UNIVERSITY COLLEGE OF ENGINEERING, KAKINADA (AUTONOMOUS)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

Board of Studies (Soil Mechanics and Foundation Engineering)
Meeting: 08th September 2016 (R16).

I - Semester

S.No.		II B. Tech. I Semester				
	Code	Subject	L	T	P/D	C
1	MSEI-1	Advanced Mathematics	3	1	--	3
2	MSEI-2	Theory of Elasticity	3	1	--	3
3	MSEI-3	Matrix Analysis of Structures	3	1	--	3
4	MSEI-4	Structural Dynamics	3	1	--	3
5		Elective –I	4	--	--	3
	MSEI-5	a) Experimental Stress Analysis				
	MSEI-6	b) Sub-Structure Design.				
	MSEI-7	c) Structural Optimization				
	MSEI-8	d) Port and Harbour Structures				
6		Elective – II	4	--	--	3
	MSEI-9	a) Repair and Rehabilitation of Structures				
	MSEI-10	b) Analysis and Design of Tall Buildings				
	MSEI-11	c) Plastic Analysis and Design				
	MSEI-12	d) Advanced Reinforced Concrete Design				
7	MSEP-1	Advanced Structural Engineering Laboratory	--	--	3	2
		Total Credits				20

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II - Semester

S.No.		II B. Tech. I Semester				
	Code	Subject	L	T	P/D	C
1	MSEII-1	Finite Element Method	3	1	--	3
2	MSEII-2	Earthquake Resistant Design	3	1	--	3
3	MSEII-3	Stability of Structures	3	1	--	3
4	MSEII-4	Theory of Plates & Shells	4	--	--	3
5		Elective - III	4	--	--	3
	MSEII-5	a) Pre-stressed Concrete				
	MSEII-6	b) Mechanics of Composite Materials				
	MSEII-7	c) Fracture Mechanics				
	MSEII-8	d) Analysis of Offshore Structures				
6		Elective – IV	4	--	--	3
	MSEII-9	a) Industrial Structures				
	MSEII-10	b) Bridge Engineering				
	MSEII-11	c) Earth Retaining Structures				
	MSEII-12	d) Inelastic Design of Slabs				
7	MSEP-2	CAD Laboratory	--	--	4	2
		Total Credits				20

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III - Semester

S.No.		II B. Tech. I Semester				
	Code	Subject	L	T	P/D	C
1	MSES-1	Seminar	--	--	--	2
2	MSED-1	Design Project	--	--	--	2
3	MSEPR1	Dissertation / Thesis	--	--	--	16
		Total Credits				20

IV - Semester

S.No.		II B. Tech. I Semester				
	Code	Subject	L	T	P/D	C
1	MSES-2	Seminar	--	--	--	2
2	MSED -2	Design Project	--	--	--	2
3	MSEPR2	Dissertation / Thesis	--	--	--	16
		Total Credits				20

Program Outcome

PO1	Able to solve mathematical/numerical problem
PO2	Able to analyze trusses, beams, frames
PO3	Estimation of forces, analysis of multi degree of freedom systems using mathematical approaches such as static quasi static and dynamic methods.
PO4	Design of Structures to contribute in the development of the society
PO5	Application of experimental techniques on structural evaluation
PO6	Able to analyze and design of structure under different types of loads
PO7	Optimization of structures and presentation of the project done with ethics

MSEI -1 - Advanced Mathematics

Common for M.Tech.

(Structural Engineering, Soil Mechanics & Foundation Engineering and Geotechnical Engineering)

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to

CO1	One-dimensional Heat equation Cartesian, cylindrical and spherical coordinates
CO2	Two-dimensional Laplace Equation in Cartesian, cylindrical and spherical coordinates and Analytical solution by separation of variables technique
CO3	Numerical solutions to Heat and Laplace Equations in Cartesian coordinates using finite – differences
CO4	Regression and correlation analysis – Method of Least squares, Curve fitting, Curvilinear Regression, Non-linear curves
CO5	Correlation of grouped bi-variate data, coefficient of determination Multiple Regression and partial Regression coefficients
CO6	Linear Programming Problems, Graphical Method, Simplex method, and Non Linear Programming Problem Gradient method, Steepest Ascent Descent Methods

Mapping of Course Outcomes with Progrom Outcomes:

Course Out Comes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	--	--	--	1	1	--
CO2	3	--	--	--	--	1	--
CO3	3	--	--	1	--	1	--
CO4	3	--	--	--	--	--	--
CO5	3	--	--	--	--	--	--
CO6	3	--	--	1	--	1	3

1. **Slightly 2. Moderately 3. Substancially**

Detailed Syllabus:

UNIT-I

Applied partial Differential Equations: One-dimensional Heat equation Cartesian, cylindrical and spherical coordinates (problems having axi-symmetry). Two-dimensional Laplace Equation in Cartesian, cylindrical and spherical coordinates (problems having axi-symmetry) – Analytical solution by separation of variables technique.

UNIT-II

Numerical solutions to Heat and Laplace Equations in Cartesian coordinates using finite – differences. Implicit methods, Crank Nicholsen Method, Jacobi Method, Guass Seidal method.

UNIT-III

Applied Statistics: Regression and correlation analysis – Method of Least squares – Curve fitting – Curvilinear Regression – Non-linear curves – correlation coefficient – Correlation of grouped bi-variate data – coefficient of determination Multiple Regression – partial Regression coefficients.

UNIT-IV

Tests of significance – Analysis of variance for regression – Multiple correlation coefficients – Multiple linear regression with two independent variables.

UNIT-V

Linear Programming Problem Formation, Graphical Method, Simplex method, artificial variable method-Big-M method-Two Phase Method. Non Linear Programming Problem Gradient method, Steepest Ascent Descent Methods.

TEXT BOOKS

1. Solutions of Partial Differential Equations" – Duffy, D.G. CBS Publishers, 1988
2. Introductory Methods of Numerical Analysis – Sastry, S.S. Prentice-Hall, 2nd Edition, 1992
3. Basic Statistics – Agarval, B.L., Wiley 1991, 2nd edition.
4. Operations Research – Hamdy A, Taha.
5. Optimization Techniques.- S.S.Rao

MSEI-2 – **Theory of Elasticity**

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to

CO1	Know the definition of stress and deformation and how to determine the components of the stress and strain tensors.
CO2	Apply the conditions of compatibility and equations of equilibrium.
CO3	Understand how to express the mechanical characteristics of materials, constitutive equations and generalized Hook law.
CO4	Use the equilibrium equations stated by the displacements and compatibility conditions stated by stresses
CO5	Understand index notation of equations, tensor and matrix notation and define state of plane stress, state of plane strain
CO6	Be able to analyze real problem and to formulate the conditions of theory of elasticity applications
CO7	Determine the boundary restrictions in calculations. Solve the basic problems of the theory of elasticity by using Airy function expressed as bi-harmonic function

Mapping of Course Outcomes with Progrom Outcomes:

Course Out Comes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	2	1	2	1	--	2	1
CO2	2	1	3	1	--	2	1
CO3	2	1	3	1	--	2	1
CO4	2	1	3	1	--	2	1
CO5	2	1	--	1	--	2	1
CO6	2	1	2	1	--	2	1
CO7	2	1	--	1	--	2	1

1. **Slightly 2. Moderately 3. Substancially**

Detailed Syllabus:

Unit: 1

Elasticity – Notation for forces and stresses – components of stresses and strains – Hooke's Law - Plane Stress – Plane strain – Differential Equations of equilibrium – Boundary conditions – Compatibility equations - Stress function – Boundary Conditions.

Unit: 2

Two dimensional problems in rectangular co-ordinates – Solution by polynomials – Saint Venant's principle – Determination of displacements – Bending of simple beams – Application of Fourier series for two dimensional problems for gravity loading

Unit: 3

Two dimensional problems in polar co-ordinates - General equations in polar co-ordinates – Stress distribution for problems having symmetrical about an axis - Strain components in polar co-ordinates – Displacements for symmetrical stress distributions - Stresses for plates with circular holes subjected to far field tension – stress concentration factor.

Unit: 4

Analysis of stress and strain in three dimension - Principal stresses – Stress ellipsoid and stress director surface – Determination of principal stresses - Maximum shear stress – Homogeneous Deformation – General Theorems - Differential equations of equilibrium – Conditions of compatibility – Equations of equilibrium in terms of displacements – Principle of superposition – Uniqueness of solution –Reciprocal theorem..

