Supported Beams and Rectangular Plates: Beams of Rectangular Cross Section Subjected for Pure Bending. Derivation of Equation of Rectangular Plate Subjected To Constant Compression in Two Directions and One Direction.

Textbooks:

1. Stability of Metalic Structure by Bleich –Mc Graw Hill
2. Theory of Beam Columns Vol I by Chen & Atsuta Mc.Graw Hill
3. Theory of Elastic Stability, Timoshenko, S., and Gere., Mc Graw Hill Book Company, 1973.

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Reference Books:

1. Elastic Stability of Structures, Smitses, Prentice Hall,1973.
2. Buckling of Bars Plates and Shells, Brush and Almorth., Mc Graw Hill Book Company ,1975.
3. Principles of Structural Stability Theory, Chajes, A., Prentice Hall,1974
4. Stability Theory of Structures, Ashwini Kumar, TATA Mc Graw Hill Publishing Company Ltd, New Delhi, 1985.

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R21 COURSE STRUCTURE & SYLLABUS FOR M.TECH COURSES
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(STRUCTURAL ENGINEERING)

Course Code	21D11207	ADVANCED STEEL DESIGN	L	T	P	C
Semester	II	(PE-IV)	3	0	0	3

Course Objectives: This Course Will Enable Students:

1. To introduce structural steel fasteners like welding and bolting
2. To introduce steel structures and its basic components like eccentric and moment connections
3. To introduce the structural steel components of industrial building.
4. To introduce tension members, compression members, beams and beam-columns
5. To introduce the fundamental of steel structures and calculate the plastic moment of different cross-sections

Course Outcomes (CO): Student will be able to

1. Learn the fundamentals of structural steel fasteners
2. Learn the basic elements of a steel structure
3. Classify and design the structural steel components of industrial building.
4. Able to design tension members, compression members, beams and beam-columns
5. Explain the fundamental of steel structures and calculate the plastic moment of different cross-sections.

UNIT - I **Lecture Hrs:10**

SIMPLE CONNECTIONS – RIVETED, BOLTED PINNED AND WELDED CONNECTIONS : Riveted Connections – Bolted Connections –Load Transfer Mechanism – Failure of Bolted Joints – Specifications for Bolted Joints – Bearing – Type Connections – Tensile Strength of Plate – Strength and Efficiency of the Joint – Combined Shear and Tension – Slip-Critical connections – Prying Action – Combined Shear and Tension for Slip-Critical Connections. Design of Groove Welds - Design of Fillet Welds – Design of Intermittent Fillet Welds – Failure of Welds.

UNIT - II **Lecture Hrs:10**

ECCENTRIC AND MOMENT CONNECTIONS : Introduction – Beams – Column Connections – Connections Subjected to Eccentric Shear – Bolted Framed Connections – Bolted Seat Connections – Bolted Bracket Connections. Bolted Moment Connections – Welded Framed Connections- Welded Bracket Connections – Moment Resistant Connections.

UNIT - III **Lecture Hrs:10**

ANALYSIS AND DESIGN OF INDUSTRIAL BUILDINGS:
Dead loads, live loads and wind loads on roofs. Design wind speed and pressure, wind pressure on roofs; wind effect on cladding and louvers; Design of angular roof truss, tubular truss, truss for a railway platform. Design of purlins for roofs, design of built up purlins, and design of knee braced trusses and stanchions. Design of bracings.

UNIT - IV **Lecture Hrs:9**

Design of steel truss girder bridges:
Types of truss bridges, component parts of a truss bridge, economic Proportions of trusses, self-weight of truss girders, design of bridge Compression members, tension members; wind load on truss girder Bridges; wind effect on top lateral bracing; bottom lateral bracing; portal Bracing; sway bracing Design of Lacing.

