आईएफटीएम विश्वविद्यालय, मुरादाबाद, उत्तर प्रदेश

IFTM University, Moradabad, Uttar Pradesh

NAAC ACCREDITED

SCHOOL OF ENGINEERING & TECHNOLOGY
DEPARTMENT OF CIVIL ENGINEERING
IFTM UNIVERSITY, MORADABAD
www.iftmuniversity.ac.in

Study & Evaluation Scheme of
Master of Technology (M.Tech) Civil Engineering (Structural Engineering)

Programme:	***Master of Technology in Civil Engineering (Structural Engineering)***
Course Level:	***Post Graduate Degree***
Duration:	***02 Years (Four semesters) Full Time***
Medium of instruction:	***English***
Minimum Required Attendance:	***75%***
Maximum credits:	***58***

Programme Outcomes (POs):

Students completing this programme will be able to:

- Independently carry out research /investigation and development work to solve practical problems.
- Write and present a substantial technical report/document.
- Demonstrate a degree of mastery for designing and solving structural engineering problems.
- Use appropriate modern tools in structural engineering. In doing so he should demonstrate sufficient knowledge of competing tools and their relative merits and demerits.
- Demonstrate the traits of learning and unlearning throughout his professional career, and be willing to learn new techniques, methods and processes.
- Tune his knowledge to be a responsible engineer adhering to all established practices of his profession.

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Master of Technology (M.Tech) Civil Engineering (Structural Engineering)

STUDY AND EVALUATION SCHEME
(Effective from Session 2020-21)

YEAR I, SEMESTER-I

S.N.	Course Code	Course Name	Periods			EVALUATION SCHEME				Course Total	Credits
						Mid Term Exam			External Exam		
			L	T	P	CT	AS +AT	Total			
THEORY											
1.	MCE-101	Advanced Structural Analysis	3	1	0	20	10	30	70	100	4
2.	MCE-102	Advanced RCC Design	3	1	0	20	10	30	70	100	4
3.	MCE-103	Advanced Concrete Technology	3	1	0	20	10	30	70	100	4
4.	MCE-104-108	Elective – I	3	1	0	20	10	30	70	100	4
		TOTAL	**12**	**04**	**00**	**-**	**-**	**-**	**-**	**400**	**16**

YEAR I, SEMESTER-II

S.N.	Course Code	Course Name	Periods			EVALUATION SCHEME				Course Total	Credits
						Mid Term Exam			External Exam		
			L	T	P	CT	AS +AT	Total			
THEORY											
1.	MCE-201	Structural Dynamics	3	1	0	20	10	30	70	100	4
2.	MCE-202	Design of Pre-stressed Concrete Structures	3	1	0	20	10	30	70	100	4
3.	MCE-203	Theory of Elasticity	3	1	0	20	10	30	70	100	4
4.	MCE- 204-209	Elective –II	3	1	0	20	10	30	70	100	4
		TOTAL	**12**	**04**	**00**	**-**	**-**	**-**	**-**	**400**	**16**

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M.Tech – I Year (I Semester)

Effective from Session 2020-21

MCE-101 Advanced Structural Analysis **L T P 3 1 0**

Course Objective:
The objective of this course is to introduce students to higher-level Theory of Structures. Emphasis is placed upon students gaining a real understanding of elementary plastic theory of structures with application for analysis of truss element and design; dynamics of structures; stability of structural elements and structural systems. This course also deals with Matrix method, which provides a comprehensive approach to the analysis of different structural systems and therefore offers a major advantage over many traditional methods.

Unit-I **(8 Sessions)**
Basic Concepts: Static and kinematic indeterminacy, stiffness and Flexibility, stiffness and flexibility matrices for prismatic members and stepped member/non-prismatic members.

Unit-II **(10 Sessions)**
Direct Stiffness Method-2 D Elements: Development of stiffness matrices for truss element, beam element, transformations of coordinates, assembly of global matrices-Stiffness matrix, load matrix, boundary conditions, solution techniques.

Unit-III **(6 Sessions)**
Direct Stiffness Method: Stiffness Matrices for truss element, beam element & grid element,

Unit-IV **(8 Sessions)**
Direct Stiffness Method & 3 D Elements
Transformation matrix for 3 D truss element & 3 D beam element, computer programming, applications to practical problems.