Unit: 5

Torsion of Prismatical bars – Bars with elliptical cross section – Other elementary solution – Membrane analogy – Torsion of rectangular bars – Solution of torsional problems by energy method.

REFERENCES

1. Theory of Elasticity- Timoshenko & Goodier
2. Elasticity: Theory, Applications and Numeric- Martin H. Sadd

MSEI-3 – **Matrix Analysis of Structures**

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to

CO1	Perform the structural analysis of determinate and indeterminate structures using classical compatibility methods, such as method of consistent displacements, force and equilibrium methods
CO2	Perform structural analysis using the stiffness method.
CO3	Solve multiple degree of freedom two and three dimensional problems involving trusses, beams, frames and plane stress
CO4	Understand basic finite element analysis

Mapping of Course Outcomes with Progrom Outcomes:

Course Out Comes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	--	3	2	1	--	1	1
CO2	--	3	2	1	--	1	1
CO3	1	3	2	1	--	1	1
CO4	--	3	2	1	--	1	1

1. Slightly 2. Moderately 3. Substancially

Detailed Syllabus:

Unit: 1

Introduction of matrix methods of analysis – Static and kinematic indeterminacy – Degree of freedom – Structure idealization-stiffness and flexibility methods – Suitability: Element stiffness matrix for truss element, beam element and Torsional element- Element force - displacement equations.

Unit: 2

Stiffness method – Element and global stiffness equation – coordinate transformation and global assembly – structure stiffness matrix equation – analysis of simple pin jointed trusses – continuous beams – rigid jointed plane frames

Unit: 3

Stiffness method for Grid elements – development of stiffness matrix – coordinate transformation. Examples of grid problems – tapered and curved beams

Unit: 4

Additional topics in stiffness methods – discussion of band width – semi band width – static condensation – sub structuring –Loads between joints-Support displacements- inertial and thermal stresses-Beams on elastic foundation by stiffness method.

Unit: 5

Space trusses and frames - Member stiffness for space truss and space frame– Transformation matrix from Local to Global – Analysis of simple trusses, beams and frames

REFERENCES

1. Matrix analysis of structures- Robert E Sennet- Prentice Hall-Englewood cliffs-New Jercy
2. Advanced structural analysis-Dr. P. Dayaratnam- Tata McGraw hill publishing company limited.
3. Indeterminate Structural analysis- C K Wang
4. Analysis of tall buildings by force – displacement – Method M. Smolira Mc. Graw Hill.
5. Foundation Analysis and design – J.E. Bowls.

MSEI-4 – Structural Dynamics

Pre-Requisites: Soil Mechanics

Course Outcomes: At the end of the course, the student will be able to

CO1	Understand the response of structural systems to dynamic loads
CO2	Realize the behavior and response of linear and nonlinear SDOF and MDOF structures with various dynamic loading
CO3	Understand the behavior and response of MDOF structures with various dynamic loading.
CO4	Possess the ability to find out suitable solution for continuous system
CO5	Understand the behavior of structures subjected to dynamic loads such as free vibration, Harmonic excitation and earthquake load
CO6	

Mapping of Course Outcomes with Progrom Outcomes:

Course Out Comes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	--	--	3	1	--	1	1
CO2	--	--	3	1	--	1	1
CO3	--	--	3	1	--	1	1
CO4	--	--	3	1	--	1	1
C05	1	--	3	1	--	1	1

1. Slightly 2. Moderately 3. Substancially

Detailed Syllabus:

Unit: 1

Introduction to Structural Dynamics: Fundamental objective of Dynamic analysis – Types of prescribed loadings – methods of Discretization – Formulation of the Equations of Motion.

Unit: 2

Theory of Vibrations: Introduction – Elements of a Vibratory system – Degrees of Freedom of continuous systems - Oscillatory motion – Simple Harmonic Motion – 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 – Band width.

Unit: 3

Single Degree of Freedom System: Formulation and Solution of the equation of Motion – Free vibration response – Response to Harmonic, Periodic, Impulsive and general dynamic loadings – Duhamel integral.

Unit: 4

Multi Degree of Freedom System: Selection of the Degrees 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.

Unit: 5

Continuous Systems: Introduction – Flexural vibrations of beams – Elementary case – Equation of motion – Analysis of undamped free vibration of beams in flexure – Natural frequencies and mode shapes of simple beams with different end conditions.

REFERENCE:

1. Dynamics of Structures by Clough & Penzien.
2. Structural Dynamics A K Chopra

MSEI-5 – EXPERIMENTAL STRESS ANALYSIS

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to

CO1	Understand the fundamentals of the theory of elasticity
CO2	Implement the principles and techniques of photo elastic measurement
CO3	Obtain the principles and techniques of strain gage measurement
CO4	Adopt the principles and techniques of moiré analysis
CO5	Apply the principles and techniques of holographic interferometer
CO6	Apply the principles and techniques of brittle coating analysis Understand the fundamentals of the theory of elasticity

Mapping of Course Outcomes with Progrom Outcomes:

Course Out Comes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	--	1	1	1	2	1	1
CO2	--	--	1	--	2	--	--
CO3	--	--	1	--	3	--	--
CO4	1	--	--	--	3	--	--
CO5	--	--	--	--	3	--	--
CO6	--	--	1	1	3	1	1

1. Slightly 2. Moderately 3. Substancially

Detailed Syllabus:

UNIT-I

Introduction and Strain measurement methods – Model & Prototype – Dimensional analysis-Factors influencing model design – Scale factors and Model material properties – Methods of model design. Definition of strain and its relation to experimental determinations - properties of strain gauge systems – Mechanical, Optical, Acoustic and Pneumatic types

UNIT-II

Electrical resistance strain gages: Introduction – gauge construction – strain gauge adhesives - mounting methods – gauge sensitivities and gage factor – performance characteristics of wire and foil strain gauges – environmental effects. Analysis of strain gauge data – the three element rectangular rosette – the delta rosette – correction for transverse sensitivity.

UNIT-III

Non – destructive testing: Introduction – objectives of non destructive testing. Ultrasonic pulse velocity method – Rebound Hammer method (Concrete hammer) – Acoustic Emission- application to assessment of concrete quality.

UNIT-IV

Theory of photo elasticity: Introduction – temporary double refraction – Index ellipsoid and stress ellipsoid – the stress optic law – effects of stressed model in a polariscope for various arrangements - fringe sharpening.

Unit-V

Two dimensional photo elasticity: Introduction – iso-chromatic fringe patterns – isoclinic fringe patterns – compensation techniques – calibration methods – separation methods – materials for photo- elasticity – properties of photo-elastic materials.

REFERENCE:

1. Experimental Stress Analysis- Riley and Dally
2. Experimental Stress Analysis - L.S. Srinath
3. Experimental Stress Analysis – Lee
4. Experimental Stress Analysis- Sadhu Singh

MSEI-6 – **Sub Structure Design**

Pre-Requisites: Soil Mechanics, Mathematics

Course Outcomes: At the end of the course, the student will be able to

CO1	Attain the perception of site investigation to select suitable type of foundation based on soil category.
CO2	Capable of ensuring design concepts of shallow foundation.
C03	Can be efficient in selecting suitable type of pile for different soil stratum and in evaluation of group capacity by formulation
C04	Design different types of well foundation.

Mapping of Course Outcomes with Progrom Outcomes:

Course Out Comes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	--	--	--	1	--	1	--
CO2	--	--	--	3	--	1	1
CO3	--	--	--	2	--	1	1
CO4	--	--	--	2	--	1	1

1. Slightly 2. Moderately 3. Substancially

Detailed Syllabus:

Unit: 1

Soil Exploration – Importance, Terminology, planning - Geophysical methods. Borings, location, spacing and depth, methods of boring including drilling, stabilization of boreholes, boring records.

Unit: 2

Soil sampling – Methods of sampling -Types of samples and samplers-cleaning of bore holes, preservation, labeling and shipment of samples - Design considerations of open drive samplers

Unit: 3

Shallow Foundations –Bearing capacity – General bearing capacity equation, Meyerhof's, Hansen's and Vesic's bearing capacity factors - Bearing capacity of stratified soils - Bearing capacity based on penetration resistance- safe bearing capacity and allowable bearing pressure. (Ref: IS -2131 & IS 6403)

Unit: 4

Types and choice of type. Design considerations including location and depth, Proportioning of shallow foundations- isolated and combined footings and mats - Design procedure for mats. Floating foundation- Fundamentals of beams on Elastic foundations. .(Ref: IS -456 & N.B.C. relevant volume)

Unit: 5

Pile foundations-Classification of piles-factors influencing choice-Load -carrying capacity of single piles in clays and sands using static pile formulae- α - β - and λ - methods –Dynamic pile formulae-limitations-Monotonic and cyclic pile load tests – Under reamed piles.