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UNIT - V		**Lecture Hrs:9**

Plastic Analysis and Design :

Introduction – Plastic Theory – Plastic neutral Axis plastic moment, Elastic & Plastic Section modulii shape factors plastic Hinge – Fundamental condition conditions in plastic analysis, methods of plastic analysis – collapse load – simply supported, propped cantilever beam, fixed beams continuous beams, portal frame single bay single storey portal frame at different level subjected to vertical and horizontal loads, Method of instantaneous center gable frame – Trial and effort method – plastic moment distribution method – continuous beam, two bay-single story portal frame – Deflections and ultimate load propped cantilever beam fixed beam minimum weight design continuous beams and single bay-single storey portal frame.

Textbooks:

1. Plastic Analysis of Structures by B.G.Neal
2. Steel Skeleton V.I and II by Baker
3. Design of Steel Structures by Vazarani and Ratwani

Reference Books:

1. Strength of Materials (Vol-II)) by Timoshenko.
2. Analysis of Steel Structure by Manohar.
3. Analysis of Steel Structure by Pinfold
4. Analysis of Steel Structure by Arya & Azmani
5. Analysis of Steel Structure by Relevant IS Codes.
6. Analysis of Steel Structure by Punmia, B.C.

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R21 COURSE STRUCTURE & SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF CIVIL ENGINEERING
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Course Code	21D11208	FRACTURE MECHANICS	L	T	P	C
Semester	II	(PE-IV)	3	0	0	3

Course Objectives: This Course Will Enable Students:

1. To design based on linear elastic fracture mechanics
2. To find out the variation of plastic zone over thickness of various elements
3. To know about the plane strain and plane stress in slip planes
4. To understand the fracture process of concrete and different materials

Course Outcomes (CO): Student will be able to

1. Acquire basic skills in fracture mechanism of brittle materials
2. Apply fracture mechanics theory to calculate stress areas
3. Calculate the "energy release rate" around crack tips
4. Examine crack growth due to fatigue

UNIT - I **Lecture Hrs:10**

Summary of Basic Problems and Concepts:
Introduction - A Crack in A Structure - The Stress At A Crack Tip - The Griffith Criterion The Crack Opening Displacement Criterion - Crack Propagation - Closure

UNIT - II **Lecture Hrs:10**

The Elastic Crack – Tip Stress Field :
The Airy Stress Function - Complex Stress Functions - Solution To Crack Problems - The Effect of Finite Size - Special Cases - Elliptical Cracks - Some Useful Expressions

UNIT - III **Lecture Hrs:10**

The Crack Tip Plastic Zone:
The Irwin Plastic Zone Correction - The Dugdale Approach - The Shape of The Plastic Zone - Plane Stress Versus Plane Strain - Plastic Constraint Factor - The Thickness Effect

UNIT - IV **Lecture Hrs:9**

The Energy Principle: The Energy Release Rate - The Criterion for Crack Growth - The Crack Resistance (R Curve) - Compliance , The J Integral (Definitions Only)
Plane Strain Fracture Toughness: The Standard Test - Size Requirements - Non-Linearity – Applicability
Plane Stress and Transitional Behaviour: Introduction - An Engineering Concept of Plane Stress - The R Curve Concept

UNIT - V **Lecture Hrs:9**

The Crack Opening Displacement Criterion:
Fracture Beyond General Yield - The Crack Tip Opening Displacement - The Possible Use of The CTOD Criterion
Determination of Stress Intensity Factors:
Introduction - Analytical and Numerical Methods - Finite Element Methods, Experimental Methods (An Ariel Views Only)

Textbooks:

1. Elementary Engineering Fracture Mechanics-David Broek, Battelle, Columbus Laboratories, Columbus, Ohieo, USA
2. Fracture and Fatigue Control in Structures-John M.Barsom, Stanley T.Rolfe, Ross H.Forney
3. Rock and other Quasi-brittle materials - Surender P Shah, Stuart E Swartz,Wiley 1995.

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Reference Books:

1. Analysis of Concrete Structures by fracture mechanics, Elfgren L, Routledge,1990
2. Fracture Mechanics- Applications to concrete, Victor C.Li and Z P Bazant , ACI SP118
3. Fracture Mechanics , CT Suri and Zh jin , Elsevier Academic Press,2012

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R21 COURSE STRUCTURE & SYLLABUS FOR M.TECH COURSES
Audit Subjects for All Specializations

Course Code		DISASTER MANAGEMENT	L	T	P	C
Semester	II		2	0	0	0

Course Objectives: Students will be able to:

1. Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
2. Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
4. Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in

Course Outcomes (CO): Student will be able to

UNIT - I	Introduction	Lecture Hrs: 04

Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.