Unit-IV **(8 Sessions)**
Non-Linear Structural Analysis: Material Non-Linearity, Introduction to plastic analysis, mechanism, plastic analysis, non-linear stiffness matrix analysis-Iterative method, incremental method.

Course outcome:

After Completion of this course the students will be able to:
- Analyze truss element and structures using stiffness method,
- Analyze skeleton structures having secondary effects using direct stiffness method,
- Derive stiffness by direct method on 2D and 3D elements,
- Solve realistic engineering problems through computational simulations using finite element code,

Suggested readings:

- 'Theory of Matrix Structural analysis', J.S. Przemicniecki, Tata McGraw Hill Book Co.
- 'Introduction to Matrix Methods of Structural Analysis' H.C. Martin, McGraw Hill Book Co.
- 'Advanced Structural Analysis with Computer Applications' A.K. Jain, Nem Chand & Bros, Roorkee.
- 'Matrix Methods of Structural Analysis' C.K. Wang, International Text Book Pasadena.

Website resources:

- http://www.calculix.de/
- https://nptel.ac.in/courses/105/106/105106050/
- https://lecturenotes.in/subject/972/advanced-structural-analysis

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M.Tech – I Year (I Semester)

Effective from Session 2020-21

MCE-102 Advanced R.C.C Design **L T P 3 1 0**

Course Objective:

The objective of this course is to enhance competence in design of advanced reinforced concrete structures and to familiarize the students with the concepts of designing concrete mixes using different methods of proportioning and to understand the effects of various parameters.

Unit-I **(6 Sessions)**
Yield Line Theory: Assumptions, location of yield lines, methods of analysis, analysis of one way and two way slabs.

Unit-II **(8 Sessions)**
Strip Method of Design of slabs: Theory, application to simply supported slab, slab fixed along edges. Flat slabs: Limitations of Direct Design Method, shear in flat slabs, equivalent frame method, openings in flat slabs. Ribbed slabs: Introduction, analysis for moments and shear, deflection, arrangement of reinforcement

Unit-III **(10 Sessions)**
Approximate Analysis of grid floors: Analysis by Timoshenko's plate theory, stiffness method and equating joint deflections. Redistribution of Moments in Beams: Conditions for moment redistribution, single span beams, multi-span beams and design of sections.

Unit-IV **(7 Sessions)**
Slender columns: Effective length, unbraced and braced columns, stability index, columns subjected to combined axial and biaxial bending.
Shear walls: Classification of shear walls, classification according to behaviour and design of rectangular and flanged shear walls.

Unit-V **(9 Sessions)**
Cast-in-situ Beam-column Joints: Forces acting on joints, strength requirement of columns, anchorage, confinement of core, shear strength of joint, corner joint and procedure for design.
Computation of deflection and crack-width: Short term and long term deflection of Beams and slabs, calculation of deflection as per IS 456, factors affecting crack width in beams, calculation of crack width as per. IS 456, shrinkage and thermal cracking.

Course Outcomes:

After completion of this course, students will l able to:

- Show competency in design of advanced reinforced concrete structures.
- Determine the deflection and crack width in case of short term and long term.
- Analyze of one way slab and two way slab.

Suggested Readings:

- "Advanced Reinforced Concrete Design", P.C. Varghese, Prentice Hall of India, New Delhi.
- "Reinforced Concrete Limit State Design" A.K. Jain, Nem Chand & Bros., Roorkee
- "Advanced R.C. Design", Krishna Raju, CBS Publishers, Hyderabad
- "Reinforced Concrete Structures", Park and Pauley, Wiley-Interscience Publications, New Jersey

Website resources:

- https://onlinecourses.nptel.ac.in/noc17_ce23/preview
- https://freevideolectures.com/course/2686/design-of-reinforced-concrete-structures
- https://nptel.ac.in/courses/105/105/105105105/
- http://www.digimat.in/nptel/courses/video/105105105/L10.html

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Effective from Session 2020-21

MCE-103: Advanced Concrete Technology **L T P 3 1 0**

Course Objective:
This course will provide the students with state-of-the art knowledge on durable and sustainable cement and concrete, on the various mineral additions and chemical admixtures to enhance the workability, strength, durability and sustainability of concrete, and will empower them in the decision making process regarding the various concrete products, construction procedures and performance test methods that will improve the durability and sustainability of concrete civil infrastructure.