Pile groups -Efficiency of pile groups- Different formulae-load carrying capacity of pile groups in clays and sands – settlement of pile groups in clays and sands – Computation of load on each pile in a group

REFERENCE:

1. Principles of Foundation Engineering by Braja M. Das.
2. Soil Mechanics in Engineering Practice by Terzagi and Peck
3. Foundation Design by Wayne C. Teng, John Wiley & Co.,
4. Foundation Analysis and Design by J.E. Bowles McGraw Hill Publishing Co.,
5. Analysis and Design of sub structures by Swami Saran
6. Design Aids in Soil Mechanics and Foundation Engineering by Shanbaga R. Kaniraj,Tata Mc. Graw Hill.
7. Foundation Design and Construction by MJ Tomlinson – Longman Scientific
8. A short course in Foundation Engineering by Simmons and Menzes – ELBS.

MSEI-7 - STRUCTURAL OPTMIZATION

Pre-Requisites: Soil Mechanics

Course Outcomes: At the end of the course, the student will be able to

CO1	Basic theoretical principles in optimization
CO2	Formulation of optimization models
CO3	Solution methods in optimization
C04	Methods of sensitivity analysis and post processing of results
C05	Applications to a wide range of engineering problems

Mapping of Course Outcomes with Progrom Outcomes:

Course Out Comes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1	--	--	--	--	1	3
CO2	1	--	---	--	1	1	3
CO3	1	--	--	1	--	1	3
CO4	1	--	--	1	1	1	3
CO5	1	--	--	1	1	1	3

1. Slightly 2. Moderately 3. Substancially

Detailed Syllabus:

Unit: 1

Introduction: Need and scope for optimization – statements of optimization problems- Objective function and its surface design variables- constraints and constraint surface- Classification of optimization problems (various functions continuous, discontinuous and discrete) and function behavior (monotonic and unimodal)

Unit: 2

Classical optimization techniques: Differential calculus method, multi variable optimization by method of constrained variation and Lagrange multipliers (generalized problem) Khun-Tucker conditions of optimality -Fully stressed design and optimality criterion based algorithms-introduction, characteristics of fully stressed design theoretical basis-examples

Unit: 3

Non-Liner programming: Unconstrained minimization- Fibonacci, golden search, Quadratic and cubic interpolation methods for a one dimensional minimization and univariate method, Powel's method, Newton's method and Davidon Fletcher Powell's method for multivariable optimization- Constrained minimization- Cutting plane method- Zoutendjik's method- penalty function methods.

Unit: 4

Linear programming: Definitions and theorems- Simplex method-Duality in Linear programming-Plastic analysis and Minimum weight design and rigid frame.

Unit: 5

Introduction to quadratic programming: Geometric programming- and dynamic programming- Design of beams and frames using dynamic programming technique.

REFERENCES:

1. Optimization Theory and Applications – S.S. Rao, Wiley Eastern Limited, New Delhi
2. Optimization Concepts and Application in Engineering- Belegundu A.D. and Chandrupatla T.R

MSEI – 8: **Port and Harbour Structures**

Course Outcomes: At the end of the course, the student will be able to

CO1	Estimation the different forces acts on port structures and Indian codal provisions
CO2	Design methods of port and harbour structures using working stress and limit state methods and crack width calculation
CO3	design of pile foundations for various Port Structures
C04	Know the Harbour planning

Mapping of Course Outcomes with Progrom Outcomes:

Course Out Comes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	--	--	1	1	--	2	1
CO2	--	--	2	3	--	2	1
CO3	--	--	1	3	--	2	1
CO4	--	--	--	--	--	--	2

Unit I

Introduction on different types of port and harbour structures- Breakwaters, Jetties, Wharves, Quays, berthing structures, Diaphragm Walls, Slipways, Docks. Types of breakwaters, types of berthing structures, Types of fenders.

Unit II

Estimation of different types of loads-berthing force, mooring force and seismic force, active and passive earth pressure, differential water pressure, Codal provisions on port and harbour structures, Analysis of jetties, wharves, quays and berthing structures, break waters, docks. Construction of port structures

Unit III

Offshore terminals, fenders and mooring facilities, Limit state and working stress design methods, crack width calculation.

Unit IV

Pile load tests, ground improvement techniques, construction methodology, Foundation for berthing structures, design of piles for berthing structures.

Unit V

Harbour facilities, Harbour planning, vessel type, and size, types of harbours, Design of harbour basin-Entrance, stopping distance, turning area, Anchorage Area, berthing area, Design of Navigational Channel.

References:

1. Port Engineering, Zhou Liu and Hans F. Burcharth, Laboratoriet for Hydraulik og Havnebygning, Alborg Universitet.
2. Port Design - Guidelines and recommendations by C. A. Thoresen, Tapir Publications.
3. Design of Marine Facilities for the Berthing, Mooring and Repair of Vessels by J. W. Gaythwaite, Van Nostrand.
4. Handbook of Offshore Engineering by S.K. Chakrabarti, Elseviers, 2005.
5. Agerschou, H., Lundgren, H., Sorensen, T., Ernst, T., Korsgaard, J., Schmidt, L.R. and Chi, W.K., (1983). “Planning and Design of Ports and Marine Terminals”, A Wiley-Interscience Publication.
6. Per brun (1983). “Port Engineering” Gulf Publishing Co.

MSFI-9 - REPAIR AND REHABILITATION OF STRUCTURES

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to

CO1	Recognize the mechanisms of degradation of concrete structures and to design durable concrete structures.
CO2	Conduct field monitoring and non-destructive evaluation of concrete structures.
CO3	Design and suggest repair strategies for deteriorated concrete structures including repairing with composites.
CO4	Understand the methods of strengthening methods for concrete structures
CO5	Assessment of the serviceability and residual life span of concrete structures by Visual inspection and in situ tests
CO6	Evaluation of causes and mechanism of damage
C07	Evaluation of actual capacity of the concrete structure Maintenance strategies

Mapping of Course Outcomes with Progrom Outcomes:

Course Out Comes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	--	1	--	1	--	1	--
CO2	--	1	1	1	--	1	1
CO3	--	1	1	1	--	1	1
CO4	--	--	1	1	--	1	1
CO5	--	--	1	1	--	1	1
CO6	--	--	1	1	--	1	1
C07	--	--	--	2	--	1	1

1. Slightly 2. Moderately 3. Substancially

Detailed Syllabus:

Unit: 1

Materials for repair and rehabilitation -Admixtures- types of admixtures-purposes of using admixtures- chemical composition- Natural admixtures- Fibres- wraps- Glass and Carbon fibre wraps- Steel Plates-Non destructive evaluation: Importance- Concrete behavior under corrosion, disintegrated mechanisms- moisture effects and thermal effects – Visual investigation- Acoustical emission methods- Corrosion activity measurement- chloride content – Depth of carbonation- Impact echo methods- Ultrasound pulse velocity methods- Pull out tests.

Unit: 2

Strengthening and stabilization- Techniques- design considerations-Beam shear capacity strengthening- Shear Transfer strengthening-stress reduction techniques- Column strengthening-flexural strengthening- Connection stabilization and strengthening, Crack stabilization.

Unit: 3

Bonded installation techniques- Externally bonded FRP- Wet layup sheet, bolted plate, near surface mounted FRP, fundamental debonding mechanisms-intermediate crack debonding- CDC debonding-plate end debonding- strengthening of floor of structures

Unit: 4

Fibre reinforced concrete- Properties of constituent materials- Mix proportions, mixing and casting methods-Mechanical properties of fiber reinforced concrete- applications of fibre reinforced concretes-Light weight concrete- properties of light weight concrete- No fines concrete- design of light weight concrete- Flyash concrete-Introduction- classification of flyash- properties and reaction mechanism of flyash- Properties of flyash concrete in fresh state and hardened state- Durability of flyash concretes

Unit: 5

High performance concretes- Introduction- Development of high performance concretes- Materials of high performance concretes- Properties of high performance concretes- Self Consolidating concrete-properties- qualifications.

REFERENCE:

1. Concrete technology- Neville & Brooks
2. Special Structural concrete- Rafat Siddique
3. Concrete repair and maintenance illustrated- Peter H Emmons
4. Concrete technology- M S Shetty

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Board of Studies (Soil Mechanics and Foundation Engineering)
Meeting: 08th September 2016 (R16).