UNIT – II	Repercussions Of Disasters And Hazards	Lecture Hrs: 04

Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT – III	Disaster Prone Areas In India	Lecture Hrs: 04

Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics.

UNIT – IV	Disaster Preparedness And Management Preparedness:	Lecture Hrs: 04

Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.

UNIT – V	Risk Assessment Disaster Risk:	Lecture Hrs: 04

Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival.

UNIT – VI		Lecture Hrs: 04

Disaster Mitigation Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.

Suggested Readings::

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.
2. Sahni, Pardeep, et.al. (Eds.), "Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.
3. Goel S. L. Disaster Administration and Management Text And Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi.

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R21 COURSE STRUCTURE & SYLLABUS FOR M.TECH COURSES
Audit Subjects for All Specializations

Course Code		CONSTITUTION OF INDIA	L	T	P	C
Semester	II		2	0	0	0

Course Objectives: Students will be able to:

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

Course Outcomes (CO): Student will be able to

1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party (CSP) under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
4. Discuss the passage of the Hindu Code Bill of 1956.

UNIT - I **Lecture Hrs: 04**

History of Making of the Indian Constitution: History Drafting Committee, (Composition & Working); Philosophy of the Indian Constitution: Preamble Salient Features

UNIT – II **Lecture Hrs: 04**

Contours of Constitutional Rights & Duties: Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties

UNIT – III **Lecture Hrs: 04**

Organs of Governance, Parliament Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT – IV **Lecture Hrs: 04**

Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: ZilaPachayat. Elected officials and their roles, CEO ZilaPachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT – V **Lecture Hrs: 04**

Election Commission: Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

Suggested Readings::

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

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R21 COURSE STRUCTURE & SYLLABUS FOR M.TECH COURSES
Audit Subjects for All Specializations

Course Code		STRESS MANAGEMENT BY YOGA	L	T	P	C
Semester	II		2	0	0	0

Course Objectives: Students will be able to:

1. To achieve overall health of body and mind
2. To overcome stress

Course Outcomes (CO): Student will be able to

1. Develop healthy mind in a healthy body thus improving social health also
2. Improve efficiency

UNIT - I		Lecture Hrs: 04
Definitions of Eight parts of yog. (Ashtanga)		
UNIT – II		**Lecture Hrs: 04**
Yam and Niyam: Do`s and Don'ts in life, Ahinsa, satya, astheya, bramhacharya and aparigraha		
UNIT – III		**Lecture Hrs: 04**
Yam and Niyam: Do`s and Don'ts in life, Shaucha, santosh, tapa, swadhyay, ishwarpranidhan		
UNIT – IV		**Lecture Hrs: 04**
Asan and Pranayam: Various yog poses and their benefits for mind & body		
UNIT – V		**Lecture Hrs: 04**
Asan and Pranayam: Regularization of breathing techniques and its effects-Types of pranayam		

Suggested Readings::

1. 'Yogic Asanas for Group Training-Part-I" : Janardan Swami Yogabhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

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DEPARTMENT OF CIVIL ENGINEERING
(STRUCTURAL ENGINEERING)

Course Code	21D11213	ADVANCED CONCRETE LABORATORY–II	L	T	P	C
Semester	II		0	0	4	2

Course Objectives:

1. To study the mix design
2. To do Strength and Split Tensile Strength Properties of High Strength Concrete (M60).
3. Familiar with the Self Compacting Concrete.
4. Knowledge about advance tests on concrete

Course Outcomes (CO):

1. the mix design
2. Strength and Split Tensile Strength Properties of High Strength Concrete (M60).
3. The Self Compacting Concrete.
4. TO gain Knowledge about advance tests on concrete

List of Experiments:

