आईएफटीएम विश्वविद्यालय, मुरादाबाद, उत्तर प्रदेश

IFTM University, Moradabad, Uttar Pradesh

NAAC ACCREDITED

Course Structure

&

Syllabus

Of

M.Tech
Civil Engineering
(Structural Engineering)

[Applicable w.e.f. Academic Session - 2022-23]

[As per CBCS guidelines given by UGC]

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

School of Engineering & Technology ★ IFTM University, Moradabad ★
Director

Registrar
IFTM University
Moradabad.

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DEPARTMENT OF CIVIL ENGINEERING
SCHOOL OF ENGINEERING & TECHNOLOGY
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:	***PG 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:

PO1: Apply the knowledge of science, mathematics, and engineering principles for developing problem solving attitude.

PO2: Identify, formulate and solve engineering problems in the domain of structural engineering at local and global level.

PO3: Use different software tools for Analysis and Design in the domain of structural engineering.

PO4: Design and conduct experiments, analyze and interpret data, for development of simulation experiments and local and global challenges.

PO5: Function as a member of a multidisciplinary team with sense of ethics, integrity and social responsibility at national and international level.

PO6: Apply current techniques and skills in the field of structural engineering.

PO7: To solve engineering problems of local and global importance by using potential feasible solutions and evaluate them to arrive at the optimal solution by considering societal and environmental factors / issues.

PO8: Have an understanding of engineering and management principles and apply the same to one's own work as a member and leader in a team and manage projects efficiently at local and global level.

PO9: Recognize the need for and ability to engage in life-long understanding independently with competence and commitment for local and nation development.

PO10: Acquire integrity, code of conduct, ethics of research of national and international level and scholarship and consideration of impact of research outcomes on professional activities.

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Programme Specific Outcomes (PSOs):

The learning and abilities or skills that a student would have developed by the end of two-years.

- Develop skill in analysis and design of contemporary engineering problems as per specifications and standards.
- Apply engineering tools, instrumentation and software for solving structural engineering problems.
- Knowledge of advance method construction technique for practicing alternatives and cost effective construction materials & methodology.
- To engage graduates for fulfilling societal needs from their learning.

Choice Based Credit System (CBCS):

Choice based credit system (CBCS), provides a learning platform wherein the student or knowledge seeker has the flexibility to choose their course from a list of elective, core and soft skill courses. This is a student-centric approach to achieve his target number of credits as specified by the UGC and adopted by our University.

Groups of CBCS:

The following is the course module designed for the M.Tech program:

1. Elementary / Fundamental Science courses (FSC)
2. Engineering Core Courses (ECC)
3. Engineering departmental Elective (EDE)
4. Dissertation/Seminar (DS)

- **Elementary / Fundamental Science courses (FSC):**
  These courses include fundamental science courses crafted for engineering students. These courses are of 4 credits each.

- **Engineering Core courses (ECC):**
  Engineering Core courses of M.Tech program will provide a holistic approach to master education, giving students an overview of the field, a basis to build and specialize upon. These core courses are the strong foundation to establish engineering knowledge and provide broad multi-disciplined knowledge can be studied further in depth during the elective phase.
  The core courses will provide more practical-based knowledge, case-based lessons and collaborative learning models. It will train the students to analyze, decide, and lead-rather than merely know-while creating a common student experience that can foster deep understanding, develop decision-making ability and contribute to the business and community at large.
  A wide range of core courses provides groundwork in the basic engineering disciplines: The integrated foundation is important for students because it will not only allow them to build upon existing skills, but they can also explore career options in a range of industries, and expand their understanding of various research fields.

- **Engineering Departmental Elective (EDE):**
  Engineering departmental Elective is an interdisciplinary additional subject that is compulsory in the first, second and third semester of a program. The score of Electives is counted in your overall aggregate marks under Choice Based Credit System (CBCS). Each Elective paper will be of 4 Credits and students will have the choice of taking electives. Each student has to take Electives from department other than the parent department.These courses are of 4 credits each.

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- **Dissertation/Seminar(DS):**
  1.Dissertation with a department faculty.
  2.The students, who take up experiential dissertation in companies, where senior executives with a stake in teaching guide them, drive the learning. All students are encouraged to do some live project other than their regularclasses.
  3.Industrial visit are essential to give students hand-on exposure and experience of how things and processes work in industries. Our institute organizes such visits to enhance students exposure to practical learning and workout for such a visit relating to their specific topic, course or even domain.

M.Tech. Civil Engineering (Structural Engineering): Two-Year (4-Semester) CBCS Programme			
Basic Structure: Distribution of Courses			
S.No.	**Type of Course**	**Credit**	**Total Credits**
1	**Elementary / Fundamental Science courses (FSC)**	01 Course of 4 Credits (Total Credit 1X4)	04
2	**Engineering Core courses (ECC)**	07 Courses of 4 Credits each (Total Credit 7X4)	28
3	**Engineering Departmental Elective (EDE)**	03 Courses of 4 Credits each (Total Credit 3X4)	12
4	**Dissertation/Seminar (DS)**	02 Courses of 2 Credits each (Total Credit 2X2) 1 Course of 10 Credits (Total credit 1x10)	14
Total Credits			**58**

Evaluation of Performance

1. Programmes: Evaluation of performance of the students in a programme shall be a continuous process based on their performance in the class test, assignments and the end semester examinations.

Theory papers in semester system (Maximum Marks: 100)

The evaluation will be done through two class test and one end semester examination. This will be in addition to assignments, attendance, etc. Each class test will carry a weightage of 10 marks, and the end semester examination will carry a weightage of 70 marks. The remaining 10 marks will be awarded on the basis of attendance and performance in quizzes and assignments.

2.Dissertation, Seminar: Seminar, Dissertation, and other learning-oriented activities shall have associated maximum marks and credits, as stated in the syllabus.

3. Examination:

a. The minimum Grade required to pass in each Theory & Practical paper is 'GRADE D'.

b. A candidate, in order to pass, minimum CGPA of 4.50 is required in a particular academic year inclusive of both semesters of that academic.

c. There shall be no minimum Grade required to pass in General Proficiency (GP). However, Grade obtained in General Proficiency (GP) shall be included in SGPA.

d. For further information, examination ordinance of IFTM University can be followed.

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Evaluation Scheme:			
Type of Exam	*Internal*	*External*	*Total*
Theory	*30*	*70*	*100*
Seminar	*100*	*--*	*100*
Pre-Dissertation	*50*	*50*	*100*
Dissertation	*250*	*250*	*500*

Unique practices adopted:

The method and practice of teaching, especially for teaching an academic subject or theoretical concept". In addition to conventional time-tested lecture method, the institute will emphasize on **experiential learning.**

Audio-Visual Based Learning:
It is clear that audio visual aids are important tools for teaching learning process. It helps the teacher to present the lesson effectively and students learn and retain the concepts better and for longer duration. Use of audio-visual aids improves student's critical and analytical thinking. It helps to remove abstract concepts through visual presentation. However, improper and unplanned use of these aids can have negative effect on the learning outcome. Therefore, teachers should be well trained through in-service training to maximize the benefits of using these aids. The curriculum should be designed such that there are options to activity-based learning through audio-visual aids. In addition, government should fund resources to purchase audio-visual aids in colleges

Field / Live Projects:
The objective of their training program is to enhance knowledge of the students on any one of the Trending technologies according to the industry standards without which the student degree is a mere degree. This is done by making students work on live projects which equip them with the required skill needed for the corporate world.

Personality Development Program (PDP):
It is conducted by professional trainers/experts from corporates as also by dedicated in-house faculty to actually bring a change in the traits of students in terms of values, behavior and personal growth. It enhances their body language, self-discipline, includes boosting one's confidence, improving language speaking abilities and widening one's scope of knowledge. Following PDP programs are undertaken in the Institute.

- **Aptitude:** Prepare students for placements by enhancing students' understanding in reasoning, numeric aptitudes, language proficiencies and general awareness.
- **Resume Writing:** Trains students about the current trend to present their Personal, Educational & Professional achievements and Strengths in an impressive manner. They learn how to write covering letter through which they can efficiently present their extra information. They also get an exposure to the Social Professional Sites like LinkedIn.
- **Group Discussion:** Help students to improve their ability to understand a topic/idea from different perspectives. They are able to realize its importance as a standard recruitment and selection tool. Students are trained to demonstrate their leadership, team work, oral and body language skills.
- **Personal Interview:** A platform to train students in improving their listening abilities and handling interviewer's questions and answer accordingly so that they are able to remove hesitation and anxiety during placement process.

Student Development Programs (SDP):
SDP has various modules dealing with professional development, awareness and opinion building, communication and self-presentation etc. The purpose of these modules is to help students grow as individuals, develop the power of critical thinking and, at a material level, secure better placements

Special Guest Lectures (SGL):
Guest lectures are a highly useful medium to provide exceptional knowledge to students, it also adds an extra variety to the classroom routine and universities put a lot of emphasis on the importance of Guest lectures. The Guest lecturers are the "real-world" arriving in the classroom in order to make classes more interesting.

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Industrial Visits:
Industrial visits are an integral part of engineering and acknowledgment of technological up gradation. Industrial visit is considered as one of the tactical methods of teaching. The main reason behind this, it lets student to know things practically through interaction, working methods and employment practices. Moreover, it gives exposure from academic point of view. Main aim of industrial visit is to provide an exposure to students about practical working environment. They also provide students a good opportunity to gain full awareness about industrial practices. Through industrial visit students get awareness about new technologies. Technology development is a main factor, about which a students should have a good knowledge. Visiting different companies actually help students to build a good relationship with those companies.

Industry Focused programs:
Industry oriented education is an approach to learning from an industry perspective where core subjects are taught in the context of application of that knowledge to product design, development and operation.Establishing collaborations with various industry partners to deliver the programme on sharing basis. The specific courses/contents are to be delivered by industry experts to provide practice based insight to the students.

Mentoring scheme:
The new process has been established as Mentoring System". Each faculty will be the mentor of a group of 10 to 15 students. Every Student shall be provided with a faculty Mentor to help him /her in their personal & Academic Issues. The mentor maintains a register of all his/her mentees with complete personal & parents 'details. It is essential to have at least to meet once in a month. The mentor enters the discussions held, advice given and efforts & improvements made by the mentee.

Extracurricular Activities:
In IFTM University, various Co-Curricular and Extra-Curricular activities are regularly conducted along with regular academic activities and students are continuously inspired and motivated to participate in these various activities to ensure the overall development of the students.

• **Cultural Activities:** The various activities undertaken are – Singing, Dancing, Playing Musical Instruments, Compering, Skit, Band, Stand-up Comedy, Poetry, Fashion Show etc. These activities help to develop self-confidence, cultural interest, creativity and sense of cooperation among students.

• **Games & Sports:** IFTM strongly believes that a healthy physique leads to a healthy mind. The Institute encourages sports culture and students also reciprocate by actively participating and distinguishing themselves at Sports Meets. IFTM possesses proper playgrounds and hard courts for outdoor sports. In Boys hostels students enjoy the facilities of Gym, badminton, and Table Tennis. The various sports activities undertaken are – cricket, football, basketball, volley ball, carom, chess, badminton, athletics etc. They increase self-esteem & mental alertness among students and promote team spirit. They also lead to balanced mental andphysical growth of the students and teach them life skills like discipline, teamwork, leadership, patience, perseverance etc.

- **Induction program:** Every year induction program is organized for 1st year students to make them familiarize with the entire academic environment of university including curriculum, classrooms, labs, faculty/ staff members, academic calendar and various activities.

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SCHOOL OF ENGINEERING & TECHNOLOGY
IFTM UNIVERSITY
(Established under UPGovt.ActNo.24 of 2010 and approved under section 22 of UGC Act 1956)
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Telephone: 0591-2360817, 2360818 **Email:**admissions@iftmuniversity.ac.in**Website:** www.iftmuniversity.ac.in

DEPARTMENT OF CIVIL ENGINEERING
Master of Technology
CBCS Programme
Effective from Session 2022-23

Course Code		CBCS BASKET	Credits			
Elementary/Fundamental Science courses(FSC)			**L**	**T**	**P**	**C**
TMCE302		Finite Element Methods	3	1	0	4
Engineering Core Courses(ECC)			**L**	**T**	**P**	**C**
TMCE101		Advanced Structural Analysis	3	1	0	4
TMCE102		Advanced RCC Design	3	1	0	4
TMCE103		Advanced Concrete Technology	3	1	0	4
TMCE201		Structural Dynamics	3	1	0	4
TMCE202		Design of Pre-stressed Concrete Structures	3	1	0	4
TMCE203		Theory of Elasticity	3	1	0	4
TMCE301		Theory of Plates and Shells	3	1	0	4
Engineering Departmental Elective (EDE)			**L**	**T**	**P**	**C**
Elective- I	TMCE106	Earth retaining Structures	3	1	0	4
	TMCE011	Soil Structure Interaction	3	1	0	4
	TMCE012	Advance Design of Steel Structures	3	1	0	4
	TMCE013	Limit State Design of Concrete Structures	3	1	0	4
	TMCE014	Matrix Methods in Structural Analysis	3	1	0	4
	TMCE015	Advanced Fluid Mechanics	3	1	0	4
	TMCE016	Building Architecture & Planning	3	1	0	4
	TMCE017	Precast & Composite Structure	3	1	0	4
	TMCE018	Advance design of hydraulic structure	3	1	0	4
	TMCE019	Numerical method in Geotechnical Engineering	3	1	0	4
	TMCE019(A)	Sustainable water and sanitation system	3	1	0	4
	TMCE019(B)	Infrastructure Development	3	1	0	4
	TMCE019(C)	Applies Elasticity and Plasticity	3	1	0	4
	TMCE019(D)	Computer Application in Water resource Engineering	3	1	0	4
Elective- II	TMCE207	Water Power Engineering	3	1	0	4
	TMCE021	Advance Design of Metal Structures	3	1	0	4
	TMCE022	Numerical Methods in Civil Engineering	3	1	0	4
	TMCE023	Rock Mechanics	3	1	0	4
	TMCE024	Design of Bridges	3	1	0	4
	TMCE025	Design of Pavements	3	1	0	4
	TMCE026	Structural Design of foundation and Retaining structure	3	1	0	4
	TMCE027	Earthquake Geotechnical Engineering	3	1	0	4
	TMCE028	Water resources development and management	3	1	0	4
	TMCE029(A)	Marine Construction	3	1	0	4
	TMCE029(B)	Computational Method in structural Engineering	3	1	0	4
	TMCE029(C)	Experimental Stress Analysis	3	1	0	4
	TMCE029(D)	Low cost materials and construction Techniques.	3	1	0	4
	TMCE029(E)	Open channel Hydraulics	3	1	0	4

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	TMCE029(F)	Strength and Deformation behaviour of soil	3	1	0	4
Elective- III	TMCE305	Theory of Plasticity	3	1	0	4
	TMCE031	Earthquake Analysis & Design of Structures	3	1	0	4
	TMCE032	Design of Steel Bridges	3	1	0	4
	TMCE033	Analysis and Design of Shell Structures	3	1	0	4
	TMCE034	Advanced Soil Mechanics	3	1	0	4
	TMCE035	Repair Rehabilitation and Retrofitting of Building	3	1	0	4
	TMCE036	Ground water flow and pollution modeling	3	1	0	4
	TMCE037	Numerical Analysis in Infrastructure Engineering	3	1	0	4
	TMCE038	Cost effective and Ecofriendly construction	3	1	0	4
	TMCE039	Plastic Analysis of structures	3	1	0	4
	TMCE039(A)	Construction costing and financial Management	3	1	0	4
	TMCE039(B)	Municipal Solid waste Management	3	1	0	4
	TMCE039(C)	Structural Health Monitoring and Rehabilitations	3	1	0	4
Dissertation/Seminar (DS)			**L**	**T**	**P**	**C**
TMCE351		Seminar	0	0	4	2
TMCE352		Pre-Dissertation	0	0	4	2
TMCE451		Dissertation Work	0	0	20	10

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

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

STUDY AND EVALUATION SCHEME (Effective from 2022-23)
YEAR I, SEMESTER- I

S.N.	Category	Course Code	Course Name	Periods			EVALUATION SCHEME				Course Total	Credits
							Mid Term Exam			External Exam		
				L	T	P	CT	AS +AT	Total			
THEORY												
1.	ECC	TMCE101	Advanced Structural Analysis	3	1	0	20	10	30	70	100	4
2.	ECC	TMCE102	Advanced RCC Design	3	1	0	20	10	30	70	100	4
3.	ECC	TMCE103	Advanced Concrete Technology	3	1	0	20	10	30	70	100	4
4.	EDE	TMCEI	Elective – I	3	1	0	20	10	30	70	100	4
TOTAL				**12**	**04**	**00**	-	-	-	-	**400**	**16**

Elective – I (TMCE-1)

Course Code	Course Name
TMCE106	Earth retaining Structures
TMCE011	Soil Structure Interaction
TMCE012	Advance Design of Steel Structures
TMCE013	Limit State Design of Concrete Structures
TMCE014	Matrix Methods in Structural Analysis
TMCE015	Advanced Fluid Mechanics
TMCE016	Building Architecture & Planning
TMCE017	Precast & Composite Structure
TMCE018	Advance design of hydraulic structure
TMCE019	Numerical method in Geotechnical Engineering
TMCE019(A)	Sustainable water and sanitation system
TMCE019(B)	Infrastructure Development
TMCE019(C)	Applies Elasticity and Plasticity
TMCE019(D)	Computer Application in Water resource Engineering

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STUDY AND EVALUATION SCHEME (Effective from 2022-23)
YEAR I, SEMESTER- II

S.N.	Category	Course Code	Course Name	Periods			EVALUATION SCHEME				Course Total	Credits
							Mid Term Exam			External Exam		
				L	T	P	CT	AS +AT	Total			
THEORY												
1.	ECC	TMCE201	Structural Dynamics	3	1	0	20	10	30	70	100	4
2.	ECC	TMCE202	Design of Pre-stressed Concrete Structures	3	1	0	20	10	30	70	100	4
3.	ECC	TMCE203	Theory of Elasticity	3	1	0	20	10	30	70	100	4
4.	EDE	TMCEII	Elective – II	3	1	0	20	10	30	70	100	4
TOTAL				**12**	**04**	**00**	-	-	-	-	**400**	**16**

Elective – II (TMCE-II)

Course Code	Course Name
TMCE207	Water Power Engineering
TMCE021	Advance Design of Metal Structures
TMCE022	Numerical Methods in Civil Engineering
TMCE023	Rock Mechanics
TMCE024	Design of Bridges
TMCE025	Design of Pavements
TMCE026	Structural Design of foundation and Retaining structure
TMCE027	Earthquake Geotechnical Engineering
TMCE028	Water resources development and management
TMCE029(A)	Marine Construction
TMCE029(B)	Computational Method in structural Engineering
TMCE029(C)	Experimental Stress Analysis
TMCE029(D)	Low cost materials and construction Techniques.
TMCE029(E)	Open channel Hydraulics
TMCE029(F)	Strength and Deformation behaviour of soil

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

STUDY AND EVALUATION SCHEME (Effective from 2022-23)
YEAR II, SEMESTER-III

S.N.	Category	Course Code	Course Name	Periods			EVALUATION SCHEME				Course Total	Credits
							Mid Term Exam			External Exam		
				L	T	P	CT	AS +AT	Total			
THEORY												
1.	ECC	TMCE301	Theory of Plates and Shells	3	1	0	20	10	30	70	100	4
2.	FSC	TMCE302	Finite Element Methods	3	1	0	20	10	30	70	100	4
3.	EDE	TMCEIII	Elective- III	3	1	0	20	10	30	70	100	4
PRACTICALS / PROJECT												
4.	DS	TMCE351	Seminar	0	0	4	-	-	100	-	100	2
5.	DS	TMCE352	Pre-Dissertation	0	0	4	-	-	50	50	100	2
TOTAL				**09**	**03**	**08**	-	-	-	-	**500**	**16**

Elective – III (TMCE-III)

Course Code	Course Name
TMCE305	Theory of Plasticity
TMCE031	Earthquake Analysis & Design of Structures
TMCE032	Design of Steel Bridges
TMCE033	Analysis and Design of Shell Structures
TMCE034	Advanced Soil Mechanics
TMCE035	Repair Rehabilitation and Retrofitting of Building
TMCE036	Ground water flow and pollution modeling
TMCE037	Numerical Analysis in Infrastructure Engineering
TMCE038	Cost effective and Ecofriendly construction
TMCE039	Plastic Analysis of structures
TMCE039(A)	Construction costing and financial Management
TMCE039(B)	Municipal Solid waste Management
TMCE039(C)	Structural Health Monitoring and Rehabilitations

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IFTM UNIVERSITY, MORADABAD.

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

STUDY AND EVALUATION SCHEME (Effective from 2022-23)
YEAR II, SEMESTER-IV

S.N.	Category	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.	DS	TMCE451	Dissertation Work	0	0	20	-	-	250	250	500	10
TOTAL				-	-	**20**	-	-	-	-	**500**	**10**

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IFTM University, Moradabad
Department of Civil Engineering

Master of Technology (M.Tech) Programme
(Effective From Session 2022-23)

TMCE101: ADVANCED STRUCTURAL ANALYSIS

L T P 3 1 0

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 and understanding for skill development & employability. The Elastic Centre Method- Introduction- Concept of elastic centre- Application to portal frames with fixed base.

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 and understanding for skill development. Ancillary diagram, resolving equations, analysis of redundant frame.

UNIT III **(6 Sessions)**
Direct Stiffness Method: Stiffness Matrices for truss element, beam element & grid element, indirect load applications, interaction scheme and load path, truss sub-divided panel and knowledge for better entrepreneurship and skill development in structures. Limit plastic analysis of frame, limit combination diagram.

UNIT IV **(8 Sessions)**
Direct Stiffness Method & 3 D Elements
Transformation matrix for 3 D truss element & 3 D beam element, Introduction reaction calculation for simple and compound and structure plane truss analysis shear and moment diagram for skill development and employability.