MSFI-10 - ANALYSIS AND DESIGN OF TALL BUILDINGS

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to

CO1	Know design principles and different types of loading
CO2	Understand various structural systems used for Tall structures.
CO3	Capable of analyzing the tall structures and design of structural elements for secondary effects
CO4	Execute stability analysis, overall buckling analysis of frames, Analysis for various secondary effects –such as Creep, Shrinkage and Temperature

Mapping of Course Outcomes with Progrom Outcomes:

Course Out Comes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1	1	3	1	--	1	1
CO2	--	2	2	1	--	1	--
CO3	1	2	2	2	--	2	--
CO4	1	2	2	2	--	2	--

1. Slightly 2. Moderately 3. Substancially

Detailed Syllabus:

Unit: 1

Design Criteria Philosophy, Materials – Modern concepts – High Performance Concrete, Fibre Reinforced Concrete, Light weight concrete, Self Compacting Concrete.

Unit: 2

Gravity Loading – Dead load, Live load, Impact load, Construction load, Sequential loading. Wind Loading – Static and Dynamic Approach, Analytical method, Wind Tunnel Experimental methods. Earthquake Loading – Equivalent lateral Load analysis, Response Spectrum Method, Combination of Loads.

Unit: 3

Behavior of Structural Systems- Factors affecting the growth, height and structural form, Behaviour of Braced frames, Rigid Frames, In-filled frames, Shear walls, Coupled Shear walls, Wall–Frames, Tubular, Outrigger braced, Hybrid systems

Unit: 4

Analysis and Design- Modeling for approximate analysis, Accurate analysis and reduction techniques, Analysis of structures as an integral unit, Analysis for member forces, drift and twist. Computerized 3D analysis. Design for differential movement, Creep and Shrinkage effects, Temperature Effects and Fire Resistance.

Unit: 5

Stability Analysis- Overall buckling analysis of frames, wall–frames, Approximate methods, Second order effect of gravity loading, P–Delta Effects, Simultaneous first order and P-Delta analysis, Translational instability, Torsional Instability, Out of plumb effects, Effect of stiffness of members and foundation rotation in stability of structures.

REFERENCE:

1. Bryan Stafford Smith and Alex Coull, "Tall Building Structures - Analysis and Design", John Wiley and Sons, Inc., 1991.
2. Taranath B.S, "Structural Analysis and Design of Tall Buildings", McGraw-Hill, 1988

MSFI-11 - PLASTIC ANALYSIS AND DESIGN

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to

CO1	Understand Concepts of stress and strain – relation of steel Moment curvature relation.
CO2	Carryout limit analysis of simply supported, fixed beams and continuous beams, Effect of partial fixity and end, invariance of collapse loads.
CO3	Study basic theorems of limit analysis, rectangular portal frames, gable frames, grids, superposition of mechanisms.
CO4	Understand Limit design Principles to solve continuous beams and simple frames designs using above principles.
C05	Develop Load deflection relations for simply supported beams, deflection of simple pin based and fixed based portal frames, method of computing deflections.
C06	Carryout Minimum weight Design using Foulkes theorems and its geometrical analogue and absolute minimum weight design.

Mapping of Course Outcomes with Progrom Outcomes:

Course Out Comes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1	1	2	1	--	2	1
CO2	1	1	2	2	--	2	1
CO3	1	2	2	2	--	2	1
CO4	--	1	2	3	--	2	1
CO5	1	2	2	3	--	2	1
CO6	1	**2**	2	2	--	2	1

1. **Slightly 2. Moderately 3. Substancially**

Detailed Syllabus:

Unit: 1

Introduction and basic hypothesis: Concepts of stress and strain – relation of steel Moment curvature relation- basic difference between elastic and plastic analysis with examples- Yield condition, idealizations, collapse criteria- Virtual work in the elastic-plastic state-Evaluation of fully plastic moment and shape factors for the various practical sections

Unit: 2

Method of Limit Analysis: Introduction to limit analysis of simply supported fixed beams and continuous beams, Effect of partial fixity and end, invariance of collapse loads, basic theorems of limit analysis, rectangular portal frames, gable frames, grids, superposition of mechanisms, drawing statistical bending moment diagrams for checks.

Unit: 3

Limit design Principles: Basic principles, limit design theorems, application of limit design theorems, trial and error method, method of combining mechanisms, plastic moment distribution method, load replacement method, continuous beams and simple frames designs using above principles.

Unit: 4

Deflection in Plastic beams and frames: Load deflection relations for simply supported beams, deflection of simple pin based and fixed based portal frames, method of computing deflections.

Unit: 5

Minimum weight Design: Introduction to minimum Weight and linear Weight functions- Foulkes theorems and its geometrical analogue and absolute minimum weight design.

REFERENCE BOOKS:

1. Plastic Methods of Structural analysis- B G Neal, Chapman and Rall publications
2. Plastic analysis and Design – C E Messennet, M A Seve

MSEI – 12: **Advanced Reinforced Concrete Design**

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to

CO1	Estimate the deflection of Concrete beams and slabs
CO2	Estimate crack width and its affects
CO3	Design flat slabs, bunkers, silos and chimneys
CO4	Understand the thermal effect on concrete members

Mapping of Course Outcomes with Progrom Outcomes:

Course Out Comes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	--	2	1	2	--	2	1
CO2	--	--	1	3	--	2	1
CO3	--	--	1	3	--	2	1
CO4	--	--	1	2	--	2	1

Unit: 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, Deflection of continuous beams by IS 456, Deflection of slabs.

Estimation of Crack width in Reinforced Concrete Members: Introduction, Factors affecting crack width in beams, Mechanisms of flexural cracking, Calculation of crack width, Simple empirical method, Estimation of crack width in beams by IS 456, Shrinkage and thermal cracking.

Unit: 2

Redistribution of Moments in Reinforced Concrete Beams: Introduction, Redistribution of moments in fixed beam, Positions of points of contraflexures, Conditions for moment redistribution, Final shape of redistributed bending moment diagram, Moment redistribution for a two-span continuous beam, Advantages and disadvantages of moment redistribution, Modification of clear distance between bars in beams (for limiting crack width) with redistribution, Moment-curvature (M - ψ), Relation of reinforced concrete sections.

Approximation Analysis of Grid Floors: Introduction, Analysis of flat grid floors, Analysis of rectangular grid floors by Timoshenko's plate theory. Analysis of grid by stiffness matrix method, Analysis of grid floors by equating joint deflections, Comparison of methods of analysis, Detailing of steel in flat grids.

Unit: 3

Design of Flat Slabs: Introduction, Proportioning of Flat Slabs, Determination of Bending moment and Shear Force, Direct Design method, Equivalent Frame method, Slab Reinforcement.

Unit: 4

Bunkers and Silos : Introduction, Design of Rectangular Bunkers, Design of Tension member, Design of Circular Bunker, Design of Silos.

Unit: 5

Chimneys : Introduction, Design factors, Stresses due to Self Weight and Wind load, Stress in horizontal reinforcement, Temperature Stresses, Combined effect of Self Weight, Wind load and Temperature, Temperature stresses in Hoop(Horizontal) Reinforcement.

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, Analytical determination of the ultimate bending moment, Capacity of reinforced concrete beams under fire, Other considerations.

References:

1. "Advanced Reinforced Concrete Design" by P.C. Varghese.
2. "Reinforced Concrete" by Park & Paulay.

MSEP-1- ADVANCED STRUCTURAL ENGINEERING LABORATORY

Common for M.Tech.

(Soil Mechanics & Foundation Engineering and Geotechnical Engineering)

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to

CO1	conduct various laboratory tests on Cement, Aggregates
C02	Know strain measurement
C03	Non-destructive testing
C04	Chemical analysis on concrete and Aggregate and Sand

Able to.

Mapping of Course Outcomes with Progrom Outcomes:

Course Out Comes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	--	--	--	--	3	1	1
	--	--	--	--	3	1	1
	--	--	--	--	3	1	1
	--	--	--	--	3	1	1

1. Slightly 2. Moderately 3. Substancially

Detailed Syllabus:

List of Experiments:

1. Strain measurement - Electrical resistance strain gauges
2. Non destructive testing- Impact Hammer test, UPV test
3. Qualifications tests on Self compaction concrete- L Box test, J Box test, U box test, Slump test
4. Tests on Buckling of columns – Southwell plot
5. Repair and rehabilitation of concrete beams
6. Chemical Analysis of water for suitability in concreting with and without Reinforcement.
7. Chemical Analysis of sand and Aggregate for Suitability in Construction.