1. Mix design and Fresh Properties of High Strength Concrete (M60).
2. Compression Strength and Split Tensile Strength Properties of High Strength Concrete (M60).
3. Flexural Strength Properties of High Strength Concrete (M60).
4. Mix Design and L – Box Test on Self Compacting Concrete.
5. Mix Design and U – Box Test on Self Compacting Concrete
6. Mix Design and V Funnel Test on Self Compacting Concrete
7. Compression Strength and Split Tensile Strength Properties of Self Compacting Concrete.
8. Flexural Strength Properties of Self Compacting Concrete.
9. Mix Design and Fresh Properties of Light Weight Concrete.
10. Compression Strength and Split Tensile Strength Properties of Light Weight Concrete.
11. Flexural Strength Properties of Light Weight Concrete.
12. Permeability Test on Hardened Concrete.
13. Impact Testing on Hardened Concrete Specimen.
14. Compression test on RCC Columns

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DEPARTMENT OF CIVIL ENGINEERING
(STRUCTURAL ENGINEERING)

Course Code	21D11214	COMPUTER AIDED DESIGN LABORATORY – II	L	T	P	C
Semester	II		0	0	4	2

Course Objectives: The students will acquire knowledge about

1. Demonstrate the design of truss bridge.
2. Demonstrate RC multi-storey buildingfor gravity and windloads
3. Explain analysis of a building for various loading.
4. Demonstrate the method of analysis of water tank.

Course Outcomes (CO): At the end of the course, students will be able to:

1. Analyze and design of truss bridge
2. Analyze and design RC multi-storey buildingfor gravity and windloads
3. Analyze for earthquake loading & wind loading of framed buildings.
4. Analyze and design of water tank, bearing structures, Bridge Girder

List of Experiments:

1. Analysis and design of truss bridge
2. Analysis of Pre-engineered building
3. Analysis and design of RC multi-storey buildingfor gravity and windloads.
4. Analysis and design of RC multi-storey buildingfor gravity and seismicloads
5. Analysis and design of RC multi-storey framed building with shear wall for lateral load
6. Analysis and designof flatslabsystem for multistorey building
7. Analysis and DesignofGantrygirdersforindustrialstructures
8. Analysis of Bridge for various Loads
9. Design of Bridge Girder Structure
10. Design of Bridge Pier Section
11. Analysis and design of Bearings
12. Analysis and design of RC elevated water tank

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R21 COURSE STRUCTURE & SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF CIVIL ENGINEERING
(STRUCTURAL ENGINEERING)

Course Code	21D11301	EARTHQUAKE RESISTANT DESIGN OF BUILDINGS	L	T	P	C
Semester	III	(PE – V)	3	0	0	3

Course Objectives: This Course Will Enable Students:

1. To understand effects of earthquakes on engineering structures and its measurement
2. To apply dynamics loadson various structures
3. To design buildings for earthquake loads as per IS Codes
4. To understand and implement the concept of ductility in Earthquake Resistant Design

Course Outcomes (CO): Student will be able to

1. Illustrate the measurement of earthquakes and their effect on engineering structures
2. Analyse the free and forced vibration response of single degree and multi degree of freedom and continuous systems
3. Apply the basic principles of conceptual design of Earthquake Resistant buildings
4. Learn the various seismic control methods

UNIT - I **Lecture Hrs:10**

Engineering Seismology :
Earthquake – Causes of Earthquake – Earthquakes and Seismic Waves – Scale and Intensity of Earthquakes – Seismic Activity – Measurements of Earth Quakes – Seismometer- Strong Motion Accelerograph / Field Observation of Ground Motion – Analysis of Earthquakes Waves – Earth Quake Motion – Amplification of Characteristics of Surface Layers – Earthquake Motion on The Ground Surface

UNIT - II **Lecture Hrs:10**

Vibration of Structures Under Ground Motion:
Elastic Vibration of Simple Structures – Modelling of Structures and Equations of Motion – Free vibrations of Simple Structures – Steady State Forced Vibrations – Non Steady State Forced Vibrations – Response Spectrum Representations; Relation Between The Nature of The Ground Motion and Structural Damage.