UNIT V **(8 Sessions)**
Non-Linear Structural Analysis: Material Non-Linearity, Introduction to plastic analysis for better skilling development, 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:

CO1: Understand the concepts of the stuffiness and flexibility matrices at local level to develop model for skill development and employability.
CO2: Analyze skeleton structures having secondary effects using direct stiffness method for enhancing skill development.
CO3: Analyze truss element and structures using stiffness method for facing global and national challenegesfor strategic alliance of skill development and entrepreneurship development.
CO4: Derive stiffness by direct method on 2D and 3D elements for the analysis of skill development and employability.
CO5: Solve realistic engineering problems through the non linear structure analysis for national importance to plastic analysis for skill development.

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PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	3	1	3	3	3	1	2
CO2	3	2	2	3	2	2	3	2	1	2
CO3	3	3	3	3	2	3	2	3	2	3
CO4	3	3	3	2	1	3	3	2	1	1
CO5	3	3	2	3	2	2	3	3	2	2

CO-Curriculum Enrichment Mapping(Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship development
CO1	3	2	1
CO2	3	1	2
CO3	3	3	1
CO4	3	3	2
CO5	3	1	1

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

Note: Latest editions of all the suggested readings must be used.

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TMCE102: ADVANCED R.C.C DESIGN **L T P 3 1 0**

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 for skill development and employability.

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 provide knowledge for better employability in industry

UNIT III **(10 Sessions)**
Approximate Analysis of grid floors: Analysis by Timoshenko's plate theory for better skilling of entrepreneurship, 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 will develop skills.

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 for better skilling of entrepreneurship, 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:
CO1: Understand the concept of yield line theory at local, national and international levelfor building skills development and employability.
CO2: Know about the flat slabs, its components and its analysis for global importancefor skill development.
CO3: Gain knowledge about the analysis of grid floors by Timoshenko's plate theory to enhance the knowledge of entrepreneurship development.
CO4: Know about the competency in design of advanced reinforced concrete structures such as Column, shear wall for building models of skill development and employability.
CO5: Determine the deflection and crack width in case of short term and long term at local leveland to implement the knowledge for enhancing skill development and entrepreneurship development.

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PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	1	3	3	3	2	1	3	1
CO2	3	3	2	3	1	3	3	3	1	3
CO3	3	3	3	2	1	3	3	2	1	3
CO4	3	2	3	3	3	2	2	3	3	1
CO5	3	2	1	3	3	3	3	2	2	3

CO-Curriculum Enrichment Mapping(Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship development
CO1	3	3	2
CO2	3	2	2
CO3	1	2	3
CO4	3	2	3
CO5	2	2	3

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

Note: Latest editions of all the suggested readings must be used.

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TMCE103: ADVANCED CONCRETE TECHNOLOGY **L T P 3 1 0**

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 to develop skill, and will empower them in the decision making process regarding the various concrete products, construction procedures and performance test methods provide knowledge for better employability 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 to develop skill.

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 for skill development and employability.

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

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 for skill development

UNIT V **(08 Sessions)**
Repairs and rehabilitation of old concrete structures for skill development and entrepreneurship.

Course Outcomes:
At the end of the course, students will be able
CO1: To analyze various constituents and properties of concrete at local and global levelto develop skill and employability.
CO2: To understand the behavior and application of special concretes in construction for skill development and employability.
CO3: To explain and design different types of concrete mixes for global importance for skill development and employability.
CO4: To understand concept of concreting under extreme weather condition and fracture mechanics of concrete for skill development and employability.
CO5: To understand techniques in repairs and rehabilitation of old concrete structures for skill development and entrepreneurship.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	3	2	3	2	1	2	2
CO2	3	3	2	3	2	2	2	2	1	3
CO3	3	3	2	2	3	2	2	2	2	2
CO4	3	3	3	3	2	2	3	1	3	1
CO5	3	3	3	3	2	2	2	2	2	2

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CO-Curriculum Enrichment Mapping (Please **write 3, 2, 1** wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	3	1
CO2	3	2	1
CO3	3	2	1
CO4	3	1	1
CO5	3	2	3

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

Note: Latest editions of all the suggested readings must be used.

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TMCE106: EARTH RETAINING STRUCTURES **L T P 3 1 0**

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 to develop skills.

UNIT II **(08 Sessions)**
Earth Pressure : Introduction, Theories of Earth Pressure provide better skills of entrepreneurship, 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 for skill development and employability.

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 provide knowledge for skill development.

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

Course Outcomes:
At the end of the course, students will be able to
CO1: Understand Mohr-Coulomb failure theory, effective stress principle and tests on soils for national and international importance for skill development.
CO2: Understand earth pressure theories and computation of earth pressure; capability to calculate the forces on retaining walls and design the retaining walls employability.
CO3: Carry out Analysis and design of sheet pile walls at local level for skill development and employability.
CO4: Understand principle of construction of coffer dams and soil pressure on them.
CO5: Analyze stresses in shaft and earth tunnel for their construction for facing global challenges for skill and entrepreneurship development.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	3	1	3	3	3	3	3
CO2	3	3	1	2	3	2	2	1	3	1
CO3	3	3	2	2	1	3	2	3	1	3
CO4	3	2	3	3	3	2	3	1	3	1
CO5	3	3	2	3	1	3	2	3	3	3

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CO-Curriculum Enrichment Mapping (Please **write 3, 2, 1** wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	**3**	2	2
CO2	1	**3**	2
CO3	**3**	**3**	2
CO4	3	2	1
CO5	**3**	2	**3**

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/

Note: Latest editions of all the suggested readings must be used.

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TMCE011: SOIL STRUCTURE INTERACTION L T P 3 1 0

Objective:
To get an idea on soil structure interaction, soil foundation models, finite difference and finite element analysis and elastic analysis of piles and piled raft. Analyse the structure with soil structure interaction effects to obtain the realistic response

UNIT I **(8 Sessions)**
Soil structure interaction and 'flexible' approach to the design of foundations, Contact Pressure from theory of Elasticity and Sub grade reaction, Concept of sub grade modulus, effects/parameters influencing sub grade modulus Experimental Determination of Sub grade, Permanent and temporary soil retaining structures for skill development and entrepreneurship skill development. Introduction, critical study of conventional methods of shallow foundation design, Critical study of conventional methods of shallow foundation design.

UNIT II **(8 Sessions)**
Beam on Elastic foundation-soil models: Infinite beam, two parameters, Isotropic elastic half space, analysis of beams of finite length, classification of finite beams in relation to their stiffness. Plate on Elastic medium: Infinite plate, Winkler, two parameters, isotropic elastic medium, thin and thick plates, analysis of finite plates: rectangular and circular plates.Semi-infinite beam, Time-dependent response, Beams on Elastic Foundation

UNIT III **(8 Sessions)**
Analysis and design of rafts and mats incorporating soil structure interaction Role of soil-structure interaction in earthquake resistant design, Finite difference solution to problems of beams on elastic foundation. Soil – structure Interaction inframedstructure, FEM Modeling. Use of appropriate software packages for skill development and employability..

UNIT IV **(8 Sessions)**
Use of Finite Difference Method (FDM) for soil structure interaction problems, Reese and Matlock's generalized solution. Modern concept of analysis of piles and pile groups Elastic analysis of piles: Elastic analysis of single pile, theoretical solutions for settlement and load distributions

UNIT V **(8 Sessions)**
Sheet pile wall deflection analysis, Pile group analysis, interaction analysis, load distribution in groups with rigid cap. Laterally loaded pile: Load deflection prediction for laterally loaded piles, sub-grade reaction and elastic analysis, interaction analysis for skill development and employability, pile raft system. Uplift capacity of piles and anchors , negative skin friction, settlement of pile group under compressive load by Interaction Factor Approach.

Course Outcomes:
At the end of the course, students will be able to
CO1: Understand soil structure interaction concept and complexities at local level involved to develop employability and entrepreneurship development.
CO2: Evaluate soil structure interaction for different types of structure at local, national and international level under various conditions of loading and subsoil characteristics to develop models for skill developments and employability
CO3: Prepare comprehensive design oriented computer programs for interaction problems based on theory of sub grade reaction such as beams, footings, rafts etc. for skill development.
CO4: Analyze different types of frame structure founded on stratified natural deposits with linear and non-linear stress-strain characteristics for facing global challeneges and its analysis for entrepreneurship development.
CO5: Evaluate action of group of piles considering stress-strain characteristics of real soils to develop the models analysis for skill development and employability.

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PO-CO Mapping (Please write 3, 2, 1 wherever required)
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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	3	1	3	3	3	3	2
CO2	3	2	2	3	3	2	3	2	1	2
CO3	3	3	3	3	2	3	2	3	2	3
CO4	3	3	3	2	3	3	3	2	3	3
CO5	3	3	2	3	2	2	3	3	2	2

CO-Curriculum Enrichment Mapping (Please **write 3, 2, 1** wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	2	3	3
CO2	3	3	1
CO3	3	2	1
CO4	2	1	3
CO5	3	3	1

Suggested readings:-

- Soil mechanics by TW Lambe&Whitmen.
- Deb, D., "Finite Element Methods- Concepts and Application in Geomechanics", PHI Learning Pvt. Ltd.
- Joseph E. Bowles, "Foundation Analysis and Design" McGraw-Hill.
- Analytical and Computer Methods in Foundation, Bowels J.E., McGraw Hill Book Co., New York, 1974.
- Numerical Methods in Geotechnical Engineering, Desai C.S. and Christian J.T., McGraw Hill Book Co., New York.
- Soil Structure Interaction - The real behaviour of structures, Institution of Structural Engineers.

Website resources:

- https://nptel.ac.in
- https://onlinecourses.nptel.ac.in/noc20_ce42/preview
- https://lecturenotes.in/subject/1040/soil structure interaction

Note: Latest editions of all the suggested readings must be used.

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TMCE012: ADVANCED DESIGN OF STEEL STRUCTURES **L T P 3 1 0**

Objective: The main objective of this course is to create awareness and share knowledge on the design provisions as per current codes leading to wider use in the future. A broader understanding of the behavior of steel structures as systems, in opposition to individual elements only, is to be achieved through this course for skill development and for better skilling of entrepreneurship.

UNIT I **(8 Sessions)**

Introduction to Limit States: Introduction, standardization, allowable stress design, limit state design, partial safety factors, concept of section classification: plastic, compact, semi-compact & slender.

UNIT II **(8 Sessions)**

Columns: Basic concepts, strength curve for an ideal strut, strength of column members in practice, effect of eccentricity of applied loading, effect of residual stresses, concept of effective lengths, no sway & sway columns, torsional and torsional-flexural buckling of columns,

UNIT III **(8 Sessions)**

Laterally Restrained beams: Flexural & shear behaviour, web buckling & web crippling, effect of local buckling in laterally restrained 'plastic' or 'compact' beams, combined bending & shear, unsymmetrical bending.

Unrestrained Beams: Similarity of column buckling & lateral buckling of beams, lateral torsional buckling of symmetric section, factors affecting lateral stability, buckling of real beams, design of cantilever beams, continuous beams for skill development and employability.

UNIT IV **(8 Sessions)**

Beam Columns: Short & long beam columns, effects of slenderness ratio and axial force on modes of failure, beam column under biaxial bending, strength of beam columns, local section failure & overall member failure.

UNIT V **(8 Sessions)**

Beams Subjected to Torsion and Bending: Introduction, pure torsion and warping, combined bending and torsion, capacity check, buckling check, design methods for lateral torsional buckling for skill development and employability.

Course Outcomes: After the completion of this course students will be able to

CO1: Identify and compute the design loads on a typical steel building for developing models for skill development.

CO2: Identify the different failure modes of steel tension and compression members and beams at local and global level, and compute their load for entrepreneurship development and skill development.

CO3: Select the most suitable section shape and size for tension and compression members and beams according to specific design criteria and develop strategic alliance for skill development.

CO4: Understand the concept of beam column- short & long beam column, strength of beam column & overall member failure, etc. for employability.

CO5: Understand the concept of beams subjected torsion and bending for national importance and develop skill and employability.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	3	3	2	3	3	3	3
CO2	3	3	1	1	3	3	2	2	3	1
CO3	3	3	3	1	3	3	3	1	1	3
CO4	3	3	1	3	3	3	2	3	2	1
CO5	3	3	1	3	3	2	3	3	3	1

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CO-Curriculum Enrichment Mapping (Please **write 3, 2, 1** wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	2	1
CO2	3	1	3
CO3	3	2	1
CO4	2	3	1
CO5	3	3	2

Suggested readings:

- Gaylord &Gaylrod, Design of Steel Structures, McGraw Hill
- Duggal, S.K., "Limit State Design of Steel Structures", Tata mcGrawHill
- Subramanian, N., "Design of Steel Structures", Oxford University Press.

Web sources:

- https://nptel.ac.in/courses/105/106/105106113/
- https://nptel.ac.in/courses/105/105/105105162/
- https://lecturenotes.in/subject/161/design-of-steel-structure-dss

Note: Latest editions of all the suggested readings must be used.

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TMCE013: LIMIT STATE DESIGN OF CONCRETE STRUCTURES **L T P 3 1 0**

Objective:
The main objective of this course is to introduce students to

- Gain basic knowledge of Limit state design RC member and understand the ductile detailing, redistribution of moments in fixed & two spans and calculation of deflection due to load, shrinkage & creep as IS code.
- Understand one way & two way and slabs on gradesand basics of pre-stressed concrete design.
- Gain knowledge of direct stiffness method to solve problems in unbounded and bounded pre-stressed concrete beam and analysis & design of of ends blocks.
- Gain knowledge of solving problems in virtual work method.

UNIT I **(08 sessions)**
Review of Limit State Design of RC members, Confinement of concrete, ductile detailing, Redistribution of Moments in Fixed & Two spans continuous beams, Calculation of deflection due to load, shrinkage & creep and calculation of crack width as per IS code for skill development and employability

UNIT II **(08 sessions)**
Slabs (one way & two way and slabs on grades), Preliminary sizing and modeling of RC structures, Design of canopy,Basics of Pre-stressed concrete Design, Material, Pre-stressing systems, Losses, Stress checks, Strength check, design and innovation for special structures.

UNIT III **(08 sessions)**
Deflection of pre-stressed concrete beams, pre-stressed slabs and Beams, Behavior of unbounded and bonded pre-stressed concrete beams, Shear and Torsional resistance of the pre-stressed concrete members,Design of staircase,Types and Planning of StaircasesDesign of End Block Structural audit of various structures such as load bearing wall type implementation of audit, format of reporting, consequences Analysis and design of End blocks for employability and for better skilling of entrepreneurship.

UNIT IV **(08 sessions)**
Analysis & Design of axially loaded Short column & analysis with uniaxial and biaxial bending, Column interaction diagram, its construction & use, Introduction to design and analysis of slender columns,design of aspects of terrorism resistant building, Introduction to Analysis & Design of folded plates and shells for employability and entrepreneurship..

UNIT V **(08 sessions)**
Yield line theory for slabs, yield line mechanisms, equilibrium and virtual work methods, special aspects, Hillerborg's strip method.

Course Outcome:
On successful completion of the course, the students shall be able:
CO1: To understand conceptually basics of Limit state Design method at local level and to develop models for skill development and entrepreneurship development.
CO2: To design two way slab & one way continuous slabs and develop strategic alliance for skill development and employability.
CO3: To Analysis and design of ends blocks for facing global challenges for skill development and employability.
CO4: To design the structural elements like RCC beam, slab and column by limit state Design method as per I.S.456-2000 for national and international importance for skill development.
CO5: To understand the concept of yield line theory for slab, yield line mechanisms and virtual work method for the analysisfor entrepreneurship development.

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PO-CO Mapping (Please write 3, 2, 1 wherever required)
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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	1	1	3	3	2	3	3	3
CO2	3	2	3	3	3	2	3	1	3	1
CO3	3	1	3	3	3	3	3	2	1	3
CO4	3	3	3	3	1	3	2	3	1	2
CO5	3	3	2	2	3	1	3	1	3	3

CO-Curriculum Enrichment Mapping (Please **write 3, 2, 1** wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	2	3
CO2	3	3	1
CO3	3	3	1
CO4	3	1	1
CO5	2	1	3

Suggested readings:

- Pippard A J S, "The Analysis of Engineering Structures", Edward Arnold PublishersLtd.
- Krishna Raju N., "Advanced Reinforced Concrete Design", CBS Publishers and distributers, New Delhi.
- Krishna Raju., "Design of Reinforced Concrete Structures"
- Punmia, Ashok K Jain, Arun K Jain,"Reinforced Concrete Vol: II".
- P C Varghese, "Limit State Design of concrete structures".
- IS code 456:2000

Website Sources:

- http://www.nptelvideos.in/2012/11/design-of-reinforced-concrete-structures.html
- https://nptel.ac.in/
- https://theconstructor.org/search/RCC/posts/
- https://en.wikipedia.org/
- https://theconstructor.org/structural-engg/

Note: Latest editions of all the suggested readings must be used.

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TMCE014: MATRIX METHOD IN STRUCTURAL ANALYSIS **L T P 3 1 0**

Objective: The main objective of this course is to introduce students to

- Gain basic knowledge of structural systems and application of concepts of flexibility and stiffness matrices for simple elements
- Understand flexibility and stiffness matrices to solve problems in beams, planar rigid-jointed frames, grillage or grid and trusses for skill development.
- Gain knowledge of direct stiffness method to solve problems in beams, frames and trusses for skill development and for better skilling of entrepreneurship.
- Gain knowledge of solving problems involving in matrix displacement analysis of 3-D structures.

UNIT I **(08 sessions)**
Introduction: A Few Historical Remarks, Matrix Methods of Analysis of Skeletal Structures, Methods of Analysis for skill development and entrepreneurship. Displacement Method: Stiffness Relationships.

UNIT II **(08 sessions)**
The Matrix Displacement Approach: Introduction. Stiffness Matrix of a Bar Element subjected to Axial Force. Co-ordinate Transformations, Global Stiffness Matrix, Application to Pin-Jointed Frames. Stiffness Matrix of a Beam Element, Application to Continuous Beams.

UNIT III **(08 sessions)**
Matrix Displacement Analysis of Planar Rigid-Jointed Frames, Neglect of Axial Strain in the Analysis of Planar Rigid-Jointed Frames, Inclined Supports, and Other Kinds of Loading & Other Kinds of Frames for skill development.

UNIT IV **(08 sessions)**
Matrix Displacement Analysis of Grillage or Grid, Co-ordinate Transformations, Element Stiffness Matrix & its Application for skill development.

UNIT V **(08 sessions)**
Matrix Displacement Analysis of Three-Dimensional Structures, Co-ordinate Transformations, Application to Space Trusses & Space Frames for skill development, employability and better skilling of employability.

Course Outcome:
After studying this course, students will be able to:
CO1: Evaluate the structural systems to application of concepts of flexibility and stiffness matrices for simple problems at local level and for skill development and entrepreneurship development.
CO2: Identify, formulate and solve engineering problems with respect to flexibility and stiffness matrices as applied to continuous beams, rigid frames and trusses for developing strategic alliance for skill development and employability.
CO3: Identify, formulate and solve engineering problems at local and global level by application of concepts of direct stiffness method as applied to continuous beams and trusses and analyse it for entrepreneurship development.
CO4: Identify and solving problems involving in matrix displacement Analysis of grillage or grid for national importance, etc for skill development
CO5: Identify and solving problems involving in matrix displacement analysis of 3-D structures and to build models for skill development and employability.

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PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	3	2	3	3	2	3	3
CO2	3	3	2	2	2	3	2	3	2	1
CO3	3	3	3	3	1	1	3	2	3	3
CO4	3	2	3	2	2	2	3	3	1	2
CO5	3	2	3	3	2	3	2	3	2	3

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	2	3
CO2	3	3	1
CO3	1	2	3
CO4	3	1	1
CO5	3	3	1

Suggested readings:

- Matrix & Finite Element Displacement Analysis of Structures: D.J.Dawe.
- Computer Analysis of Structural Systems: John F. Fleming.
- Matrix Methods of Structural Analysis: C.K.Wang.
- Matrix Analysis of Framed Structures: Gere & Weaver.
- Introduction to Matrix Methods of Structural Analysis: Martin, H.C.

Website resources:

- https://nptel.ac.in/courses/105/105/105105180/
- https://www.inspirenignite.com/vtu/matrix-method-of-structural-analysis

Note: Latest editions of all the suggested readings must be used.

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TMCE015: ADVANCED FLUID MECHANICS **L T P 3 1 0**

Course Objectives:-

- Upon completion of this course, students will be able to mathematically analyze simple flow situations.
- They will be able to evaluate the performance of pumps and turbines

UNIT I **(8 Sessions)**

Fundamental concepts and scope for skill development and employability. UNIT s and dimensions-Properties of fluids, mass density, Bernoulli's equation and its applications .kinematics of fluid motion , continuity equation for 3D and 1D flows, circulation, stream function and velocity potential. Pilot tube, orifice meter, venturi meter and bend meter, notches and weirs, momentum equation and its application topipe bends.

UNIT II **(6 Sessions)**

Dynamics of ideal fluids, Euler's equation of motion and their integration will develop the skills problem .Buckingham's Pi theorem, important dimensionless numbers and their significance.

UNIT III **(10 Sessions)**

Equation of motion for laminar flow through pipes, instability of laminar flow, iscous Laminar flow, turbulent flow, isotropic, scale and intensity of turbulence, measurement of turbulence, eddy viscosity, resistance to flow, minor losses, pipe in series and parallel, power transmission through a pipe, siphon, water hammer, three reservoir problems and pipe networks, Theory of boundary layer , boundary layer approximations, laminar sub layer, separation, Turbulent flow – Prandtl's mixing length theory , Von Karman similarity hypothesis understanding for entrepreneurial & skill development

UNIT IV **(9 Sessions)**

Introduction to hydrodynamic thrust of jet on a fixed and moving surface, Classification of turbines, Impulse turbines, Constructional details, Velocity triangles, Power and efficiency calculations, Governing of Pelton wheel. Francis and Kaplan turbines, Constructional details, UNIT and specific speed, Performance characteristics, Selection of water turbines it will develop the skills

UNIT V **(8 Sessions)**

Classifications of centrifugal pumps, Vector diagram, Work done by impellor, Efficiencies of centrifugal pumps, Specific speed, Cavitation & separation, Performance characteristics. Reciprocating pump theory, Slip, Indicator diagram, Effect of acceleration, air vessels, Comparison of centrifugal and reciprocating pumps, Performance characteristics for development and employability.