NOTE: A minimum of five experiments from the above set have to be conducted

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

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MSEII-1 - **Finite Element Method**

Common for M.Tech.

(Structural Engineering, Soil Mechanics & Foundation Engineering and Geotechnical Engineering)

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to

CO1	Develop finite element formulations of 1 degree of freedom problems and solve them
CO2	Understand any Finite Element software to perform stress, thermal and modal analysis
CO3	Compute the stiffness matrices of different elements and system
CO4	Interpret displacements, strains and stress resultants

Mapping of Course Outcomes with Progrom Outcomes:

Course Out Comes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1	2	3	--	--	2	1
CO2	1	2	3	--	--	2	1
CO3	1	2	3	--	--	2	1
CO4	1	2	3	--	--	2	--

1. Slightly 2. Moderately 3. Substancially

Detailed Syllabus:

Unit: 1

Introduction: Review of stiffness method- Principle of Stationary potential energy-Potential energy of an elastic body- Rayleigh-Ritz method of functional approximation - variational approaches -weighted residual methods

Unit: 2

Finite Element formulation of truss element: Stiffness matrix- properties of stiffness matrix –Selection of approximate displacement functions- solution of a plane truss- transformation matrix and stiffness matrix for a 3-D truss- Inclined and skewed supports- Galerkin's method for 1-D truss – Computation of stress in a truss element.

Unit: 3

Finite element formulation of Beam elements: Beam stiffness- assemblage of beam stiffness matrix- Examples of beam analysis for concentrated and distributed loading- Galerkin's method - 2-D Arbitrarily oriented beam element – inclined and skewed supports –rigid plane frame examples

Unit: 4

Finite element formulation for plane stress, plane strain and axi-symmetric problems- Derivation of CST and LST stiffness matrix and equations-treatment of body and surface forces-Finite Element solution for plane stress and axi-symmetric problems- comparison of CST and LST elements –convergence of solution- interpretation of stresses.

Unit: 5

Iso-parametric Formulation: An iso-parametric bar element- plane bilinear iso-parametric element – quadratic plane element - shape functions, evaluation of stiffness matrix, consistent nodal load vector - Gauss quadrature- appropriate order of quadrature – element and mesh instabilities – spurious zero energy modes, stress computation- patch test.

REFERENCES:

1. Concepts and applications of Finite Element Analysis – Robert D. Cook, Michael E Plesha, John Wiley & sons Publications
2. A first course in the Finite Element Method – Daryl L. Logan, Thomson Publications.
3. Introduction to Finite Elements in Engineering- Tirupati R. Chandrupatla, Ashok D. Belgunda, PHI publications.

MSEII-2 -- EARTHQUAKE RESISTANT DESIGN

Pre-Requisites: Soil Mechanics, Advanced Soil Mechanics, foundation Engineering -I

Course Outcomes: At the end of the course, the student will be able to

CO1	To learn the fundamentals of seismology and basic earthquake mechanisms, tectonics, types of ground motion, and propagation of ground motion.
C02	Understand qualitative and quantitative representations of earthquake magnitude
C03	Determine the natural frequency of a single degree of freedom dynamic system for given mass, stiffness and damping properties.
C04	Determine the maximum dynamic response of an elastic vibrating structure to a given forcing function
C05	Learn the fundamentals of building code based structural design.
C06	Determine the static design base shear based on the type of structural system, irregularity, location and occupancy.
C07	Distribute the static base shear to the structure based on vertical distribution of mass, horizontal distribution of mass, and centers of rigidity.
C08	Recognize special conditions such as irregular buildings, building separation, P-delta effects and base isolation.

Mapping of Course Outcomes with Progrom Outcomes:

Course Out Comes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	--	--	2	--	---	2	1
CO2	--	--	2	--	--	2	1
CO3	--	--	2	--	--	2	1
CO4	--	--	2	--	--	2	1
CO5	--	1	2	3	---	2	1
CO6	--	**1**	2	3	--	2	1
C07	--	**1**	2	3	--	2	1

1. **Slightly 2. Moderately 3. Substancially**

Detailed Syllabus:

Unit: 1

Engineering seismology – rebound theory – plate tectonics – seismic waves - earthquake size and various scales – local site effects – Indian seismicity – seismic zones of India – theory of vibrations – near ground and far ground rotation and their effects

Unit: 2

Seismic design concepts – EQ load on simple building – load path – floor and roof diaphragms – seismic resistant building architecture – plan configuration – vertical configuration – pounding effects – mass and stiffness irregularities – torsion in structural system- Provision of seismic code (IS 1893 & 13920) – Building system – frames – shear wall – braced frames – layout design of Moment Resisting Frames(MRF) – ductility of MRF – Infill wall – Non- structural elements

Unit: 3

Calculation of EQ load – 3D modeling of building systems and analysis (theory only) Design and ductile detailing of Beams and columns of frames Concept of strong column weak beams, Design and ductile detailing of shear walls

Unit: 4

Cyclic loading behavior of RC, steel and pre- stressed concrete elements - modern concepts- Base isolation – Adaptive systems – case studies

Unit: 5

Retrofitting and restoration of buildings subjected to damage due to earthquakes- effects of earthquakes – factors related to building damages due to earthquake- methods of seismic retrofitting- restoration of buildings

REFERENCE

1. Pankaj Agarwal and Manish ShriKhande, Earthquake Resistant Design of Structures, Prentice – Hall of India, 2007, New Delhi.
2. Bullen K.E., Introduction to the Theory of Seismology, Great Britain at the University Printing houses, Cambridge University Press 1996.
3. Relevant code of practices

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MSFII-3 - **STABILITY OF STRUCTURES**

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to

CO1	Analyze different types of structural instabilities
CO2	Execute and work out the inelastic buckling using various methodologies.
CO3	Examine the behaviour of beam columns and frames with and without side sway using classical and stiffness methods.
CO4	To be well versed in the lateral buckling, torsional buckling, Flexural torsional buckling of various beams and non-circular sections.
CO5	

Mapping of Course Outcomes with Progrom Outcomes:

Course Out Comes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	--	3	2	1	--	2	--
CO2	--	3	2	1	--	2	--
CO3	--	3	2	1	--	2	--
CO4	--	3	2	1	--	2	--

1. Slightly 2. Moderately 3. Substancially

Detailed Syllabus:

Unit: 1

Beam columns: Differential equation for beam columns – Beams column with concentrated loads – continuous lateral load – couples – Beam column with built in ends – continuous beams with axial load – application of Trigonometric series – Determination of allowable stresses

Unit: 2

Elastic buckling of bars : Elastic buckling of straight columns – Effect of shear stress on buckling – Eccentrically and laterally loaded columns –Sway & Non Sway mode - Energy methods – Buckling of a bar on elastic foundation – Buckling of 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 – Effect of Initial curvature on bars – Buckling of frames – Sway & Non Sway mode

Unit: 3

In-elastic buckling: Buckling of straight bars – Double modulus theory Tangent modulus theory. Experiments and design formulae:

Experiments on columns – Critical stress diagram – Empirical formulae of design – various end conditions – Design of columns based on buckling. Mathematical Treatment of stability problems: Buckling problem orthogonality relation – Ritz method –Stiffness method and formulation of Geometric stiffness matrix- Applications to simple frames

Unit: 4

Torsional Buckling: Pure torsion of thin walled bars of open cross section – Non uniform torsion of thin walled bars of open cross section - Torsional buckling – Buckling of Torsion and Flexure

Unit: 5

Lateral Buckling of simply supported Beams: Beams of rectangular cross section subjected for pure bending, Buckling of I Section subjected to pure bending

REFERENCES:

1. Theory of Elastic stability by Timshenko & Gere-Mc Graw Hill
2. Theory of Stability of Structures by Alexander ChaJes.

MSEII-4- **Theory of Plates and Shells**

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to

CO1	Have a knowledge about various plate theories due to bending
CO2	Gain the knowledge of Navier's solution, Levy's solution and solve for the rectangular and square plates.
CO3	Analyze circular plates with various boundary conditions.
CO4	Focus on the finite difference method of solving plate problems.
CO5	Ability to realize the potential energy principle and find the solution of rectangular plates for various loadings
C06	Understand the behaviour of folded plates and shells.