UNIT - III **Lecture Hrs:10**

Lateral Force Procedure Seismic Base Shear – Seismic Design Co-Efficient - Vertical Distribution of Seismic Forces and Horizontal Shear – Twisting Moment - Over Turning Moment – Vertical Seismic Load and Orthogonal Effects Lateral Deflection – P- Δ Characteristics Effect – Soil Structure Interaction. Seismic – Graphs Study, Earthquake Records for Design – Factors Affecting Accelerogram Characteristics - Artificial Accelerogram – Zoning Map. Dynamic – Analysis Procedure: Model Analysis – Inelastic – Time History Analysis Evaluation of the Results.

UNIT - IV **Lecture Hrs:9**

Earthquake – Resistant Design of Structural Components and Systems:
Introduction – Monolithic Reinforced – Concrete Structures – Precast Concrete Structures – Prestressed Concrete Structures – Steel Structures – Composite – Structures, Masonry Structures – Timber Structures.

UNIT - V **Lecture Hrs:9**

Fundamentals of Seismic Planning: Selection of Materials and Types of Construction Form of Superstructure – Framing Systems and Seismic Units – Devices for Reducing. Earthquake Loads,

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Textbooks:
1. Design of Earthquake Resistant Structures by Minoru Wakabayashi. 2. Strucutural Dynamics for Earthquake Engineering", A.K.Chopra,Pearson Pubilications. 3. Dynamics of Structures. R.W.Clough, Mc Graw – Hill, 2nd Edition,
Reference Books:
1. Fundamentals of Earthquake Engineering,N.M Newmark and E.Rosenblueth, Prentice Hall,1971. 2. Earthquake Design Practice for Buildings. David Key," Thomas Telford,London,1988 3. Earthquake Engg; R.L. Wegel, Prentice Hall 12nd Edition 1989. 4. Design of Multi –Storied Buildings for Earthquake Ground Motions J.A. Blume, N.M. Newmark, L.H. Corning.,', Portland Cement Association, Chicago,1961 5. I.S.Codes No. 1893,4326,13920. 6. Earthquake Resistant Design by Pankaj Agarwal.

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DEPARTMENT OF CIVIL ENGINEERING
(STRUCTURAL ENGINEERING)

Course Code	21D11302	COST EFFECTIVE HOUSING TECHNIQUES (PE – V)	L	T	P	C
Semester	III		3	0	0	3

Course Objectives: This course will enable students:

1. To possess comprehensive knowledge of planning, design, evaluation, construction and financing of housing projects.
2. To focuses on cost effective construction materials and methods.
3. To understand on the principles of sustainable housing policies and programmes.
4. to adopt the suitable techniques in rural and disaster prone areas by using locally available materials.

Course Outcomes (CO): Student will be able to

1 Development of construction technology and innovative techniques as tools to address demand mass construction
2 Knowledge of eco-friendly material with their application
3 Learn the use of locally available material according to their availability and maintenance

UNIT - I **Lecture Hrs:10**

Housing Scenario: Introduction - Status of Urban Housing - Status of Rural Housing

Housing Finance: Introducing - Existing Finance System in India - Government Role As Facilitator - Status At Rural Housing Finance - Impedimently in Housing Finance and Related Issues

Land Use and Physical Planning for Housing: Introduction - Planning of Urban Land - Urban Land Ceiling and Regulation Act - Efficiency of Building Bye Lass - Residential Densities

Housing The Urban Poor: Introduction - Living Conditions in Slums - Approaches and Strategies for Housing Urban Poor

UNIT - II **Lecture Hrs:10**

Development and Adoption of Low Cost Housing Technology

Introduction - Adoption of Innovative Cost Effective Construction Techniques - Adoption of Precast Elements in Partial Prefatroices - Adopting of Total Prefactcation of Mass Housing in India- General Remarks on Pre Cast Rooting/Flooring Systems -Economical Wall System - Single Brick Thick Loading Bearing Wall - 19cm Thick Load Bearing Masonery Walls - Half Brick Thick Load Bearing Wall - Flyash Grypsym Thick for Masonry - Stone Block Masonery - Adoption of Precast R.C. Plank and Join System for Roof/Floor in The Building

UNIT - III **Lecture Hrs:10**

Alternative Building Materials for Low Cost Housing

Introduction - Substitute for Scarce Materials – Ferrocement - Gypsum Boards - Timber Substitutions - Industrial Wastes - Agricultural Wastes - Fitire Starateru; for ,P,Topm of Alternative Building Maintenance

Low Cost Infrastructure Services:

Introduce - Present Status - Technological Options - Low Cost Sanitation - Domestic Wall - Water Supply, Energy.