Course Outcomes:

CO1: To learn about the application of mass and momentum conservation laws for fluid flows at local level for skill development.
CO2: To understand the importance of dimensional analysisat local, national and international levels for skill development and employability
CO3: To obtain the employabilityfor velocity and pressure variations in various types of simple flows.
CO4: To analyze the flow in water pumps and turbines for skill development and entrepreneurship development.
CO5: Understand the efficiencies of centrifugal pumpsfor facing global challenges for entrepreneurship development

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PO-CO Mapping (Please write 3, 2, 1 wherever required)
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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	1	3	3	3	1	2	1
CO2	3	3	2	1	3	2	2	2	1	2
CO3	3	3	1	2	2	3	3	1	2	1
CO4	3	2	2	1	3	2	3	1	2	1
CO5	3	3	1	2	3	3	2	1	1	2

CO-Curriculum Enrichment Mapping (Please **write 3, 2, 1** wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	2	1
CO2	3	3	1
CO3	1	3	2
CO4	3	1	3
CO5	2	1	3

Books and References:

1. Introduction to fluid mechanics and Fluid machines by S.K Som, Gautam Biswas, S Chakraborty.
2. Fluid mechanics and machines by R.K Bansal.
3. F. M. White, Fluid Mechanics, 6th Ed., Tata McGraw-Hill, 2008.
4. Fluid Mechanics and Its Applications byV.K.Gupta et.al.
5. Fluid Mechanics byYunusCengel.

Website Sources:

- nptel.ac.in/course.html
- www.nsf.gov
- en.wikipedia.org
- www.sciencedirect.com
- www.slideshare.net
- www.researchgate.net

Note: Latest editions of all the suggested readings must be used.

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TMCE016: BUILDING ARCHITECTURE & PLANNING **L T P 3 1 0**

Objective: To understand the concept of building planning and architecture. To understand the various building codes to be followed while planning a building. To have the knowledge of various building components.

UNIT I **(05 Sessions)**

Drawing of Building Elements- Drawing of various elements of buildings like various types of footing, open foundation, raft, grillage, pile and well foundation, Drawing of frames of doors, window, various types of door, window and ventilator, lintels and arches, stairs and staircase, trusses, flooring, roofs etc.

UNIT II **(10 Sessions)**

Building Planning- Classification of buildings, Provisions of National Building Codes and Rules, Building bye-laws, open area, Setbacks, FAR terminology, Design and drawing of Building, Design concepts and philosophies, Preparing sketch plans and working drawings of various types of buildings like residential building, institutional buildings and commercial buildings, site plans, presentation techniques, pictorial drawings, perspective and rendering, model making, introduction to computer aided design and drafting for skill development and employability, Applying of principle of architectural composition (i.e. UNIT y, contrast, etc.), Principles of planning, orientation in detailed drawings.

UNIT III **(08 Sessions)**

Principles of architectural design – Definition of architecture, factors influencing architectural development, characteristics features of style, historic examples, and creative principles. Principles of architectural composition – UNIT y, balance, proportion, scale, rhythm, harmony, Accentuation and contrast. Organising principles in architecture-Symmetry, hierarchy, axis linear, concentric, radial, and asymmetric grouping, primary and secondary masses, Role of colour, texture, shapes/forms in architecture. Architectural space and mass, visual and emotional effects of geometric forms, space activity and tolerance space. Forms related to materials and structural systems.

UNIT IV **(07 Sessions)**

Elements of architecture: Functions – Pragmatic utility, circulatory function, symbolic function, physiological function. Structure– Physical structure, Perceptual structures. Space in architecture –Positive and negative space. Aesthetics: Visual perception. Protective: Protection from climate and other elements for skilling of entrepreneurship, architecture a part of the environment. Comfort factors.

UNIT V **(10 Sessions)**

Perspective Drawing and Town Planning- Elements of perspective drawing involving simple problems, one point and two point perspectives, energy efficient buildings. Concepts of master plan, structure plan, detailed town planning scheme and action plan, estimating future needs - planning standards for different land use, allocation for commerce, industries, public amenities, open areas etc., planning standards for density distributions, density zones, planning standards for traffic network, standard of roads and paths, provision for urban growth, growth models, plan implementation, town planning legislation and municipal acts, panning of control development schemes, urban financing, land acquisition, slum clearance schemes, pollution control aspects

Course Outcomes: After completion of the module the students will be able to do the following:
CO1: Understanding of building planning, orientation, drawing and architectural aspects at local, national and international level which help in skill development and employability.
CO2: Representation of a building on Paper helps the student for facing globalcahllenges and to build the skill development.
CO3: Understand how to implement the architectural design features in the building help in gaining the knowledge about the entrepreneurship development.

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CO4: Gain Knowledge about the functional elements of architecture for national importance help in the analysis of skill development.
CO5: Knowledge about the Town Planning help in building the model for entrepreneurship development.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	1	3	2	2	1	2	2
CO2	3	3	3	1	2	1	2	1	2	2
CO3	3	3	3	1	3	2	2	1	3	3
CO4	3	2	2	2	3	3	2	3	3	2
CO5	2	3	3	1	3	3	3	2	3	2

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	3	2
CO2	3	2	1
CO3	1	2	3
CO4	3	1	2
CO5	2	1	3

Suggested Reading:

1. Shah, Kale &Patki; Building Design and Drawing; TMH
2. Malik &Meo; Building Design and Drawing
3. W B Mckay,OrientBlackswan Building Construction Vol 1 -4, Pearson
4. Gurucharan Singh &Jagdish Singh, Building Planning, Designing and Scheduling, Standard Publishers Distributors.
5. Layal JS, Dongre A, Building Design and Drawing, Satya Prakashan
6. Ghose D.N., Civil Engineering Design and Drawing, CBS publishe

Website sources:

- https://nptel.ac.in/courses
- https://www.britannica.com/topic/architecture/Architectural-planning
- https://theconstructor.org/practical-guide/building-plans-types/24963/

Note: Latest editions of all the suggested readings must be used.

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TMCE017: PRECAST &COMPOSITE STRUCTURE **L T P 3 1 0**

Objective:
To Learn the concepts and techniques of precast construction various applied loading and to enable students to determine composite material , stresses, deflection and behaviour of various structural members when subjected to different types of loading to inculcate skill, provide better employability and entrepreneurship development.

UNIT I **(08 Sessions)**
CONCEPTS, COMPONENTS, STRUCTURAL SYSTEMS AND DESIGN OF PRECAST CONCRETE FLOORS:
Need and types of precast construction, Modular coordination, precast elements- Floor, Beams provide better employability and entrepreneurship development, Columns and walls. Structural Systems and connections.
DESIGN OF PRECAST CONCRETE FLOORS:
Theoretical and Design Examples of Hollow core slabs. Precast Concrete Planks, floor with composite toppings with and without props

UNIT II **(08 Sessions)**
DESIGN OF PRECAST REINFORCED AND PRESTRESSED CONCRETE BEAMS:
Theoretical and Design Examples of ITB – Full section precast, Semi Precast, propped and uncropped conditions provide better employability and development, Design of RC Nibs

UNIT III **(08 Sessions)**
DESIGN OF PRECAST CONCRETE COLUMNS AND WALLS:
Design of braced and unbraced columns with corbels subjected to pattern and full loading.
Design of Corbels, Design of RC walls subjected to Vertical, Horizontal loads and moments, Design of vertical ties and horizontal joints for skill development.

UNIT IV **(08 Sessions)**
DESIGN OF PRECAST CONNECTIONS AND STRUCTURAL INTEGRITY:
Beam bearing, Beam half Joint, Steel Inserts, Socket Connection, Structural integrity, Avoidance of progressive collapse, Design of Structural Ties to understand skill and employability.

UNIT V **(08 Sessions)**
DESIGN OF STEEL CONCRETE COMPOSITE FLOORS AND BEAMS COMPOSITE FLOORS:
Profiled Sheeting with concrete topping, Design method, Bending and Shear Resistance of Composite Slabs, Serviceability Criteria, Design Example
COMPOSITE BEAMS:
Elastic Behaviour, Ultimate Load behavior of Composite beams, Stresses and deflection in service and vibration, Design Example of Simply Supported beams for skill and employability development.

Course Outcomes:
On successful completion of the course, the students shall be able to understand the following
CO1: For skill development and employability, to Learn the concepts and techniques of precast construction at local and global level.
CO2: Apply& analyze the concept of influence lines for deciding the critical forces and sections for facing global challengesfor skill development and employability while designing.
CO3: Apply the concept of strain energy to analyze beams and frame for skill development.
CO4: Learn the principles and Design of Precast and Composite Structures for skill development.

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CO5: To understand the concept of composite structures and their analysis at national and international levelfor skill development and employability.

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(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	3	3	1	1	3	3	3
CO2	2	3	2	1	3	1	3	3	2	2
CO3	1	2	3	3	2	3	3	1	1	1
CO4	2	3	1	2	1	3	1	1	2	1
CO5	1	1	3	1	1	1	2	3	1	3

CO-Curriculum Enrichment Mapping (Please **write 3, 2, 1** wherever required**)**
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	3	1
CO2	3	2	1
CO3	3	1	1
CO4	3	2	1
CO5	3	2	1

Suggested Readings:

- Hubert Bachmann, Alfred Steinle, Design of Precast Concrete Structures,Ernst & John Publications.
- NBC – 2005 (Part I to Part VII) BIS Publications, New Delhi, IS 15916- 2011,IS 11447,IS6061 – I and III
- "Basic structural Analysis" C.S. Reddy

Website Sources:

- https://civildigital.com/powerpoint-presentations/
- https://www.aboutcivil.org/structural-engineering.html
- https://en.wikipedia.org/
- http://www.nptelvideos.in/2012/11/advanced-structural-analysis.html
- https://www.asce.org/

Note: Latest editions of all the suggested readings must be used.

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TMCE018: ADVANCE DESIGN OF HYDRAULIC STRUCTURE **L T P 3 1 0**

Objective:

- Demonstrate and understanding of advanced fluid mechanics principles.
- Implementation of geotechnical engineering principles.
- To get a knowledge of various types of dam
- Understand the different elements of dam

UNIT I **(6 Sessions)**
Elements of dam engineering
Introductory perspectives, Embankment types and Characteristics- Concrete dams and characteristics- for provide knowledge for building entrepreneurship skills, Spillways and ancillary works – site assessment and selection of type of dam

UNIT II **(10 Sessions)**
Embankment dam engineering
Nature and classification of soil- engineering characteristics of soil, principles of design –Material and construction- Internal seepage – Stability and stresses, Settlement and deformation in rock fill embankments and skilling for entrepreneurship development

UNIT III **(10 Sessions)**
Concrete dam engineering
Loading -Concepts and criteria will develop. Gravity dam analysis design features and stability elementary profile of gravity dam- Concrete for dams – roller compacted concrete gravity dams.

UNIT IV **(8 Sessions)**
Dam outlet works
Spillways – Ogee spillway - cavitations on spillway – design feature- design principles and design of spillways – Chute spillways –Energy dissipation – stilling basins – plunge pools and skilling for entrepreneurship development

UNIT V **(6 Sessions)**
Drop Structures
Sarda fall – Glacis fall –Design principles- Cross regulator, head regulator and functions for skill development and employability

Course Outcomes:
After completion of this course students will able to
CO1: Understand the principles, Select hydraulic structural elementsat local level for skill development and employability.
CO2: Understand basic concepts of hydrologic simulation modeling to evaluate potential impacts of management decisions and skill development.
CO3: Evaluate surface water dam of skill development and employability.
CO4: Be able to select the type of dam, design and to construct for entrepreneurship development.
CO5: Be able to integrate relevant concept and methodologies in the area of hydraulics at local and global level, hydrology and geotechnical engineering of skill development.

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(Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1	2	1	2	3	3	1	2	3
CO2	3	3	2	3	3	2	3	3	3	2
CO3	3	3	3	2	3	3	1	1	1	1
CO4	3	2	3	3	2	1	2	1	2	1
CO5	3	2	3	3	3	3	3	2	2	3

CO-Curriculum Enrichment mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	3	1
CO2	3	1	2
CO3	3	3	1
CO4	3	1	3
CO5	3	2	2

Suggested readings:

- Arora, K.R., Irrigation, Water Power and Water Resources Engineering, Standard Publishers Distributors, Delhi
- Modi, P.N., Introduction To Water Resources And Waterpower Engineering, Standard Publication, Delhi
- Garg, S.K., Irrigation Engineering and Hydraulic Structures Khanna Publishers
- Asawa, G, L Irrigation And Water Resources Engineering, New Age Int. Ltd.

Web Materials:
1. http://nptel.iitm.ac.in/video.php?courseId=1029&v=XmO2pltg7YBz
2. http://nptel.iitm.ac.in/video.php?courseId=1029&v=SO0suW7TLiCs
3. http://nptel.iitm.ac.in/courses/Webcoursecontents/IIT%20Kharagpur/Water%20Resource%20Engg/New_index1.html
4. http://nptel.iitm.ac.in/courses/Webcourse

Note: Latest editions of all the suggested readings must be used.

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TMCE019: NUMERICAL METHODS IN GEOTECHNICAL ENGINEERING **L T P 3 1 0**

Objective:
To understand Enable students to apply the knowledge of numerical methods to solve the real world problems of Geotechnical engineering for skill development and provide employability and entrepreneurial skills.

UNIT I **(8 Sessions)**
Introduction: Categories of Problems in Geo-technical Engineering, Finite Difference Method, Boundary Corrections for Grids. Accuracy, Convergence and Stability. Idealization of soil behaviour; Linear, Bilinear and multilinear, Hyperbolic, Spline function, Ramberg – Osgood's Model, Polynomials, Higher order elastic models to develop the skills, perfect plasticity, frictional. Elastic models of soil behaviour – The winkler – Filenenko-boroditch – Pasternak – Ressiener models.

UNIT II **(8 Sessions)**
Seepage: Finite Difference Solution to Laplace equation for Homogeneous and Layered Soils improve and develop the student's skills.

UNIT III **(8 Sessions)**
Consolidation: Finite Difference Solution for One Dimensional, Two and three dimensional consolidations, Multi layered systems improve and develop the student's skills. Consolidation of Ground for Construction Load and Static Load.

UNIT IV **(8 Sessions)**
Shallow Foundations: Beams on Elastic foundations, solution by Finite Difference and – Finite Element Method (Direct Approach) Limit analysis, Lower Bound and Upperbound theories Method of Finite difference solution of Raft foundations develop the skills.

UNIT V **(8 Sessions)**
Pile Foundation: Pile Stresses – Static loading – Finite Element Method Solution (Direct approach) of the pile static pile capacity- wave equation -Lateral piles by Finite Element Method (Direct Approach) and Finite Difference method entrepreneurship development.

Course Outcomes:
At the end of the course, the student will be able to:
CO1: Apply various models to the soil mass to find out the behavior of the soil at local and global level which is helpful for entrepreneurship development.
CO2: Apply FD solution to homogenous and layered soil, one, and two, three dimensional to improve and develop the student's skills.
CO3: Understand the consolidation problem for facing global challenges for construction and static load for entrepreneurship development.
CO4: Understand the FD and FEM solutions for shallow foundations for nationalimportance.
CO5: Demonstrate Finite Element Method Solution (Direct approach) for pile foundation improve and develop the student's skills.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	3	3	3	3	1	2	3
CO2	3	3	3	3	3	2	1	1	1	3
CO3	3	3	3	2	3	1	3	1	3	3
CO4	3	3	3	2	3	1	2	1	3	1
CO5	3	3	3	3	3	3	2	2	3	2

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CO-Curriculum Enrichment Mapping (Please **write 3, 2, 1** wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	3	1
CO2	3	2	2
CO3	3	3	3
CO4	2	3	2
CO5	3	2	3

Suggested readings:

- Numerical methods in Geotechnical Engineering by C.S. Desai and J.T. Christian McGraw Hill publications
- Foundation analysis and design, JE Bowles, McGraw Hill publications.
- Analytical and computer methods in foundation engineering, JE Bowles, McGraw Hill publications.
- Foundation analysis and design, JE Bowles, McGraw Hill publications.

Website resources:

- https://nptel.ac.in/courses/105105043
- https://ascelibrary.org/doi/book/10.1061/9780784405024

Note: Latest editions of all the suggested readings must be used.

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TMCE019(A): SUSTAINABLE WATER AND SANITATION SYSTEM **L T P 3 1 0**

Objective:
To give an experience in the implementation of engineering concepts which are applied in field of environmental engineering and provide a coherent development to the students for the courses in sector of engineering like water and waste system. To provide a coherent development in design factor for skill development and provide employability and entrepreneurial skills.

UNIT I **(8 Sessions)**
Introduction: Water sustainability and parallels of past and present civilization with respect to water utilization.

UNIT II **(8 Sessions)**
Modern water practices: Water treatment/sanitation in the demographic transitions of developed countries vs the 3rd world; also Ecology and economics for improve and develop the student's skills.

UNIT III **(8 Sessions)**
Modern infrastructure for water treatment: coagulation and softening; also a case study for managing for sustainability to improve and develop the student's skills.

UNIT IV **(8 Sessions)**
Sustainable sanitation: suitable sanitation, sanitation management today and future, sanitation and public health, treatment, resuse and application to develop the skills.

UNIT V **(8 Sessions)**
Modern infrastructure for wastewater treatment: The priority list for water and wastewater treatment, disinfection carcinogens and ecosystem. The water cycle and climate change effect. Desalination and resuse limitation. Model for water supply and sanitation is more sustainable- privatization or government for entrepreneurship development.

Course Outcomes:
At the end of the course, the student will be able to:
CO1: Understand the sustainability for past and present civilization at local level which is helpful for entrepreneurship development.
CO2: Utilization of modern practices for water treatment and sanitation for global and national importance to improve and develop the student's skills.
CO3: Understand the procedure of coagulation and softening to sanitize the water forentrepreneurship development.
CO4: Understand Sustainable sanitation management for present and future at local, national and international level.
CO5: Demonstrate Modern infrastructure for wastewater treatment to improve and develop the student's skills.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	3	2	1	3	1	2	3
CO2	3	3	3	3	3	2	1	2	1	2
CO3	3	2	3	2	3	2	3	1	3	3
CO4	3	3	3	2	2	3	2	1	2	1
CO5	3	3	3	3	3	3	2	2	2	2

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CO-Curriculum Enrichment Mapping (Please **write 3, 2, 1** wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	1	3
CO2	2	2	3
CO3	3	2	2
CO4	2	3	2
CO5	2	2	3

Suggested readings:

- Pathways to Sustainability book series by Adrian Ely, Adrian Smith, Patrick Van Zwanenberg, Gerald Bloom.
- Water and Wastewater Treament by Schroder- McGraw Hill
- Water 7 Wastewater Engineering – II by Fiar, Geyer & Okun – John Wiley.

Website resources:

- https://nptel.iitm.ac.in
- https://www.indiaenvironmentportal.org.in
- http://www.filtersource.com

Note: Latest editions of all the suggested readings must be used.

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TMCE019 (B): INFRASTRUCTURE DEVELOPMENT **L T P 3 1 0**

Objective:

- Review the existing status of infrastructure as a whole, and the extant polices relating to infrastructure development in India and other developing countries.
- Identify the inadequacies in different infrastructure sectors and the policy changes required to facilitate rapid infrastructure development.
- Discuss new methods employed in addressing issues particularly relating to sustainability and regulatory practices.
- Discuss the role of public private participation in financing of infrastructure

UNIT I **(8 Sessions)**

Infrastructure Development: Definition of infrastructure, The inter-relationship between the infrastructure and economic and social development. Typical problems in infrastructure development such as designing appropriate projects, funding the projects, identifying and obtaining the human resources required for implementing the project efficiently, then ensuring the delivery of infrastructure services in a cost-effective manner for skill development.

UNIT II **(8 Sessions)**

Emerging issues: The importance of appropriate public policy andgovernmental involvement in infrastructuraldevelopment.Role of central, state and local governments for infrastructure development. The role of private investment (foreign and domestic) in the development of infrastructure. International experience in development of major infrastructure for better skilling pf entrepreneurship.

UNIT III **(8 Sessions)**

Funding of Infrastructure: Funding of infrastructure, Public Private Participation. Establishment of specific companies (SPVs) to develop and implement projects for understanding entrepreneurship skills. Development of debt markets. Role of multilateral and bilateral agencies in infrastructure growth in developing countries

UNIT IV **(8 Sessions)**

Regulation of Infrastructure services: The need for independent regulation of infrastructure toensure equity, quality, cost effective pricing, a levelplaying field for investors and consumer satisfaction.The evolution of independent regulation in India.The framework of independent regulation in differentsectors in India and the variation of important legalprovisions relating to the scope of regulation and theindependence of the regulators.The impact of regulation on performance of the utilities for skill development and employability.

UNIT V **(8 Sessions)**

Infrastructure and Sustainability: Sustainability issues in infrastructure development. Land, forest and other environmental concerns. Green growth, judicious use of natural resources. Low carbon technologies in transport and energy. Incorporation of SDGs in infrastructure policies for entrepreneurship and employability.