Mapping of Course Outcomes with Progrom Outcomes:

Course Out Comes	PO1	PO2	PO3	PO4	PO5
CO1	2	--	1	1	--
CO2	--	2	2	--	--
CO3	--	--	3	--	--
CO4	--	--	3	1	--
CO5	--	1	1	--	3

1. **Slightly 2. Moderately 3. Substancially**

Detailed Syllabus:

Unit: 1

Derivation of governing differential equation for plate– in plane bending and transverse bending effects- Rectangular plates: Plates under various loading conditions like concentrated, uniformly distributed load and hydrostatic pressure. Navier and Levy's type of solutions for various boundary condition.

Unit: 2

Circular plates: Symmetrically loaded, circular plates under various loading conditions, Annular plates.

Unit: 3

Introduction to Shells- Single and double curvature- Equations of Equilibrium of Shells: Derivation of stress resultants, Principles of membrane theory and bending theory.

Unit: 4

Cylindrical Shells: Derivation of the governing DKJ equation for bending theory, details of Schorer's theory. Application to the analysis and design of short and long shells. Use of ASCE Manual coefficients for the design.

Unit: 5

Beam theory of cylindrical shells: Beam and arch action. Design of diaphragms - Geometry analysis and design of elliptic Paraboloid, Conoidal and Hyperbolic Paraboloid shapes by membrane theory.

REFERENCES:

1. Theory of Plates and Shells – Timoshenko and Krieger, McGraw-Hill book company, INC, New york.
2. K. Chandra Sekhara
3. A Text Book of Plate Analysis – Bairagi, K, Khanna Publisher, New Delhi.
4. Design and Construction of Concrete Shell Roofs – Ramaswamy, G.S, Mc Graw – Hill, New York

MSEII-5- **Pre-Stressed Concrete**

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to

CO1	Explain the principle, types and systems of prestressing and analyze the deflections.
CO2	Determine the flexural strength and design the flexural members, end blocks.
CO3	Analyze the statically indeterminate structures and design the continuous beam.
C04	Design the tension and compression members and apply it for design of piles.
C05	Analyze the stress, deflections, flexural and shear strength and apply it for the design of bridges.
C06	Analyze the Composite construction of Pre-stressed and in-situ concrete.

Mapping of Course Outcomes with Progrom Outcomes:

Course Out Comes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1							
CO2							
CO3							
CO4							
CO5							
CO6							
C07							

1. **Slightly 2. Moderately 3. Substancially**

Detailed Syllabus:

Unit: 1

Flexural, shear; torsional resistance and design of Prestressed concrete section. Types of flexural failure – code procedures-shear and principal stresses – Prestressed concrete members in torsion – Design of sections for flexure, Axial Tension, Compression and bending, shear, Bond

Unit: 2

Analysis of continuous beams –Elastic theory- Linear transformation and Concordant tendons-

Deflections of pre-stressed concrete beams: Importance of control of deflections- factors influencing deflections-short term deflections of un-cracked member – prediction of long term deflections

Unit: 3

Analysis of end blocks: By Guyon's method and Magnel's method, Anchorage zone stresses- Approximate method of design- anchorage zone reinforcement- transfer of pre stresses- pre tensioned members-Composite sections: Introduction-Analysis for stresses- differential shrinkage- general design considerations

Unit: 4

Statically Indeterminate Structures: Advantages of Continuous Members --Effect of Prestressing Indeterminate Structures -- Methods of Achieving Continuity -- Definitions of Common Terms -- Methods of Analysis of Secondary Moments --- Concordant Cable Profile --- Guyon's Theorem -- Effect of Axial Deformation and Tertiary Moments --- Ultimate Load Analysis of Continuous Prestressed Members --- Determination of Concordant Tendon Profile -- Design of Continuous Prestressed Concrete Beams --- Design of Prestressed Portal Frames.

Unit: 5

Composite Construction of Prestressed and in situ Concrete: Composite Structural Members -- Types of Composite Construction -- Analysis of Stresses -- Differential Shrinkage --- Deflection of Composite Members -- Stresses at Serviceability Limit State --- Flexural Strength of Composite Sections -- Shear Strength of Composite Sections -- Design of Composite Sections.

REFERENCES:

1. Prestressed Concrete- N. Krishna Raju
2. Prestressed Concrete- S. Ramamrutham
3. Prestressed Concrete- P. Dayaratnam
4. Prestressed Concrete- T.Y.Lin

MSEII-6 – **Mechanics of Composite Materials**

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to

CO1	Identify the fibre types and classify the composite material.
CO2	Relate the stress –strain properties, longitudinal and transverse properties of composites lamina.
CO3	Analyze the laminated composites and compute the lamina strength.
C04	Find the failure criterion and fracture mechanics of composites.
C05	Apply the load deformation relation, residual stresses for the design of composites.

Mapping of Course Outcomes with Progrom Outcomes:

Course Out Comes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	--	--	--	1	--	2	--
CO2	--	1	2	1	--	2	1
CO3	--	--	2	2	--	2	1
CO4	--	--	1	2	--	2	2
CO5	--	--	2	3	--	2	1

1. **Slightly 2. Moderately 3. Substancially**

Detailed Syllabus:

Unit: 1

Introduction to Composite Materials: Introduction ,Classification: Polymer Matrix Composites, Metal Matrix Composites, Ceramic Matrix Composites, Carbon–Carbon Composites, Fiber-Reinforced Composites and nature-made composites, and application-**Reinforcements:** Fibres-Glass, Silica, Kevlar, carbon, boron, silicon carbide, and born carbide fibres. Particulate composites, Polymer composites, Thermoplastics, Thermosetts, Metal matrix and ceramic composites.-**Manufacturing methods:** Autoclave, tape production, moulding methods, filament winding, man layup, pultrusion, RTM.

Unit: 2

Macromechanical Analysis of a Lamina: Introduction, Definitions: Stress, Strain ,Elastic Moduli, Strain Energy. Hooke's Law for Different Types of Materials, Hooke's Law for a Two-Dimensional

Unidirectional Lamina, Plane Stress Assumption, Reduction of Hooke's Law in Three Dimensions to Two Dimensions, Relationship of Compliance and Stiffness Matrix to Engineering Elastic Constants of a Lamina,

Unit: 3

Hooke's Law for a Two-Dimensional Angle Lamina, Engineering Constants of an Angle Lamina, Invariant Form of Stiffness and Compliance Matrices for an Angle Lamina Strength Failure Theories of an Angle Lamina : Maximum Stress Failure Theory Strength Ratio, Failure Envelopes, Maximum Strain Failure Theory ,Tsai–Hill Failure Theory, Tsai–Wu Failure Theory, Comparison of Experimental Results with Failure Theories. Hygrothermal Stresses and Strains in a Lamina: Hygrothermal Stress–Strain Relationships for a Unidirectional Lamina, Hygrothermal Stress–Strain Relationships for an Angle Lamina

Unit: 4

Micromechanical Analysis of a Lamina :Introduction, Volume and Mass Fractions, Density, and Void Content, Evaluation of the Four Elastic Moduli, Strength of Materials Approach, Semi-Empirical Models, Elasticity Approach, Elastic Moduli of Lamina with Transversely Isotropic Fibers, Ultimate Strengths of a Unidirectional Lamina, Coefficients of Thermal Expansion, Coefficients of Moisture Expansion

Unit: 5

Macromechanical Analysis of Laminates: Introduction , Laminate Code , Stress–Strain Relations for a Laminate, In-Plane and Flexural Modulus of a Laminate , Hygrothermal Effects in a Laminate, Warpage of Laminates -**Failure, Analysis, and Design of Laminates** : Introduction , Special Cases of Laminates, Failure Criterion for a Laminate, Design of a Laminated Composite

TEXT BOOKS:

1. Engineering Mechanics of Composite Materials by Isaac and M Daniel, Oxford University Press, 1994.
2. B. D. Agarwal and L. J. Broutman, Analysis and performance of fibre Composites, Wiley-Interscience, New York, 1980.
3. Mechanics of Composite Materials, Second Edition (Mechanical Engineering), By Autar K. Kaw ,Publisher: CRC

MSEII-7 – **Fracture Mechanics**

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to

CO1	Predict material failure for any combination of applied stresses.
CO2	Estimate failure conditions of a structures
CO3	Determine the stress intensity factor for simple components of simple geometry
CO4	Predict the likelihood of failure of a structure containing a defect
CO5	

Mapping of Course Outcomes with Progrom Outcomes:

Course Out Comes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	--	1	2	2	--	2	1
CO2	--	1	2	2	--	2	1
CO3	--	1	2	2	--	2	1
CO4	--	1	2	2	--	2	1

1. Slightly 2. Moderately 3. Substancially

Detailed Syllabus:

Unit: 1

Introduction: Fundamentals of elastic and plastic behaviour of materials- stresses in a plate with a hole – Stress Concentration factor-modes of failure- Brittle fracture and ductile fracture- history of fracture mechanics-Griffiths criteria for crack propagation cracks- Energy release rate, G_I G_{II} and G_{III} - Critical energy release rate G_{Ic} , G_{IIc} and G_{IIIc} – surface energy - R curves – compliance.