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UNIT - IV		**Lecture Hrs:10**
Rural Housing: Introduction Traditional Practice of Rural Housing Continuous - Mud Housing Technology Mud Roofs - Characteristics of Mud - Fire Treatment for Thatch Roof - Soil Stabilization - Rural Housing Programs.		
UNIT - V		**Lecture Hrs:10**
Housing in Disaster Prone Areas: Introduction – Earthquake - Damages To Houses - Traditional Prone Areas - Type of Damages and Railways of Non-Engineered Buildings - Repair and Restore Action of Earthquake Damaged Non-Engineered Buildings Recommendations for Future Constructions. Requirement's of Structural Safety of Thin Precast Roofing Units Against Earthquake Forces, Status of R&D in Earthquake Strengthening Measures - Floods, Cyclone, Future Safety		
Textbooks:		
1. Building Materials for Low –Income Houses – International Council for Building Research Studies and Documentation. 2. Hand Book of Low Cost Housing by A.K.Lal – Newage International Publishers. 3. Modern Trends in Housing in Developing Countries – A.G. Madhava Rao, D.S. Ramachandra Murthy & G.Annamalai.		
Reference Books:		
1. Properties of Concrete – Neville A.M. Pitman Publishing Limited, London. 2. Light Weight Concrete, Academic Kiado, Rudhai.G – Publishing Home of Hungarian Academy of Sciences 1963. 3. Low Cost Housing – G.C. Mathur.		

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R21 COURSE STRUCTURE & SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF CIVIL ENGINEERING
(STRUCTURAL ENGINEERING)

Course Code	21D11303	BUILDING CONSTRUCTION MANAGEMENT	L	T	P	C
Semester	III	(PE- V)	3	0	0	3

Course Objectives: This Course Will Enable Students:

1. To create construction project cost estimates.
2. Analyze construction documents for planning and management of construction processes.
3. Understand the legal implications of contract, common, and regulatory law to manage a construction project.
4. Understand different methods of project delivery and the roles and responsibilities of all constituencies involved in the design and construction process.

Course Outcomes (CO): Student will be able to

1. Plan, coordinate and control of a project from beginning to completion.
2. Adopting the most effect method for meeting the requirement in order to produce a functionally and financially viable project.
3. Implement different methods of project delivery
4. Follow the legal provisions implied

UNIT - I **Lecture Hrs:10**

Introduction – Types Constructions Public and Private Contract Management – Scrutinizing Tenders and Acceptance of Tenders, Contracted, Changes and Terminating of Contract – Subcontracts Construction Organizations – Organizational Chart-Decentralization Payrolls and Records – Organization Chart of A Construction Company.

UNIT - II **Lecture Hrs:10**

Construction Practices – Times Management – Bar Chart, CPM, PERT – Progress Report

UNIT - III **Lecture Hrs:**

Resources Management and Inventor- Basic Concepts Equipment Management, Material Management Inventory Control.

UNIT - IV **Lecture Hrs:9**

Accounts Management – Basic Concepts, Accounting System and Book Keeping, Depreciation, Balance Sheet, Profit and Loss Account, Internal Auditing. Quality Control by Statistical Methods, Sampling Plan and Control Charts, Safety Requirements.

UNIT - V **Lecture Hrs:9**

Cost and Financial Management – Cost Volume Relationship, Cost Control System, Budget Concept of Valuation, Cost of Equity Capital Management Cash. Labor and Industrial; Laws – Payment of Wages Act. Contract Labor, Workmen's Compensation, Insurance, Industrial Disputes Act.

Textbooks:

1. Construction Project Management by Jha ,Pearson Pubilications,New Delhi.
2. Construction Technology by Subir K.Sarkar and Subhajit Saraswati – Oxford Higher Education- Univ.Press, Delhi.

Reference Books:

1. Project Planning and Control With PERT and CPM by Dr.B.C.Punmia, K.K.Khandelwal, Lakshmi Publications New Delhi.

2. Optimal Design of Water Distribution Networks P.R.Bhave, Narosa Publishing House 2003.
3. Total Project Management, The Indian Context- by : P.K.JOY- Mac Millan Publishers India Limited.

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DEPARTMENT OF CIVIL ENGINEERING
(STRUCTURAL ENGINEERING)

Course Code	21D10301	GREEN BUILDINGS (OPEN ELECTIVE)	L	T	P	C
Semester	III		3	0	0	3

Course Objectives: This Course Will Enable Students:

1. Exposure to the green building technologies and their significance.
2. Understand the judicial use of energy and its management.
3. Educate about the Sun-earth relationship and its effect on climate
4. Enhance awareness of end-use energy requirements in the society
5. Develop suitable technologies for energy management

Course Outcomes (CO): Student will be able to

1. Understand the fundamentals of energy use and energy processes in building
2. Identify the energy requirement and its management.
3. Know the Sun-earth relationship vis-a-vis its effect on climate.
4. Be acquainted with the end-use energy requirements.
5. Be familiar with the audit procedures of energy.

UNIT - I **Lecture Hrs: 10**

Introduction What is Green Building, Why to go for Green Building, Benefits of Green Buildings, Green Building Materials and Equipment in India, What are key Requisites for Constructing a Green Building, Important Sustainable features for Green Building,

UNIT - II **Lecture Hrs: 10**

Green Building Concepts And Practices Indian Green Building Council, Green Building Moment in India, Benefits Experienced in Green Buildings, Launch of Green Building Rating Systems, Residential Sector, Market Transformation; Green Building Opportunities And Benefits: Opportunities of Green Building, Green Building Features, Material and Resources, Water Efficiency, Optimum Energy Efficiency, Typical Energy Saving Approach in Buildings, LEED India Rating System and Energy Efficiency,

UNIT - III **Lecture Hrs:**

Green Building Design Introduction, Reduction in Energy Demand, Onsite Sources and Sinks, Maximize System Efficiency, Steps to Reduce Energy Demand and Use Onsite Sources and Sinks, Use of Renewable Energy Sources. Eco-friendly captive power generation for factory, Building requirement,

UNIT - IV **Lecture Hrs: 9**

Air Conditioning Introduction, CII Godrej Green business centre, Design philosophy, Design interventions, Energy modeling, HVAC System design, Chiller selection, pump selection, Selection of cooling towers, Selection of air handing units, Precooling of fresh air, Interior lighting system, Key feature of the building. Eco-friendly captive power generation for factory, Building requirement. Envelope design basics, ECBC compliant design strategy for a building, Compliance approaches viz. Prescriptive, Whole building Performance and Trade off approaches. Introduction to Eco Nivas Samhitha (ENS) and software tool for checking building energy, carbon, lighting and comfort performance.

UNIT - V **Lecture Hrs: 9**

Material Conservation Handling of non-process waste, waste reduction during construction, materials with recycled content, local materials, material reuse, certified wood ,Rapidly

renewable building materials and furniture; Indoor Environment Quality And Occupational Health: Air conditioning, Indore air quality, Sick building syndrome, Tobacco smoke control, Minimum fresh air requirements avoid use of asbestos in the building, improved fresh air ventilation, Measure of IAQ, Reasons for poor IAQ, Measures to achieve Acceptable IAQ levels,
Textbooks:
1. Handbook on Green Practices published by Indian Society of Heating Refrigerating and Air conditioning Engineers, 2009. 2. Green Building Hand Book by Tomwoolley and Samkimings, 2009. 3. Complete Guide to Green Buildings by Trish riley
Reference Books:
1. Standard for the design for High Performance Green Buildings by Kent Peterson, 2009 2. Energy Conservation Building Code –ECBC-2020, published by BEE 3. "Eco Niwas Samhita -2021 " published by BEE