Course Outcomes:

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

CO1: Critically reflect on the challenges at local level in the development of sustainable infrastructure for developing skills

CO2: Achieve a level of well-informed professional at global and national level so that he contributes to the delivery of infrastructure development and management for building models for skill development and employability

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CO3: Gain the knowledge about the concept of funding of infrastructure for skill development and entrepreneurship skills.
CO4: Understand the concept of Infrastructure services for facing globalchalleneges for better employability
CO5: Understand the concept of sustainability issues in infrastructure development for strategic alliance of entrepreneurship skills

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	1	2	3	2	1	1	2
CO2	3	1	1	1	2	2	2	3	2	2
CO3	3	2	1	1	2	3	3	2	2	2
CO4	3	3	3	3	2	2	3	2	3	2
CO5	3	1	1	2	2	2	3	1	2	2

CO-Curriculum Enrichment Mapping (Please **write 3, 2, 1** wherever required**)**
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	2	2
CO2	3	3	1
CO3	3	2	3
CO4	1	3	2
CO5	2	1	3

Suggested readings:

- Piyush Joshi, (2003). Law relating to Infrastructure Projects (Second edition) LexiNexusButterworths India New Delhi (Module 1)
- Delmon, Jeffrey. (2011) Public Private Partnership projects in Infrastructure: An essential guide for policy makers, Cambridge University Press (Module 2)
- Mehta, Pradeep S, (2009). Developing infrastructure through an ideal regulatory framework, CUTS Institute for regulation and Competition (Module 3)
- Fay, Marianne and Toman, Michael (2010). Infrastructure and Sustainable development, World Bank (Module 4)

Website resources:

- Ministry of Finance, Department of Economic Affairs; NitiAayog; World Bank

Note: Latest editions of all the suggested readings must be used.

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TMCE019(C): APPLIED ELASTICITY AND PLASTICITY **L T P 3 1 0**

Objective: .The main objective of this course is to make familiar the students about the concept of stress strain analysis in elasticity and plasticity and also the bending concept of prismatic bars.

UNIT I **(8 Sessions)**

Elasticity: Two dimensional stress analysis – Plane stress – Plane strain – Equations of compatibility – Stress function – Boundary conditions. Problem in Rectangular Coordinates – Solution by polynomials – Saint Venent's principles – Determination of displacement – Simple beam problems. Problems in Polar Coordinates – General equations in polar coordinates – Stress distribution symmetrical about axis – Strain components in polar coordinates – Simple and symmetric problems for skill development.

UNIT II **(8 Sessions)**

Analysis of Stress and Strain in Three Dimensions: Principle stresses – Homogeneous deformations – Strain spherical and deviatoric stress – Hydrostatic strain. General theorems: Differential equations of equilibrium and compatibility for building knowledge about the employability – Displacement – Uniqueness of solution – Reciprocal theorem.

UNIT III **(8 Sessions)**

Bending of Prismatic Bars: Stress function – Bending of cantilever beam – Beam of rectangular cross-section – Beams of circular cross-section for building entrepreneurship skills

UNIT IV **(8 Sessions)**

Plasticity: Plastic deformation of metals – Structure of metals – Deformation – Creep stress relaxation of deformation – Strain rate condition of constant maximum shear stress – Condition of constant strain energy – Approximate equation of plasticity for skilling entrepreneurship.

UNIT V **(8 Sessions)**

Methods of Solving Practical Problems: The characteristic method – Engineering method – Compression of metal under press – Theoretical and experimental data drawing for skill development.

Course Outcomes:

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

CO1: Understand the basic concept of stress strain analysis at local, national and international level for skill development.

CO2: Gain knowledge about the stress strain concept in three dimensions for facing global challenges for building models for employability.

CO3: Understand the bending concept in prismatic bars for skill development and employability.

CO4: Create the models for better employabilityby considering the plastic deformation of metals at locallevels.

CO5: Understand the concept for solving practical problems of metal under press for skill development and entrepreneurship development.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	1	2	2	3	1	2	1	1
CO2	3	2	2	1	3	1	3	1	2	2
CO3	3	2	1	2	2	2	3	1	2	2
CO4	3	1	1	1	3	1	3	2	3	2
CO5	3	3	2	1	2	2	3	2	3	3

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PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	3	2	3	3	2	3	3
CO2	3	3	2	2	2	3	2	3	2	1
CO3	3	3	3	3	1	1	3	2	3	3
CO4	3	2	3	2	2	2	3	3	1	2
CO5	3	2	3	3	2	3	2	3	2	3

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	2	3
CO2	3	3	1
CO3	1	2	3
CO4	3	1	1
CO5	3	3	1

Suggested readings:

- Matrix & Finite Element Displacement Analysis of Structures: D.J.Dawe.
- Computer Analysis of Structural Systems: John F. Fleming.
- Matrix Methods of Structural Analysis: C.K.Wang.
- Matrix Analysis of Framed Structures: Gere & Weaver.
- Introduction to Matrix Methods of Structural Analysis: Martin, H.C.

Website resources:

- https://nptel.ac.in/courses/105/105/105105180/
- https://www.inspirenignite.com/vtu/matrix-method-of-structural-analysis

Note: Latest editions of all the suggested readings must be used.

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TMCE019(D): COMPUTER APPLICATION IN WATER RESOURCE ENGINEERING **L T P 3 1 0**

Objective: The main objective of this course is to provide knowledge to the students about the computer application used in water resource engineering and the numerical methods included to solve the boundary problems and learn the basic concept of finite the element method and its shape function.

UNIT I **(8 Sessions)**
Overview of the course, the need for computational and statistical methods, overview of the applications in Civil Engineering in general and Water Resources and Environmental Engineering in particular to skill development.

UNIT II **(6 Sessions)**
Review of numerical techniques for finding roots of non-linear equations and numerical integration for building entrepreneurship skills.

UNIT III **(8 Sessions)**
Ordinary differential equations, nature of problems, boundary and initial equations, Euler's method, modified Euler's method, Predictor-Corrector methods, Runge-Kutta methods, Boundary value problems, Applications for reservoir routing for building better employability, gradually varied flow problems, pipe networks.

UNIT IV **(10 Sessions)**
Partial differential equations, classification, nature of problems, Concepts of finite difference method for skill development and employability, finite difference schemes, Solution of parabolic equations, pollutant transport, Solution of elliptical equations, solution of Laplace equation and Poisson equation, flow through porous media, Solution of hyperbolic equation, method of characteristics, unsteady flow through open channels, propagation of waves, Concepts of finite volume method.

UNIT V **(8 Sessions)**
Basic concepts of Finite Element Method, FEM vs FDM, Element shapes, shape functions, development of shape functions for linear elements, Formulation of FEM for stress analysis problems, flow through porous media provide skilling of entrepreneurship,Galerkin's method and Variational method for formulation of stiffness matrix.

Course Outcomes:
At the end of the course, the student will be able to:
CO1: Understand the basic concept of computation at locallevel for skill development.
CO2: Gain knowledge about methods of computation for globalimportance for building models for employability.
CO3: Understand the bending concept in prismatic bars for skill development and employability.
CO4: Create the models for better employability by considering the plastic deformation of metals at local, national and international levels.
CO5: Understand the concept for solving practical problems of metal under press for skill development and entrepreneurship development.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	2	1	2	2	3	1	2	1	1
CO2	3	2	2	1	3	1	3	1	2	2
CO3	3	2	1	1	2	2	3	1	2	2
CO4	3	1	1	1	3	1	3	2	3	2
CO5	3	3	2	1	2	2	3	2	3	3

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CO-Curriculum Enrichment Mapping (Please **write 3, 2, 1** wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	1	2
CO2	2	3	2
CO3	2	3	2
CO4	2	3	1
CO5	3	1	3

Suggested readings:

- Numerical Methods for Engineers and Scientists, Hoffman, J.D., CRC Press, Special Indian Edition, 2011
- Statistics, Probability and Reliability for Civil and Environmental Engineers, Kotteguda, N.T. and Renzo Resso, McGraw Hill Companies Inc., New York, 1998
- Applied Numerical Methods for Engineering, Schilling, R.J., and S.L. Harris, CENGAGE Learning, India Edition, 2007
- Computational Hydraulics,Abbot, M.A. and Vervey, Elsevier Publications, 1996

Website resources:

- https://nptel.ac.in/courses/112/105/112105045/
- https://www.sanfoundry.com/best-reference-books-water-resources-engineering/
- https://www.Water-Resources-Engineering-Larry-Mays/dp/0470460644

Note: Latest editions of all the suggested readings must be used.

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TMCE201: STRUCTURAL DYNAMICS **L T P 3 1 0**

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 provide knowledge for better employability. Introduce students to analytical and numerical methods in structural dynamics with emphasis on vibration and to opportUNIT ies 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 motionFailure Analysis of material and structures, Outstanding structures for skill development.Free Vibration of a Shear Building, Stiffness equation for the shear building.

UNIT II **(08 Sessions)**
Single Degree of Freedom System: Analysis of free and forced vibration, Duhamels integral for skill development and employability, 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 for skill development and employability. Natural frequencies and normal modes, orthogonality property of the normal modes.

UNIT IV **(08 Sessions)**
Multi Degree of Freedom Systems: Equations of motion, evaluation of structural property matrices to understand skilling of entrepreneurship, problem statement and solution methods, free vibration, Forced harmonic vibration, damped motion for MDOF, generalized coordinates, principle of orthogonality of modes.Rayleigh's quotient, problem on Rayleigh's quotient

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

Course Outcomes:
At the end of the course, students will be able to
CO1: To classify the principles of structural dynamics and formulationof equation of motion at locallevel for skill development and employability.
CO2: For skill development and employability, to understand fundamental concept of single degree of freedom system for facing global cahllenges and solving for the free and forced response, response of SDOF systems to harmonics excitation, periodic excitation.
CO3: To understand response to general dynamic loading for national importance for skill development and employability, numerical evaluation of dynamic response.
CO4: To summarize the solution technique for dynamics of MDOF systemsfor skill development and entrepreneurship.
CO5: To understand the concept of various methods of MDOF for skill developmentand behavior of civil structures.

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PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	3	3	3	1	3	3
CO2	3	3	2	3	3	2	2	2	3	2
CO3	3	3	3	3	2	3	2	2	2	2
CO4	3	3	3	2	3	2	2	2	3	3
CO5	3	3	3	3	2	3	3	1	2	2

CO-Curriculum Enrichment Mapping (Please **write 3, 2, 1** wherever required**)**
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	2	1
CO2	3	2	1
CO3	3	2	1
CO4	3	2	2
CO5	3	1	1

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

Note: Latest editions of all the suggested readings must be used.

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TMCE202: DESIGN OF PRE-STRESSED CONCRETE STRUCTURES **L T P 3 1 0**

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) for skill development and entrepreneurship.Different methods and systems of prestressing like Hoyer system, Freyssinet system, Magnel Blaton system, Lee-Mc call system. Allowable stresses – Elastic design of simple beams having rectangular and I-section for flexure – kern lines – cable profile and cable layout.Short time and long time deflection, prestress analysis_ loading stage and computation of section properties, critical section underworking load for pre tension and post tension members

UNIT II **(10 Sessions)**

Complete design of post and pre-tensioned simply supported PSC beams -including end blockdesign-concordant cable profile and cap cable - shear, bond, deflection. Serviceability requirements- deflection and cracking limitstates to develop skills. Transmission of prestressing force by bond – Transmission length – Flexural bond stresses – IS: 1343 : 2012 provisions – Anchorage zone stresses in post tensioned members – stress distribution in End block – Analysis by approximate, Guyon and Magnel methods – Anchorage zone reinforcement.Design and analysis of post and pre-tensioned PSC slabsDesign of tension members – Application in the design of prestressed cylindrical water tanks.

UNIT III **(06 Sessions)**

Analysis and design of statically indeterminate structures for better skilling of entrepreneurship -continuous beams- con-cordancy and lineartransformation- simple cases of cantilever beams and slabs. Advantages & disadvantages of continuous PSC beams – Primary and secondary moments – P and C lines – Linear transformation concordant and nonconcordant cable profiles – Analysis of continuous beams and simple portal frames (single bay and single story).

UNIT IV **(08 Sessions)**

Design criteria and manufacturing methods of uniformly pre-stressed members.PC poles, pipes and railway sleepers. Design and analysis of post and pre-tensioned PSC slabsDesign of tension members – Application in the design of prestressed cylindrical water tanks provide knowledge of better employability in industry. Determination of anchorage zone stresses in post-tensioned beams by Magnel's method, Guyon's method and IS 1343 method; design of anchorage zone reinforcement, Check for transfer bond length in pre-tensioned beams.

UNIT V **(06 Sessions)**

Composite beams –Analysis and design – Ultimate strength – applications, Elementary idea ofcomposite construction for tee beams in bridges Partial pre-stressing- Definitions, principles and design approaches for skill development.

Course Outcomes:

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

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CO1: Understand the general mechanical behavior of pre-stressed concrete at local, national and internationallevel to enhance skill development and employability.

CO2: Analyze and design pre-stressed concrete flexural members to build models for skill development and employability.
CO3: Analyze and design for vertical and horizontal shear in pre-stressed concretefor global importance and to implement the knowledge for building entrepreneurship development.
CO4: Analyze transfer and development length as well as pre-stress losses at locallevel and to analyse the same for skill development
CO5: Analyze and design for deflection and crack control of pre-stressed concrete members and also to control the skill development and employability.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	1	2	3	3	3	3	3	3
CO2	3	3	3	3	1	3	3	2	1	3
CO3	3	3	3	2	3	3	3	2	3	1
CO4	3	2	1	3	3	3	2	1	2	3
CO5	3	3	1	3	2	3	3	3	2	1

CO-Curriculum Enrichment Mapping (Please **write 3, 2, 1** wherever required**)**
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	3	2
CO2	3	3	2
CO3	2	1	3
CO4	3	1	2
CO5	3	3	2

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/

Note: Latest editions of all the suggested readings must be used.

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TMCE203: THEORY OF ELASTICITY **L T P 3 1 0**

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 helpful in skill development and provide knowledge for better employability. 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 for skill development. Introduction to tensor, constitutive relation, boundary value problem in elasticity. Airy's stress function

UNIT II **(8 Sessions)**
Plane Cartesian Elasticity: Plane stress - Plane strain - Equations of equilibrium in two dimensions Compatibility of strain - Boundary conditions for skill development and employability.Introduction to plastic behaviour and failure theories, membrane analogy, torsion of shaft, tubes, bars, torsion of rolled profile sections

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 for skill development and entrepreneurship. General solution – torsion of prismatic bar.

UNIT IV **(6 Sessions)**
Strain Energy Methods: Total strain energy- complementary energy - Principle of virtual work and total potential energy. Introduction to thermoelasticity, introduction to photo elasticity, introduction to non linear elasticity.

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 for skill development

Course Outcome:

After completion of this course students will be able
CO1: To apply elastic analysis to study the fracture mechanics at national and international level, it will develop the skills of students and for the better skilling of entrepreneurship.
CO2: To apply linear elasticity in the design and analysis of structures such as beams, plates, shells and sandwich composites for global importance.
CO3: Understand and analyze stress and deformation, it will make students employable
CO4: Understand Basic field equations of linear elastic solids at locallevel that will develop the skills of students.
CO5: Formulations and solution strategies of various boundary value problems, it will make students employable.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	2	3	1	3	3	3
CO2	3	3	3	3	1	3	3	1	3	2
CO3	3	3	3	3	3	3	1	2	3	1

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CO4	3	2	2	3	3	2	3	1	1	1
CO5	3	1	3	1	1	3	3	3	1	3

CO-Curriculum Enrichment Mapping (Please **write 3, 2, 1** wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	**Employability**	**Entrepreneurship Development**
CO1	3	1	3
CO2	1	1	1
CO3	3	2	1
CO4	3	1	1
CO5	1	3	1

Suggested Readings:

- "Theory of Elasticity", Filenenko&Boridith, Mir publisher
- "Elasticity Tensor, Dyadic and Engineering applications" P.C. Chwo and, N.J. Pagano, D.VanNestrand 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/

Note: Latest editions of all the suggested readings must be used.

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TMCE207: WATER POWER ENGINEERING **L T P 3 1 0**

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 I **(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 for skill development.

UNIT II **(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 provide better skilling of entrepreneurship, Selection of water turbines, scroll castings and draft tubes, Speed regulation and governing of turbines.

UNIT III **(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 for skill development employability.

UNIT IV **(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 for understanding of entrepreneurship skills.

UNIT V **(08 Sessions)**

Power house: Types of power house, substructure and superstructure. General arrangement and space requirements for standard power house facilities to develop skills

Course Outcomes:

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

CO1: Design different components and their arrangement for hydel plants of both run off river plants and pumped storage plants for national importance.

CO2: Design various components of different types of turbines at local level for employability and entrepreneurship development.

CO3: Design different components of water conveyance system for power plants for facing globalchallenges skill development and employability.

CO4: Understand the concepts of surge tank and water hammer analysis skill development.

CO5: Perform planning of a power house for entrepreneurship development.

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PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	2	1	3	1	3	3	3
CO2	3	3	3	3	1	2	3	2	3	1
CO3	3	3	3	2	3	3	2	1	3	3
CO4	2	2	1	3	3	2	3	1	2	1
CO5	3	2	3	2	1	3	3	3	2	3

CO-Curriculum Enrichment Mapping (Please **write 3, 2, 1** wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	2	1	1
CO2	1	3	3
CO3	3	3	2
CO4	3	2	1
CO5	1	2	3

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/

Note: Latest editions of all the suggested readings must be used.

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TMCE021: ADVANCED DESIGN OF METAL STRUCTURES **L T P 3 1 0**

Objective: This course introduces stability-based design of steel structural elements, plastic analysis and design of steel frames, design of cold formed steel structural elements and steel-concrete composite structures. This course also introduces about the design of aluminum structures for skill development and makes the students employable.

UNIT I **(8 sessions)**

Plastic method of analysis: Comparison between elastic and plastic analysis, Plastic behaviour under static and cyclic loading. Analysis of continuous beams, Portal and gable frames, method for plastic moment distribution, Effect of axial force and shear force on plastic moments and connections.

UNIT II **(10 sessions)**

Design of Connections: Types of connections - Design framed beam connections - Seated beam connections, Unstiffened, Stiffened seat connections, Continuous beam-to-beam connections and continuous beam-to-column connection both welded riveted

UNIT III **(8 sessions)**

Design for light gauge steel structures: Types of cross sections - Local buckling and lateral buckling, post buckling strength, concepts of Effective width - Design of compression and tension members, Design of beams, Columns, Combined stresses and connections, wall studs for skill development and for the better skilling of entrepreneurship.

UNIT IV **(8 sessions)**

Design of tubular structures: Design of tension and compression members, Connections, truss configurations, space structures for skill development and for the better skilling of entrepreneurship.

UNIT V **(6 sessions)**

Design of Aluminum structures: Design of tension and compression members, beams and columns to develop the design skills

Course Outcomes: After successful completion of the course it is expected that student will be able to.
CO1: Apply unified code philosophy to steel building design at national and international level for developing models for skill development and entrepreneurship development.
CO2: Apply plastic method for design of beams and frames for strategic alliance of skill development.
CO3: Design & detail Industrial building for globalimportance, steel stacks & composite structures as per the IS codefor skill development and employability.
CO4: Use of cold form sections in the steel structure including pre-engineered building at locallevel to build models for employability.
CO5: Able to design Tension and compression member made of Aluminum and to analyses it for entrepreneurship development.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	3	3	3	3	1	3	1
CO2	3	3	1	2	3	3	3	1	2	1
CO3	3	3	3	3	1	1	2	3	3	3
CO4	3	1	2	3	3	3	1	1	1	3
CO5	3	3	1	3	1	3	1	3	3	3

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CO-Curriculum Enrichment Mapping (Please **write 3, 2, 1** wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	2	3
CO2	3	2	2
CO3	3	3	2
CO4	2	3	2
CO5	1	1	3

Suggested readings:

1. Gaylord &Gaylrod, Design of Steel Structures, McGraw Hill
2. Duggal, S.K., "Limit State Design of Steel Structures", Tata mcGrawHill
3. Subramanian, N., "Design of Steel Structures", Oxford University Press.

Web sources:

- https://nptel.ac.in/courses/105/105/105105162/
- https://nptel.ac.in/courses/105/106/105106113/

Note: Latest editions of all the suggested readings must be used.

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TMCE022: NUMERICAL METHODS IN CIVIL ENGINEERING **L T P 3 1 0**

Objective: The aim of the course is to develop a sound understanding of the various numerical techniques, principles and their application to Civil Engineering problems, selection and use appropriate methods for finding roots of equations as well as interpolation and approximation methods.

UNIT I **(8 sessions)**

Systems of linear algebraic equations: Elimination and factorization methods: Gauss, Cholesky and Crout's methods – Ill-conditioned systems – Symmetric and Banded systems – Gauss Siedel iteration - Relaxation method condition of convergence of iterative methods.

Systems of non-linear equations – Newton-Raphson Method for skill development

UNIT II **(8 sessions)**

Partial differential equations: Ordinary differential equations in more than two variables – first order P.D.E-integral surface passing through a given curve-surfaces orthogonal to given system-compatible systems of first order P.D.E charpits method -solution satisfying the given conditions-linear P .D.E with constant coefficients for skill development and entrepreneurship

UNIT III **(8 sessions)**

Interpolation and integration: Lagrange – Hermitian and cubic spline methods – Isoparametric style of interpolation Numerical Integration using Gaussian quadrature - One and Two Dimensions Gauss Hermite Quadrature Method - Newton–Cotes open quadrature - Monte Carlo Method - Application to deflection of beams and plates for skill development and employability

UNIT IV **(8 sessions)**

Eigen Value Problems: Introduction – Methods of solutions: method of characteristic polynomial for better skilling of entrepreneurship – Faddeev-Leverrier Method - Approximate Methods:- Forward iteration, inverse iteration – (Vianello-Stoodala method) Power Method with deflation - Rayleigh – Ritz Method.

UNIT V **(8 sessions)**

Boundary Value Problems: Boundary Value Problems in Ordinary and Partial Differential Equations: Finite difference methods for solving two-point linear boundary value problems-Finite difference techniques for the solution of two dimensional Laplace's and Poisson's equations on rectangular domain..

Course Outcomes:

After the completion of this course, students will

CO1: Exposure to various numerical methodsat national level for performing tasks, such as interpolation, differentiation, integration, solution of linear and nonlinear equations, solution of differential and integral equations and to develop models for skill development and entrepreneurship development.

CO2: Able to apply numerical methods to obtain approximate solutions to mathematical problems and analyse it for global importance for skill development and employability.

CO3: Able to analyze and evaluate accuracy of various numerical methods and their applicability to build models for skill development.

CO4: Exposure to established and advanced numerical methods like Finite Element Method, Meshfree Methods and Boundary Element Methods etc. for employability.

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CO5: Able to solve the polynomial and Eigen value problem at local leveland for strategic alliance of entrepreneurship development.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	1	1	3	3	3	2	3	1
CO2	3	3	3	3	3	2	2	1	1	3
CO3	3	2	1	3	1	2	3	3	3	3
CO4	3	3	1	3	1	3	3	2	3	1
CO5	3	3	1	2	1	3	3	1	1	3

CO-Curriculum Enrichment Mapping (Please **write 3, 2, 1** wherever required**)**
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	2	3
CO2	3	3	1
CO3	3	2	1
CO4	1	3	2
CO5	2	1	3

Suggested readings:

1. Michael D Greenberg, "Advanced Engineering Mathematics", Pearson education.
2. Ian Sneddon, "Elements of Partial Differential Equations", McGraw Hill, International Editions.
3. Balagurusamy , "Numerical Methods", Tata McGraw Hill

Web sources:

- https://onlinecourses.swayam2.ac.in/arp19_ap81/preview
- https://nptel.ac.in/courses/105/105/105105043/
- https://nptel.ac.in/courses/111/107/111107105/

Note: Latest editions of all the suggested readings must be used.

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TMCE023: ROCK MECHANICS **L T P 3 1 0**

COURSE OBJECTIVE
To make the students understand the properties of rock, pattern of failure, evaluation of stresses and stability considerations of rock masses. To understand microscopic study of rocks,

UNIT I **(9 Sessions)**
Classification and index properties of rocks, Rock strength and failure criteria, initial stresses in rocks, influence of joints and their orientation in distribution of stresses- deformability of rocks.

UNIT II **(8 Sessions)**
Measurement of in-situ, laboratory and in-situ measurements of shear, tensile and compressive strength, deformability of rocks for employability and entrepreneurship.

UNIT III **(8 Sessions)**
Simple engineering applications in rock mechanics, underground openings, rock slopes, foundations, mining subsidence – case studies for skill development

UNIT IV **(6 Sessions)**
Rock bolt systems- installation techniques, testing of rock bolts for employability and entrepreneurship, choice of rock bolts.

UNIT V **(9 Sessions)**
Rock Slope Stability in Surface Mining: Slope failure in rock quarry batter, Failure in weathered rock: Toppling failure, plane failure and wedge failure in rock slope; Slope failure in soil slope or soft rock.

COURSE OUTCOMES
At the end of the course, students will be able to
CO1: Know the formation and classification of rocks in India at local, national and international level for skill development and employability.
CO2: To understand the strength of the rocks in field assessment and develop strategic alliance for skill development.
CO3: Understand the in-situ stresses developed and methods of measurement for facing global challenegesand build models for skill development and entrepreneurship development.
CO4: Evaluate the strength parameters of rocks and adopt appropriate remedial measures for stability of critical slopes of rocks and analyse it for employability.
CO5: To give suitable remedial measures in fractured rocksfor entrepreneurship development.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	3	3	3	3	3	1	2
CO2	3	2	2	3	2	2	3	2	3	2
CO3	3	3	3	3	2	3	2	3	2	3
CO4	3	3	3	2	1	3	3	2	3	1
CO5	3	3	2	3	3	2	3	3	2	2

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CO-Curriculum Enrichment Mapping (Please **write 3, 2, 1** wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	3	1
CO2	3	2	1
CO3	3	1	3
CO4	1	3	2
CO5	2	1	3

Suggested readings:-:

- Godman, P.E."Introduction to Rock Mechanics", John Wiley, New York,1989.
- Jager, G. "Rock Mechanics and Engineering", Cambridge University Press, 1972.
- Stillborg, B. "Professional user handbook for rock bolting", Tran Tech publications, 1986
- Bazant, Z.P., Mechanics of Geomaterials Rocks, Concrete and Soil, John Wiley and Sons, Chichester, 1985.
- Wittke, W., Rock Mechanics: Theroy and Applications with Case Histories, Springerverlag, Berlin, 1990.

Website resources:

- https://onlinecourses.nptel.ac.in/noc17_ce23/preview
- https://freevideolectures.com/course/2686 |rock mechanics
- https://nptel.ac.in/courses/105/105/105105105/
- http://www.digimat.in/nptel/courses/video/105105105/L10.html

Note: Latest editions of all the suggested readings must be used.

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TMCE024: DESIGN OF BRIDGES **L T P 3 1 0**

Course Objectives:

- To study the various bridge forms and typical loadings on the bridges.
- To get familiarised with the design of short span bridges.To possess knowledge on the design concepts of long span bridges.
- To design the prestressed concrete bridges.To design the superstructure for bridges, slab culvert, box culvert, T-bridge etc, plate girder to IRS loadings, bearings and foundation for bridges

UNIT I **(08 sessions)**

Types of Bridge Super Structures: Introduction and types, temporary bridge superstructures, military bridges, other temporary bridges, permanent bridges, R.C.C. bridges, prestressed concrete bridges, steel bridges, movable steel bridges for skill development

.

UNIT II **(08 sessions)**

Considerations of Loads and Stresses in Road Bridges: Introduction, loads, forces and stresses, dead loads, bridge loading as per relevant IRC and IRS specifications, traffic lanes, foot way, kerbs, railing and parapet loading, Impact, wind load, longitudinal forces, Temperature effects, secondary stresses, erection stresses, earth pressure, effect of live load on backfill and on the abutment for better skilling of entrepreneurship.

UNIT III **(08 sessions)**

Design of R.C.Bridges: Slab culvert, box culvert, pipe culvert, T-beam bridge super-structure, design examples to develop skills, brief introduction to rigid frame, arch and bow string girder bridges.

UNIT IV **(08 sessions)**

Pier, Abutment and Wing Walls: Introduction, types of piers, design of piers, forces on piers, stability, abutments, bridge code provisions for abutments, wing walls, design examples.

Bearings: Introduction, function of bearings, bearings for steel bridges and concrete bridges, bearings for continuous span bridges, I.R.C. provisions for bearings provide knowledge for better employability, fixed bearings, expansion bearings, materials and specifications, permissible stresses in bearings, design considerations for rocker and roller-cumrocker bearings, sliding bearings.

UNIT-V **(08 sessions)**

Foundations: Types of foundations and general design criteria for skill development and entrepreneurship, design of well and pile foundations for piers and abutments.

Course Outcome:

CO1: At the end of the course the student will understand the design theories for superstructure and substructure of bridges at local and global leveland develop model models for employability.

CO2: The student will be able to design Culvert, R.C.C T Beam Bridge and analyse itfor facing global challengesfor entrepreneurship development.

CO3: The student will possess the knowledge to design prestressed concrete bridges and develop strategic alliance for skill development and entrepreneurship development.

CO4: The student will be able to design different types of bearings, abutments; piers at national leveland create models for skill development.

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CO5: The student will able design various types of foundations for Bridges and analyse it for skill development and employability.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	1	2	3	3	3	1	1	3
CO2	3	2	2	2	3	3	3	3	3	3
CO3	3	3	3	3	3	2	1	2	3	3
CO4	3	3	2	3	1	3	3	2	1	1
CO5	3	3	3	3	1	2	3	3	1	3

CO-Curriculum Enrichment Mapping (Please **write 3, 2, 1** wherever required**)**
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	2	3	1
CO2	2	2	3
CO3	3	2	3
CO4	3	1	2
CO5	3	3	1

Suggested readings:

1. Victor, OJ., 'Essential of Bridge Engineering' Oxford & IBH Pub.CO
2. Rowe, R.E.,'Concrete Bridge Design' C.R.BooksLtdf., London.
3. Krishna Raju,N., 'Design of Bridges' Oxford & IBH Pub.Co.,N.Delhi.
4. Krishna Raju, N.,'Prestressed Concrete' Tata McGraw Hill, New Delhi.
5. Raina.V.K,"Concrete Bridge Practice", Tata McGraw Hill Publishing Co., New Delhi-1991.
6. Taylor F.W, Thomson S.E and Smulski.E"Reinforced Concrete Bridges", John Wiley &Sons, New York-1955.

Website resources:

- https://www.ajce.in/ce/downloads
- http://nptel.ac.in/courses/105106118/

Note: Latest editions of all the suggested readings must be used.

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TMCE025: DESIGN OF PAVEMENTS **L T P 3 1 0**

COURSE OBJECTIVE
To gain knowledge on assessing stresses, design of flexible and rigid pavements and pavement rehabilitation techniquesGain knowledge about the process of collecting data required for design, factors affecting pavement design, and maintenance of pavement.Understand design concepts of flexible pavement by various methods (CBR, IRC 37-2001, Mcleods, Kansas) and also the same of rigid pavement by IRC 58-2002

UNIT I **(9 Sessions)**
Introduction: Comparison between Flexible & Rigid Pavements -Highway and Airport pavements – Types and Component layers of Pavements – their functions - A brief study on aggregates, bitumen and modified bitumen like cutback, emulsion, polymer modified bitumen - Factors affecting Design and Performance of Pavements for skill development and employability.

UNIT II **(9 Sessions)**
Analysis & Design of Flexible Pavement: Stresses and Deflections in Homogeneous Masses - Burmister's 2-layer, 3- layer Theories - Wheel Load Stresses - ESWL of Multiple Wheels - Repeated Loads and EWL factors - Sustained Loads and Pavement behaviour under Traffic Loads - Empirical, Semi-empirical and Theoretical Approaches - Development, Principle, Design steps for skill development and entrepreneurship Advantages and Applications of different Pavement Design Methods

UNIT III **(9 Sessions)**
Analysis & Design of Rigid pavements: Types of Stresses and Causes, Factors influencing the Stresses; General conditions in Rigid Pavement Analysis, ESWL, Wheel Load Stresses, Warping
Stresses, Friction Stresses, Combined Stresses - Types of Joints in Cement Concrete Pavements and their Functions, Joint Spacing, Design of Slab Thickness, Design of Joint Details for Longitudinal Joints, Contraction Joints and Expansion Joints, IRC Method of Design for skill development and entrepreneurship.

UNIT IV **(6 Sessions)**
Pavement Structure: Factors affecting Structural Condition of Flexible and Rigid Pavements; Effects of Sub grade Soil, Moisture, Pavement Layers, Temperature, Environment and Traffic on Structural Stability, Pavement Deterioration for skill development and employability

UNIT V **(8 Sessions)**
Pavement Overlays & Design: Pavement Overlays, Design of Flexible Overlay over Flexible Pavement by Benkelman Beam Deflection and other Methods for skill development and entrepreneurship, Flexible Overlays and Rigid Overlays over Rigid Pavements, Use of Geo synthetics in Pavement Overlays

COURSE OUTCOMES
At the end of the course, students will be able to
CO1: Learn loading conditions and corresponding stresses and deformation developed at local and global level for skill development.
CO2: Carry out material characterization and the design of flexible pavementfor national importance to analyse for skill development and employability.
CO3: Design of rigid pavement as per IRC guidelines and develop models for entrepreneurship development.
CO4: Evaluate pavement and to select appropriate rehabilitation technique for strategic alliance for employability.
CO5: Select suitable stabilizers and there applicability in pavements at local level for skill development andentrepreneurship development.

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PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	3	3	3	3	3	3
CO2	3	3	3	3	2	2	2	1	2	1
CO3	3	3	3	3	2	3	3	2	2	2
CO4	3	2	1	1	3	2	2	3	3	3
CO5	3	3	2	3	1	2	3	2	1	2

CO-Curriculum Enrichment Mapping (Please **write 3, 2, 1** wherever required**)**
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	1	1
CO2	3	3	2
CO3	1	2	3
CO4	2	3	2
CO5	3	2	3

Suggested readings:-:

- Wright, P.H., Highway Engineers, Johwiley& Sons, Inc. New York, 2009.
- Yoder, R.J and Witchak, M.W., Principles of Pavment Design, John wiley, 2000.
- Khanna, S.K and Justo C.E.G., Highway Engineering, New Chand and Brothers, Roorkee, 1998.
- Design and specification of Rural Roads (Manual), Ministry of rural roads, Government of India, New Delhi, 2001.
- Guidelines for the Design of Flexible Pavements, IRC: 37 – 2012, the Indian Roads Congress, New Delhi.

Website Sources:

- https://en.wikipedia.org/
- https://ts-nitk.vlabs.ac.in/transportation-engineering/design of pavements
- https://civildigital.com/powerpoint-presentations/transportation-engineering-ppts/

Note: Latest editions of all the suggested readings must be used.

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TMCE026: STRUCTURAL DESIGN OF FOUNDATION AND RETAINING STRUCTURES L T P 3 1 0

Objective:

To develop an ability and skill to apply the codal provisions for the design of various types of foundation, impart knowledge about the various earth pressure concepts and the geotechnical design of retaining structures and to select, analyze, and design an appropriate foundation and/or an earth retaining structure for a given scenario for skill development and provide employability and entrepreneurial skills.

UNIT I **(8 Sessions)**

Foundation Structures & Design of Centrally Loaded Isolated Footings and Column Pedestals – Introduction, Rigid and Flexible Foundations, Loads and their Effects, Design Requirements, Geotechnical Design, Empirical and Exact Methods of Analysis of foundations for improve and develop the student's skills , Design Loads for Foundations, Recommended Approach to Structural Design of Foundations. Introduction, General Procedure for Design, Design of Square Footing of Uniform Depth (Pad Footing), Design of sloped Rectangular Footings, Design Procedure, Detailing of Steel, Design of Rectangular Pad Footings, Design of Plain Concrete Footings, Design of Pedestals, Design Calculation for Pedestals.

UNIT II **(8 Sessions)**

Wall Footings – Introduction Simple Plain Concrete Wall Footings, Reinforced Concrete Continuous Strip Wall Footings, Design of continuous Strip Wall Footings, Design for Longitudinal Steel, R.C. T Beam Footings in Shrinkable Soils, Foundations of Partition Wall in Ground Floors, Summary.

Strip Footings Under Several Columns – Introduction, Design Procedure for Equally loaded and Equally Spaced Columns, Analysis of Continuous Strip Footing for Unsymmetric Loading, Analysis of Strip Footing with Unsymmetrical Loads to develop the skills, Detailing of Members.

UNIT III **(8 Sessions)**

Raft Foundations – Introduction, Rigid and Flexible Foundations, common Types of Rafts, Deflection Requirements of Beams and Slabs in Rafts, General considerations in Design of Rigid Rafts, Types of Loadings and Choice of Rafts, Record of Contact Pressures Measured under Rafts, Modern Theoretical Analysis.

Design of Flat Slab Rafts-Mat Foundations – Introduction, Components of Flat Slabs, Preliminary Planning of Flat Slab Rafts, Analysis of Flat Slab by Direct Design Method, Method of Analysis, Values for Longitudinal Distribution and Transverse, Redistribution, Shear in Flat Slabs, Bending of Columns in flat Slabs, Limitations of Direct Design Method for Mats, Detailing of Steel, Design of Edge Beam in Flat Slabs.

Beam and Slab Rafts – Introduction, Planning of the Raft, Action of the Raft, Approximate Dimensioning of the Raft, Design of the Beam and Slab Raft under Uniform Pressure, Structural Analysis for the Main Slab to develop the skills , Design of Secondary and Main Beams, Analysis by Winkler Model, Detailing of Steel.

UNIT IV **(8 Sessions)**

Combined Piled Raft Foundations (CPRF) – Introduction, Types and uses of Piled Rafts, , Interaction of Pile and Raft, Ultimate Capacity and Settlement of Piles, Estimation of Settlement of Raft in Soils, Allowable Maximum and Differential Settlement in Buildings, Design of CPRF System, conceptual Method of Design, Conceptual Method of Analysis for improve and develop the student's skills, Distribution of Piles in the Rafts, Theoretical Methods of Analysis.

Circular and Annular Rafts – Introduction, Positioning of chimney Load on Annular Raft, Forces Acting on Annular Rafts, Pressures Under Dead Load and Moment, Methods of Analysis, Conventional Analysis of Annular Rafts, Analysis of Ring Beams Under circular Layout of Columns, Analysis of Ring Beam Transmitting Column Load to Annular Rafts, Detailing of Annular Raft Under Columns of a Circular Water Tank.

UNIT V **(8 Sessions)**

Under-reamed Pile Foundations – Introduction, Safe Loads on Under-reamed Piles, Design of Under-reamed Pile Foundation for Load Bearing Walls of Buildings, Design of Grade Beams, Design of Under-reamed Piles Under Columns of Buildings, Use of Under-reamed Piles for Expansive Soils.

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Design of cantilever and Basement Retaining Walls – Introduction, Earth Pressure and Rigid Walls, Calculation of Earth Pressure on Retaining Walls, Design of Rigid Walls, Design of Ordinary R.C. cantilever Walls, Design of cantilever Walls without Toe, Design of Basement Walls, Calculation of Earth Pressures in Clays, Design of Free Standing Basement Walls for entrepreneurship development.

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 at local levelfor improve and develop the student's skills.
CO2: Understand the design procedure of simple wall footings and strips footing for global importancefor improve and develop the student's skills.
CO3: Identification problems come in the design of raft foundation, flat slab rafts and mat foundation design for entrepreneurship development.
CO4: Understand the ground design procedure of pile raft foundation cicular and annular rafts to improve and develop the student's skills,
CO5: Design different types of wall foundationat national and international level, under- reamed piles and cantilever retaining wall for entrepreneurship development.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	3	3	3	2	3	3
CO2	3	3	3	3	3	2	1	2	1	2
CO3	3	3	3	2	3	1	3	1	3	3
CO4	3	3	3	3	3	2	1	1	2	1
CO5	3	3	3	3	3	2	2	2	2	3

CO-Curriculum Enrichment Mapping (Please **write 3, 2, 1** wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	3	3
CO2	3	1	2
CO3	3	3	1
CO4	3	2	2
CO5	3	3	3

Suggested readings:

- Design of Reinforced Concrete Foundations by P. C Varghese, PHI Learning Private Limited., New Delhi.
- Das B. M. "Principles of Geotechnical Engineering", Thompson Learning.
- Arora K. R., "Soil Mechanics And Foundation Engineering", Standard Publishers Distributors.
- Bowles. J.E., "Foundation Analysis and Design", Tata McGraw-Hill International Edition.

Website resources:

- http://www.digimat.in/nptel/courses/video/105105105/L10.html
- https://www.getpowerplay.in/blog/retaining-wall-design-and-types-of-retaining-wall/

Note: Latest editions of all the suggested readings must be used.

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TMCE027: EARTHQUAKE GEOTECHNICAL ENGINEERING L T P 3 1 0

Objective: To understand the dynamics of earth and to estimate dynamic properties of soils. To develop the site specific design spectrum for design of sub structure and evaluation of liquefaction potential for skill development and provide employability and entrepreneurial skills.

UNIT I **(8 Sessions)**

Seismology and Earthquakes : Internal Structure of the Earth, Continental Drift and Plate Tectonics, Faults, Elastic rebound theory, Different sources of Seismic Activity, Geometric Notation, Location of Earthquakes, Size of Earthquakes.

UNIT II **(8 Sessions)**

Dynamic properties of soils: Measurement of Dynamic Properties of soils, Field Tests, Low strain, Seismic Reflection, Seismic Refraction, Horizontal layering, Steady State Vibration, Spectral analysis of surface wave improve and develop the student's skills, Seismic cross hole, Down Hole Up hole tests. Laboratory tests, Resonance Column Test, Bender Element, Cyclic Tri-axial test.

UNIT III **(8 Sessions)**

Seismic hazard analysis: Identification and Evaluation of Earthquake Sources, Geologic Evidence, Tectonic Evidence, Historical Seismicity, Instrumental Seismicity to develop the skills, Deterministic Seismic Hazard Analysis, Probabilistic Seismic Hazard Analysis.

UNIT IV **(8 Sessions)**

Ground response analysis: Ground Response Analysis, One Dimensional Linear, Evaluation of Transfer Function, Uniform undamped soil on rigid rock, Uniform damped soil on Rigid Rock, Uniform damped soil on elastic rock, layered damped soil on elastic rock, Equivalent linear Approximation, Deconvolution.

UNIT V **(8 Sessions)**

Liquefaction analysis: Liquefaction, Flow liquefaction, Cyclic Mobility, Evaluation of liquefaction Hazards develop the skills, Liquefaction Susceptibility, Criteria Historical Geologic Compositional State, Evaluation of Initiation of Liquefaction, Cyclic stress approach, Characterization of Liquefaction Resistance, SPT Test , Various correction factor of Safety.

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

CO1: Understand the internal structure of earth surface, reason and sources of earthquakeat local and global level which is helpful for entrepreneurship development.

CO2: Understand dynamic properties of soil, field and laboratory test for global importancefor improve and develop the student's skills.

CO3: Identification of earthquake sources for and performs seismic hazard analysis for entrepreneurship development.

CO4: Understand the ground response analysis and response in uniform and non uniform rock for facing nationalchallenges.

CO5: Demonstrate different approach for liquefaction analysis and various field test for improve and develop the student's skills.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	3	3	3	1	3	3
CO2	3	3	3	2	3	2	1	1	1	3
CO3	3	3	3	1	3	1	3	2	3	2
CO4	3	3	3	3	3	2	1	1	3	1
CO5	3	3	3	3	3	2	2	1	3	3

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CO-Curriculum Enrichment Mapping (Please **write 3, 2, 1** wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	3	3
CO2	3	1	3
CO3	3	3	1
CO4	3	2	2
CO5	3	2	3

Suggested readings:

- Krammer S.L., "Geotechnical Earthquake Engineering", Prentice Hall, International Series, Pearson Education Inc and Donling Kindersley Publishing Inc. 2013
- Roberto Villaverde, "Fundamental Concepts of Earthquake Engineering",CRC Press Taylor & Francis Group, 2009.

Website resources:

- https://nptel.ac.in/courses/105101134
- https://www.geoengineer.org/education/geotechnical-earthquake-engineering

Note: Latest editions of all the suggested readings must be used.

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TMCE028: WATER RESOURCES DEVELOPMENT AND MANAGEMENT L T P 3 1 0

Objective:

- To study water resources of India, their importance and planning of water resources projects for better employability.
- To understand the structure of the gravity dams, earth dam, spillways, cross drainage works and diversion headworks for skill and entrepreneurshipdevelopment.
- To learn about watershed development, rain water harvesting and strategies for flood damage for employability and entrepreneurship development.

UNIT I

Introduction: Need for sustainable water management, hydrologic processes, global water scenario, water budget in India, irrigation development, major issues in land and water resources management to develop skill. **(8 Sessions)**

UNIT II

Frequency analysis of hydrologic events, frequency distribution models, rainfall intensity-duration and frequency relationships for skill development and employability. **(7 Sessions)**

UNIT III

Model structure for time series, structural analysis, stationary series, non-stationary series analysis for employability and entrepreneurship development. **(6 Sessions)**

UNIT IV

Hydrographs, flood routing, system models, conceptual and dynamic models of runoff hydrograph for employability and entrepreneurship development. **(08 Sessions)**

UNIT V

Types of storage structures, water yield from catchments, runoff diversion, ponds and reservoirs, reservoirs and planning for dam reservoirs, earthen embankments and dams for skill and entrepreneurship development. **(06 Sessions)**

Course Outcomes:

On the completion of the course one should be able to understand:

CO1: Familiarize with the global and regional water scenario and issues in water resources management at local, national and international level for employability.

CO2: Establish the understanding of cross drainage works, diversion head works and their design for skill and entrepreneurship development.

CO3: Analyze and interpret hydrological data though frequency distribution, probability and hydrological model applicationfor global importancefor better employability.

CO4: Quantify the rainfall, runoff and base flow and analyse using models of runoff hydrographfor employability and entrepreneurship development.

CO5: Estimate water yield from catchment and plan for design of water resources storage structures for entrepreneurship development.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	2	1	2	3	2	3	3
CO2	3	3	3	1	2	1	3	1	1	3

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CO3	3	2	2	3	1	2	3	2	2	1
CO4	3	2	3	3	2	1	3	1	1	2
CO5	3	3	2	3	2	1	3	2	2	2

CO-Curriculum Enrichment Mapping (Please **write 3, 2, 1** wherever required**)**
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	**Employability**	**Entrepreneurship Development**
CO1	2	3	1
CO2	3	2	3
CO3	2	3	1
CO4	2	3	3
CO5	2	2	3

Suggested Readings:

- Subramanyam, K. Engineering Hydrology, Tata McGraw Hill Publication Co., New Delhi
- Sharma, R. K. Hydrology and Water Resources Engineering, Dhanpat Rai and Sons,
- Chow, V. T. Handbook of Applied Hydrology. McGraw Hill Book Co., USA
- Garg, S.K. Hydrology and Water Resources Engineering, Khanna Publishers, ND.
- Das, Ghanashyam. Hydrology and Soil Conservation Engineering, Prentice Hall of India, Pvt. Ltd, New Delhi

Website Sources:

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

Note: Latest editions of all the suggested readings must be used.

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TMCE029(A): MARINE CONSTRUCTION

L T P 3 1 0

Objective: Marine engineering involves knowledge of mechanical equipment that is used in ships, sailboats, submarines, etc. Basically, marine engineering courses are related to the concepts that are relevant in nautical science and architecture.

UNIT I **(8 Sessions)**

Advanced Marine Heat Engines: The concepts related to turbo blowers, compressors, heat exchangers, etc. are explained in this subject for skill development

UNIT II **(8 Sessions)**

Renewable Energy Sources & Applications: The renewable energy sources and their applications in maritime engineering are discussed through this subject to provide knowledge for better employability

UNIT III **(8 Sessions)**

Environmental Science & Technology: The significance of environmental science and its relation with the evolving technologies are covered in this subject for skill development

UNIT IV **(8 Sessions)**

Advanced Material Science & Surface Coating Engineering: Advanced surface coating materials and related concepts are discussed in this subject to build skilling of entrepreneurship.

UNIT V **(8 Sessions)**

Ship Fire Prevention: How to prevent fire disasters in ships are taught in this UNIT.
Ship Construction: The basics ad advanced concepts involved in the construction of ships for entrepreneurship and employability are discussed in this subject.

Course Outcomes: At the end of the course, the student will be able to:
CO1: Gain the knowledge about the advance marine heat engines at national and international level for building models for skill development
CO2: Understand the concept of renewable energy sources and its application for skill development and employability.
CO3:.Understand the concept for building skills for environment science and technology at global level
CO4:.Provide knowledge for advance materials science and surface costing engineering for skill development and employability.
CO5: Gain the concept of ship fire prevention and construction for building entrepreneurship skills.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	1	2	3	2	1	1	2
CO2	3	1	1	1	2	2	2	3	2	2
CO3	3	2	1	1	2	3	3	2	2	2
CO4	3	3	3	3	2	2	3	2	3	2
CO5	3	1	1	2	2	2	3	1	2	2

CO-Curriculum Enrichment Mapping (Please **write 3, 2, 1** wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

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	Skill Development	Employability	Entrepreneurship Development
CO1	3	2	2
CO2	3	3	1
CO3	3	1	2
CO4	3	3	2
CO5	1	2	3

Suggested readings:

- Introduction to marine engineering by D.A. Taylor provides information on every aspect of the ship's machinery systems.
- General Engineering Knowledge by H.D McGeorge is the perfect textbook
- H.D McGeorge, the Marine Auxiliary Machinery is a highly respected book
- Pounder's Marine Diesel Engines and Gas Turbines is one of the oldest books on marine diesel engines and gas turbines.

Website resources:

- https://archive.nptel.ac.in/courses/114/105/114105004/
- https://www.digimat.in/nptel/courses/video/114105031/L01.html

Note: Latest editions of all the suggested readings must be used.

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TMCE029(B): COMPUTATION METHOD IN STRUCTURAL ENGINEERING **L T P 3 1 0**

Objective:

- To study computation program of projects for better employability.
- To understand the structure of the head works for skill and entrepreneurshipdevelopment.
- To learn about finite difference of plates for employability and entrepreneurship development.

UNIT I **(08 Sessions)**

IntroductionComputer Oriented Methods in Structural Analysis: Stiffness method: Developing a computer program for the analysis of Grid Floors by using stiffness method to develop skill.

UNIT II **(7 Sessions)**

Flexibility Method: Developing a computer program for the analysis of Portal Frames by using flexible method for skill development and employability.

UNIT III **(6 Sessions)**

Finite Difference Method (FDM): Determination of deflections of plates by using FDM & Determination of natural frequency in a beam for employability and entrepreneurship development.

UNIT IV **(08 Sessions)**

Hydrographs Design of Reinforced Concrete Members: Design, detailing and estimating of beams, slabs, columns and foundations, Shear wall design for employability and entrepreneurship development.

UNIT V **(06 Sessions)**

Analysis of plane and space truss and frames subjected to gravity and lateral loads. Determination of natural frequency of a beam. Dynamic analysis (Response spectrum) of plane frames. Analysis of water tanks by using plate elements for skill and entrepreneurship development.

Course Outcomes:

On the completion of the course one should be able to understand:

CO1: Understand the concepts of the stuffiness and flexibility matrices at local levelto develop model for skill development and employability.

CO2: Analyze skeleton structures having secondary effects using direct stiffness method for facing global challengesfor enhancing skill development.

CO3: Know about the competency in design of advanced reinforced concrete structures such as Column, shear wall for building models of skill development and employability

CO4: To analyze various constituents and properties of concrete for national importance for skill development and employability.

CO2: To understand the behavior and application of special concretes in construction for skill development and employability.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	2	1	2	3	2	3	3
CO2	3	3	3	1	2	1	3	1	1	3
CO3	3	2	2	3	1	2	3	2	2	1
CO4	3	2	3	3	2	1	3	1	1	2
CO5	3	3	2	3	2	1	3	2	2	2

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CO-Curriculum Enrichment Mapping (Please **write 3, 2, 1** wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	2	3	1
CO2	3	2	3
CO3	2	3	1
CO4	2	3	3
CO5	2	2	3

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/018-06/584.html
- https://freevideolectures.com/course/3357/concrete-technology

Note: Latest editions of all the suggested readings must be used.

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TMCE029(C): EXPERIMENTAL STRESS ANALYSIS

L T P 3 1 0

Course Objective:

- Recognize the various techniques available to measure the stress and Strains for skill developmentusing different sources.
- Realize the working of recording instruments and data logging methods for skill development and employability
- Distinguish the principles of photo elasticity in two dimensional stress analyses to develop skill.

UNIT I **(08 Session)**

Strain measurement methods: Various types of strain gauges, Electrical Resistance strain gauges, Gage Sensitivity and Gage Factor Semiconductor strain gauges, Temperature compensation, strain gauge circuits to develop skills.

Analysis of strain gage data: Three Element Rectangular Rosette, Delta Rosette, strain gauge rosette.

UNIT II **(08 Session)**

Extensometers: Mechanical, Optical Acoustical and Electrical extensometers to provide knowledge for better employability in industries and their uses, Advantages and disadvantages.

UNIT III **(08 Session)**

Electrical resistance strain gauges: Principle of operation and requirements, Types and their uses, Materials for strain gauge to develop skills. Calibration and temperature compensation, isochromatic and isoclinic fringe patterns, cross sensitivity, Rosette analysis, Wheastonebridge and potentiometer circuits for static and dynamic strain measurements, and strain indicators for employability.

UNIT IV **(08 Session)**

Photoelasticity: Two dimensional photo elasticity, wave theory, Concept of light – photoelastic effects, stress optic law, Interpretation of fringe pattern, Compensation and separation techniques, Photo elastic materials. Introduction to three dimensional photo elasticity for skill development and employability

UNIT V **(08 Session)**

Non – destructive testing: Fundamentals of NDT, Radiography, ultrasonic, magnetic particle inspection, Fluorescent penetrant technique, Eddy current testing, Acoustic Emission Technique, Fundamentals of brittle coating methods, Introduction to Moiré techniques for skill development and employability, Holography, ultrasonic C- Scan, Thermograph, Fiber – optic Sensors.

Course Outcomes:

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

CO1: Explain the measurement of strain under static and dynamic loadsat local levelfor skill development.
CO2: Describe the Mechanical, optical, pneumatic and electrical strain gauges for strain measurementfor skill development and employability.
CO3: Understand the overall concepts of stress/strain analysis to develop skillsby experimental means for national importance.
CO4: Familiar with the theory and practice of common experimental stress analysis Methods including more methods, photo elasticityfor global importance for skill development and employability.
CO5: Acquire the knowledge on Brittle and bi-refrigent coatings and working of strain gaugesfor employability.

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PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	2	1	2	2	2	1	1
CO2	3	2	3	2	1	2	2	1	1	1
CO3	3	2	2	2	1	1	2	2	2	1
CO4	3	3	2	2	1	1	2	2	2	1
CO5	3	3	2	3	2	2	1	2	1	2

CO-Curriculum Enrichment Mapping (Please **write 3, 2, 1** wherever required**)**
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	2	1
CO2	3	2	1
CO3	3	2	1
CO4	3	3	1
CO5	2	3	1

Suggested Readings:

- Srinath, L.S., Raghava, M.R., Lingaiah, K., Garagesha, G., Pant B., and Ramachandra, K., "Experimental Stress Analysis", Tata McGraw-Hill, New Delhi, 1984.
- Hetyenyi, M., "Hand book of Experimental Stress Analysis", John Wiley and Sons Inc., New York, 1972.
- Experimental stress analysis, (6th edition) by Dr. Sadhu Singh, KhannaPublishers, New Delhi, 1996.
- Experimental stress analysis, (Third Edition) by James Dally and Riley, McGraw-Hill International, New Delhi.1978.

Website Source:

- https://onlinecourses.nptel.ac.in
- https://aktu.ac.in

Note: Latest editions of all the suggested readings must be used.

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TMCE029(D): LOW COST MATERIALS AND CONSTRUCTION TECHNIQUES L T P 3 1 0

Objective: This course emphasises on the methods of using low cost housing technique for better skilling of employability and skill development. It provides us a challenge to use the natural materials and their by-product so as to reduce the wastage or bye products obtained from industries and environmental pollution. Various natural materials with their property, advantages disadvantages, and their availability have been discussed.

UNIT I **(16 Sessions)**

Concepts of energy efficient & environment friendly materials and techniques: Cost effective materials: Soil, Fly ash, Ferro-cement, Lime, Fibers, Stone Dust, Red mud, Gypsum, Alternate Wood, Polymer. Energy Efficient & Environment friendly building material products: Walls - Stabilized and sun dried, soil blocks & bricks, Solid & Hollow concrete blocks, stone masonry blocks, Ferro cement partitions. Roofs – Pre-cast R.C. Plank & Joists roof, Pre-cast channel roof, Pre-cast L-panel roof, Pre-cast Funicular shells, Ferro cement shells, Filler Slab, SeasalFibre roof, Improved country tiles, Thatch roof, M.C.R. tile. Green Materials, Green Buildings – Definition - Features- Necessity – Environmental benefit - Economical benefits - Health and Social benefits - Major Energy efficient areas for buildings – Embodied Energy in Materials for skill development.

UNIT II **(8 Sessions)**

Cost effective construction techniques and equipments:- (a) Techniques: Rat trap bond construction, Energy Efficient roofings, Ferro cement technique, Mud Technology. (b) Equipments: Brick moulding machine, Stabilized soil block making machine and plants for the manufacturing of concrete blocks for better skilling of entrepreneurship, M.C.R. tile making machine, Ferro cement wall panel & Roofing channel making machine, R.C.C. Chaukhat making m/c.

UNIT III **(6 Sessions)**

Cost effective sanitation: (a) Waste water disposal system (b) Cost effective sanitation for rural and urban areas for entrepreneurship and employability(c) Ferrocement Drains

UNIT IV **(5 Sessions)**

Low Cost Road Construction: Cost effective road materials for skill development, stabilization, construction techniques tests, equipment used for construction, drainage, maintenance.

UNIT V **(5 Sessions)**

Cost analysis and comparison: (a) All experimental materials (b)All experimental techniques Green Building rating systems for understanding entrepreneurship skills.

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

CO1: Gain knowledge about the energy efficient and environment friendly materials at local and global levelfor skill development

CO2: Understand the concept of energy efficient roofing and build skill development and employability for national importance.

CO3: Understand the concept of cost effective sanitation for developing strategic alliance for entrepreneurship skills.

CO4: Build the concept of low cost road construction techniques for building models for skill development.

CO5: Gain knowledge about the cost analysis and will provide entrepreneurship skills and employability at national and international level.

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PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	1	3	2	2	1	2	1
CO2	3	1	1	1	3	2	2	1	2	2
CO3	3	1	1	1	2	2	3	2	3	2
CO4	3	2	1	1	3	2	2	1	2	1
CO5	3	1	1	1	2	2	3	1	1	2

CO-Curriculum Enrichment Mapping (Please **write 3, 2, 1** wherever required**)**
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	2	2
CO2	3	3	2
CO3	2	1	3
CO4	3	1	2
CO5	1	3	3

Suggested readings:

- Alternative Building Materials and Technologies – K S Jagadeesh, B V Venkatta Rama Reddy & K S NanjundaRao – New Age International Publishers
- Integrated Life Cycle Design of Structures – AskoSarja –CRC Press
- Non-conventional Energy Resources –D S Chauhan and S K Sreevasthava – New Age International Publishers
- Buildings How to Reduce Cost – Laurie Backer - Cost Ford
- Lynne Elizabeth, Cassandra Adams Alternative Construction : Contemporary Natural BuildingMethods ", Softcover, Wiley & Sons Australia, Limited, John,2005
- Givoni, "Man, Climate, Architecture, Van Nostrand, New York, 1976.
- Charles J. Kibert, Sustainable Construction: Green Building Design and Delivery,John Wiley & Sons,2005.
- Eugene Eccli- Low Cost, Energy efficient shelter for owner & builder, Rodale Press, 1976

Website resources:

- https://archive.nptel.ac.in/courses/105/106/105106206/
- http://notescivil.blogspot.com/2016/03/mvct-105-low-cost-building-materials.html

Note: Latest editions of all the suggested readings must be used.

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TMCE029(E): OPEN CHANNEL HYDRAULICS

L T P 3 1 0

Objective:

- Analyze the gradually varied flow in channel section.
- Analyze the rapidly varied flow in channel sections.
- Apply numerical methods for profile computation in channels.

UNIT I **(6 Sessions)**

Open Channel flow-Classification-Velocity distribution-Energy Coefficient, Momentum Coefficient-Basic Equations, Continuity Equation, Energy Equation, Momentum Equation-Energy Depth Relationships, Specific Energy, Specific Force- Transition in Open Channels will develop skills.

UNIT II **(10 Sessions)**

Cross drainage works - necessity - types of cross drainage works - selection of suitable type of cross drainage works - types of aqueducts- design of aqueduct - syphon aqueduct (type II and III) super passage and canal siphon for better skilling of entrepreneurship

UNIT III **(8 Sessions)**

(Detailed designs and drawings of aqueduct and syphon aqueduct (Type II) are expected). Inclusive of drawing classes help to inculcate skills and provide employability.

UNIT IV **(10 Sessions)**

Basic principles, Differential SVF equations for increasing and decreasing discharge, Classifications and solutions, Numerical methods for profile computation, low over side-weir and Bottom-rack.

UNIT V **(6 Sessions)**

Flow in channel of non-linear alignment and non-prismatic channel sections, Design considerations for sub critical and super critical flows, Design of culvert develop entrepreneurship skills.

Course Outcomes:

Students completing this course will able to

CO1: Understand the common ways of classifying open channel hydraulics at national and international level for skill development and employability.
CO2: Calculate open channel flow resistance, Manning equation, uniform and non-uniform flow, and develop strategic alliance for skill development for national importance.
CO3: Analysis of computation of flow profiles for Entrepreneurship Development.
CO4: Formulate advanced models based on the governing equations for free-surface flows and to study different system of flow measurements for developing employability.
CO5: Gain knowledge about the unsteady flow, to study about the surge and its analysis for skill development and entrepreneurship development.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	2	2	1	1	1	3	3
CO2	3	3	3	3	3	1	1	3	3	1
CO3	2	3	3	2	3	3	1	1	3	1

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CO4	3	3	3	2	3	1	3	3	3	3
CO5	3	3	3	3	1	1	2	1	3	1

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	3	2
CO2	3	2	2
CO3	2	1	3
CO4	2	3	2
CO5	3	1	2

Suggested readings:

- " Open Channel Hydraulics", VenTe Chow, McGraw-Hill civil engineering series
- "Open Channel" F.M.Henderson.
- "Flow in open channels" K . Subramanya. Tata McGraw-Hill Publications
- " Fundamentals of Open Channel hydrualices Glenn E Moglen, CRC press

Website Resources:

- https://nptel.ac.in/courses/105/107/105107059/
- https://civilenggforall.com/gate-material-ies-master-open-channel-flow-study-material-for-gate-psu-ies-govt-exams-free-download-pdf-www-civilenggforall-com/

Note: Latest editions of all the suggested readings must be used.

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TMCE029 (F): STRENGTH AND DEFORMATION BEHAVIOUR OF SOIL L T P 3 1 0

Objective: The main objective is to understand Elastic and Plastic analysis of soil and Ability to evaluate Shear strength of unsaturated soils, and also to understand Constitutive Models in Soil Mechanics

UNIT I **(8 Sessions)**
Introduction: Physico-Chemical aspects, Failure theories, Yield criteria, Elastic and Plastic analysis of soil, Mohr's diagram for skill development

UNIT II **(8 Sessions)**
Stresses in Soil: Description of state of stress and strain at a point, stress distribution problems in elastic half pace. Boussinessqu, WestergardMindlin and Kelvin problems. Distribution of contact pressure for skill development and employability.

UNIT III **(8 Sessions)**
Analysis of Elastic settlement. Soil Plasticity; Shear Strength of Soils: Experimental determination of shear strength, Types of tests based on drainage conditions and their practical significance for building better understanding for employability.

UNIT IV **(8 Sessions)**
Skempton's and Henkel's pore water pressure coefficients, Stress path, Shear strength of unsaturated soils for developing entrepreneurship skills, Row's stress dilatancy theory.

UNIT V **(8 Sessions)**
Constitutive Models: Constitutive Models in Soil Mechanics: Isotropic Elastic, Anisotropic Plasticity and Viscous Models. Representing Soil Behaviour using these Models; Advances in Constitutive models for skill development.

Course Outcomes:
At the end of the course, the student will be able to:
CO1: Understand the stresses in soil for skill development at local level.
CO2: Understand the concept of brief explanation on types of tests based on drainage conditions for entrepreneurship development and for global importance.
CO3: Understand the concept of analysis of elastic settlement of soils for skill development
CO4: Create the skempton's and henkels pore water pressure models for developing entrepreneurship skills.
CO5: Gain knowledge about the soil behaviour using isotropic and elastic models and develop employability at national level.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	1	2	3	2	1	1	2
CO2	3	1	1	1	2	2	2	3	2	2
CO3	3	2	1	1	2	3	3	2	2	2
CO4	3	3	3	3	2	2	3	2	3	2
CO5	3	1	1	2	2	2	3	1	2	2

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CO-Curriculum Enrichment Mapping (Please **write 3, 2, 1** wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	1	2
CO2	2	2	3
CO3	3	2	2
CO4	1	2	3
CO5	2	3	2

Suggested readings:

- A.P.S. Selvadurai, Plasticity &Geomechanics, Cambridge University Press, 2002
- W.F. Chen, Limit Analysis & Soil Plasticity, Elsevier Scientific, 1975.
- C. S. Desai and J. T. Christian, Numerical Methods in Geotechnical Engineering, McGrew Hill, New York.
- R. F. Scott, Principles of Soil Mechanics, Addison & Wesley

Website resources:

- https://www.researchgate.net/publication/343917254_Strength_and_deformation_behaviour_of_sand-_rubber_mixture
- https://www.icevirtuallibrary.com/doi/abs/10.1680/moge.57074.0175

Note: Latest editions of all the suggested readings must be used.

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TMCE301: THEORY OF PLATES AND SHELLS **L T P 3 1 0**

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 to develop skill, provide employability and entrepreneurship for the students.