Unit: 2

Principles of Linear Elastic Fracture Mechanics: SOM vs Fracture Mechanics -stressed based Criteria for fracture- Stress Intensity Factors- K_I K_{II} and K_{III} – Critical stress Intensity Factors, K_{Ic} K_{IIc} and K_{IIc} – crack tip plastic zone – Erwin's plastic zone correction –Critical crack length-Load carrying capacity of a cracked component- Design of components based on fracture mechanics.

Unit: 3

Mixed mode crack propagation- Maximum tangential stress criterion – crack propagation angle - Material characterisation by Crack Tip Opening Displacements (CTOD)- Crack Mouth Opening Displacement (CMOD)- Critical crack tip opening displacement ($CTOD_c$) –critical Crack Mouth Opening Displacement ($CMOD_c$).

Unit: 4

Fatigue Crack propagation- Fatigue load parameters Fatigue crack growth curve –Threshold stress intensity factor-Paris law- Retardation effects.

Unit: 5

Applications of fracture Mechanics to concrete- reasons –strain softening behaviour –Bazant's size effect law.

REFERENCES

1. Elementary engineering fracture mechanics – David Broek – Sijthoff & Noordhoff – Netherlands.

2. Elements of Fracture Mechanics – Prasanth Kumar, wiley Eastern Publications

3. Fracture Mechanics: Fundamentals and applications – T. L. Andrason, PhD, CRC publications

4. Fracture Mechanics of Concrete: Applications of fracture mechanics to concrete, Rock, and other quasi-brittle materials, Surendra P. Shah, Stuart E. Swartz, Chengsheng Ouyang, John Wiley & Son publications

MSEII-8 – **Analysis of Offshore Structures**

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to

CO1	perform concept development of offshore structure
CO2	find the wave force on vertical cylinder
CO3	perform static and dynamic analysis of fixed offshore structure

Mapping of Course Outcomes with Progrom Outcomes:

Course Out Comes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	---	--	--	1	--	1	1
CO2	--	--	2	1	--	2	1
CO3	--	--	3	3	--	2	1

1. Slightly 2. Moderately 3. Substancially

Detailed Syllabus:

Unit: 1

Introduction to different types of offshore structures, Concept of fixed, compliant and floating structures, Law of floatation, fluid pressure and centre of pressure, estimation of centre of gravity, hydrostatic particulars, stability criteria of floating bodies, and motions of a floating body.

Unit: 2

Conservation mass and momentum, Euler equation, Bernoullis Equation, Potential flow, Classification of waves, small amplitude or Linear Airy's theory, dispersion relationship, water particle kinematics, wave energy.

Unit: 3

Wave force estimation- Wave force on small bodies-Morison equation, Estimation of wave force on a vertical cylinder, Force due to current, Effect of marine growth on vertical cylinders.

Unit: 4

Wave force on large bodies-Froude-krylov theory, Diffraction theory.

Unit: 5

Static and dynamic analysis of fixed offshore structures.

References

1. Hand book of offshore Engineering, Vol I, Subrata Chakrabarti, Offshore Structure Analysis, Inc., Plainfield, Illinois, USA.
2. Graff, W. J., Introduction to Offshore Structures, Gulf Publ. Co.1981.
3. API RP 2A., Planning, Designing and Constructing Fixed Offshore Platforms, API.
4. McClelland, B & Reifel, M. D., Planning & Design of fixed Offshore Platforms, Van
5. Nostrand, 1986.
6. Dawson, T. H., Offshore Structural Engineering, Prentice Hall, 1983.

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MSEII-9 – **Industrial Structures**

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to

CO1	Plan the functional requirements of structural systems for various industries.
CO2	Get an idea about the materials used and design of industrial structural elements.
CO3	Realize the basic concepts and design of power plant structures.
CO4	Design power transmission structures.
C05	Possess the ability to understand the design concepts of Chimneys, bunkers and silos

Mapping of Course Outcomes with Progrom Outcomes:

Course Out Comes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	--	--	1	--	--	--	1
CO2	--	--	1	--	--	--	1
CO3	--	--	1	--	--	--	1
CO4	--	--	--	3	--	3	
CO5	--	--	2	3	--	3	2

2. Slightly 2. Moderately 3. Substancially

Detailed Syllabus:

Unit: 1

Planning and functional requirements- classification of industries and industrial structures- planning for layout- requirements regarding lighting ventilation and fire safety- protection against noise and vibrations

Unit: 2

Industrial buildings- roofs for industrial buildings (Steel) - design of gantry girder- design of corbels and nibs- machine foundations

Unit: 3

Design of Folded plates- Design considerations- analysis of folded plates- analysis of multibay folded plates- design of diaphragm beam

Unit: 4

Power plant structures- Bunkers and silos- chimney and cooling towers-Nuclear containment structures

Unit: 5

Power transmission structures- transmission line towers- tower foundations- testing towers

REFERENCES:

1. Advanced reinforced concrete design- N. Krishnam Raju
2. Handbook on machine foundations- P. Srinivasulu and C.V. Vaidyanathan
3. Tall Chimneys- Design and construction – S.N. Manohar
4. Transmission Line Structures- A.R. Santakumar and S.S. Murthy
5. SP 32: 1986, Handbook on functional requirements of Industrial buildings
6. Design of shells- K. Chandrasekhara

MSEII-10 – **Bridge Engineering**

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to

CO1	Design theories for super structure and substructure of bridges
CO2	Design Culvert, R.C.C T Beam Bridge.
CO3	Understand the behavior of continuous bridges, box girder bridges.
C04	Possess the knowledge to design prestressed concrete bridges.
C05	Design Railway bridges, Plate girder bridges, different types of bearings, abutments, piers and various types of foundations for Bridges

Mapping of Course Outcomes with Progrom Outcomes:

Course Out Comes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	--	1	2	1	--	1	--
CO2	--	1	2	3	--	2	2
CO3	--	1	2	3	--	2	1
CO4	--	1	2	2	--	2	1
CO5	--	1	2	3	--	2	2

1. Slightly 2. Moderately 3. Substancially

Detailed Syllabus:

Unit: 1

Masonry arch Bridge design details- Rise, radius, and thickness of arch- Arch ring- Dimensioning of sub structures- Abutments pier and end connections.(Ref: IRC- SP-13)

Unit: 2

Super Structure: Slab bridge- Wheel load on slab- effective width method- slabs supported on two edges- cantilever slabs- dispersion length- Design of interior panel of slab- Pigeaud's method- design of longitudinal girders- Guyon-Messonet method- Hendry Jaegar method- Courbon's theory. (Ref: IRC-21), voided slabs, T-Beam bridges.

Unit: 3

Plate girder bridges- Elements of plate girder and their design-web-flange- intermediate stiffener- vertical stiffeners- bearing stiffener-design problem

Unit: 4

Prestressed Concrete and Composite bridges- Preliminary dimensions-flexural and torsional parameters- Courbon's Theory – Distribution coefficients by exact analysis- design of girder section- maximum and minimum prestressing forces- eccentricity- live load and dead load shear forces- cable zone in girder- check for stresses at various sections- check for diagonal tension-diaphragms and end block design- short term and long term deflections- Composite action of composite brides- shear connectors- composite or transformed section- design problem. (Ref: IRC: Section-VI)

Unit: 5

Sub structure- Abutments- Stability analysis of abutments- piers- loads on piers – Analysis of piers- Design problem(Ref: IRC-13, IRC-21, IRC-78)- Pipe culvert- Flow pattern in pipe culvers-culvert alignment-culvert entrance structure- Hydraulic design and structural design of pipe culverts- reinforcements in pipes .(Ref: IRC: SP-13)

REFERENCES:

1. Design of concrete bridges- Aswini, Vazirani, Ratwani
2. Essentials of bridge engineering- Jhonson Victor D
3. Design of bridges- Krishna Raju

UNIVERSITY COLLEGE OF ENGINEERING, KAKINADA (AUTONOMOUS)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

Board of Studies (Soil Mechanics and Foundation Engineering)
Meeting: 08th September 2016 (R16).