UNIT-I **(06 Sessions)**
Review of constituents of concrete, mix design and properties of concrete.

UNIT-II **(08 Sessions)**
Plain Concrete, Reinforced concrete, Pre-stressed concrete, Cellular Concrete, Light weight concrete, Hollow concrete blocks, Smart Concrete, Fiber Reinforced Concrete, Ferro-cement,

UNIT-III **(08 Sessions)**
Polymer Concrete Composites, Self-Compacting Concrete, Admixtures, Fly Ash Concrete, High Performance Concrete.

UNIT-IV **(10 Sessions)**
Concreting under extreme weather conditions; Behavior of concrete under aggressive environmental conditions including temperature; Admixtures; Polymers in concrete; Fiber reinforced concrete; Fracture mechanics of concrete.

UNIT-V **(08 Sessions)**
Repairs and rehabilitation of old concrete structures

Course Outcomes:
At the end of the course, students will be able to
- Analyze various constituents and properties of concrete.
- Understand the behaviour and application of various concretes in construction.
- Design different types of concrete mixes.
- Understand techniques in repairs and rehabilitation of old concrete structures.

Suggested Readings:

- Neville A.M., 'Properties of concrete', 3rd ed., 1985, ELBS
- Lea F.M 'Chemistry of cement and concrete', 3rd ed., 1970
- Edward Arnold Proceedings of recent seminars etc. and journals
- Taylor, Concrete Technology
- Orchid, Concrete Technology

Website Sources:
- https://onlinecourses.nptel.ac.in/noc18_ce21/preview
- https://swayam.gov.in/courses/4667-july-2018-advanced-concrete-technology
- https://www.freesharebox.com/mooc/2018-06/584.html
- https://freevideolectures.com/course/3357/concrete-technology

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Effective from Session 2020-21

MCE-106: Earth Retaining Structures **L T P 3 1 0**

Course Objective:
To impart knowledge on earth pressure theories, design of retaining walls, sheet pile walls, coffer dams and earth tunnels.

UNIT- I **(08 Sessions)**
Strength : Introduction, Mohr-Coulomb Failure Theory, Effective Stress Principle, Measurement of Shear Strength, Direct Shear Test, Triaxial Compression Test, Unconfined Compression Test, Skempton's Pore Pressure Parameters.

UNIT- II **(08 Sessions)**
Earth Pressure : Introduction, Theories of Earth Pressure, Active and Passive Earth Pressure using Rankine's and Coulomb's theories, Rebhann's Graphical Method, Culmann's Graphical Method, Design of Gravity Retaining Wall.

UNIT- III **(08 Sessions)**
Sheet Piles: Introduction, Cantilever and Anchored Sheet pile, Cantilever sheet pile wall in cohesive soils, Free Earth Support method, Fixed Earth Method, Rowe's Moment Reduction Curves, Design of Anchors.

UNIT- IV **(08 Sessions)**
Braced Cuts and Coffer Dams: Construction, Types of Coffer dams, Lateral earth pressure on Sheetings, Types of Sheeting and Bracing Systems, Soil pressure on Braced Coffer Dam or Strutted Excavation.

UNIT- V **(08 Sessions)**
Shafts and Tunnels: Stresses in Soil in the vicinity of Vertical Shaft, Stresses in Soil around Tunnels, Construction of Earth Tunnels, Arching in Soils.

Course Outcomes:
At the end of the course, students will be able to
- Understand earth pressure theories and computation of earth pressure.
- Capability to calculate the forces on retaining walls and design the retaining walls.
- Carry out Analysis and design of sheet pile walls.
- Understand principle of construction of coffer dams and soil pressure on them.
- Analyse stresses in shaft and earth tunnel for their construction.

Suggested Readings:
- "Soil Mechanics and Foundation Engineering", V.N.S. Murthy
- "Soil Mechanics and Foundation Engineering", K.R. Arora
- "Pile Foundations Design and Construction", Mittal, S., CBS Publishers New Delhi.

Website Sources:
- https://nptel.ac.in/
- https://en.wikipedia.org/
- https://www.asce.org/

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M.Tech – I Year (II Semester)

Effective from Session 2020-21

MCE-201: Structural Dynamics **L T P 3 1 0**

Course Objective:
The objective is to provide the fundamental understanding of the structural dynamics and the problem solving ability for dynamic response in civil engineering design, analysis and research. Introduce students to analytical and numerical methods in structural dynamics with emphasis on vibration and to opportunities to optimize system for desired dynamic response.

UNIT-I **(08 Sessions)**
Introduction: Objectives, difference between static and dynamic analysis, loading, essential characteristics of a dynamic problem, principles of dynamics, formulation of equation of motion.

UNIT-II **(08 Sessions)**
Single Degree of Freedom System: Analysis of free and forced vibration, Duhamels integral, Damping - types and evaluation, Response of SDOF systems to harmonic excitation, Periodic excitation, Impulsive loading, arbitrary, step, pulse excitation,

UNIT-III **(08 Sessions)**
Response to general dynamic loading, Numerical evaluation of dynamic response- superposition and step by step methods, generalized SDOF systems.

UNIT-IV **(08 Sessions)**
Multi Degree of Freedom Systems: Equations of motion, evaluation of structural property matrices, problem statement and solution methods, free vibration, Forced harmonic vibration, damped motion for MDOF, generalized coordinates, principle of orthogonality of modes.

UNIT-V **(08 Sessions)**
Various Methods of MDOF: Eigen value problem, modal response, approximate methods, Stodalla-Vinaello, Modified Reyleigh's method, Holzer's method, Holzer Myklested method, Energy method, Lagrange's equation, Modal analysis, Stochastic response of linear SDOF and MDOF system to Gaussian inputs.

Course Outcomes:
At the end of the course, students will be able to
- Apply knowledge of mathematics, science, and engineering by developing the equations of motion for vibratory systems and solving for the free and forced response.
- Understand fundamental theory of dynamic equation of motion.
- Understand fundamental analysis methods for dynamic systems.
- Understand dynamic properties and behavior of civil structures.

Suggested Readings:

- Mario Paz, "Structural Dynamics - Theory and Computations", CBS Publications, New Delhi, 1983
- Timoshenko, “Vibration problems in Engineering”, Van Nostrand Co., Inc.
- Biggs, “Introduction to Structural Dynamics”, McGraw Hill Book Co. 1975

Website Sources:
- https://swayam.gov.in/course/3697-structural-dynamics
- http://nptel.ac.in/courses/105101006/
- https://freevideolectures.com/course/3129/structural-dynamics

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M.Tech – I Year (II Semester)

Effective from Session 2020-21

MCE-202: Design of Pre-stressed Concrete Structures **L T P 3 1 0**

Course Objective:
- To familiarize the students with concepts of pre-stressed concrete.
- To impart knowledge to design pre-stressed concrete structures.

UNIT-I **(10 Sessions)**
Review- Basic concept and principles of pre-stressed concrete systems- loss of pre-stress computation of losses. Design and analysis of pre-stressed section for flexure -Stresses at transfer and service loads - study of code provisions - ultimate strength in flexure - code provisions for calculation of deflection (short & long term) in (IS, BS, ACI codes).

UNIT-II **(10 Sessions)**
Complete design of post and pre-tensioned simply supported PSC beams -including end block design- cable profile- shear, bond, deflection. Serviceability requirements- deflection and cracking limit states. Design and analysis of post and pre-tensioned PSC slabs Design of tension members – Application in the design of prestressed cylindrical water tanks.

UNIT-III **(10 Sessions)**
Analysis and design of statically indeterminate structures-continuous beams- con-cordancy and linear transformation- simple cases of cantilever beams and slabs Design criteria and manufacturing methods of uniformly pre-stressed members. PC poles, pipes and railway sleepers (detailed design not expected).

UNIT-IV **(10 Sessions)**
Composite beams –Analysis and design – Ultimate strength – applications, Elementary idea of composite construction for tee beams in bridges Partial pre-stressing- Definitions, principles and design approaches.

Course Outcomes:
At the end of the course, students will be able to
- Understand the general mechanical behavior of pre-stressed concrete.
- Analyze and design pre-stressed concrete flexural members.
- Analyze and design for vertical and horizontal shear in pre-stressed concrete.
- Analyze transfer and development length as well as pre-stress losses.
- Analyze and design for deflection and crack control of pre-stressed concrete members.

Suggested Readings:

- Krishna Raju.N, "Prestressed Concrete", 4th Edition, Tata McGraw Hill Publishing Co. New Delhi 2000
- Dayaratnam.P., "Prestressed Concrete", Tata McGraw Hill Publishing Co. New Delhi 2000
- Sinha .N.C & S.K. Roy, "Fundamentals of Prestressed Concrete, S.Chand & Co., 1985
- Rajagopalan.N. "Prestressed Concrete", Narosa Publishing House, New Delhi – 2002
- Lin .T.Y. "Design of Prestressed Concrete Structures", John Wiley and Sons - Inc – 1960

Website Sources:
- http://nptel.ac.in/courses/105106118
- https://freevideolectures.com/course/94/prestressed-concrete-structures
- https://www.asce.org/

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M.Tech – I Year (II Semester)

Effective from Session 2020-21

MCE-203: Theory of Elasticity **L T P 3 1 0**

Course Objective:
The objective of this course is to make students understand the principles of elasticity; familiarize students with basic equations of elasticity and to expose students to two dimensional problems in Cartesian and polar coordinates. This course also deals with principle of superposition and virtual work.

Unit-I **(8 Sessions)**
Introduction: State of stress at a point in three dimensional elasticity - Principal stresses – Octahedral stresses - Strain at a point - Equilibrium and compatibility conditions - Generalised Hooke's law.

Unit-II **(8 Sessions)**
Plane Cartesian Elasticity: Plane stress - Plane strain - Equations of equilibrium in two dimensions Compatibility of strain - Boundary conditions -

Unit-III **(10 Sessions)**
Plane Problem in Polar Co-ordinates: Solution of two dimensional problems in Polar co-ordinates –axisymmetric Stress distribution – thick cylinder, rotating disc, curved beam- Effect of circular holes on stress distribution in plates - Loads on straight boundaries

Unit-IV **(6 Sessions)**
Strain Energy Methods: Total strain energy- complementary energy - Principle of virtual work and total potential energy

Unit-V **(8 Sessions)**
Theorem of minimum potential energy, Betti's reciprocal theorem, principle of linear superposition, uniqueness of elasticity solution. Theorem of minimum complementary

Course Outcome:

After completion of this course students will be able
- To apply elastic analysis to study the fracture mechanics.
- To apply linear elasticity in the design and analysis of structures such as beams, plates, shells and sandwich composites.
- Understand and analyze stress and deformation
- Understand Basic field equations of linear elastic solids,
- Formulations and solution strategies of various boundary value problems

Suggested Readings:

- "Theory of Elasticity", Filenenko & Boridith, Mir publisher
- "Elasticity Tensor, Dyadic and Engineering applications" P.C. Chwo and, N.J. Pagano, D.Van Nestrand Co.,
- "Theory of Elasticity", Sadhu Singh, Khanna Publishers, New Delhi
- "Theory of Elasticity" , Timoshenko & Goodier, McGraw Hill Company
- "Elasticity: Theory, Applications and Numeric", Martin H. Sadd, Academic Press

Website resources:

- https://nptel.ac.in/courses/105/105/105105177/
- https://onlinecourses.nptel.ac.in/noc20_ce42/preview
- https://www.classcentral.com/course/swayam-theory-of-elasticity-20013
- https://virtual-engineering.com/courses/course-on-theory-of-elasticity/

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Master of Technology (M.Tech) Civil Engineering (Structural Engineering)
M.Tech – I Year (II Semester)

Effective from Session 2020-21

MCE-207: Water Power Engineering **L T P 3 1 0**

Course Objective:
- To develop an understanding of design concept of different components and their arrangement for hydel plants of both run off river plants and pumped storage plants.
- To understand design concept of different components of water conveyance system for power plants.
- To be able to design various components of different types of turbines.
- To gain the knowhow of planning of a power house.

UNIT-1 **(08 Sessions)**
Power from flowing streams, demand for power, role of storage and pondage in water power development, firm power and secondary power. Types of water power developments : Run-off river, storage, pumped storage, tidal and others, characteristics and layout of low, medium and high head hydropower developments.

UNIT-2 **(08 Sessions)**
Types of hydro power plants and their schemes, Elements of hydro power plants
Types of hydraulic turbines and their parts. Water turbines, Types of water turbines, Selection of water turbines, scroll castings and draft tubes, Speed regulation and governing of turbines.

UNIT-3 **(08 Sessions)**
Conveyance of water : Channels, Penstocks, flumes and tunnels. Surges in open channels and water hammer and surges in closed conduits following rapid load changes in the hydro-power plant.

UNIT-4 **(08 Sessions)**
Surge Tanks : Different types of surge tanks, effect of surge tanks on water hammer analysis, calame-Gaden equations. Influence of water hammer on turbine speed regulation , transfer functions for the effect of water hammer on governing stability

UNIT-5 **(08 Sessions)**
Power house : Types of power house, substructure and superstructure. General arrangement and space requirements for standard power house facilities.

Course Outcomes:
At the end of the course, students will be able to
- To design different components and their arrangement for hydel plants of both run off river plants and pumped storage plants.
- To design different components of water conveyance system for power plants.
- To design various components of different types of turbines.
- To perform planning of a power house.

Suggested Readings:

- Singh, B., "Fundamentals of Irrigation Engineering", 9th Ed., Nem Chand & Bros.
- Asawa, G.L., "Irrigation and water Resources Engineering", New Age International.
- Ranga Raju, K.G., "Flow through open Channels", 2nd Ed., Tata McGraw-Hill.
- Varshney, R.S., "Hydro power Structures including canal Structures and small Hydro", 4th Ed., Nem Chand & Bros.

Website Sources:
- https://nptel.ac.in/
- https://en.wikipedia.org/
- https://www.aboutcivil.org/irrigation-engineering-water-resources-lectures.html
- https://www.asce.org/

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STUDY AND EVALUATION SCHEME
(Effective from Session 2020-21)

YEAR II, SEMESTER-III

S.N.	Course Code	Course Name	Periods			EVALUATION SCHEME				Course Total	Credits
						Mid Term Exam			External Exam		
			L	T	P	CT	AS +AT	Total			
THEORY											
1.	MCE-301	Theory of Plates and Shells	3	1	0	20	10	30	70	100	4
2.	MCE-302	Finite Element Methods	3	1	0	20	10	30	70	100	4
3.	MCE-303-306	Elective-III	3	1	0	20	10	30	70	100	4
PRACTICALS / PROJECT											
5.	MCE-351	Seminar	0	0	4	-	100	100	-	100	2
6.	MCE-352	Pre-Dissertation	0	0	4	-	50	50	50	100	2
		TOTAL	**09**	**03**	**08**	**-**	-	-	**-**	**500**	**16**

***Dissertation to be started in III Semester and continued in IV Semester.**

YEAR II, SEMESTER-IV

S.N.	Course Code	Course Name	Periods			EVALUATION SCHEME				Course Total	Credits
						Mid Term Exam			External Exam		
			L	T	P	CT	AS +AT	Total			
PRACTICALS / PROJECT											
1.	MCE-451	Dissertation Work	0	0	20	-	250	250	250	500	10
		TOTAL	**-**	**-**	**20**	**-**	-	-	**-**	**500**	**10**

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Master of Technology (M.Tech) Civil Engineering (Structural Engineering)
M.Tech – II Year (III Semester)

Effective from Session 2020-21

MCE-301 Theory of Plates and Shells **L T P 3 1 0**

Course Objective:
The objective of this course is to the student analyze and design thin shell structures including domes, hyperbolic, parabolic, elliptic and cylindrical shells, and enable them to formulate Finite Element Equations for solution of the structural response of plate bending problems .

UNIT-I **(8 Sessions)**
Theory of Plates:
Introduction to thin plates under small deflection theory - Kirchoff's assumptions - Lame's parameters- Development of strain - Displacement relationships - stress-strain relationships

UNIT-II **(8 Sessions)**
Force-displacement equations and equilibrium equations in curvilinear co-ordinates - Lame's parameters u,v,w equations - variation principles and its applications to plate problems - Study of various boundary conditions.

UNIT-III **(8 Sessions)**
Symmetrical bending of circular plates - Differential equations - Uniformly loaded and concentrically loaded plates with various simply supported and clamped boundary conditions.
Theory of Shells
Introduction - Review of basic theory of shells - Definition and assumptions –strain displacement relationships - Stress-strain relationships

UNIT-IV **(8 Sessions)**
Membrane theory of shells- Application to various shapes - Shells of double curvature – Circular cylindrical shells - Membranes deformation of symmetrically loaded cylindrical and spherical shells.

UNIT-V **(8 Sessions)**
Folded plates -- types- Structural Behavior of folded plates - Equation of three shears – Application-Whitney's method of analysis Design and detailing of folded plates- design by ACI-ASCE task committee method Formwork for shells and folded plates

Course Outcomes: On completing the course the student should be able to:
- Analyze and design thin shell structures including domes, hyperbolic, parabolic, elliptic and cylindrical shells.
- Formulate Finite Element Equations for solution of the structural response of plate bending problems and obtain solutions to shell structures.
- Analyze plates under different boundary conditions by various classical methods and approximate methods.

Suggested Readings

- "Theory of plates and shells", S.P.Timoshenko and S.Woinowsky-Krieger, Tata McGraw Hill,
- "Theory and analysis of plates - classical and numerical methods", Szilard, Prentice Hall Inc.,
- "Design and construction of concrete shell roofs", G.S. Ramaswamy, CBS Publishers
- "Theory of thin shells", Valentin Valentinovich Novozhilov,
- "Theory and Analysis of Elastic Plates and Shells", Reddy J N, McGraw Hill Book company, 2006.
- "Stresses in Plates and Shells", A.C.Ugural, McGraw-Hill, 1999

Website Resources:
- https://nptel.ac.in/noc/courses/noc18/SEM2/noc18-me65/
- https://www.scribd.com/document/355512325/Nptel-for-Beam-Shell
- https://lecturenotes.in/subject/1040/theory-of-plates-and-shells

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Master of Technology (M.Tech) Civil Engineering (Structural Engineering)
M.Tech – II Year (III Semester)

Effective from Session 2020-21

MCE-302 Finite Element Methods **L T P 3 1 0**

Course Objective:
The objective of this course is to introduce importance and applications of Finite Element Method in Simple one dimensional problem, analysis of beams and simplified modeling of two dimensional problems, analysis of plate bending and shell elements.

UNIT-I **(8 Sessions)**
Introduction to Finite Element Method – History of development – Advantages – Disadvantages General description of the method -Basic equations of elasticity- Strain – Displacement relations –Theories of stress and strain – Stress-Strain relations – Plain stress – Plain strain conditions
Direct stiffness method – Review of basic concepts of matrix displacement analysis – Complete stiffness matrices

UNIT-II **(10 Sessions)**
Calculus of variations – Variation principles of solid mechanics – Principles of virtual work –Approximate methods – Rayleigh-Ritz, Weighted residual (Galerkin) and Finite Difference Method. Concept of elements – Displacement model – Shape functions – General coordinates – Natural coordinates – Convergence and Compatibility conditions

UNIT-III **(8 Sessions)**
Analysis of framed structure **– 2D** and **3D** truss and frame elements – applications – Plain stress and plain strain analysis – Triangular elements – CST and LST elements – Rectangular elements –Isoparametric elements – Incompatible models – 8 noded and 20 noded isoparametric solid elements – Axisymmetric solid elements (for solid elements principles of formulations only).

UNIT-IV **(10 Sessions)**
Analysis of plate bending – Basic equation of thin plate theory- Reissner-Mindlin theory – plate elements and applications – Analysis of shells – generated shell elements Programming concepts – Assembling – Boundary conditions – Solution techniques – Band width minimization – Gauss elimination Modelling and analysis using recent softwares

Course Outcomes: Upon successful completion of the course, the students will be able to

- Identify the uses Finite Element Analysis in civil engineering
- Describe different techniques and procedure of the Finite Element Analysis in civil engineering.
- Apply principles of different Finite Element Formulation Techniques.
- Assess the Applications of FEM in civil engineering

Suggested Readings:

- Finite Element Analysis - Theory and Programming, C. S. Krishnamoorthy, Tata McGraw Hill
- Finite Element Procedures in Engineering Analysis, K.J. Bathe, Prentice Hall of India
- Elementary Finite Element Method, C.S. Desai, Prentice Hall of India
- Concepts & Applications of Finite Element Analysis, R. D. Cook, D.S. Malkus & M.F. Plesha,, John Wiley
- An Introduction to the Finite Element Method, J.N. Reddy, McGraw Hill, 2006.
- 6. Introduction to Finite Elements in Engineering, T.R. Chandrupatla & A.D. Belegundu, Pearson

Website resources:

- https://nptel.ac.in/courses/112/104/112104193/
- https://nptel.ac.in/courses/105/105/105105041/
- https://www.simscale.com/docs/simwiki/fea-finite-element-analysis/what-is-fea-finite-element-analysis/
- http://www.scholarpedia.org/article/Finite_element_method

SCHOOL OF ENGINEERING & TECHNOLOGY
DEPARTMENT OF CIVIL ENGINEERING
IFTM UNIVERSITY, MORADABAD

Master of Technology (M.Tech) Civil Engineering (Structural Engineering)
M.Tech – II Year (III Semester)

Effective from Session 2020-21

MCE- 305: Theory of Plasticity **L T P 3 1 0**

Course Objective:
The goal of plasticity theories is the generalization of the one-dimensional model to general, three-dimensional states of stress and strain. This condition justifies the use of deformation theory, a constitutive model relating plastic strain to stress independently of the loading path.

UNIT-I **(8 Sessions)**
Basic equations of theory of elasticity: Index notation. Equations of equilibrium. Strain displacement relations, compatibility. Displacement and traction boundary conditions, plane stress and plane strain problems.

UNIT-II **(6 Sessions)**
Plastic behavior in simple tension, Generalization of results in simple tension, yield surfaces, convexity of yield surface a. normality rule, limit surfaces.

UNIT-III **(8 Sessions)**
Initial Yield Surfaces for Polycrystalline Metals: general form of plastic constitutive equations, hydrostatic stress states and plastic volume change in metals. shear stress on a plane. thevon mises initial yield condition, the Tresca initial yield condition.

UNIT-IV **(10 Sessions)**
Plastic Behavior under Plane Stress Conditions: Initial and subsequent yield surfaces in tension-torsion, elastic perfectly plastic materials. Plastic Behavior of Structures -beam in pure bending, simply supported beam subject. to a central point load. Combined bending and axial force.

UNTI-V **(8 Sessions)**
Theorems of Limit Analysis - Alternative statement of the limit theorems. the specific dissipation friction. Limit Analysis in Plane Stress a. Plane Strain: Discontinuities in stress a. velocity fields, the Tresca yield condition in plane stress and plane strain

Course outcomes:

Students completing this course will be able to.

- This course intends to provide students a comprehensive knowledge on the theory of elasticity and plasticity.
- The course focuses on the following topics: continuous medium, Cartesian tensors, deformation, displacement and strain tensors, compatibility conditions.
- Ability to use standard external and internal forces, equilibrium, stress tensors, principal stresses, invariants and stress deviators, Mohr's circle.
- Ability to use constitutive law, plasticity theory, yield and failure criteria, stability postulates, laws of mechanics, Navier's equations, plane stress and plane strain problems.
- Ability to variation principles, general theory of plane strain for perfectly plastic materials.

Suggested Readings:

- Martin. J.B., Plasticity, Fundamentals a. General Results, NM' Press, Landon.
- Kachanov. L.M.. Fundamentals of the Theory of Plasticity. nr Publishers. Moscow
- Hill, H. Mathematical Theory of Plasticity, Oxford University Press.
- Chen, W.F.. and Han. D.J., Plasticity for Stnictural Engineers. Springer Verlag.
- Timoshenko. Theory of Plasticity, McGraw Hill

Website resources:

- https://nptel.ac.in/courses/105/105/105105177/
- https://nptel.ac.in/courses/112/103/112103279/
- https://easyengineering.net/theory-of-elasticity-and-plasticity-by-jane-helena/
- http://www.scholarpedia.org/article/Finite_element_method