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 for skill development.Classification of plates, analysis of rectangular and circular plates, classification of shells,buckling of shell

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 for skill development and employability.navier method for rectangular plates, introduction to shell structure and shell geometry, membrane theory for surface of revolution, membrane theory of pressure vessels.

UNIT III **(8 Sessions)**
Symmetrical bending of circular plates - Differential equations - Uniformly loaded and concentrically loaded plates with various simply supported and clamped boundary conditionssimply supported rectangular plates under sinusoidal load for skill development and employability.

Theory of Shells
Introduction - Review of basic theory of shells - Definition and assumptions –strain displacement relationships - Stress-strain relationships for skill development.

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 for better skilling of entrepreneurship. Anisotropic plates, buckling of thin plates

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 for skill development and entrepreneurship.

Course Outcomes: On completing the course the student should be able to:
CO1: To understand the concept of thin plates under small deflection theory and analyze of Rectangular Platesfor skill development and employability at local and global level by using Navier solution and Levy's Method.
CO2: To formulate equations for force displacement equations and equilibrium equations in curvilinear co-ordinates for skill development at national level.
CO3: To understand the equilibrium theories for analysis of Plates and Shell Structuresfor skill development and employability.Analyze plates under different boundary conditions by various classical methods and approximate methods.

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CO4: To understand the concept of membrane theory of shells and analyze the circular cylindrical shell loaded symmetricallyfor skill development and entrepreneurshipdevelopment with different conditions.
CO5: To understand the structural behaviour of folded plates for facing global challenges and for skill development and employability.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	3	3	3	2	3	3	3
CO2	3	3	3	3	3	3	3	3	3	2
CO3	3	3	2	2	3	2	2	2	2	3
CO4	3	3	2	2	3	2	3	2	1	2
CO5	3	3	3	3	2	3	3	3	2	2

CO-Curriculum Enrichment Mapping (Please **write 3, 2, 1** wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	2	1
CO2	3	2	1
CO3	3	2	1
CO4	2	1	3
CO5	2	1	1

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", ValentinValentinovichNovozhilov,
- "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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TMCE302: FINITE ELEMENT METHODS **L T P 3 1 0**

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 for skill development to inculcate skill, provide employability and entrepreneurship skills.

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 for skill development.

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 for skill development

UNIT III **(8 Sessions)**
Analysis of framed structure – **2D** and **3D** truss and frame elements – applications for skill development and entrepreneurship – Plain stress and plain strain analysis – Triangular elements – CST and LST elements – Rectangular elements –Isoparametric elements – Incompatible models – 8 noded and 20 nodedisoparametric 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 for skill development and entrepreneurship.

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

CO1: Identify the uses of Finite Element Analysis and different stiffness methods in civil engineeringfor skill development and employability at local and global level.
CO2: Describe different techniques and procedure of the variations in Finite Element Analysis in civil engineeringfor skill development.
CO3: Apply principles of different methods for framed structures using Finite Element Formulation Techniquesfor facing global cahllenges and for skill development.
CO4: Assess the plate and shell bendingusing various techniques & with different softwarefor skill developmentat national ands international level.
CO5: Understand the various boundary conditionsand solution techniquesfor employability and entrepreneurship.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	1		3	1	3	3	3
CO2	3	3	3	3	2	3	3	2	3	1

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CO3	3	3	3	1	3	3	2	1	3	3
CO4	3	1	3	3	3	2	3	1	1	3
CO5	3	1	3	3	2	3	3	3	1	3

CO-Curriculum Enrichment Mapping (Please **write 3, 2, 1** wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	**Employability**	**Entrepreneurship Development**
CO1	3	3	1
CO2	3	1	2
CO3	3	3	1
CO4	3	2	2
CO5	3	3	3

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

Note: Latest editions of all the suggested readings must be used.

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TMCE305: THEORY OF PLASTICITY **L T P 3 1 0**

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 ofequilibrium. Strain displacement relations, compatibility. Displacement and traction boundary conditions, plane stress and plane strain problems for skill development and entrepreneurship

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

UNIT III **(8 Sessions)**
Initial Yield Surfaces for Polycrystalline Metals: general form of plastic constitutive equations for better skilling of entrtepreneurship, hydrostatic stress states and plastic volume change in metals. Shear stress on a plane. The von 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 provide knowledge for better employability, 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 for skill development

Course Outcomes:

Students completing this course will be able to.

CO1: This course intends to provide students a comprehensive knowledge on the theory of elasticity and plasticity and help them to build model for skill development and employability at national level.
CO2: The course focuses on the following topics: yield surface, normality rule and limit surfaces and guide them to build a model for skill development.
CO3: Ability to use standard external and internal forces, equilibrium, stress tensors, principal stresses, hydrostatic stress state analysis for skill development and employability.
CO4: Ability to use constitutive law, plasticity theory, yield and failure criteria, stability postulates, general theory of plane strain for perfectly plastic materials and strategic alliance for entrepreneurship development.
CO5: Ability to understand concept of plane stress & plane strain problem, limit analysis theorems& control for skill development and employability at local and global level.

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	1	3	1	3	3	2	1	3
CO2	3	2	3	3	3	2	1	3	3	1
CO3	3	3	1	2	3	3	3	2	3	1
CO4	3	3	3	3	1	2	2	1	2	3
CO5	3	3	1	2	3	3	2	3	3	1

CO-Curriculum Enrichment Mapping (Please **write 3, 2, 1** wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	3	2
CO2	3	1	2
CO3	3	3	2
CO4	1	1	3
CO5	3	3	2

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

Note: Latest editions of all the suggested readings must be used.

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TMCE031: EARTHQUAKE ANALYSIS AND DESIGN OF STRUCTURES **L T P 3 1 0**

Course objective:
To assists analyzing the interaction between civil infrastructure and the ground, including the consequences of earthquakes on structures. For the proper design and construction of buildings in accordance with building codes, so as to minimize damage due to earthquakes

UNIT I **(08 sessions)**
EARTHQUAKES AND GROUND MOTION
Engineering Seismology (Definitions, Introduction to Seismic hazard, Earthquake Phenomenon), Seismotectonics and Seismic Zoning of India, Earthquake Monitoring and Seismic Instrumentation for skill development, Characteristics of Strong Earthquake Motion, Estimation of Earthquake Parameters, Microzonation.

UNIT II **(08 sessions)**
EFFECTS OF EARTHQUAKE ON STRUCTURES
Dynamics of Structures (SDOFS/ MDOFS), Response Spectra - Average Response Spectra - Design Response Spectra, Evaluation of Earthquake Forces as per codal provisions for skill development and employability, Effect of Earthquake on Different Types of Structures, Lessons Learnt From Past Earthquakes

UNIT III **(08 sessions)**
EARTHQUAKE RESISTANT DESIGN OF MASONRYSTRUCTURES
Structural Systems - Types of Buildings, Causes of damage, Planning Considerations, Philosophy and Principle of Earthquake Resistant Design, Guidelines for Earthquake Resistant Design, Earthquake Resistant Earthen Buildings, Earthquake Resistant Masonry Buildings - Design consideration – Guidelines for skill development and employability

UNIT IV **(08 sessions)**
EARTHQUAKE RESISTANT DESIGN OF RC STRUCTURES
Earthquake Resistant Design of R.C.C. Buildings - Material properties - Lateral load analysis - Design and detailing – Rigid Frames – Shear wall – Coupled Shear wall for skill development and entrepreneurship.

UNIT V **(08 sessions)**
SPECIAL TOPICS
Mathematical modeling of multistoried RC Buildings – Capacity based design. Vibration Control - Tuned Mass Dampers – Principles and application, Basic Concept of Seismic Base Isolation – various Systems- Case Studies, Important structures.

Course outcomes:
Student will be able to
CO1: Understand the basic knowledge of earthquake and ground motions and can plan a good structural configuration for seismic resistance for facing global challenges and for developing models for skill development.
CO2: Apply fundamentals of structural dynamics to different structures and analyse them for skill development and entrepreneurship development.
CO3: Ensure proper design of buildings so they will resist damage due to earthquakes, but at the same time not be unnecessarily expensive for employabilityat local and national level.
CO4: Understand the proper seismic designing concept of RC structures and design it for employability and skill development.
CO5: Understand the mathematical application applied to multistoried RC buildings for developing models for entrepreneurship development.

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PO-CO Mapping (Please write 3, 2, 1 wherever required)
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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	3	3	3	3	3	3
CO2	3	3	2	3	2	3	3	1	3	1
CO3	3	2	3	3	1	2	2	2	2	3
CO4	3	3	3	3	2	3	3	1	1	2
CO5	3	2	2	2	3	3	2	3	2	3

CO-Curriculum Enrichment Mapping (Please **write 3, 2, 1** wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	2	2
CO2	3	1	3
CO3	1	3	1
CO4	3	3	2
CO5	2	1	3

Suggested readings:

1. Pankaj Agarwal and Manish Shrikhande, "Earthquake Resistant Design of Structures", Prentice Hall of India, 2006.
2. S K Duggal, "Earthquake Resistant Design of Structures", Oxford University Press, 2007. Course Notes "Design of Reinforced Concrete Buildings", IIT Kanpur, June 1999.
3. Paulay,T and Priestly, M.N.J., "A seismic Design of Reinforced Concrete and Masonry buildings", John Wiley and Sons, 1991.
4. Bruce A Bolt, "Earthquakes" W H Freeman and Company, New York, 2004
5. Bungale S.Taranath,"Structural Analysis and Design of Tall Buildings", McGraw Hill Book Company, New York, 1999.

Website resources:

- https://www.coep.org.in/sites/
- https://aktu.ac.in/
- https://nptel.ac.in/courses

Note: Latest editions of all the suggested readings must be used.

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TMCE032: DESIGN OF STEEL BRIDGES **L T P 3 1 0**

Objective: The objective of this course is to provide the basic principles of strength, serviceability, fatigue analysis, redundancy and load path, as well as seismic analysis of steel bridges. This course also emphasis on the general theory and performance of structural steel, as well as design and analysis of structural members subjected to various loading conditions for skill development and for better skilling of entrepreneurship.

UNIT I **(10 Sessions)**
INTRODUCTION
Classification, investigations and planning, choice of type, I.R.C. specifications for road bridges, standard live loads, other forces acting on bridges, general design considerations for skill development and entrepreneurship

UNIT II **(6 Sessions)**
LONG SPAN GIRDER BRIDGES
Design principles of continuous bridges to develop skills, box girder bridges, and balanced cantilever bridges.

UNIT III **(8 Sessions)**
DESIGN OF PLATE GIRDER BRIDGES
Design of riveted and welded plate girder bridges for highway and railway loading provide knowledge for better employability in industry – wind effects – main section, splicing, curtailment, stiffeners

UNIT IV **(8 Sessions)**
BEARINGS AND SUBSTRUCTURES
Different types of bearings – Design of bearings – Design of piers and abutments of different types – Types of bridge foundations – Design of foundations for skill development and entrepreneurship

UNIT V **(8 Sessions)**
RAILWAY STEEL BRIDGES
General – Railway loadings – dynamic effect – Railway culvert with steel beams – Plate girder bridges – Box girder bridges – Truss bridges – Vertical and Horizontal stiffeners to develop skills

Outcomes: After the completion of this course, students will be
CO1: Able to understand the basic concepts in proportioning and design of bridges in terms of aesthetics at local level, geographical location and functionality, and specifications for loads for skill development and employability.
CO2: Able to understand the design of bridge starting from conceptual design, selecting suitable bridge, geometry to sizing of its elements for anlysing it for employability and entrepreneurship development.
CO3: Able to analyse and design simple connections between structural members including riveted and welded connections and to build models for skill development and employability.
CO4: Able to provide cost-effective solutions for bridge construction by analyzing the designing of bridge foundation and analyse it for employability at national and international level.
CO5: Able to analyse and design tension members, columns (compression members), built-up sections, beams (flexural members) and plate girders to create models for skill development and entrepreneurship development.

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PO-CO Mapping (Please write 3, 2, 1 wherever required)
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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	3	3	3	3	3	3	3
CO2	3	3	3	2	1	3	2	1	1	3
CO3	3	3	2	3	1	3	3	2	1	3
CO4	3	3	2	3	2	3	2	1	3	1
CO5	3	3	3	3	3	2	3	3	1	3

CO-Curriculum Enrichment Mapping (Please **write 3, 2, 1** wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	3	1
CO2	1	3	3
CO3	3	3	2
CO4	2	3	2
CO5	3	2	3

Suggested readings:

1. Ponnuswamy, S., "Bridge Engineering", Tata McGraw Hill, 2008.
2. Johnson Victor, D. "Essentials of Bridge Engineering", Oxford and IBH Publishing Co. New Delhi, 1990
3. Jagadeesh.T.R. and Jayaram.M.A., "Design of Bridge Structures", Prentice Hall of India Pvt. Ltd. 2004

Web sources:

- https://nptel.ac.in/courses/105/106/105106113/
- https://nptel.ac.in/courses/105/105/105105162/

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TMCE033: ANALYSIS AND DESIGN OF SHELL STRUCTURE **L T P 3 1 0**

Course Objective:
To understand the basic concept, mathematical modeling, behavior and analysis of circular domes, conical roofs, cylindrical shells, folded plate, etc for skill development and better skiing of entrepreneurship.

UNIT I **(08 sessions)**
CLASSIFICATION OF SHELL
Classification of shells, types of shells, structural action, - Design of circular domes, conical roofs, circular cylindrical shells by ASCE Manual No.31 for employability and for skill development

UNIT II **(08 sessions)**
FOLDED PLATES
Folded Plate structures, structural behavior, types, design by ACI - ASCE Task Committee method – pyramidal roof.

UNIT III **(08 sessions)**
INTRODUCTION TO SPACE FRAME
Space frames - configuration - types of nodes - general principles of design Philosophy - Behavior

UNIT IV **(08 sessions)**
ANALYSIS AND DESIGN
Analysis of space frames – detailed design of Space frames for employability and better skilling of entrepreneurship – Introduction to Computer Aided Design and Software Packages.

UNIT V
SPECIAL METHODS **(08 sessions)**
Application of Formex Algebra, FORMIAN for generation of configuration for skill development and employability

Course outcomes:
At the end of the course, the student will be able to:
CO1: Classify the shells and know the shell action for creating models at locallevel and for skill development.
CO2: Understand the bending theory of cylindrical shells to develop strategic alliance for employability.
CO3: Design and detail cylindrical shells to analyse it for skill development and entrepreneurship development at national level
CO4: Analyse and detail folded plates by ACIfor global importance and for employability
CO5: Analyse and design of space frames for building at national level for employability and skill development.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	3	2	3	3	2	1	3
CO2	3	3	2	3	3	3	3	2	3	3
CO3	3	1	3	3	2	2	3	3	3	3
CO4	3	3	3	3	1	1	1	1	2	3
CO5	3	1	3	3	3	3	3	3	3	1

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CO-Curriculum Enrichment Mapping (Please **write 3, 2, 1** wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	1	1
CO2	1	3	2
CO3	3	2	3
CO4	2	3	1
CO5	3	3	2

Suggested readings:

1. Billington.D.P, "Thin Shell Concrete Structures", McGraw Hill Book Co., New York, 1982.
2. ASCE Manual No.31, Design of Cylindrical Shells
3. Ramasamy, G.S., "Design and Construction of Concrete Shells Roofs", CBS Publishers, 1986.
4. Subramanian.N ,"Principles of Space Structures", Wheeler Publishing Co. 1999
5. Varghese.P.C., Design of Reinforced Concrete Shells and Folded Plates, PHI Learning Pvt.Ltd., 2010

Website resources:

- http://gvpce.ac.in/
- https://en.wikipedia.org/wiki/Shell_(structure)

Note: Latest editions of all the suggested readings must be used.

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TMCE034: ADVANCED SOIL MECHANICS **L T P 3 1 0**

Course Objective:
Objectives of introducing this subject are:
- To understand the engineering properties of soil and identify the problematic soils for skill development
- To evaluate the soil shear strength for different types of soil for skill and employability and in different conditions of weather
- To analyse the soil behavior under loading and the stresses developed within soil mass for saturated and unsaturated conditions for skill development and employability
- To apply the knowledge of soil compressibility and consolidation theory in practice to estimate settlement to provide better employability.

UNIT I **(08 Session)**
Introduction: Origin of soil and its types, mineralogy and structure of clay minerals, X-ray and Differential Thermal Analysis; structure of coarse grained soil, behavior of granular and cohesive soils with respect to their water content for skill development

UNIT II **(08 Session)**
Consolidation: Steady State flow, 2D and 3D seepage, transient flow; Compressibility and rate of consolidation, one, two, and three dimensional consolidation theories provide knowledge for better employability in industry.

UNIT III **(08 Session)**
Sand drains; Critical state soil mechanics: Critical State Line, Hvorslev Surface, Yield Surfaces: Modified Cam-clay and Original Cam-clay for skill development

UNIT IV **(08 Session)**
Elastic and plastic analysis of soil:- Constitutive relationships of soil; failure theories. Limit analysis, Upper bound theorems, lower bound theorems, limit equilibrium methods for skill development and employability.

UNIT V **(08 Session)**
Soil Stabilization: Classification of stabilizing agents and stabilization processes. Nature and surface characteristics of soil particles.Concepts of surface area and contact points.Inorganic stabilizing agents.Strength improvement characteristic of soft and sensitive clay, Marine clay and waste material for skill development and employability.

Course Outcomes (CO):
After successful completion of the course it is expected that student will be able to:
CO1: Identify the type of soil and understand the numerical value-ranges of its engineering properties at local and global level to develop skill
CO2: Analyse the seepage through hydraulic structures for skill development and employability.
CO3: Analyse and compute the soil settlement for given structure and soil conditions for skill development and employability
CO4: Apply the knowledge of consolidation theories and accelerate the consolidation process for quick construction to develop skill and entrepreneurship for global importance.
CO5: Analyse the stresses produced in the soil for given foundation shape and soil type for skill development

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PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	1	1	2	2	2	1
CO2	3	2	2	2	1	2	1	1	2	1
CO3	3	2	1	2	1	2	2	1	2	1
CO4	3	2	1	2	2	1	1	2	1	2
CO5	3	2	1	2	1	2	2	2	2	1

CO-Curriculum Enrichment Mapping (Please **write 3, 2, 1** wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	2	1
CO2	3	3	1
CO3	3	3	1
CO4	3	2	3
CO5	3	3	1

Suggested Reading:

- B M Das, Advanced Soil Mechanics, Taylor and Francis
- R F Scott, Principles of Soil Mechanics, Addison & Wesley.
- R.O. Davis and A.P.S. Selvadurai, Elasticity and Geomechanics, Cambridge University Press, New York.
- Mitchell, James K, Fundamentals of Soil Behaviour, John Wiley and Sons.
- D.M. Wood, Soil Behaviour and Critical State Soil Mechanics, University of Glasgow

Website Source:

- https://onlinecourses.nptel.ac.in
- https://aktu.ac.in

Note: Latest editions of all the suggested readings must be used.

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TMCE035: REPAIR REHABILITATION AND RETROFITTING OF BUILDING L T P 3 1 0

Objective: The objective of this course is to enhance competence in design of Repair, Rehabilitation and Retrofitting Techniques: Repairs to overcome low member strength, deflection, cracking, and chemical disruption, weathering corrosion, wear, fire, leakage and marine exposure.

UNIT I **(6 Sessions)**

Maintenance: Repair and rehabilitation, facts of maintenance better skilling of entrepreneurship importance of maintenance various aspects of inspection, assessment procedure for evaluating damaged structure, causes of deterioration.

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UNIT II **(8 Sessions)**

Repair Strategies: Causes of distress in concrete structures, construction and design failures for skill development and employability, condition assessment and distress-diagnostic techniques, assessment procedure for inspection and evaluating a damaged structure

UNIT III **(10 Sessions)**

Serviceability and Durability of Concrete: better skilling of entrepreneurshipQuality assurance for concrete construction, concrete properties – strength, permeability, thermal properties and cracking. effects due to climate, temperature, chemicals, corrosion

UNIT IV **(7 Sessions)**

Materials and Techniques for Repair: Special concretes and mortar, concrete chemicals, special elements for accelerated strength gain, expansive cement, polymer concrete, sulphur infiltrated concrete, ferro cement, fibre reinforced concrete, bacterial concrete, rust eliminators and polymers coating for rebars during repair, foamed concrete for skill development and employability, mortar and dry pack, vacuum concrete, gUNIT e and shotcrete, epoxy injection, mortar repair for cracks, shoring and underpinning.

UNIT V **(9 Sessions)**

Repair of structure: Common types of repairs in concrete structures, repairs in under water structures. Strengthening of Structures: Strengthening Methods, retrofitting, jacketing for skill development andentrepreneurship

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

CO1: Understand the fundamentals of maintenance and repair strategiesfor skill development and employability at local and global level.

CO2: Identify for serviceability and durability aspects of concrete,for facing globalchallenges and skilling of entrepreneurship

CO3: Know the materials and techniques used for repair of structures, skilling of entrepreneurship

CO4: Decide the appropriate repair and retrofitting techniques,for skill development and employability.

CO5: Use appropriate health monitoring technique and demolition methods forentrepreneurship

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	1	3	3	3	2	1	3	1
CO2	3	3	2	3	1	3	3	3	1	3
CO3	3	3	3	2	1	3	3	2	1	3
CO4	3	2	3	3	3	2	2	3	3	1
CO5	3	2	1	3	3	3	3	2	2	3

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CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
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	Skill Development	Employability	Entrepreneurship development
CO1	3	2	1
CO2	3	3	3
CO3	3	3	2
CO4	2	2	3
CO5	3	3	2

Suggested Readings:

1. Concrete Technology by A.R. Santakumar, Oxford University press
2. Defects and Deterioration in Buildingts, E F & N Spon, London
3. Non-Destructive Evaluation of Concrete Structures by Bungey - Surrey University
4. Maintenance and Repair of Civil Structures, B.L. Gupta and Amit Gupta, Standard Publications.

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

Note: Latest editions of all the suggested readings must be used.

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TMCE037: NUMERICAL ANALYSIS IN INFRASTRUCTURE ENGINEERING **L T P 3 1 0**

Objective:

- To understand and acquaint the concept of various numerical methods.
- To develop numerical skills in solving problem of engineering interest.
- To enrich the concept of finite element techniques.
- To extract the roots of a polynomial equation.

UNIT I **(8 Sessions)**

EIGEN VALUES EIGEN VECTORS AND INTERPOLATION: Eigen values and Eigen vectors: Numerical evaluation of largest as well as smallest (numerically) Eigen values and corresponding Eigen vectors for skill development

UNIT II **(8 Sessions)**

Interpolation: Introduction, Newton Gregory Forward Interpolation Formula, Newton Gregory Backward Interpolation Formula, Central difference interpolation formula, Lagrange's Interpolation Formula for unevenly spaced Formula, Error in interpolation, Newton's Divided Difference Formula, cubic spline interpolation, surface interpolation for better understanding for employability.

UNIT III **(8 Sessions)**

NUMERICAL SOLUTION NON LINEAR EQUATIONS AND POLYNOMIAL: Introduction, Solution of non linear simultaneous equations, Descarte's Sign rule, Horner's method, Lin-Bairstow's method for better skilling for entrepreneurship, Graeffe's root squaring method, Muller's method, Comparison of various methods.

UNIT IV **(8 Sessions)**

NUMERICAL SOLUTION OF ODEs AND PDEs: Taylor's method, Euler's method, Runge-Kutta methods of various Orders, Modified Euler's method, Predictor corrector method: Adam's method, Milne's method. Solution of Boundary value problems using finite differences. Finite difference approximation of partial derivatives, Classification of 2nd order PDEs, different type of boundary conditions, solutions of Elliptic, parabolic and hyperbolic equations of one and two dimensions, Crank- Nicholson method, ADI method for skill development and employability

UNIT V **(8 Sessions)**

FINITE ELEMENT METHOD: Introduction, Method of Approximation for building in knowledge for better employability, The Rayleigh-Ritz Method, The Galerkin Method, Application to One dimensional and two dimensional problems.

Course Outcomes:

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

CO1: Apply a suitable numerical technique to extract approximate solution to the problem whose solution cannot be obtained by routine methods.Estimate the errors in various numerical methods for skill development

CO2: Analyse/ interpret the achieved numerical solution of problems by reproducing it in graphical or tabular form for better knowledge of entrepreneurship skills at national and international level.

CO3: Approximate the data generated by performing an experiment or by an empirical formula with a polynomial on which operations like division, differentiation and integration can be done smoothly for providing employability.

CO4: Evaluate a sufficiently accurate solution of various physical models of science as well as engineering interest whose governing equations can be approximated by nonlinear ODEs or PDEs or system of ODEs or PDEs to develop skills at local level.

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CO5: Design/ create an appropriate numerical algorithm for various problems of science and engineeringfor skill development and employability for globalimportance.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	1	2	2	2	3	2	2
CO2	2	2	3	2	2	1	2	3	1	1
CO3	3	3	2	2	2	1	1	3	2	1
CO4	2	3	2	3	2	1	2	3	3	3
CO5	2	3	1	2	2	1	3	3	1	1

CO-Curriculum Enrichment Mapping (Please **write 3, 2, 1** wherever required**)**
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	1	2
CO2	2	2	3
CO3	2	3	1
CO4	3	1	2
CO5	3	3	2

Suggested readings:

- B.S. Grewal, Numerical Methods in Engineering and Science with Programs in C & C++, Khanna Publishers (2010).
- S.S. Sastry, Introductory Methods for Numerical Analysis,4th Ed., Prentice Hall of India (2009).
- M.K. Jain, S.R.K. Iyenger and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, 5thEd. New Age International (2007).
- C F Gerald and P O Wheatley, Applied Numerical analysis, Pearson education, 7th edition, 2003.
- Erwin Kreyszig, Advanced Engineering Mathematics, Wiley publication, 9th edition. 2005
- R.K. Jain & S.R.K. Iyenger Advanced Engineering Mathematics, 3rd Ed., Narosa (2002).
- S C Chapra, Raymond P. Canale, Numerical Methods for Engineers, Tata McGraw Hill Pub. Co. Ltd.

Website resources:

- https://pubmed.ncbi.nlm.nih.gov/32597711/
- https://archive.nptel.ac.in/courses/105/105/105105043/

Note: Latest editions of all the suggested readings must be used.

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TMCE038: COST EFFECTIVE AND ECOFRIENDLY CONSTRUCTION **L T P 3 1 0**

Course Objectives:
To study of cost effective construction materials and technologies in rural sector to develop skill. Understand the Definition, Concept & Objectives of the terms cost effective construction and green building. Apply cost effective Technologies and Methods in Construction.

UNIT I **(08 Session)**
Concepts of energy efficient & environment friendly materials and techniques. Cost effective materials:- Soil, Fly ash, Ferrocement, Lime, Fibres, Stone Dust, Red mud, Gypsum, Alternate Wood, Polymer. Energy Efficient & Environment friendly building material products:- Walls - Stabilised and sun dried, soil blocks & bricks, Solid & Hollow concrete blocks, stone masonry blocks, Ferrocement partitions. Roofs - Precast R.C. Plank & Joists roof, precast channel roof, Precast L-panel roof, Precast Funicular shells, Ferrocement shells, Filler Slab, Seasal Fibre roof, Improved country tiles, Thatch roof, M.C.R. tile will develop skill and employability.

UNIT II **(08 Session)**
Cost effective construction techniques and equipments :- (a) Techniques:- Rat trap bond construction, Energy Efficient roofings, Ferrocement technique, Mud Technology to provide knowledge for better employability in industries. (b) Equipments:- Brick moulding machine, Stablilised soil block making machine and plants for the manufacturing of concrete blocks, M.C.R. tile making machine, Ferrocement wall panel & Roofing channel making machine, R.C.C. Chaukhat making m/c.

UNIT III **(08 Session)**
Cost effective sanitation:- (a) Waste water disposal system (b) Cost effective sanitation for rural and urban areas for employability (c) Ferrocement Drains

UNIT IV **(08 Session)**
Low Cost Road Construction:- Cost effective road materials, stabilization, construction techniques tests to provide employability and entrepreneurship, equipment used for construction, drainage, maintenance.

UNIT V **(08 Session)**
Cost analysis and comparison:- (a) All experimental materials (b) All experimental techniques will develop skills and employability

Course Outcomes (CO):
CO1: Understand the Concepts of energy efficient & environment friendly materials and techniquesto develop skills and employability at local and global level.
CO2: Understand the techniques for rat trap bond constructionto develop skill and equipment's used in it
CO3: Understand cost effective sanitation for waste water disposal in rural and urban areasto develop skill
CO4: Demonstrate the low cost road construction techniques for nationalimportance and for employability and entrepreneurship development
CO5: Understand the Cost analysis method and its comparison with all experimental techniquesto develops skills and employability at national and international level.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	3	1	2	1	2	1	1
CO2	3	3	2	2	2	2	2	1	1	2
CO3	3	2	1	2	1	2	2	1	1	1

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CO4	3	2	2	3	2	2	1	2	1	2
CO5	3	2	2	2	2	2	1	1	2	1

CO-Curriculum Enrichment Mapping (Please **write 3, 2, 1** wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	**Employability**	**Entrepreneurship Development**
CO1	3	3	1
CO2	3	2	1
CO3	3	2	1
CO4	2	3	3
CO5	3	2	3

Suggested Reading:

- Alternative Building Materials and Technologies – K S Jagadeesh, B V Venkatta Rama Reddy & K S NanjundaRao – New Age International Publishers
- Integrated Life Cycle Design of Structures – AskoSarja –CRC Press
- Non-conventional Energy Resources –D S Chauhan and S K Sreevasthava – New Age International Publishers
- Buildings How to Reduce Cost – Laurie Backer - Cost Ford
- Lynne Elizabeth, Cassandra Adams Alternative Construction : Contemporary Natural BuildingMethods ", Softcover, Wiley & Sons Australia, Limited, John,2005
- Givoni, "Man, Climate, Architecture, Van Nostrand, New York, 1976.
- Charles J. Kibert, Sustainable Construction: Green Building Design and Delivery, John Wiley & Sons, 2005.
- Eugene Eccli- Low Cost, Energy efficient shelter for owner & builder, Rodale Press, 1976

Website resources:

- https://pubmed.ncbi.nlm.nih.gov/32597711/
- https://archive.nptel.ac.in/courses/105/105/105105043/

Note: Latest editions of all the suggested readings must be used.

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TMCE039: PLASTIC ANALYSIS OF STRUCTURES **L T P 3 1 0**

Course Objectives: To impart knowledge on the analysis of steel structures like continuous beams, steel frames and connection to inculcate skill, provide employability and entrepreneurship by using Plastic Analysis.

UNIT I **(08 Session)**
Analysis of Structures for Ultimate Load: Fundamental Principles – statically method of Analysis – Mechanism method of analysis – Method of analysis, Moment check – Carry over factor – Moment Balancing Method will develop skill.

UNIT II **(08 Session)**
Design of Continuous Beams: Continuous Beams of uniform section throughout – Continuous Beams with different cross-sections will develop skill and employability.

UNIT III **(08 Session)**
Secondary Design Problems: Introduction – Influence of Axial force on the plastic moment – influence of shear force – local buckling of flanges and webs – lateral buckling – column stability for skill development.

UNIT IV **(08 Session)**
Design of Connections: Introduction – requirement for connections – straight corner connections – Haunched connection – Interior Beam-Column connections for skill and entrepreneurship development.

UNIT V **(08 Session)**
Design of Steel Frames: Introduction – Single bay, single storey frames – simplified procedures for Single span frames – Design of Gable frames with Haunched Connection for skill and entrepreneurship development.Ultimate Deflections: Introduction – Deflection at ultimate load – Deflection at working load – Deflections of Beams and Single span frames.

Course Outcomes (CO):
CO1: Understand the fundamental principles of different method of analysis of structures for ultimate Load will develop skill at national and international level.
CO2: Demonstrate the continuous beam design of continuous in naturewill develop skill and employability
CO3: Understand the secondary design problem using axial force method on plastic momentwill skill development.
CO4: Apply design method of connection using method like haunched connection for global importance and other alsofor skill and entrepreneurship development
CO5: Understand the design of steel frames like single bays single story frames will develop skill and employability at global and local level.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	1	2	1	2	1	1
CO2	3	3	2	2	2	2	2	1	2	2
CO3	2	2	1	1	1	1	2	1	1	1
CO4	3	2	2	2	2	2	1	2	2	2
CO5	3	2	2	2	2	2	1	1	2	1

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CO-Curriculum Enrichment Mapping (Please **write 3, 2, 1** wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	2	1
CO2	3	3	1
CO3	3	2	1
CO4	3	1	3
CO5	3	2	1

Suggested Reading:

- Plastic Design of Steel Frames, L.S. Beedle. John Willey & Sons.
- Plastic Analysis, B.G.Neal. SponPres
- Design of Steel Structures by N. Subramanian, Oxford University Press

Website resources:

- https://pubmed.ncbi.nlm.nih.gov/32597711/
- https://archive.nptel.ac.in/courses/105/105/105105043/

Note: Latest editions of all the suggested readings must be used.

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TMCE039 (A): CONSTRUCTION COSTING AND FINANCIAL MANAGEMENT L T P 3 1 0

Course Objective: To provide an in depth knowledge of the detailed procedures and documentation involved in cost ascertainment systems. To understand the concepts of Financial Management and its application for managerial decision making.

UNIT I **(08 Session)**

Cost and Management Accounting: Introduction to Management Accounting - Relationship between Management Accounting and Cost Accounting for skill development and entrepreneurship development

Decision Making Tools: (a) Marginal Costing: Break Even Analysis and Cost - volume - profit analysis; break-even charts and profit charts; differential cost analysis; stock valuation under marginal costing vs. absorption costing; applications of marginal costing in decision making.

(b) Transfer Pricing - Determination of Inter-departmental or Inter-company Transfer Price

UNIT II **(08 Session)**

Budgeting and Budgetary Control:

(a) Budgetary Control and Preparation of Functional and Master Budgeting.

(b) Fixed, Variable, Semi-Variable Budgets

(c) Zero Based Budgeting (ZBB)

Standard Costing & Variance Analysis: Computation of variances for each of the elements of costs, Sales Variances, Investigation of variances - Valuation of Stock under Standard Costing - Uniform Costing and inter-firm comparison to develop skills

UNIT III **(03 Session)**

Introduction to Financial Management: Meaning - Objectives - Scope of Financial Management sources of Finance - Introduction to Financial Markets.

Tools for Financial Analysis and Planning: Financial Ratio Analysis - Funds Flow Analysis - Cash Flow Analysis for skilling of entrepreneurship development

UNIT IV **(08 Session)**

Working Capital Management: Working Capital Management - Financing of Working Capital Cost of Capital, Capital Structure Theories, Dividend Decisions and Leverage Analysis: Meaning of Cost of Capital - Computation of Cost of Capital - Capital Structure Theories and Dividend Decisions Theories (Walters - MM - Gordon Models) - Leverage Analysis for building better knowledge of employability

UNIT V **(08 Session)**

Capital Budgeting - Investment Decisions: Concept of Capital Budgeting - Non-Discounted and Discounted Cash Flow Method - Ranking of Projects for skill development and employability

Course Outcomes (CO):

CO1: Understand the cost and management accounting techniques for evaluation, analysis and application in managerial decision makingat local and global level for skill development and employability

CO2: Compare and contrast marginal and absorption costing methods in respect of profit reportingfor building models for skill development

CO3: Apply marginal and absorption costing approaches in job, batch and process environmentsfor skilling entrepreneurship development at local level.

CO4: Prepare and interpret budgets and standard costs and variance statementsfor employability

CO5: Identify and apply the concepts of Financial Managementfor facing global challenges and for skill development and employability

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PO-CO Mapping (Please write 3, 2, 1 wherever required)
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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	3	1	2	1	2	1	1
CO2	3	3	2	2	2	2	2	1	1	2
CO3	3	2	1	2	1	2	2	1	1	1
CO4	3	2	2	3	2	2	1	2	1	2
CO5	3	2	2	2	2	2	1	1	2	1

CO-Curriculum Enrichment Mapping (Please **write 3, 2, 1** wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	2	3
CO2	3	1	2
CO3	1	2	3
CO4	2	3	2
CO5	3	3	2

Suggested Reading:

- "Financial Management and Accounting Fundamentals for Construction" by Daniel W Halpin and Bolivar A Senior
- "Construction Accounting and Financial Management (Classic Reprint)" by William E Coombs
- "Construction Cost Management: Learning from Case Studies" by Keith Potts and Nii Ankrah
- "Financial Management in Construction Contracting" by Andrew Ross and Peter Williams

Website resources:

- https://pubmed.ncbi.nlm.nih.gov/32597711/
- https://archive.nptel.ac.in/courses/105/105/105105043/

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TMCE039(B): MUNICIPAL SOLID WASTE MANAGEMENT **L T P 3 1 0**

Objective: To make the students conversant with the types, sources, generation, storage, collection, transport, processing and disposal of municipal solid waste.

UNIT I **(8 Sessions)**

SOURCES AND CHARACTERISTICS: Sources and types of municipal solid wastes- Public health and environmental impacts of improper disposal of solid wastes- sampling and characterization of wastes - factors affecting waste generation rate and characteristics - Elements of integrated solid waste management – Requirements and salient features of Solid waste management rules (2016) -- Role of public and NGO"s- Public Private participation – Elements of Municipal Solid Waste Management Plan for skill devlopment

UNIT II **(8 Sessions)**

SOURCE REDUCTION, WASTE STORAGE AND RECYCLING: Waste Management Hierarchy - Reduction, Reuse and Recycling - source reduction of waste – On-site storage methods – Effect of storage, materials used for containers – segregation of solid wastes – Public health and economic aspects of open storage – case studies under Indian conditions – Recycling of Plastics and Construction/Demolition wastes for better understanding of entrepreneurship skills

UNIT III **(8 Sessions)**

COLLECTION AND TRANSFER OF WASTES: Methods of Residential and commercial waste collection – Collection vehicles – Manpower – Collection routes – Analysis of waste collection systems; Transfer stations – location, operation and maintenance; options under Indian conditions – Field problems- solving for skill development and entrepreneurship.

UNIT IV **(8 Sessions)**

PROCESSING OF WASTES: Objectives of waste processing – Physical Processing techniques and Equipment; Resource recovery from solid waste composting and bio methanation; Thermal processing options to develop skills – case studies under Indian conditions.

UNIT V **(8 Sessions)**

WASTE DISPOSAL: Land disposal of solid waste- Sanitary landfills – site selection, design and operation of sanitary landfills for building knowledge for employability– Landfill liners – Management of leachate and landfill gas- Landfill bioreactor – Dumpsite Rehabilitation

Course Outcomes:

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

CO1: Gain knowledge about the municipal solid waste to develop skills at local, national and international level.

CO2: Apply the knowledge of waste management and public health for building models for global importance and for skill development.

CO3: Understand the concept of commercial waste collection and develop skills for entrepreneurship development.

CO4: Understand about the concept of waste processing for strategic alliance of employability.

CO5: Gain knowledge about the waste disposal system for skill development at local level.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	1	2	3	2	1	1	2
CO2	3	1	1	1	2	2	2	3	2	2
CO3	3	2	1	1	2	3	3	2	2	2

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CO4	3	3	3	3	2	2	3	2	3	2
CO5	3	1	1	2	2	2	3	1	2	2

CO-Curriculum Enrichment Mapping (Please **write 3, 2, 1** wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	2	2
CO2	3	2	1
CO3	2	1	3
CO4	2	3	2
CO5	3	1	2

Suggested readings:

- William A. Worrell, P. AarneVesilind (2012) Solid Waste Engineering, Cengage Learning, 2012.
- John Pitchel (2014), Waste Management Practices-Municipal, Hazardous and industrial – CRC Press, Taylor and Francis, New York.
- William A. Worrell et.al., Solid Waste Engineering - 2nd edition, Cengage Learning – USA

Website resources:

- **CPHEEO (2014), "Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organisation, Government of India, New Delhi.**
- **https://studymaterialspdf.com/en8591-municipal-solid-waste-management-civil/**

Note: Latest editions of all the suggested readings must be used.

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Department of Civil Engineering

Master of Technology (M.Tech) Programme
(Effective From Session 2021-22)

TMCE039(C): STRUCTURAL HEALTH MONITORING AND REHABILITATIONS L T P 3 1 0

Course Objectives: The main objective of this course is to make familiar the students with the structural health monitoring concept which is emerging day by day in today's era. It also aims at providing the techniques for repair and rehabilitation and retrofitting knowledge.

UNIT I **(08 Session)**

Maintenance: Repair and rehabilitation, facts of maintenance, importance of maintenance various aspects of inspection, assessment procedure for evaluating damaged structure, causes of deterioration. Repair Strategies: Causes of distress in concrete structures, construction and design failures, condition assessment and distress-diagnostic techniques, assessment procedure for inspection and evaluating a damaged structure for skill development.

UNIT II **(08 Session)**

Serviceability and Durability of Concrete: Quality assurance for concrete construction for better skilling of entrepreneurship, concrete properties – strength, permeability, thermal properties and cracking. Effects due to climate, temperature, chemicals, corrosion.

UNIT III **(08 Session)**

Materials and Techniques for Repair: Special concretes and mortar, concrete chemicals, special elements for accelerated strength gain, expansive cement, polymer concrete, sulphur infiltrated concrete, ferro cement, fibre reinforced concrete, bacterial concrete, rust eliminators and polymers coating for rebars during repair, foamed concrete, mortar and dry pack, vacuum concrete, gUNIT e and shotcrete, epoxy injection, mortar repair for cracks, shoring and underpinning for building knowledge for better employability.

UNIT IV **(08 Session)**

Repair, Rehabilitation and Retrofitting Techniques: Repairs to overcome low member strength, deflection, cracking, chemical disruption, weathering corrosion, wear, fire, leakage and marine exposure. Repair of structure: Common types of repairs repair in concrete structures, repairs in under water structures for skill development and employability. Strengthening of Structures: Strengthening Methods, retrofitting, jacketing.

UNIT V **(08 Session)**

Health Monitoring and Demolition Techniques: Long term health monitoring techniques, engineered demolition techniques for dilapidated structures, use of sensors for building instrumentation for better skilling of entrepreneurship

Course Outcomes (CO):

CO1: Understand the maintenance repair and rehabilitation methods by planning different strategiesfor skill developmentat local and global level.

CO2: Analysis the Serviceability and Durability of Concrete by knowing the property of concretefor entrepreneurship development.

CO3: Understand Materials and Techniques for Repair and understand different material propertyfor building better skills and employability for national importance.

CO4: Understand the Repair, Rehabilitation and Retrofitting Techniques for Strengthening of Structures for developing skills.

CO5: Demonstrate the Health Monitoring and Demolition Techniquesfor skill development and entrepreneurship

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PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	3	1	2	1	2	1	1
CO2	3	3	2	2	2	2	2	1	1	2
CO3	3	2	1	2	1	2	2	1	1	1
CO4	3	2	2	3	2	2	1	2	1	2
CO5	3	2	2	2	2	2	1	1	2	1

CO-Curriculum Enrichment Mapping (Please **write 3, 2, 1** wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	1	2
CO2	2	1	3
CO3	3	3	2
CO4	3	2	1
CO5	3	2	3

Suggested Reading:

- Concrete Technology by A.R. Santakumar, Oxford University press
- Defects and Deterioration in Buildingts, E F & N Spon, London
- Non-Destructive Evaluation of Concrete Structures by Bungey - Surrey University
- Maintenance and Repair of Civil Structures, B.L. Gupta and Amit Gupta, Standard Publications.
- Concrete Repair and Maintenance Illustrated, RS Means Company Inc W. H. Ranso, (1981)
- Building Failures: Diagnosis and Avoidance, EF & N Spon, London, B.

Website resources:

- https://pubmed.ncbi.nlm.nih.gov/32597711/
- https://archive.nptel.ac.in/courses/105/105/105105043/

Note: Latest editions of all the suggested readings must be used.

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