MSFII-11- **Earth Retaining structures**

Common for M.Tech.

(Structural Engineering, Soil Mechanics & Foundation Engineering and Geotechnical Engineering)

Pre-Requisites: Soil Mechanics

Course Outcomes: At the end of the course, the student will be able to

CO1	Quantify the lateral earth pressures associated with different earth systems
CO2	Evaluate the mechanical properties of geosynthetics used for soil reinforcement
CO3	Identify the merits and demerits of different earth retaining systems.
CO4	Select the most technically appropriate type of retaining wall for the application from a thorough knowledge of available systems
CO5	Design of retaining structures using appropriate design methods, factors of safety, earth pressure diagrams and field verification methods
CO6	Aware of current guidelines regarding the design of earth retaining structures.
CO7	Design retaining structures considering both external and internal stability aspects

Mapping of Course Outcomes with Progrom Outcomes:

Course Out Comes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	--	--	1	1	--	1	1
CO2	--	--	1	1	--	1	1
CO3	--	--	--	1	--	1	1
CO4	--	--	1	1	--	1	1
CO5	--	--	2	3	--	2	2
CO6	--	--	2	2	--	2	2
C07	--	--	1	3	--	2	2

1. Slightly 2. Moderately 3. Substancially

Detailed Syllabus:

Unit: 1

Earth pressures – Different types and their coefficients- Classical Theories of Earth pressure – Rankine's and Coulomb's Theories for Active and Passive earth pressure- Computation of Lateral Earth Pressure in Homogeneous and Layered soils- Graphical solutions for Coulomb's Theory in active and passive conditions.

Unit: 2

Retaining walls – different types - Type of Failures of Retaining Walls – Stability requirements – Drainage behind Retaining walls – Provision of Joints – Relief Shells.

Unit: 3

Sheet Pile Structures – Types of Sheet piles – Cantilever sheet piles in sands and clays – Anchored sheet piles – Free earth and Fixed earth support methods – Rowe's moment reduction method – Location of anchors and Design of Anchorage system.

Unit: 4

Soil reinforcement – Reinforced earth - Different components – their functions – Design principles of reinforced earth retaining walls.

Unit: 5

Braced cuts and Cofferdams: Lateral Pressure in Braced cuts – Design of Various Components of a Braced cut – Stability of Braced cuts – Bottom Heave in cuts. – types of cofferdam, suitability, merits and demerits – Design of single – wall cofferdams and their stability aspects – TVA method and Cummins' methods.

REFERENCES

1. Principles of Foundation Engineering by Braja M. Das.
2. Foundation analysis and design – Bowles, JE – McGraw Hill
3. Soil Mechanics in Engineering Practice – Terzaghi, K and Rolph, B. peck 2nd Edn. – John Wiley & Co.,
4. Analysis and Design of Foundations and Retaining Structures, Prakash, S – Saritha Prakashan, Mearut.

UNIVERSITY COLLEGE OF ENGINEERING, KAKINADA (AUTONOMOUS)

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Board of Studies (Soil Mechanics and Foundation Engineering)
Meeting: 08th September 2016 (R16).

MSEII-12: **Inelastic Design of Slabs**

Pre-Requisites: Soil Mechanics

Course Outcomes: At the end of the course, the student will be able to

CO1	Perform elastic theory of analysis
CO2	Perform yield line theory
CO3	Analysis of rectangular/Square slabs by principle of virtual work
CO4	Design of of rectangular/Square slabs for different boundary conditions

Mapping of Course Outcomes with Progrom Outcomes:

Course Out Comes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1	2	2	2	--	2	1
CO2	1	2	2	2	--	2	1
CO3	1	2	2	3	--	3	1
CO4	1	2	2	3	--	3	1

1. **Slightly 2. Moderately 3. Substancially**

Detailed Syllabus:

Unit: 1

Basic elastic theory Analysis: Classical plate theory, Lagrange's equation, moment-deformation, shear-deformation relationships. Examples on square and rectangular plates carrying uniformly distributed load for different edge conditions.

Unit: 2

Principles of yield line theory: slab reinforcement, section behavior and conditions at ultimate load. Yield lines as axes of rotation and basic rules for the determination of the pattern of yield lines. Different yield line patterns for rectangular and non rectangular slabs supported on three and four sides with different edge conditions.

Unit: 3

Analysis by principle of virtual work: Derivation of virtual work equations for Isotropic and Orthotropic two-way Square/ Rectangular slabs supported on four sides for different edge conditions.

Analysis of rectangular/Square slabs supported on three sides with different edge conditions and one edge is free (Balcony slabs) using virtual work principle.

Analysis of rectangular/Square slabs supported on three (Balcony slabs) and four sides with different edge conditions using equilibrium method.

Unit: 4

Design of rectangular/Square slabs supported on three (Balcony slabs) and four sides for different edge conditions.

Unit: 5

Derivation of virtual work equations only, for two-way slabs supported on four sides with different edge conditions having openings at centre, central eccentric, corner, central short side and central long side.

Text Books

1. "Reinforced Concrete Slabs", Robert Park, William L Gamble , JOHN WILEY &SONS. INC, New York., 2010.
2. "Ultimate Strength Design for Structural Concrete". V.Ramakrishnan, P.D.Arthur. Wheeler books.
3. R H Wood and LL Jones "Yield line Analysis of Slabs". Thames and Hudson, Chatto & Windus, London,1967

MSEP-2 – CAD Laboratory

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to

CO1	Develop Computer Programs for Analysis and Design of various Structural Elements
CO2	Use different Structural Engineering software's to solve various civil Engineering programs

Mapping of Course Outcomes with Progrom Outcomes:

Course Out Comes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1	3	3	3	1	3	3
CO2	1	3	2	3	1	3	3

1. Slightly 2. Moderately 3. Substancially

Detailed Syllabus:

Analysis and Design using STADD, STRAP, STRUDS, ANSYS

1. Programming for beams subject to different loading (mandatory).
2. Analysis of reinforced concrete multistoried building
3. Analysis of steel transmission line tower
4. Analysis of plane and space truss
5. Analysis of plane and space frame
6. Determination of mode shapes and frequencies of tall buildings using lumped mass (stick model) approximation
7. Wind analysis on tall structure
8. Analysis of pre stressed concrete bridge girder
9. Analysis of Cylindrical shell
10. Modal Analysis of a Cantilever Beam

NOTE: A minimum of eight (including item 1) from the above set have to be conducted.

REFERENCE:

Computer aided design laboratory (Civil Engineering) by Shesha Prakash and Suresh.S

MSES-1 - **Seminar**

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to

CO1	Collect research material on some topic and to summaries it report and give to present the same

Mapping of Course Outcomes with Progrom Outcomes:

Course Out Comes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	--	--	1	1	2	2	2

1. **Slightly 2. Moderately 3. Substancially**

MSED-1 – **Design Project**

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to

CO1	Analyse, design and prepare a report on Special Design topic related to Structural Engineering

Mapping of Course Outcomes with Progrom Outcomes:

Course Out Comes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1	1	2	3	1	3	2

1. **Slightly 2. Moderately 3. Substancially**

MSFER1 - **Dissertation / Thesis**

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to

CO1	Identifying the topic after thorough review of literature on chosen topic and Can able to do the Project either Experimental Work or analytical Work

Mapping of Course Outcomes with Progrom Outcomes:

Course Out Comes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1	2	2	3	3	3	3

1. **Slightly 2. Moderately 3. Substancially**

MSES-2 - **Seminar**

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to

CO1	Collect research material on some topic and to summaries it report and give to present the same

Mapping of Course Outcomes with Progrom Outcomes:

Course Out Comes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	--	--	1	1	2	2	2

2. Slightly 2. Moderately 3. Substancially

Detailed Syllabus:

MSED-2 – **Design Project**

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to

CO1	Analyse, design and prepare a report on Special Design topic related to Structural Engineering

Mapping of Course Outcomes with Progrom Outcomes:

Course Out Comes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1	1	2	3	1	3	2

2. Slightly 2. Moderately 3. Substancially

Detailed Syllabus:

MSFPR2 - **Dissertation / Thesis**

Common for M.Tech.

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to

CO1	Identifying the topic after thorough review of literature on chosen topic and Can able to do the Project either Experimental Work or analytical Work
CO2	Prepare the Detailed report on the Work done by them

Mapping of Course Outcomes with Progrom Outcomes:

Course Out Comes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1	2	2	3	3	3	3
C02	--	--	1	1	2	1	2

2. Slightly 2. Moderately 3. Substancially

Detailed Syllabus: