University of Mumbai

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विद्याविषयक प्राधिकरणे
सभा आणि सेवा विभाग(ए.ए.एम.एस)
रूम नं. १२८ एम.जी.रोड, फोर्ट,
मुंबई – ४०० ०३२
टेलिफोन नं. – ०२२ – ६८३२००३३

(नॅक पुनर्मूल्यांकनाद्वारे ३.६५ (सी.जी.पी.ए.) सह अ++ श्रेणी
विद्यापीठ अनुदान आयोगाद्वारे श्रेणी १ विद्यापीठ दर्जा)

क्र.वि.प्रा.स.से./आयसीडी/२०२५-२६/३७ दिनांक : २७ मे, २०२५

परिपत्रक:-

सर्व प्राचार्य/संचालक, संलग्नित महाविद्यालये/संस्था, विद्यापीठ शैक्षणिक विभागांचे संचालक/ विभाग प्रमुख यांना कळविण्यात येते की, राष्ट्रीय शैक्षणिक धोरण २०२० च्या अमंलबजावणीच्या अनुषंगाने **शैक्षणिक वर्ष २०२५-२६** पासून **पदवी व पदव्युत्तर अभ्यासक्रम** विद्यापरिषदेच्या दिनांक २८ मार्च २०२५ व २० मे, २०२५ च्या बैठकीमध्ये मंजूर झालेले सर्व अभ्यासक्रम मुंबई विद्यापीठाच्या www.mu.ac.in या संकेत स्थळावर NEP २०२० या टॅब वर उपलब्ध करण्यात आलेले आहेत.

मुंबई – ४०० ०३२
२७ मे, २०२५

(डॉ. प्रसाद कारंडे)
कुलसचिव

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8	The Deputy Registrar, Executive Authorities Section (EA) eau120@fort.mu.ac.in He is requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to the above circular.
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AC –20/5/2025
Item No. –6.47 (N)

As Per NEP 2020

University of Mumbai

Syllabus for Major Vertical – 1 , 4, 5 & 6		
Name of the Programme – B.E. (Civil and Infrastructure Engineering)		
Faculty of Engineering		
Board of Studies in Civil & Infrastructure Engineering		
U.G. Second Year Programme	**Exit Degree**	**U.G. Diploma in Civil and Infrastructure Engineering.**
Semester		**III & IV**
From the Academic Year		**2025-26**

University of Mumbai

(As per NEP 2020)

Sr. No.	Heading	Particulars
1	**Title of program** **O:_____**	**B.E. (Civil and Infrastructure Engineering)**
2	**Exit Degree**	**U.G. Diploma in Civil and Infrastructure Engineering.**
3	**Scheme of Examination** **R: _____**	NEP 40% Internal 60% External, Semester End Examination Individual Passing in Internal and External Examination
4	**Standards of Passing** **R: _____**	**40%**
5	**Credit Structure** **R. TEU-655C** **R. TEU-655D**	**Attached herewith**
6	**Semesters**	**Sem. III & IV**
7	**Program Academic Level**	**5.00**
8	**Pattern**	**Semester**
9	**Status**	**New**
10	**To be implemented from Academic Year**	**2025-26**

Sd/-	**Sd/-**	**Sd/-**
Dr. Rajendra B. Magar	**Dr. Deven Shah**	**Prof. Shivram S. Garje**
BoS-Chairman-Civil Engineering	**Associate Dean**	**Dean**
Faculty of Technology	**Faculty of Science & Technology**	**Faculty of Science & Technology**

Preamble

To meet the challenge of ensuring excellence and NEP 2020 policy in engineering education, the issue of quality needs to be addressed, debated, and taken forward systematically. Accreditation is the principal means of quality assurance in higher education. The major emphasis of the accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering) of the University of Mumbai has taken the lead in incorporating the philosophy of NEP 2020 education in the process of curriculum development.

The second-year engineering course is a core training program to impart scientific and logical thinking training to learners in general, with a choice of course selection from the program core course, multidisciplinary minor, and vocational skill-enhanced course. Simultaneously, the objectives of NEP 2020 demand nurturing the core program and skills required for the Civil & Infrastructure engineering in the learner. Keeping this in view, a pool of courses is offered in Core Courses covering fundamentals required to understand core and modern engineering practices and emerging trends in technology. Considering the shift in pedagogy and the convenience of a stress-free learning process, a choice-based subject pool is offered in the coursework under the heads of Civil & Infrastructure Engineering for open electives and multidisciplinary minor courses in the third and fourth semesters. Essentially, to give a glimpse of trends in the industry under vocational and enhanced skill practices, the pool is offered to nurture and develop creative skills in contemporary industrial practices. Criteria met in the structure is the opportunity for learners to choose the course of their interest in all disciplines.

Program Core Course Cover Civil & Infrastructure Engineering core courses. Also, OE and MDM where a pool of subjects are given for selection. Considering the present scenario, diverse choices need to be made available to fulfill the expectation of a learner to aspire for a career in the field of current trends of Technology and interdisciplinary research. Ability enhancement can be achieved in Undergraduate training by giving an objective viewpoint to the learning process and transitioning a learner from a rote learner to a creative professional. For the purpose Design Thinking is introduced in the Fourth Semester to orient a journey learner to become a skilled professional. Considering the NEP-2020 structure of award of Certificate & Diploma at multiple exit-point pools of Vocational skills is arranged for giving exposure to the current Industry practices.

The faculty resolved that course objectives and course outcomes are to be clearly defined for every course so that all faculty members in affiliated higher education institutes understand the depth and approach of the course to be taught, which will enhance the learner's learning process. NEP 2020 grading system enables a much-required shift in focus from teacher-centric to continuous-based learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation, which will enhance the quality of education. Credit assignment for courses is based on a 15-week teaching-learning process for NEP 2020, however, the content of courses is to be taught in 12-13 weeks, and the remaining 2-3 weeks are to be utilized for revision, tutorial, guest lectures, coverage of content beyond the syllabus, etc.

There was a concern that in the present system, the second-year syllabus must not be heavily loaded to the learner and it is of utmost importance that the learner entering into the second year of an engineering course should feel at ease by lowering the burden of syllabus and credits. This is necessary for a learner to get accustomed to the new environment of a college and to create a bond between the teacher and the learner. The present curriculum will be implemented for the Second Year of Engineering from the academic year 2025-26. Subsequently, this system will be carried forward for Third Year and Final Year Engineering in the academic years 2026-27, and 2027-28, respectively.

Sd/-	**Sd/-**	**Sd/-**
Dr. Rajendra B. Magar	**Dr. Deven Shah**	**Prof. Shivram S. Garje**
BoS-Chairman-Civil Engineering	**Associate Dean**	**Dean**
Faculty of Technology	**Faculty of Science & Technology**	**Faculty of Science & Technology**

Under Graduate Diploma in Engineering- Civil & Infrastructure Engineering.

Credit Structure (Sem. III & IV)

	R. TEU-655C								
Level	**Semester**	**Major**		**Minor**	**OE**	**VSC, SEC (VSEC)**	**AEC, VEC ,IKS**	**OJT, FP, CEP, CC, RP**	**Cum. Cr. / Sem.**	**Degree/ Cum. Cr.**
		Mandatory	**Electives**							
5.0	III	PCC301:3 PCC302:3 PCC303:3 PCC304:3 PCL301: 1 PCL302:1	--	--	OE:2	--	VEC: 2 HSL: 2	CEP: 2	22	**UG Diploma 45**
	R. TEU-655D									
	IV	PCC401:3 PCC402:3 PCC403:3 PCL401:1 PCL402:1	--	MDM: 4	OE:2	VSEC:2	VEC: 2 EEM:2	--	23	
	Cum Cr.	25	--	4	4	2	*2+2+2+2*	2	45	

Exit option: Award of UG Diploma in Major and MDM with 90 credits and additional 4 credits core **one** theory subject with 3 credits and **one** lab with 1 credit from one third year from where they want to take Exit degree. Along with theory and practical course student must compulsory do internship for **one month or 160 hours** which internship is equal to 4 credits.

[Abbreviation - OE – Open Electives, VSC – Vocation Skill Course, SEC – Skill Enhancement Course, (VSEC), AEC – Ability Enhancement Course, VEC – Value Education Course, IKS – Indian Knowledge System, OJT – on Job Training, FP – Field Project, CEP – Continuing Education Program, CC – Co-Curricular, RP – Research Project]

S.E.
Civil & Infrastructure Engineering
Scheme

Program Structure for Second Year of Civil & Infrastructure Engineering

UNIVERSITY OF MUMBAI (With Effect from 2025-2026)

SEMESTER III

Course Code	Course Description	Teaching Scheme (Contact Hours)			Credit Assigned			
		Theory	Practical	Tutorial	Theory	Tutorial	Practical	Total Credits
2083111	Applied Mathematics for Civil Engineering-I	2	–	1	2	1	–	3
2083112	Mechanics of Solids	3	–	–	3	–	–	3
2083113	Concrete Technology: Materials & Machineries	3	–	–	3	–	–	3
2083114	Architectural Planning & Drawing	3	–	–	3	–	–	3
2083311	Open Elective (OE) Other than a particular program	2#	–	–	2	–	–	2
2083115	Mechanics of Solids Lab	–	2	–	–	–	1	1
2083116	Concrete Technology: Materials & Machineries Lab	–	2	–	–	–	1	1
2083611	Mini Project	–	4	–	–	–	2	2
2993511	Entrepreneurship Development	–	2*+2	–	–	–	2	2
2993512	Environmental Science	–	2*+2	–	–	–	2	2
Total		**13**	**16**	**01**	**13**	**01**	**08**	**22**

* Two hours of practical class to be conducted for full class as demo/discussion.

Theory / Tutorial 1 credit for 1 hour and Practical 1 credit for 2 hours

Institute shall offer a course for Open Elective from Science/Commerce/Management stream bucket provided by the University of Mumbai.

#Institute shall offer a course for MDM from other Engineering Boards.

Course Code	Course Description	Examination scheme							
		Internal Assessment Test (IAT)			End Sem. Exam Marks	End Sem. Exam Duration (Hrs.)	Term Work (Tw)	Oral & Pract.	Total
		IAT-I	IAT-II	Total (IAT-I) + IAT-II)					
2083111	Applied Mathematics for Civil Engineering-I	20	20	40	60	2	25	–	125
2083112	Mechanics of Solids	20	20	40	60	2	–	–	100
2083113	Concrete Technology: Materials & Machineries	20	20	40	60	2	–	–	100
2083114	Architectural Planning & Drawing	20	20	40	60	2	–	–	100
2083311	Open Elective (OE) Other than a particular program	20	20	40	60	2	–	–	100
2083115	Mechanics of Solids Lab	–	–	–	–	–	25	25	50
2083116	Concrete Technology: Materials & Machineries Lab	–	–	–	–	–	25	25	50
2083611	Mini Project	–	–	–	–	–	50	25	75
2993511	Entrepreneurship Development	–	–	–	–	–	50	--	50
2993512	Environmental Science	–	–	–	–	–	50	--	50
Total		**100**	**100**	**200**	**300**	**10**	**225**	**75**	**800**

Program Structure for Second Year of Civil & Infrastructure Engineering

UNIVERSITY OF MUMBAI (With Effect from 2025-2026)

SEMESTER IV

Course Code	Course Description	Teaching Scheme (Contact Hours)			Credit Assigned			
		Theory	Practical	Tutorial	Theory	Tutorial	Practical	Total Credits
2084111	Applied Mathematics for Civil Engineering-II	2	–	1	2	1	–	3
2084112	Modern Surveying	3	–	–	3	–	–	3
2084113	Structural Analysis	3	–	–	3	–	–	3
2084211	Multidisciplinary minor (form Other Engineering Branch/Science/Commerce /Management)	3	–	–	3	–	–	3
2084311	Open Elective (From other boards Science/Commerce/Management stream)	2#	–	–	2	–	–	2
2084114	Modern Surveying Lab	–	2	–	–	–	1	1
2084115	Structural Analysis Lab	–	2	–	–	–	1	1
2084212	Multidisciplinary minor (form Other Engineering Branch/Science/Commerce /Management)	–	2	–	–	–	1	1
2084411	Computer Aided Architectural Planning & Design Lab	–	4	–	–	–	2	2
2994511	Business Model Development	–	2*+2	–	–	–	2	2
2994512	Design Thinking	–	2*+2	–	–	–	2	2
Total		**13**	**18**	**01**	**13**	**01**	**09**	**23**

* Two hours of practical class to be conducted for full class as demo/discussion.

Theory / Tutorial 1 credit for 1 hour and Practical 1 credit for 2 hours

Students must select course for Open Elective from Science/Commerce/Management stream bucket provided by the University of Mumbai.

#Institute shall offer a course for MDM from other Engineering Boards.

Course Code	Course Description	Examination scheme							
		Internal Assessment Test (IAT)			End Sem. Exam Marks	End Sem. Exam Duration (Hrs.)	Term Work (Tw)	Oral & Pract.	Total
		IAT-I	IAT-II	Total (IAT-I) + IAT-II)					
2084111	Applied Mathematics for Civil Engineering-II	20	20	40	60	2	25	–	125
2084112	Modern Surveying	20	20	40	60	2	–	–	100
2084113	Structural Analysis	20	20	40	60	2	–	–	100
2084211	Multidisciplinary minor (form Other Engineering Branch/Science/Commerce/Management)	20	20	40	60	2	–	–	100
2084311	Open Elective (From other boards Science/Commerce/ Management stream)	20	20	40	60	2	–	–	100
2084114	Modern Surveying Lab	–	–	–	–	–	25	25	50
2084115	Structural Analysis Lab	–	–	–	–	–	25	25	50
2084212	Multidisciplinary minor (form Other Engineering Branch/Science/Commerce/Management)	–	–	–	–	–	25	–	25
2084411	Computer Aided Architectural Planning & Design Lab	–	–	–	–	–	50	25	75
2994511	Business Model Development	–	–	–	–	–	50	–	50
2994512	Design Thinking	–	–	–	–	–	50	–	50
Total		**100**	**100**	**200**	**300**	**10**	**250**	**75**	**825**

Sem. - III

Vertical – 1
Major

SEMESTER –III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2083111	Applied Mathematics for Civil Engineering-I	02	-	01	02	-	01	03

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs.)			
		IAT-I	IAT-II	Total					
2083111	Applied Mathematics for Civil Engineering-I	20	20	40	60	2	25	-	125

Pre-requisite: Applied Mathematics-I,
Applied Mathematics-II,

Course Objectives:

1. To familiarize with the Laplace Transform, Inverse Laplace Transform of various functions, its applications.
2. To acquaint with the concept of Fourier Series, its complex form and enhance the problem solving skills.
3. To familiarize with the concept of complex variables, C-R equations with applications.
4. To study the application of the knowledge of matrices and numerical methods in complex engineering problems.

Course Outcomes:

Learner will be able to….

1. Apply the concept of Laplace transform to solve the real integrals in engineering problems.
2. Apply the concept of inverse Laplace transform of various functions in engineering problems.
3. Expand the periodic function by using Fourier series for real life problems and complex engineering problems.
4. Find analytic function by using basic concepts of complex variable theory.
5. Apply Matrix algebra to solve the engineering problems.
6. Solve Partial differential equations by applying numerical solution and analytical methods for one dimensional heat and wave equations.

DETAILED SYLLABUS:

Module	Detailed Contents	Hours	CO Mapping
I	**Module: Laplace Transform** 1.1 Definition of Laplace transform, Condition of Existence of Laplace transform, Laplace Transform (L) of Standard Functions like $e^{at}, sin(at), cos(at), sinh(at), cosh(at)$ and $t^n, where\ n \geq 0$. 1.2 Properties of Laplace Transform: Linearity, First Shifting theorem, change of scale Property, multiplication by *t*, Division by *t*, Laplace Transform of derivatives and integrals (Properties without proof). 1.3 Evaluation of integrals by using Laplace Transformation. **Self-learning topics:** Heaviside's Unit Step function, Laplace Transform of Periodic functions, Dirac Delta Function, Second Shifting Theorem.	**05**	**CO1**
II	**Module: Inverse Laplace Transform** 2.1 Inverse Laplace Transform, Linearity property, use of standard formulae to find inverse Laplace Transform, finding Inverse Laplace transform using derivative 2.2 Partial fractions method & first shift property to find inverse Laplace transform. 2.3 Inverse Laplace transform using Convolution theorem (without proof) **Self-learning Topics:** Applications to solve initial and boundary value problems involving ordinary differential equations.	**04**	**CO2**
III	**Module: Fourier Series:** 3.1 Dirichlet's conditions, Definition of Fourier series. Fourier series of periodic functions with period 2π and $2l$ (No questions should be asked on split function) 3.2 Fourier series of even and odd functions. (No question should be asked on split function) 3.3 Half range Sine and Cosine Series. **Self-learning Topics:** Complex form of Fourier Series, orthogonal and orthonormal set of functions, Fourier Transform, Parseval's Identity.	**04**	**CO3**
IV	**Module: Complex Variables:** 4.1 Function *f*(z) of complex variable, limit, continuity and differentiability of *f*(z), Analytic function, necessary and sufficient conditions for *f*(z) to be analytic (without proof), Cauchy-Riemann equations in cartesian coordinates (without proof) 4.2 Milne-Thomson method to determine analytic function *f*(z) when real part (u) or Imaginary part (v) is given. 4.3 Harmonic function, Harmonic conjugate. **Self-learning Topics:** Conformal mapping, linear, bilinear mapping, cross ratio, fixed points and standard transformations, orthogonal trajectories.	**04**	**CO4**

V	**Module: Matrices:** 5.1 Characteristic equation, Eigen values and Eigen vectors, Properties of Eigen values and Eigen vectors. (**No theorems/ proof**) 5.2 Cayley-Hamilton theorem (without proof): Application to find the inverse of the given square matrix and to determine the given higher degree polynomial matrix. 5.3 Similarity of matrices, Diagonalization of matrices **Self-learning Topics:** Verification of Cayley Hamilton theorem, Minimal polynomial and Derogatory matrix & Quadratic Forms (Congruent transformation & Orthogonal Reduction), Functions of square matrix.	**04**	**CO5**
VI	**Module: Numerical methods for PDE** 6.1 Introduction of Partial Differential equations, method of separation of variables, Vibrations of string, Analytical method for one dimensional heat and wave equations. (only problems) 6.2 Crank Nicholson method 6.3 Bender Schmidt method **Self-learning Topics:** Analytical methods of solving two and three dimensional problems.	**04**	**CO6**

Term Work:

General Instructions:

1) Batch wise tutorials are to be conducted. The number of students per batch should be as per University pattern for practicals.
2) Students must be encouraged to write at least 6 class tutorials on entire syllabus.
3) A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project in Applied Mathematics. This project should be graded for 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows –

1	Attendance (Theory and Tutorial)	05 marks
2	Class Tutorials on entire syllabus	10 marks
3	Mini project	10 marks

Assessment:

Internal Assessment (IA) for 20 marks:

IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test Duration of each test shall be one hour.

End Semester Theory Examination:

Question paper format

- Question Paper will comprise a total of Six **questions each carrying 15 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **Four questions** needs to be answered.

References:

1 Engineering Mathematics, Dr. B. S. Grewal, KhannaPublication
2 Advanced Engineering Mathematics, Erwin Kreyszig, Wiley EasternLimited,
3 Advanced Engineering Mathematics, R. K. Jain and S.R.K. Iyengar, Narosapublication
4 Advanced Engineering Mathematics, H.K. Das, S. Chand Publication
5 Higher Engineering Mathematics B.V. Ramana, McGraw HillEducation
6 Complex Variables and Applications, Brown and Churchill, McGraw-Hilleducation,
7 Text book of Matrices, Shanti Narayan and P K Mittal, S. ChandPublication
8 Laplace transforms, Murray R. Spiegel, Schaum's OutlineSeries

****

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2083112	Mechanics of Solids	3	-	-	3	-	-	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs.)			
		IAT-I	IAT-II	Total					
2083112	Mechanics of Solids	20	20	40	60	2	--	--	100

Rationale :

Civil & Infrastructure engineering structures are made using various engineering materials such as steel, concrete, timber, other metals or their composites. They are subjected to force systems resulting in to axial forces, bending moments, shear forces, torsion and their combinations. Different materials respond differently to these by getting deformed and having induced stresses. Determination of stress, strain, and deflection suffered by structural elements when subjected to diverse loads is prerequisite for an economical and safe design.

In this course, learners will understand the behavior; determine the internal forces and analyses the stresses of various structural elements under action of different type of force systems. The knowledge of Mechanics of Solids will be foundation of essential theoretical background for the subjects of Structural Analysis and Structural Design.

Course Objectives:

The students will be able to learn:

1. To compute area moment of inertia and to learn stress - strain behavior and physical properties of materials and to compute the Stresses developed and estimate deformation of Elastic members under the action of axial forces and temperature change.
2. To learn relationship of distribution of axial force, shear force and bending moment for the loaded, statically determinate beams and portal frames and learn to represent graphically.
3. To analyze the distribution of shear stress and the flexural (bending) stress across the cross section of structural members.
4. To analyze and estimate the direct and bending stresses in columns and study buckling behavior of centrally and eccentrically loaded columns.
5. To analyze and determine the slope and deflection of elastic beams and general theorems used in this computation.
6. To relate the action of twisting moment with geometry of circular shafts and to determine strain energy stored in elastic members.

Course Outcomes:

Upon completion of the course, students shall have ability to:

1. Understand concept of stress-strain and determine different types of stress, strain in determinate homogeneous and Calculate Moment of Inertia for cross sections.

2. Calculate shear force and bending moment in statically determinate beams and portal frames for different loading conditions and illustrate axial force, shear force and bending moment diagram.
3. Explain the concept of shear and bending stresses in beams and demonstrate shear and bending stress distribution diagram.
4. Compute direct and bending stresses developed in the cross section of centrally and eccentrically loaded columns.
5. Evaluate slope and deflection of beams supported and loaded in different ways.
6. Use theory of torsion to determine the stresses in circular shaft and to calculate strain energy stored in members due to elastic deformation.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content		Hours	CO Mapping
I	**Moment of Inertia, Simple Stresses and Strains, Principal planes and stresses**	**1.1**	Moment of Inertia: Area Moment of inertia, Parallel and Perpendicular axis theorem, polar moment of inertia. Radius of gyration.(Rectangular, Triangular, Circular)	**07**	CO1
		1.2	Simple Stresses and Strains , Principal planes and stresses: Types of Stresses and Strains, stress-strain curve, different types of Elastic moduli and relationships between them, Poisson's ratio, factor of safety. Bars of varying sections, temperature stresses. Basics of Principal planes and stresses.		
II	**Axial force, shear force and bending moment diagrams for beams and portal frames**	**2.1**	Concept of Axial Force, Shear Force and Bending Moment. Axial Force Shear Force and Bending Moment Diagrams for statically determinate Simply Supported and Cantilever beams without internal hinges and for single loading like point load, UDL, UVL or Couple moment.	**08**	CO2
		2.2	Axial Force Shear Force and Bending Moment Diagrams for statically determinate 3-member Portal Frames without Internal hinges.		
III	**Shear stresses and Bending stresses in beams**	**3.1**	Distribution of shear stress across plane sections Commonly used for structural purposes.	**05**	CO3
		3.2	Theory of pure bending, Flexure formula for straight beam, simple problems involving application of Flexure formula, section modulus, moment of resistance.		
IV	**Stresses and Deflection of columns**	**4.1**	Direct and bending stresses Circular and rectangular Columns, Core of section, Determination of stresses.	**05**	CO4

		4.2	Buckling of Columns, Members subjected to axial loading, concept of buckling, effective length, different support conditions, Determination of crippling load by Euler's and Rankin's formula.		
V	**Slope and Deflection in Beams**	**5.1**	Slope and Deflection of Beams: Determination of Slope and deflection in beams, using Macaulay's method of double integration, Moment area method only. Simply supported or Cantilever beam of constant EI and subjected to Point load, UDL only shall be studied.	**08**	CO5
		5.2	General Theorems of Slope and Deflection: Betti and Maxwell Reciprocal Theorem, Principal of Virtual work. Application of Unit Load Method and Strain Energy Method for finding out slope and deflection in beams.		
VI	**Torsion of Shafts and strain energy**	**6.1**	Torsion in solid and hollow circular shafts, Shafts transmitting and receiving power at different points. Stresses in Shafts while transmitting power.	**06**	CO6
		6.2	Strain energy stored due to axial force (due to gradual, sudden and impact load) in regular solid and hollow bars. Strain Energy stored due to bending of beams. Strain energy stored in member due to torsion.		

Text Books:

1. Strength of Materials: S. Ramamrutham, Dhanpatrai Publishers.
2. Strength of Materials: R. K. Rajput, S. Chand Publications.
3. Mechanics of Materials: Vol-I: S. B. Junnarkar and H. J. Shah, Charotar Publications.
4. Strength of Materials: Subramanian, Oxford University Press
5. Strength of Materials: S. S. Rattan, Tata Mc-Graw Hill, New Delhi
6. StrengthofMaterials(MechanicsofMaterials):R.S.LehriandA.S.Lehri,S.K.Katar i a Publishers, New Delhi
7. Strength of Materials: Dr. V. L. Shah, Structures Publications, Pune

References:

1. Mechanics of Materials: James, M. and Barry J. ;Cengage Learning.
2. Mechanics of Materials: Andrew Pytel and Jaan Kiusalaas, Cengage Learning.
3. Mechanics of Materials: Timoshenko and Gere, Tata McGrawHill, New Delhi.
4. Mechanics of Materials: James M .Gere, Books/Cole.
5. Strength of Materials: G. H. Ryder, Mc-Millan.
6. Mechanics of Materials: E. P. Popov, Prentice Hall India (PHI) Pvt. Ltd.
7. Mechanics of Materials: Pytel and Singer, Mc-GrawHill, NewDelhi.
8. Strength of Materials: William A. Nash and Nillanjan Mallick, Mc Graw Hill BookCo. (Schaum_s Outline Series)

Online References:

Sr. No.	Website Name
1.	https://archive.nptel.ac.in/courses/105/104/105104160/

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 15 marks. Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **Three questions** need to be answered from Q .2 to Q.6

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2083113	Concrete Technology: Materials & Machineries	3	-	-	3	-	-	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs.)			
		IAT-I	IAT -II	Total					
2083113	Concrete Technology: Materials & Machineries	20	20	40	60	2	--	--	100

Rationale :

Materials are essential elements, constituent parts (or) substances which are used to raise a building, but materials could not be turned into structures without a method of construction. This course provides necessary knowledge about properties, uses of different types of building materials, selection of materials, its mix proportioning and equipment used for the construction. This course is intended for gaining useful knowledge with respect to materials, concrete technology, procedures related to building materials, and construction equipment so that student can learn the aspects required to execute quality during construction work.

Course Objectives:

1. To acquire knowledge about the different constituent materials and their composition in concrete and study of its mix design as per the need.
2. To articulate the important properties of fresh and hardened concrete and corresponding tests conducted for assurance of concrete in terms of properties.
3. To acquire knowledge about the properties of different building materials like brick, timber, steel, concrete blocks and chemicals.
4. To understand the techniques of field and laboratory testing, and awareness of recyclability and Sustainability of Building Materials.
5. To acquire knowledge of machinery and equipment used in construction activities, their types and suitability.
6. To learn the working and usage of heavy equipment and vehicles for various construction activities.

Course Outcomes:

Upon completion of the course, students shall have ability to:

1. Develop and implement the knowledge of constituent materials and their composition in concrete and its mix design.

2. Assess fresh and hardened concrete by conducting tests.

3. Select suitable building materials like brick, timber, steel, concrete blocks and chemicals materials on the basis of its properties.

4. Apply field and laboratory testing for assuring quality of materials and have awareness of recyclability and Sustainability of Building Materials.

5. Employ suitable machinery and equipment for construction activities.

6. Take a call on usage of right type of heavy equipment and vehicles for various construction activities

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content		Hours	CO Mapping
I	**Constituent of Concrete and Mix design**	**1.1**	Cement - Different types, Chemical composition and Properties, Hydration of cement, Tests on cement, IS Specifications. Aggregates – Classification, Mechanical properties and tests as per BIS, Grading requirements. Water - Quality of water for use in concrete. W/C ratio. Admixtures , Accelerators , Retarders, Plasticizers, Super plasticizers ,Water proofers ,Mineral Admixtures like Fly Ash, Silica Fume, Ground Granulated Blast Furnace Slag	**08**	CO1
		1.2	Principles of Mix Proportioning, Mix Design – Design Mix and Nominal Mix, BIS Method of Mix Design - Mix Design Examples, Calculation of ingredients of concrete for batching as per concrete mix proportions for different grades.		
II	**Properties of concrete and testing**	**2.1**	Workability of concrete, Segregation and Bleeding, Creep and shrinkage. Properties of Hard concrete - Compressive strength, split tensile strength, Flexural strength, Stress-strain curve for concrete, Modulus of elasticity.	**08**	CO2
		2.2	Types of concrete, Durability of concrete, Causes of loss of durability. Tests on concrete- UPV, Rebound Hammer, Carbonation, permeability.		
III	**Building Materials**	**3.1**	Timber - Types of natural wood and artificial wood, preservative treatments, defects in timber, wood products and wood composites. Plywood, Block board, alternatives, laminates.	**08**	CO3
		3.2	Steel - Properties of steel as building material, different types of steel used in construction. Strengthening mechanism in metals. Behavior in service and corrosion. Aluminium and Composites- different uses in construction		
		3.3	Bricks - Classification, Manufacturing of clay bricks, Requirement of good bricks.		

		3.4	Concrete blocks, Paver block, Autoclaved Aerated Concrete (AAC) blocks, Cellular Light Weight Concrete (CLC) blocks and ceramic tiles: raw materials, manufacturing process and properties.		
IV	**Testing Methods, recyclability and Sustainability of Building Materials**	**4.1**	Field and laboratory tests on bricks: compressive strength, water absorption, efflorescence, dimension and warpage	**04**	CO4
		4.2	Recyclability, Sustainability, Carbon cycle and role of construction material such as concrete and steel, CO2 contribution from cement and other construction materials		
V	**Mixers, Vibrators, Lifts and Pumps**	**5.1**	Mixers: Tilting, Non-Tilting and Reversing, Transit Mixers, Maintenance of Mixers	**07**	CO5
		5.2	Vibrators: Needle Vibrator, Formwork Vibrator, Table Vibrator, Platform Vibrator, Surface Vibrator and Vibratory Roller.		
		5.3	Pulley blocks, Lifts and conveyors, their components		
		5.4	Pumps: different types used for buildings, their components		
VI	**Excavators, Earthmovers, carriers and Road Rollers**	**6.1**	Types of Excavators, Applications of different types of excavator. Earthmoving equipment, tractors and attachments, dozers and rippers, scrapers, shovels, draglines, trenching machines, clamshell, hoes, dozers, trenching machines.	**04**	CO6

Text Books:

1. A Building Construction: S.C. Rangwala, Charotar Publications, Gujarat, India.
2. Building Construction: S.P. Arora, Dr.S.P. Bindra, DhanpatRai Publication, New Delhi.
3. Building Construction: Dr. B.C. Punmia, A.K.Jain, A.R.Jain, Laxmi Publication., NewDelhi.
4. Concrete Technology Theory and Practice: M.S. Shetty, S.Chand Publication.
5. Concrete Technology: M.L. Gambhir, Tata McGraw Hill, NewDelhi.
6. Concrete Technology: A.M. Neville & J. J. Brooks., ELBS-Longman.
7. Concrete Technology: A.M. Neville & Isaac Pitman, London.
8. Concrete Technology: A. R. Shanthakumar, Oxford University Press.
9. Materials of Construction: D. N. Ghose, Tata McGraw Hill, Delhi.
10. Building Materials: S.K. Duggal, New Age International Publishers.
11. Construction Planning, Equipment and Methods, Robert Peurifoy, McGraw Hill Education

References:

1. Engineering Materials: S.R. Rangwala, Charotar Publications.
2. Architectural Materials science: D. Anapetor, Mir Publishers.
3. Introduction to Engineering Materials: B. K. Agrawal, Tata McGraw Hill, NewDelhi.
4. Engineering Materials: P. Surendra Singh, Vani Education Books,New Delhi.
5. Building Materials (Products, Properties and Systems): M.L. Gambhir and Neha Jamwal , McGraw Hill Publications.
6. Properties of concrete: Neville, Isaac Pitman, London.
7. NPTEL Lecture series on Building Materials, Concrete Technology and construction equipment.
8. Government of India, Ministry of Railways, Compendium of Construction Equipments. https://rdso.indianrailways.gov.in

Assessment:

Internal Assessment -IA1 for 20 marks & IA2 for 20 marks each

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test.

Question paper format

- Question Paper will comprise of a total of **six questions each carrying 15 marks. Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **Three questions** need to be answered from Q .2 to Q.6

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2083114	Architectural Planning & Drawing	03	-	-	03	-	-	03

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs.)			
		IAT-I	IAT -II	Total					
2083114	Architectural Planning & Drawing	20	20	40	60	2	--	--	100

Rationale :

Drawing is the language of civil engineers to communicate. Drawing is one of the most essential documents as far as civil engineering is concerned. It provides guidance and instructions to architects, engineers and workmen at field, on how to construct structures according to the figures and dimensions shown in the drawing. Approved drawings are also essential for the estimation of cost and materials; as well as a very important contract document.

Course Objectives:

1) To remember and recall the intricate details of building design and drawing.
2) To gain an understanding of the basic concepts of building design and drawing.
3) To learn how to apply professional ethics and act responsibly pertaining to the norms of building design and drawing practices, rules, regulation and byelaws, Building codes.
4) To identify problems associated with design and drawing of complex building.
5) To analyze and define solutions for complex building design and drawing problems.
6) To effectively communicate ideas related to building design and drawing, both orally as well as in written format like reports & drawings.

Course Outcomes:

At the end of the course learners will be able to:
1) Describe the basic concepts of building planning and its bye-laws.
2) Understand various working plans of residential and public buildings.
3) Identify the design and drawing technique of different building components and its services.
4) Effectively visualize and understand the concepts of perspective drawing of buildings.
5) Understand the concepts of architectural planning and RERA.
6) Learn the applications of CAD software and fundamentals of BIM.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content		Hours	CO Mapping
I	**Introduction to Building planning and Bye-laws**	**1.1**	Basics of Building, major components and building types, Requirements of a good building planning.	**04**	CO1
		1.2	Principles of planning, building Bye-laws: Principles, objectives, necessity, applications		
		1.3	Factors affecting building planning. Detail study on elements of building planning.		
		1.4	Study of sun path diagram, wind rose diagram and sun shading devices.		
		1.5	Calculation of setback distances, carpet area, built-up area and floor space index (FSI).		
II	**Principles and Codes of Practices for Planning and Designing of Buildings (Residential and Public buildings)**	**2.1**	Study of IS 962: 1989 – Code of Practice for Architectural and Building Drawings; How to develop Line plan into actual PLAN, elevation, section etc. including all the constructional details of various components in a building.	**16**	CO2
		2.2	Classification of buildings: residential –individual bungalows & apartments/flats. public – education (schools, colleges etc.) & health (primary health center, hospital) related building		
		2.3	Study & drawing of SITE PLAN, FOUNDATION PLAN, ROOF PLAN of building; Application of building Bye – laws, Zoning Regulations and permissions required from commencement to completion of the building according to National Building Code (N.B.C.) of India and local Development Control (D.C.) rules		
		2.4	Study of Principles of planning for public buildings: i) Building for education: schools, colleges, institutions etc. ii) Buildings for health: hospitals, primary health centers etc.		
III	**Components and Services of a Building**	**3.1**	Staircase (dog -legged) planning, designing & drawing in details.	**07**	CO3
		3.2	Foundations: stepped footing, isolated sloped footing and combined footing.		
		3.3	Openings: doors and windows.		
		3.4	Types of pitched roof and their suitability (plan and section).		
		3.5	Building services: Water supply, sanitary and electrical layouts.		
IV	**Perspective Drawings**	**4.1**	One-point perspective drawing.	**04**	CO4
		4.2	Two-point perspective drawing.		
V	**Architectural Planning & Overview of RERA**	**5.1**	Architectural Planning: introduction and principles.	**04**	CO5
		5.2	Introduction & Necessity of RERA, Key Features of RERA ACT		
		5.3	Advantages & Disadvantages of the RERA, Carpet definition in RERA		

		5.4	Implementing RERA in Maharashtra State. ODPS (Online development Permission System)		
VI	**Computer Aided Drawing (CAD)& BIM**	**6.1**	Details and learning methods of CAD in Civil Engineering structures	**04**	CO6
		6.2	Study and demonstration of any one of the professional CAD software's		
		6.3	Fundamental of Building Information Modelling (BIM)		

Text Books:

1) Planning and Designing Buildings by Y. S. Sane (Modern Publication House, Pune)

2) Building Drawing and Detailing by B.T.S. Prabhu, K.V. Paul and C. V. Vijayan (SPADES Publication, Calicut)

3) Building Planning by Gurucharan Singh (Standard Publishers & Distributors, New Delhi)

References:

1) IS 962: 1989 – Code of Practice for Architectural and Building Drawings.

2) National Building Code of India – 2005 (NBC 2005)

3) Development Control Regulations for Mumbai Metropolitan Region for 2016 – 2036 (https://mmrda.maharashtra.gov.in)

4) Development Control Regulations for Navi Mumbai Municipal Corporation – 1994 (https://www.nmmc.gov.in/development-control-regulations)

5) Development Plan and Control Regulation KDMC, https://mmrda.maharashtra.gov.in

Reference Codes:

1) National Building Code of India, 2005

2) IS 779-1978 Specification for Water Meter

3) IS 909-1975 Specification for Fire Hydrant

4) IS 1172-1983 Code of Basic Requirement for Water Supply, Drainage & Sanitation

5) IS 1742-1983 Code of Practice for Building Drainage

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Only 4 questions (out of 6) need to be attempted.
- Question no. 1 will be compulsory and based on the drawing work of any one building, may be residential or public building.. Some questions from the remaining may be on Theory portion.
- Any 3 out of the remaining 5 questions need to be attempted.
- In question paper, weightage of each module maybe approximately proportional to the number of lecture hours assigned to it in the syllabus

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2083115	Mechanics of Solids Lab	-	2	-	-	1	-	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		IAT-I	IAT-II	Total				
2083115	Mechanics of Solids Lab	-	-	-	-	25	25	50

Lab Objectives:

The students will be able to learn:

1. To learn stress-strain behavior and physical properties of materials and to compute the Stresses developed and deformation of Elastic members.
2. To learn computing the compressive stress in structural members.
3. To learn computing the flexural (bending) stress across the cross section of structural members.
4. To study the behavior of circular shafts under the action of twisting moment
5. To learn the concept of amount of energy absorbed by the material during fracture.
6. To learn the computation of slope and deflection of elastic beams and make use of general theorems used in this computation.

Lab Outcomes:

Upon completion of the course, students shall have ability to:

1. Evaluate stress-strain behavior of materials and assess the structural behavior by the virtue of stresses developed and deformation of elastic members.
2. Analyze the material response under the action compression and compute the compressive stress in structural members.
3. Evaluate flexural (bending) stress across the cross section of structural members like beams supported and loaded in different ways.
4. Predict the angle of twist and shear stress developed in torsion.
5. Analyze the material response under the action of impact load.
6. Make the computation of slope and deflection of elastic beams and apply general theorems used in this computation.

Prerequisite:

Basic concepts of materials of strength.

DETAILED SYLLABUS

List of Experiments

Mechanics of Solids (Practical performance)			
Sr. No.	**Name of Experiment**	**Duration (Hours)**	**LO**
1	1. Using UTM find different Moduli of a material or 2. The Tension Test on M S rod or 3. The Tension Test on M S Flat	**02**	LO1
2	1. The Compression Test on Concrete cube or 2. The Compression Test on Timber or 3. The Compression Test on Brick	**02**	LO2
3	1. Test of Bending Using a Strain Guage or 2. Test of Bending Using a other electronic devices or 3. Test of Shear Stress in Beams	**02**	LO3
4	1. Using Torsion Testing Machine, verify the torsion equation, find different Moduli of a material. or 2. Spring Stiffness Test using strain gauges or other electronic devices	**02**	LO4
5	1. Charpy impact testing and Energy concept. or 2. Izod impact testing and Energy concept.	**02**	LO5
6	1. Using U T M perform experiments and verify Slope and deflection equations, 3 points and 4 points loading. (Performance) or 2. Deflection of Simply supported Beams (Performance) or 3. Deflection of Cantilever Beams (Performance)	**02**	LO6

Assignment:

(At least 1 from each module as per the Course instructor's guidelines; it is to be assessed during Laboratory hours. In order to avoid Copying/ repetition, Course Instructor may give different assignments to different groups.)

Mechanics of Solids			
Sr. No.	**Name of Assignment**	**Duration (Hours)**	**CO Mapping**
1	Stresses and strains in Elastic members, Spherical and Cylindrical shells 1. Prepare a model of Cylindrical vessel or 2. Prepare a model of spherical vessel or 3. Prepare a model of Cylindrical vessel with hemispherical ends or 4. Prepare a chart showing diagrammatic representation of stresses or 5. A set of 5 questions on a module designed by course instructor, or 6. A site visit to a relevant place or 7. A model / chart based on a module or 8. Design of a new experiment based on a module or 9. Write a Computer program in C++ or MS Excel on how to find a particular quantity from given data (Ex: Find output, Elongation 'ϭ' from the	**02**	CO1

	input values of P,L,A and E) 10. A chart about scientists and their contribution to the study of 'Mechanics of Solids' (Example given at the end of this document –Appendix I)		
2	Axial force, shear force and bending moment diagrams for beams and portal frames 1. A set of 5 questions on a module designed by course instructor, or 2. A site visit to a relevant place or 3. A model / chart based on a module or 4. Design of a new experiment based on a module or 5. A chart about scientists and their contribution to the study of 'Mechanics of Structures' (Example given at the end of this document) or 6. Prepare a chart showing AFD, SFD & BMD for different symmetric and asymmetric loads on S S beams or 7. Prepare a chart showing AFD, SFD & BMD for different loads on Cantilever beams.	**02**	CO2
3	Area Moment of Inertia, Bending stresses and Shear stresses in beams 1. Prepare a chart showing MI @ XX, YY &ZZ axes passing through the centroid. or 2. Prepare 3D models of different typical cross sections of beams and find their cross sectional area, I_{xx}, I_{yy} and I_{zz} or 3. Prepare charts showing typical cross sections and variation of Bending stresses and shear stresses across the cross section. or 4. A set of 5 questions on a module designed by course instructor, or 5. A site visit to a relevant place or 6. A model / chart based on a module or 7. Design of a new experiment based on a module or 8. Write a Computer program in C++ or MS Excel on how to find a particular quantity from given data (Ex: Find output, Flexural stress 'f' from the input values of P,L,I and E) 9. A chart about scientists and their contribution to the study of 'Mechanics of Structures' (Example given at the end of this document)	**02**	CO3
4	Columns 1. Prepare 3D models of different solid and hollow circular cross sections of shafts and find their cross sectional area, Ixx, Iyy and Izz. or 2. A set of 5 questions on a module designed by course instructor, or 3. Write a Computer program in C++ or MS Excel on how to find a particular quantity from given data (Ex: Find output, Shear stress 'q' or angle 'Ɵ' from the input values of T,L,G and J) 4. A site visit to a relevant place or 5. A model / chart based on a module or 6. Design of a new experiment based on a module or 7. A chart about scientists and their contribution to the study of 'Mechanics of Solids' (Example given at the end of this document)	**02**	CO4
5	Torsion of Shafts, Strain Energy 1. Draw typical stress transformation cases of Mohr's circle using graph paper. or 2. A set of 5 questions on a module designed by course instructor, or 3. A site visit to a relevant place or 4. A model / chart based on a module or 5. Design of a new experiment based on a module or 6. A chart about scientists and their contribution to the study of 'Mechanics of solids' (Example given at the end of this document)	**02**	CO5

6	Slope and Deflection in Beams ; General Theorems 1. Prepare chart to explain General theorems for slope and deflection. or 2. A set of 5 questions on a module designed by course instructor, or 3. A site visit to a relevant place or 4. A model / chart based on a module or 5. Design of a new experiment based on a module or 6. A chart about scientists and their contribution to the study of 'Mechanics of Solids' (Example given at the end of this document)	**02**	CO6

Recommended Books:

1. Strength of Materials: S. Ramamrutham, Dhanpatrai Publishers.
2. Strength of Materials: R. K. Rajput, S. Chand Publications.
3. Mechanics of Materials: Vol-I: S. B. Junnarkar and H. J. Shah, Charotar Publications.
4. Strength of Materials: Subramanian, Oxford University Press
5. Strength of Materials: S. S. Rattan, Tata Mc-Graw Hill, New Delhi
6. StrengthofMaterials(MechanicsofMaterials):R.S.LehriandA.S.Lehri,S.K.Kataria Publishers, New Delhi
7. Strength of Materials: Dr. V. L. Shah, Structures Publications, Pune

Reference Books:

1. Mechanics of Materials: James, M. and Barry J.; Cengage Learning.
2. Mechanics of Materials: Andrew Pytel and Jaan Kiusalaas, Cengage Learning.
3. Mechanics of Materials: Timoshenko and Gere, Tata McGrawHill, New Delhi.
4. Mechanics of Materials: James M .Gere, Books/Cole.
5. Strength of Materials: G. H. Ryder, Mc-Millan.
6. Mechanics of Materials: E. P. Popov, Prentice Hall India (PHI) Pvt. Ltd.
7. Mechanics of Materials: Pytel and Singer, Mc-GrawHill, NewDelhi.
8. Strength of Materials: William A. Nash and Nillanjan Mallick, Mc Graw Hill BookCo.(Schaum's Outline Series)

Appendix -I:

A chart about scientists and their contribution to the study of 'Mechanics of solids' be made by students. Contributions of Scientists like Giordano Riccati, Leonhard Euler, Saint Venant, Christian Otto Mohr, William J M Rankine, Carlo Castigliano, Enrico Betti, Robert Hooke, W. H. Macaulay, Augustin- Louis Cauchy, Simeon Poisson can be studied and presented**.**

Important Websites:

1. http://www.iitk.ac.in/mseold/mse_new/facilities/laboratories/MaterialTestingLab/MSE313A.pdf
2. https://home.iitm.ac.in/kramesh/Strength of Materials Laboratory Manual.pdf
3. https://www.researchgate.net/publication/338139499_Me_8381-Strength_Of_Materials_Lab_Manual

Assessment:

TermWork:

Including Laboratory Work and Assignments both, Distribution of marks for Term Work shall be as follows:

Laboratory work: 10 Marks

Assignments : 10 Marks

Attendance : 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted 75% - 80%: 03 Marks; 81% - 90%: 04 Marks; 91% onwards: 05 Marks.

End Semester Oral Examination

Oral examination will be based on entire syllabus

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2083116	Concrete Technology: Materials & Machineries Lab	-	2	-	-	1	-	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		IAT-I	IAT-II	Total				
2083116	Concrete Technology : Materials & Machineries Lab	-	-	-	-	25	25	50

Lab Objectives:

The students will be able to learn:

1. To determine physical and mechanical properties of materials used in the manufacturing of concrete like cement and aggregates.
2. To test the physical attributes and mechanical strength of burnt clay bricks used in the construction of structures.
3. To determine the various properties of fresh and hardened concrete with and without the addition of admixtures
4. To utilize the knowledge of mix design in the manufacturing of concrete, in the laboratory
5. To test the physical attributes and mechanical strength of timber and tiles used in the construction of various components of the structure.
6. To understand the practical scenario of the commonly used building materials in terms of their availability, cost and significance through market surveys

Lab Outcomes:

Upon completion of the course, students shall have ability to:

1. To test physical properties of cement.
2. To test physical properties of aggregates.
3. To test physical properties of concrete and design the concrete mix.
4. To evaluate the effects of admixtures on physical properties of concrete and design the concrete mix.
5. To test physical properties of bricks, timber and tiles.
6. To bridge the gap between theoretical and market practices by market survey.

DETAILED SYLLABUS-

List of Experiments

Sr. No.	List of Experiments	Hrs.	LO Mapping
1	Testing of Cement: fineness, Consistency, setting time, Soundness and strength.	**02**	LO1
2	Physical Properties of Fine and Coarse Aggregates: Specific gravity, bulk density, Moisture content, Water absorption, Fineness modulus, Silt content and bulking of sand	**04**	LO2
3.	Effect of w/c ratio on workability (slump cone, compaction factor, V- B test, flow table) and strength of concrete	**02**	LO3
4	Study of admixtures and their effect on workability and strength of concrete.	**02**	LO4
5	Tests on burnt clay bricks	**02**	LO5
6	Test on tiles	**02**	LO5
7	Compression test on timber (Parallel/ perpendicular to the grains).	**02**	LO5
8	Market survey on common building materials and construction equipments.	**04**	LO6

Site Visit/ Industrial Visit:
The students shall visit the brick manufacturing unit, concrete block, cement and RMC industrial plants. They shall prepare a report of the visit and the same shall be evaluated by the concerned teacher.

Sr No	List of Assignments / Tutorials	CO Mapping
1	Constituent of Concrete and Mix design	CO1
2	Properties of concrete and testing	CO2
3	Building Materials	CO3
4	Testing Methods, recyclability and Sustainability of Building Materials	CO4
5	Mixers, Vibrators, Lifts and Pumps	CO5

Text Books:

1. A Building Construction: S.C. Rangwala, Charotar Publications, Gujarat, India.
2. Building Construction: S.P. Arora, Dr.S.P. Bindra, DhanpatRai Publication, New Delhi.
3. Building Construction: Dr. B.C. Punmia, A.K.Jain, A.R.Jain, Laxmi Publication., NewDelhi.
4. Concrete Technology Theory and Practice: M.S. Shetty, S.Chand Publication**.**

References:

1. Engineering Materials: S.R. Rangwala, Charotar Publications.
2. Architectural Materials science: D. Anapetor, Mir Publishers.
3. Introduction to Engineering Materials: B. K. Agrawal, Tata McGraw Hill, NewDelhi.
4. Engineering Materials: P. Surendra Singh, Vani Education Books,New Delhi.
5. Building Materials (Products, Properties and Systems): M.L. Gambhir and Neha Jamwal , McGraw Hill Publications.

Assessment:

The term work shall consist of:

• Report of experiments performed.

• Industrial visit report to at least any one of the above mentioned industrial plants.

• Although minimum numbers of market surveys and industrial visits are prescribed, the students shall be encouraged to perform more number of experiments and site/ industrial visits

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components of the term work and depending upon the quality of the term work including industrial/ site visit report. The final certification and acceptance of term work warrants the satisfactory performance of laboratory work by the student, appropriate completion of the assignments. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Practical Work	:	10 Marks
Assignments	:	05 Marks
Site Visit/Industrial visit	:	05 Marks
Attendance	:	05 Marks
Total	:	**25 Marks**

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted 75% - 80%: 03 Marks; 81% - 90%: 04 Marks; 91% onwards: 05 Marks.

Practical& Oral Exam: An Oral exam will be held based on the above syllabus.

Vertical – 5

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2993511	Entrepreneurship Development	-	2*+2	-	-	2*+2	-	2

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		IAT-I	IAT-II	Total				
2993511	Entrepreneurship Development	-	-	-	-	50	-	50

Note: * Two hours of practical class to be conducted for full class as demo/discussion/theory.

Lab Objectives:

1. To introduce students to entrepreneurship concepts and startup development.
2. To develop business idea generation, validation, and business model preparation.
3. To provide hands-on experience in market research, financial planning, and business pitching.
4. To enhance problem-solving and decision-making skills in entrepreneurial ventures.
5. To familiarize students with government schemes and support systems for entrepreneurs.
6. To develop communication and presentation skills required for business pitching.

Lab Outcomes:

Upon successful completion of this course, students will be able to:

1. Understand the fundamental concepts of entrepreneurship and business models.
2. Conduct market research and develop business plans.
3. Utilize financial planning and cost analysis for startups.
4. Apply entrepreneurial skills to identify and solve business challenges.
5. Develop prototypes using open-source software for business operations.
6. Pitch business ideas effectively with structured presentations.

DETAILED SYLLABUS

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	**Prerequisite**	Fundamentals of communication and leadership skills.	**01**	**--**
I	**Introduction to Entrepreneurship**	Definition, Characteristics, and Types of Entrepreneurs. Entrepreneurial Motivation and Traits. Start-up Ecosystem in India. Challenges in Entrepreneurship	**02**	**LO1**
II	**Business Idea Generation & Validation**	Ideation Techniques: Design Thinking, Brainstorming, Mind Mapping. Business Model Canvas (BMC). Market Research & Customer Validation. Minimum Viable Product (MVP) Concept.	**04**	**LO2**
III	**Business Planning & Strategy**	Writing a Business Plan. SWOT Analysis and Competitive Analysis. Financial Planning and Budgeting. Risk Assessment and Management	**04**	**LO3**
IV	**Funding and Legal Framework**	Sources of Funding: Bootstrapping, Angel Investors, Venture Capital Government Schemes & Start-up India Initiatives. Business Registration & Legal Formalities. Intellectual Property Rights (IPR) & Patents	**05**	**LO4**
V	**Marketing & Digital Presence**	Branding and Digital Marketing. Social Media Marketing & SEO. Customer Relationship Management (CRM). E-commerce & Online Business Models	**05**	**LO5**
VI	**Business Pitching & Prototype Development**	Pitch Deck Preparation & Presentation Techniques. Prototyping with Open-source Tools. Elevator Pitch & Investor Pitch. Case Studies of Successful Start-ups	**05**	**LO6**

Text Books:

1. "Entrepreneurship Development and Small Business Enterprises" – Poornima M. Charantimath, Pearson, 3rd Edition, 2021.
2. "Innovation and Entrepreneurship" – Peter F. Drucker, Harper Business, Reprint Edition, 2019.
3. "Startup and Entrepreneurship: A Practical Guide" – Rajeev Roy, Oxford University Press, 2022.
4. "Essentials of Entrepreneurship and Small Business Management" – Norman Scarborough, Pearson, 9th Edition, 2021.
5. "The Lean Startup" – Eric Ries, Crown Publishing, 2018.

References:

1. "Disciplined Entrepreneurship: 24 Steps to a Successful Startup" – Bill Aulet, MIT Press, 2017.
2. "Zero to One: Notes on Startups, or How to Build the Future" – Peter Thiel, 2014.
3. "The $100 Startup" – Chris Guillebeau, Crown Business, 2019.
4. "Business Model Generation" – Alexander Osterwalder & Yves Pigneur, Wiley, 2020.
5. "Blue Ocean Strategy" – W. Chan Kim & Renée Mauborgne, Harvard Business Review Press, 2019.

Online Resources:

Website Name
1. Startup India Portal – https://www.startupindia.gov.in 2. MIT OpenCourseWare – Entrepreneurship – https://ocw.mit.edu/courses/sloan-school-of-management/ 3. Coursera – Entrepreneurship Specialization – https://www.coursera.org/specializations/entrepreneurship 4. Harvard Business Review – Entrepreneurship Articles – https://hbr.org/topic/entrepreneurship 5. Udemy – Startup & Business Courses – https://www.udemy.com/courses/business/entrepreneurship/

List of Experiments.

Sr No	List of Experiments	Hrs.
01	Business Idea Generation using Mind Mapping.	02
02	Conducting Market Research & Customer Validation.	02
03	Preparing a Business Model Canvas for a Startup Idea.	02
04	Developing a Financial Plan & Break-even Analysis.	02
05	Creating a Website using WordPress/Wix.	02
06	Social Media Marketing Campaign using Open-source Tools.	02
07	Digital Prototyping using Figma/Inkscape.	02
08	Business Pitch Deck Preparation & Presentation.	02
09	Exploring Government Schemes for Startups.	02
10	Legal Compliance & IPR Basics (Case Study).	02

Sr No	List of Assignments / Tutorials	Hrs.
01	a. Write a report on any successful entrepreneur and their startup journey. b. Conduct SWOT analysis for a real-life startup.	02
02	Develop a business idea and create a one-page business plan.	02
03	Conduct market research using surveys & present findings.	02
04	Design a simple logo and branding strategy for a startup.	02
05	Create a financial model and cost estimation for a startup.	02
06	Make a case study report on startup failure analysis.	02

List of Open-Source Software
1. Canva – Designing pitch decks, social media posts, and branding materials. 2. Trello / Asana – Project management for startups. 3. GIMP / Inkscape – Graphic design and logo creation. 4. WordPress / Wix – Website development for startups. 5. OpenCart / PrestaShop – E-commerce website setup. 6. Figma – UI/UX design and prototyping. 7. LibreOffice Calc – Financial planning and budgeting. 8. Google Suite (Docs, Sheets, Slides) – Documentation and presentations. 9. Python (Pandas, Flask, Django) – Data analytics and web application development. 10. MailChimp – Email marketing and customer engagement.

Assessment:

Term Work: Term Work shall consist of at least 08 to 10 practical's based on the above list. Also, Term work Journal must include at least 6 assignments.

Term Work Marks: 50 Marks (Total marks) = 20 Marks (Experiment) + 15 Marks (Assignments) + 5 Marks (Attendance) + 10 Marks (Report)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2993512	Environmental Science	--	2*+2	-	--	2*+2	-	2

Course Code	Course Name	Theory					Term work	Practical / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	Total					
2993512	Environmental Science	--	--	--	--	--	50	--	50

Note: * Two hours of practical class to be conducted for full class as demo/discussion/theory.

Rationale:

Most of the engineering branches are offspring of applied sciences, and their practices have a significant impact on the environment. Understanding environmental studies is essential for engineers to develop sustainable solutions, minimize ecological footprints, and promote responsible resource management. This course equips students with the knowledge of ecosystems, biodiversity, pollution control, and environmental laws, enabling them to integrate sustainability into engineering practices.

Lab Objectives:

1. To understand the scope, importance, and role of environmental studies in public awareness and health.
2. To study different natural resources, their issues, and sustainable conservation.
3. To understand ecosystem types, structures, and functions.
4. To explore biodiversity, its importance, threats, and conservation.
5. To learn about pollution types, causes, effects, and control measures.
6. To understand environmental challenges, sustainability, and ethics.

Lab Outcomes:

1. Explain the significance of environmental studies and the role of IT in environment and health.
2. Describe resource types, associated problems, and conservation methods.
3. Classify ecosystems and explain their role in ecological balance
4. Analyze biodiversity levels and conservation strategies, especially in India.
5. Explain pollution impacts and suggest preventive measures.
6. Discuss environmental issues and propose sustainable solutions.

DETAILED SYLLABUS:

Unit Name	Topic Name	Topic Description	Hours	LO Mapping
I	**The Multidisciplinary Nature of Environmental Studies**	Definition, scope and importance. Need for public awareness, Role of Civil & Infrastructure Engineering in environment and human health. Human population and the environment: Population growth, variation among nations. Population Explosion- family welfare program. Environment and human health Women and child welfare	**03**	LO1
II	**Natural Resources**	Renewable and non-renewable resources. Natural resources & associated problems: a) Forest resources: b) Water resources: Natural resources & associated problems c) Mineral resources: d) Food resources: e) Energy resources: Role of an individual in conservation of natural resources: f) Equitable use of resources for sustainable lifestyles.	**04**	LO2
III	**Ecosystems**	Concepts of an ecosystem. Introduction, types, characteristic features, structure and function of the following ecosystem: a. Forest ecosystem b. Grassland ecosystem c. Desert ecosystem d. Aquatic ecosystem (ponds, streams, lakes, rivers, oceans, estuaries). Case study on various ecosystems in India.	**05**	LO3
IV	**Biodiversity and its Conservation**	Introduction-Definition: genetic species and ecosystem diversity. Bio-geographical classification of India Value of biodiversity : Consumptive use, productive use, social, ethical, aesthetic and option values, Bio-diversity at global, national, local levels India as a mega diversity nation Case study on Bio diversity in India.	**05**	LO4
V	**Environmental Pollution**	Causes, effects and control measures of:	**05**	

	Definition	a) Air pollution b) Water pollution c) Soil pollution. Solid waste management: Causes, effect and control measures of urban and industrial wastes. Role of an individual in prevention of pollution, Case study on Pollution Disaster management: floods, earthquake, cyclone and landslides. Carbon Credits for pollution prevention		LO5
VI	**Social Issues and Environment**	From unsustainable to sustainable development Urban problems related to energy, Water conservation, rain water harvesting, watershed management. Environmental ethics: issues and possible solution. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies. Consumerism and waste products. Environment protection act. Public awareness Case study on Environmental Ethics	**04**	LO6

Textbooks

1. Environmental Science: Towards a Sustainable Future, G. Tyler Miller and Scott Spoolman, 13th Edition, Cengage Learning 2021
2. Environmental Management: Text and Cases, Bala Krishnamoorthy, 3rd Edition, PHI Learning, Publication Year: 2016
3. Green IT: Concepts, Technologies, and Best Practices, Markus Allemann, Springer 2008
4. Sustainable IT: Slimming Down and Greening Up Your IT Infrastructure, David F. Linthicum, IBM Press 2009
5. Environmental Modelling: Finding Solutions to Environmental Problems, David L. Murray, Cambridge University Press 2016
6. Remote Sensing and Image Interpretation, Thomas M. Lillesand, Ralph W. Kiefer, and Jonathan W. Chipman, 9th Edition, John Wiley & Sons 2020
7. Business Ethics: Concepts and Cases, Manuel Velasquez, Pearson 2012

Reference Books

1. Environmental Law and Policy in India, Shyam Divan and Armin Rosencranz, 2nd Edition, Oxford University Press 2018
2. The International Handbook of Environmental Laws, David Freestone and Jonathon L. Rubin, Edward Elgar Publishing 2000
3. E-Waste Management: Challenges and Opportunities in Developing Countries, Ruediger Kuehr and Ram K. Jain, Springer 2008
4. The E-Waste Handbook: Managing Electronic Waste, Klaus Hieronymi, Ruediger Kuehr, and Ram K. Jain, Earthscan 2009
5. Environmental Ethics: An Introduction, J. Baird Callicott, University of Georgia Press1999

Online References:

Sr. No.	Website Name
1.	Centre for Science and Environment (CSE), Website: cseindia.org
2.	Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India
3.	CSIR-National Environmental Engineering Research Institute (NEERI)

List of Experiments.

Sr No	List of Experiments	Hrs.
01	Study of Environmental Components and Ecosystems.	2
02	Visit and Report on Solid Waste Management Plant.	2
03	Study of Renewable Energy Sources (Solar, Wind, Biogas).	2
04	Analysis of Air and Water Quality Parameters.	2
05	Study of Local Biodiversity and Conservation Methods.	2
06	Awareness Activity on Environmental Issues.	2
07	Rainwater Harvesting System Design	2
08	Case Study on Environmental Pollution & Control Measures.	2
09	Report on Climate Change Impact and Adaptation.	2
10	Study of Environmental Laws and Acts.	2
11	Study of Disaster Management Techniques.	2
12	Report on Role of IT in Environmental Protection.	2

Sr No	List of Assignments / Tutorials	Hrs.
01	Prepare a report on Renewable and Non-Renewable Resources.	2
02	Write a case study on Ecosystem Types in India	2
03	Write a report on Biodiversity in India.	2
04	Prepare a report on Pollution Types and Control Measures.	2
05	Prepare a report on Environmental Ethics and Sustainability.	2
06	Prepare a case study report on Global Warming and Climate Change.	2
07	Report on Role of an Individual in Environmental Protection.	2
08	Write a report on Disaster Management Techniques.	2
09	Prepare a report on Environmental Laws and Acts in India.	2
10	Case Study on E-waste Management and Recycling Techniques.	2

Assessment :

Term Work: Term Work shall consist of at least 10 to 12 practical's based on the above list. Also, Term work Journal must include at least 8 to 10 assignments.

Term Work Marks: 50 Marks (Total marks) = 20 Marks (Experiment) + 15 Marks (Assignments) +

5 Marks (Attendance) + 10 Marks (Report)

Vertical – 6

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2083611	Mini Project	-	4	-	-	2	-	2

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical / Oral	Total
		Internal assessment			End Sem. Exam			
		IAT-I	IAT-II	Total				
2083611	Mini Project	--	--	--	--	50	25	75

Rationale :

From primitive habitats of early years to modern infrastructure, the civil engineering industry's growth has been need based and society centric. Civil and infrastructure engineers deal with many challenges on daily basis that most people do not have any idea. Mumbai University proposed Mini projects in the syllabus so that the budding civil engineers can connect with the world outside their textbooks and have the idea of future course.

The Mini project should actually provide solution to a typical problem after a brainstorming and in a stipulated period. The competitions ahead will give students the experience of the civil engineering industry's real-world problems and make students brainstorm ideas, learn, and explore the civil engineering industry.

Course Objectives:

1. To recognize societal problems and convert them into a problem statement by understanding of facts and ideas in a group activity.
2. To deal with new problems and situations by applying acquired knowledge, facts, techniques and rules in a different way.
3. To examine and break information into parts, by analyzing motives or causes.
4. To learn evaluating information, validity of ideas and work based on a set of criteria.
5. To create solutions by compiling information together in a novel way.
6. To design model by combining elements in a new pattern or proposing new solutions.

Course Outcomes:

Learner will be able to…

1. Identify problems based on societal/research needs and formulate a solution strategy.
2. Apply fundamentals to develop solutions to solve societal problems in a group.
3. Analyze the specific need, formulate the problem and deduce the interdisciplinary approaches, software based solutions and computer applications.
4. Develop systematic flow chart, evaluate inter disciplinary practices, devices, available software, estimate and recommend possible solutions.
5. Draw the proper inferences from available results through theoretical/experimental/simulations and assemble physical systems.
6. Create devises or design a working model for a particular application

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
- Marks awarded by guide/supervisor based on log book : 20
- Marks awarded by review committee : 20
- Quality of Project report : 10

Review/progress monitoring committee may consider following points for assessment based on half year project as mentioned in general guidelines.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
  - Identification of need/problem
  - Proposed final solution
  - Procurement of components/systems
  - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
  - First shall be for finalization of problem and proposed solution
  - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project -

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Feasibility of proposed problem solutions and selection of best solution
4. Cost effectiveness
5. Societal impact
6. Effective use of skill sets
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working / non-working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

SEMESTER IV

Vertical – 1
Major

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2084111	Applied Mathematics for Civil Engineering - II	3	-	-	3	-	-	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT -I	IAT -II	Total					
2084111	Applied Mathematics for Civil Engineering -II	20	20	40	60	2	--	--	100

Pre-requisite:

- Applied Mathematics-I,
- Applied Mathematics-II,
- Applied Mathematics for Civil Engineering II

Objectives:

1) To study the concept of Vector calculus & its applications in engineering.
2) To study Line and Contour integrals and expansion of complex valued function in a power series.
3) To familiarize with the concepts of statistics for data analysis.
4) To acquaint with the concepts of probability, random variables with their distributions and expectations.
5) To familiarize with the concepts of probability distributions and sampling theory with its applications.

Outcomes:

Learner will be able to,

1) Apply the concept of Vector calculus to evaluate line integrals, surface integrals using Green's theorem, Stokes theorem & Gauss Divergence theorem.
2) Use the concepts of Complex Integration for evaluating integrals, computing residues & evaluate various contour integrals.
3) Apply the concept of Correlation, Regression and curve fitting to the engineering problems in data science.
4) Illustrate understanding of the concepts of probability and expectation for getting

the spread of the data and distribution of probabilities.

5) Apply the concept of probability distribution to engineering problems& Testing hypothesis of small samples using sampling theory
6) Apply the concepts of parametric and nonparametric tests for analyzing practical problems.

DETAILED SYLLABUS:

Module	Detailed Contents	Hrs.	CO Mapping
I	**Module : Vector Calculus** 1.1 Solenoidal and irrotational (conservative) vector fields. 1.2 Line integrals – definition and problems. 1.3 Green's theorem (without proof) in a plane, Stokes' theorem (without Proof) only evaluation problems, Gauss' Divergence theorem (without proof) and problems (only evaluation). **Self- Learning Topics**: Identities connecting Gradient, Divergence and Curl, Angle between surfaces. Verifications of Green's theorem, Stoke's theorem & Gauss- Divergence theorem, related identities & deductions.	**05**	**CO1**
II	**Module: Complex Integration** 2.1 Line Integral, Cauchy's Integral theorem for simple connected and multiply connected regions (without proof), Cauchy's Integral formula (without proof). 2.2 Taylor's and Laurent's series (without proof). 2.3 Definition of Singularity, Zeroes, poles of *f(z)*, Residues, Cauchy's Residue Theorem (without proof) **Self-learning Topics:** Application of Residue Theorem to evaluate real integrations.	**05**	**CO2**
III	**Module: Statistical Techniques** 3.1 Karl Pearson's Coefficient of correlation (r) and related concepts with problems 3.2 Spearman's Rank correlation coefficient (R) (Repeated & non repeated ranks problems) 3.3 Lines of regression. **Self-learning Topics:** Covariance, fitting of exponential curve, Fitting of first and second degree curves.	**04**	**CO3**
IV	**Module: Probability Theory:** 4.1 Discrete and Continuous random variables, Probability mass and density function, Probability distribution for random variables, 4.2 Expectation, Variance, Co-variance. 4.3 Moments, Moment generating functions, (Four moments about the origin & about the mean). **Self- learning Topics:** Conditional probability, Total Probability and Baye's Theorem. Properties variance and covariance.	**04**	**CO4**
V	**Module: Probability Distribution and Sampling Theory-I** 5.1 Probability Distribution: Poisson and Normal distribution 5.2 Sampling distribution, Test of Hypothesis, Level of Significance, Critical region, One-tailed, and two-tailed test, Degree of freedom. 5.3 Student's t-distribution (Small sample). Test the significance of single sample mean and two independent sample means and paired t- test) **Self -learning Topics:** Test of significance of large samples, Proportion test, Survey based project.	**05**	**CO5**

VI	**Module: Sampling theory-II** 6.1 Chi-square test: Test of goodness of fit and independence of attributes (Contingency table). 6.2 Analysis of variance: F-test (significant difference between variances of two samples) **Self- learning Topics:** ANOVA**:** One way classification, Two-way classification (short- cut method), Yate's Correction.	**04**	**CO6**

Term Work:

General Instructions:

1) Batch wise tutorials are to be conducted. The number of students per batch should be as per University pattern for practical.
2) Students must be encouraged to write at least 6 class tutorials on entire syllabus.
3) A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project in Applied Mathematics for Civil Engineering-I. This project should be graded for 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows –

1	Attendance (Theory and Tutorial)	05 marks
2	Class Tutorials on entire syllabus	10 marks
3	Mini project	10 marks

Assessment:

Internal Assessment (IA) for 20 marks:

IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test Duration of each test shall be one hour.

End Semester Theory Examination:

Question paper format

- Question Paper will comprise of a total of Six **questions each carrying 15 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **Four questions** needs to be answered.

References:

1. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication

2. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Eastern Limited,
3. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication,
4. Vector Analysis, Murray R. Spiegel, Schaum Series
5. Complex Variables and Applications, Brown and Churchill, McGraw-Hilleducation
6. Probability Statistics and Random Processes, T. Veerarajan, Mc. GrawHilleducation.

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2084112	Modern Surveying	3	-	-	3	-	-	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT -I	IAT -II	Total					
2084112	Modern Surveying	20	20	40	60	2	--	--	100

Rationale:

Surveying is the scientific technique to determine the position of points and angles & distances between them. The process of surveying is necessary to accomplish all civil engineering works or projects successfully like highways, railways, bridges, airports, harbours, canals, dams, reservoirs, sand waste water disposal.

In this core subject, students will learn about the principles and methods in surveying. They will study various conventional instruments which are used in the field for surveying.

For all infrastructures projects, very precise measurements are needed. Thus, the use of modern equipment and methods has become standard. It allows the gathering of much more accurate data in a time-efficient manner and aids in creating the best design possible. Students will learn about the Modern Surveying Instruments and methods, their suitability and applications.

Course Objectives:

The students will be able to learn:

1. Understand appropriate principles and methods of surveying based on accuracy and precision required as per the availability of resources, economics and duration of the project.
2. Learn to apply the technique for measurement of distances in a vertical plane using surveying instruments.
3. Compare direct and indirect methods of measurement and decide the suitable method.
4. Acquire the knowledge of different curves and estimate the quantities.
5. Understand the Modern Surveying Instruments and methods and their suitability.
6. Demonstrate applications of modern instruments and techniques to real problems.

Course Outcomes:

Upon completion of the course, students shall have ability to:

1. Apply the principles and methods of surveying for project works.
2. Measure distances in vertical plane accurately.
3. Suggest solutions to the surveying field problems.
4. Apply the geometric principles for computing data and preparation of drawings.
5. Highlight the improvements in modern surveying instruments/techniques.
6. Use modern surveying tools to solve day to day surveying field problems

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content		Hours	CO Mapping
I	**Introduction**	**1.1**	Definition, principles, objectives, fundamental Classification-plane and geodetic.	**06**	CO1
		1.2	Chaining, Ranging and offsetting: Definitions, Principles, Instruments required, Obstacles, conventional signs and symbols.		
		1.3	Bearings – Different types, compass – prismatic, surveyor, dip, declination and local attraction, compass traversing.		
		1.4	Plane Table Surveying- principle, accessories and method.		
II	**Levelling and Contouring.**	**2.1**	Basic terms, principal axes of dumpy level, temporary and permanent adjustments.	**05**	CO2
		2.2	Booking and reduction of levels.		
		2.3	Contouring: terms, contour, contouring, contour interval, horizontal equivalent, characteristics of contour lines.		
III	**Theodolite Surveying**	**3.1**	Various parts and axes of transit, technical terms, measurement of horizontal and vertical angles.	**08**	CO3
		3.2	Theodolite traverse, Latitudes and departures, traverse adjustments by Bowditch's and transit rule, Gales traverse table.		
		3.3	Tacheometry - Principle, Objective, Suitability and different methods of tacheometry, Stadia formula.		
IV	**Curves**	**4.1**	Horizontal Curves - Definitions of different terms, necessity and types of curves. Methods of setting out Simple circular curves- linear methods and Angular methods (Numericals on imple circular curves only).	**06**	CO4
		4.2	Vertical curves – Definitions, geometry and types. Tangent correction and chord gradient methods.		

V	**Introduction to Modern Surveying Instruments Techniques**	**5.1**	EDM	**08**	CO5
		5.2	Electronic Theodolite		
		5.3	Total Station		
		5.4	Smart Station		
		5.5	GPS		
		5.6	GIS		
		5.7	Remote Sensing		
VI	**Application of Modern Surveying Techniques**	**6.1**	Application of Total Station, GIS, GPS, Remote Sensing, LIDAR, Drones.	**06**	CO6
		6.2	Introduction to GRAM++, Q-GIS.		

Text Books:

1. Surveying and Levelling: R. Agor, Vol. -I, 11th Edition, Khanna Publishers (ISBN8174092358).
2. Surveying and Levelling: Kanetkar and Kulkarni, Vol.-I, 24th Edition, PuneVidyarthiGriha, Pune. (ISBN 8185825114).
3. Surveying and Levelling: Dr. B.C. Punmia, Vol.-I, 16th Edition, Vol. -II 4th Edition,Laxmi Publications (ISBN9788170088530).
4. Surveying and Levelling: N N Basak, 2nd Edition, Tata McGraw Hill, New Delhi.(ISBN9789332901537)
5. Remote Sensing and GIS: B Bhatia, Oxford University Press, New Delhi.
6. Remote Sensing and Geographical Information Systems: M. Anji Reddy, B.S.Publications, Hyderabad, 2001.
7. Concepts and Techniques of Geographic Information Systems: Lo, C.P. & YeungA.K.W., PrenticeHall of India, New Delhi, 2002.

References:

1. Surveying: Volume - I: Dr K.R. Arora, Standard Book House.
2. Surveying and Levelling (2nd Edition): R. Subramanian; Oxford Higher Education.
3. Surveying and Levelling (Vol.-I): S.K. Duggal, Tata McGraw Hill.
4. Textbook of Surveying: C Venkatramaiah, University Press, Hyderabad, Latest Edition.
5. Fundamentals of Surveying: S.K. Roy, Prentice Hall India, New Delhi.
6. Surveying for Engineers: John Uraine and Bill Price, Palgrave Macmillan.
7. Surveying: Theory and Practice, James Anderson, Edward M. Mikhail, Tata Mcgraw Hill.
8. GIS, Spatial Analysis, and Modeling: Maguire, D., M. Batty, and M.Goodchild 2005.ESRI Press(070.212.05842005).
9. Global Positioning System: Signals, Measurements, and Performance, Pratap Misra andPerEnge (2nd Ed.), 2006.
10. Remote Sensing Principles and Interpretation: Floyd, F. Sabins, Jr:,Freeman and Co.,San Francisco,1978.
11. Geographic Information System and Science: Longley, Paul A., Michael F. Goodchild, David J.Maguuire, David W. Rhind, John Wiley and Sons, New York (2nd Ed.), 2005.

Online References:

Sr. No.	Website Name
1.	https://archive.nptel.ac.in/courses/105/107/105107121/

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

Question paper format

- Question Paper will comprise of a total of **six questions each carrying 15 marks. Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**

- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **Three questions** need to be answered from Q .2 to Q.6

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2084113	Structural Analysis	3	-	-	3	-	-	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	Total					
2084113	Structural Analysis	20	20	40	60	2	--	--	100

Rationale:

Civil & Infrastructure engineering structures are made using various engineering materials such as steel, concrete, timber, other metals or their composites. They are subjected to force systems resulting in to axial forces, bending moments, shear forces, torsion and their combinations. Different materials respond differently to these by getting deformed and having induced stresses. Determination of stress, strain, and deflection suffered by structural elements when subjected to diverse loads is prerequisite for an economical and safe design. In this course, learners will understand the behavior; determine the internal forces and analyses the stresses of various structural elements under action of different type of force systems. The knowledge of Mechanics of Solids will be foundation of essential theoretical background for the subjects of Structural Analysis and Structural Design. Different components of Civil & Infrastructure engineering structures are subjected to various force systems and their combinations. For designing the components, these are analyzed for their response. The structural systems are determinate or indeterminate in nature and so there are different analysis methods. These will be learnt in this course. Subject knowledge of Engineering Mechanics and Mechanics of solids is the prerequisite of this course. Their application on solids and mechanisms, the action of force systems is studied and further extended in this subject. Learner will learn to apply these to the analysis of various members of structural systems such as beams, trusses, portal frames and arches. These analyses will further be used while designing of Steel and RCC structures.

Course Objectives:

The students will be able to learn:

1. To analyze for axial force in the Coplanar, perfect trusses and analysis of statically determinate truss for finding deflection at joints using unit load and strain energy method.
2. To interpret the concept of Influence Line Diagrams for Reactions, SF and BM in Beams and axial forces in trusses and their application for rolling load systems.
3. To compute static and kinematic indeterminacy (degrees of freedom) of the structures

such as beams, rigid jointed and pin jointed frames.

4. To analyze the indeterminate structures using Flexibility method.
5. To analyze the indeterminate structures such as beams & simple rigid jointed frames using slope deflection, moment distribution and direct stiffness method
6. To articulate the concept of plastic hinge, plastic moment carrying capacity, shape factor and collapse load for single and multiple span beams

Course Outcomes:

Upon completion of the course, students shall have ability to:

1. Calculate axial forces in the Coplanar trusses by using Method of joints and calculate the deflection of truss joints using Unit load method and strain energy method.
2. Draw Influence Line Diagrams for axial forces in trusses, Reactions, SF and B M in beams and find their values when rolling loads are passing over them.
3. Evaluate rotation and displacement at a joint in frames with the understanding of static and kinematic indeterminacy of structure.
4. Analyze the indeterminate structures such as beams & simple rigid jointed frames using force method (Flexibility) to analyze the indeterminate structures.
5. Analyze the indeterminate structures such as beams & simple rigid jointed frames using displacement method like slope deflection, moment distribution and direct stiffness method.
6. Understand the behavior of various statically indeterminate beams under plastic state.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content		Hours	CO Mapping
I	**Analysis of truss and deflection of truss joints**	**1.1**	Trusses: Analysis of Perfect Coplanar Trusses by Method of Joints.	**06**	CO1
		1.2	Deflection of truss joints: Application of Unit Load Method and Strain Energy method for calculating deflection of a point on Pinjointed truss.		
II	**Influence line diagrams and rolling loads**	**2.1**	Influence lines for Reactions, shear force and bending moment ata section of cantilever, simply supported, overhanging beams without internal hinges.	**07**	CO2
		2.2	Determination of S,F and B.M at a section , criteria for maximum shear force and bending moment, Absolute maximum shear force and bending moment under Rolling loads rolling loads (UDL and series of point loads) for simply supported girder.		
III	**Determinate and Indeterminate structures**	**3.1**	Static and kinematic indeterminacies: Types of structures occurring in practice, their classification, linear and non-linear behavior of materials, geometric non-linearity.	**05**	CO3

		3.2	Static and kinematic determinacy and indeterminacy of structure.		
IV	**Analysis of indeterminate structures by Force method**	**4.1**	Flexibility coefficients and their use in formulation of compatibility equations.	**04**	CO4
		4.2	Application of flexibility method to propped cantilevers, fixed beams & continuous beams, Simple Rigid jointed frames		
V	**Analysis of indeterminate structures by displacement methods**	**5.1**	Slope Deflection method: Application to indeterminate beams & Simple rigid jointed frames having up to three degrees of freedom Including the effect of support settlement.	**12**	CO5
		5.2	Moment distribution method: Application to indeterminatebeams & simple rigid jointed frames having up to three degrees of Freedom including the effect of support settlement.		
		5.3	Direct stiffness method: Stiffness coefficients for prismatic members and their use for formulation of equilibrium equations. Application of Direct stiffness method to indeterminate beams & Simple rigid jointed frames.		
VI	**Plastic analysis of structures**	**6.1**	Introduction to plastic analysis, concept of plastic hinge, plastic moment carrying capacity, shape factor. Determination of collapse load for single and Multiple span beams.	**05**	CO6
		6.2	Static and Kinematic method ofplastic analysis. Determination of collapse load for single and multiple span beams.		

Text Books:

1. Basic Structural Analysis: C. S. Reddy, Tata McGraw Hill NewDelhi.
2. Mechanics of Structures: Vol-I: S. B. Junnarkar and H.J.Shah, Charotar Publishers,Anand.
3. Analysis of Structures: Vol.I and II, Vazirani and Ratwani.
4. Strength of Materials: S. Ramamrutham, Dhanpatrai and Publishers, Delhi
5. Theory of Structures: S. Ramamrutham, Dhanpatrai and Sons, Delhi
6. Structural Analysis- I: Hemant Patil, Yogesh Patil, Jignesh Patel, SynergyKnowledgeware, Mumbai.
7. Strength of Materials: Rajput, S. Chand Publications, Delhi
8. Structural Analysis: Bhavikatti, Vikas publisher house Pvt, ltd.
9. Structural Analysis: Devdas Menon, Narosa Publishing House.
10. Basic Structural Analysis: K.U. Muthu, et.al., I.K. International Publishing House Pvt. Ltd.
11. Elementary Structural Analysis: Jindal
12. Structural Analysis: L.S. Negi and R. S. Jangid, TataMc-Graw Hill India.
13. Structural Analysis: T.S. Thandavamoorthy, Oxford University Press.
14. Structural Analysis: Manmohan Das, BharghabMohan Pentice Hall International.

References:

1. Structural Analysis: Hibbler, Prentice Hall International.
2. Structural Analysis: Chajes, ElBS London.
3. Theory of Structures: Timoshenko and Young, Tata Mc Graw Hill NewDelhi.
4. Structural Analysis: Kassimali, TWS Publications.
5. Element of Structural Analysis: Norris and Wilbur, McGraw Hill.
6. Structural Analysis: Laursen H.I, McGraw Hill Publishing Co.
7. Structural theorem and their application :B.G.Neal, Pergaman Press.
8. Elementary theory of Structures: Hsieh, Prentice Hall

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test.

Question paper format

- Question Paper will comprise of a total of **six questions each carrying 15 marks. Q.1** will be **compulsory** and should **cover maximum contents of the syllabus.**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **three questions** need to be answered from Q .2 to Q.6.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2084114	Modern Surveying Lab	-	2	-	-	1	-	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	IAT-II	Total				
2084114	Modern Surveying Lab	-	-	-	-	25	25	50

Lab Objectives:

The students will be able to learn:

1. Study various surveying instruments, their least counts, various parts and suitable uses.
2. Apply methods of measurements in the field.
3. Demonstrate skills for collecting, recording and analyzing the field data.
4. Learn advanced instruments/techniques.
5. Acquire first hand practical experience by receiving field exposure to collect site specific data.
6. Exhibit setting out techniques.

Lab Outcomes:

Upon completion of the course, students shall have ability to:

1. Operate and use the surveying instruments.
2. Measure linear and angular dimensions in horizontal and vertical planes.
3. Collect records and analyze the field data systematically.
4. Compare advanced instruments/ techniques with the conventional ones.
5. Prepare the drawings from the collected data in the form of plans, sections and contours.
6. Set out curves and foundation plans.

Prerequisite:

Basic concepts of surveying.

DETAILED SYLLABUS

List of Experiments.
(Any 6 experiments to be performed)

Sr. No.	List of Experiments	Hours	LO Mapping
1	Chain and compass surveying.	02	LO1
2	Simple and compound leveling practices	02	LO1
3	Measurement of horizontal angles and vertical angles using a Theodolite.	02	LO2
4	Measurement of distances, bearings and area using total station.	02	LO2
5	Plane Table Surveying by intersection method.	02	LO3
6	Find constants, heights and distances using Tacheometry.	02	LO3
7	Setting out a simple circular curve.	02	LO5
8	Setting out a simple foundation plan.	02	LO6
9	Determination of co -ordinates and lengths of a profile using GPS.	02	LO4
10	Analysis of survey projects conducted using various softwares.	02	LO4

Projects	
A survey camp of three days is to be arranged to execute the following projects for undergoing the students through practical instructions in civil engineer's career with the actual field exposure at an ideal site location.	
1	**Project I:** Road project using Auto level for a minimum length of 500 m including fixing of alignment, profile leveling, cross-sectioning at 20 m interval, plotting of 'L' section and 'C' section. (Two full imperial sheets, the first sheet with key plan and section and the second sheet covering any three typical Cross-sections)
2	**Project II:** Block Contouring project using Auto level for minimum 60 m × 60 m Area and generating contours by MS Excel. (Take contour interval as 0.2 meter)
3	**Project III:** Tacheometric contouring project on a hilly area with at least two instrument stations about 60 m to 100 m apart and generating contours by taking Contour intervals as 1 meter.

References:

1. Surveying and Levelling : R. Agor, Vol-I, 11th Edition, Khanna Publishers (ISBN 8174092358).
2. Surveying and Leveling: Kanetkar and Kulkarni,Vol-I, 24th Edition, Pune Vidyarthi Griha, Pune. (ISBN 8185825114).
3. Surveying and Levelling : Dr. B.C. Punmia, Vol.-I, 16th Edition, Vol -II 4 th Edition, Laxmi Publications (ISBN9788170088530).
4. Surveying and Levelling: N N Basak, 2nd Edition, Tata McGraw Hill, New Delhi. (ISBN 9789332901537).
5. Surveying: Vol-I: Dr K.R. Arora, Standard Book House.
6. Surveying and Levelling (2nd Edition): R. Subramanian; Oxford Higher Education.
7. Surveying and Levelling (Vol.-I): S.K. Duggal, Tata Mc-Graw Hill.
8. Global Positioning System: Signals, Measurements, and Performance, Pratap Misra (2nd Ed.), 2006.
9. Imaging Radar for Resource Survey: Remote Sensing Applications: W. Travelt, Chapman and Hall.
10. A Remote Sensing Perspective: Introductory Digital Image Processing: John, R. Jensen, Prentice Hall.

11. Remote sensing and Image interpretation, T.M Lilles, R.W Kiefer and J.W Chipman,5th edition,John Wiley and Sons India.

Online Resources:

Sr. No.	Website Name
1.	https://youtu.be/TKzEBJ1qkz8?feature=shared
2.	https://youtu.be/Mb2jbdqMJHA?feature=shared
3.	https://youtu.be/z0wV0VsXdX0?feature=shared

Assessment:

Term Work: Term Work shall consist of at least 06 practicals based on the experiment list. Also, Including above practical work, projects and assignments, distribution of marks for Term Work shall be as follows:

Practical Work	: 05 marks
Assignments	: 05 marks
Project	: 15 marks
Total	: **25 marks**

End Semester Practical/ Oral Examination

Practical Examination : 10 Marks

Oral Examination : 15 Marks.

Oral examination will be conducted after conduction of practical examination & it will be based on term work & Practical examination.

Practical & Oral Exam: An Oral exam will be held based on the above syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2084115	Structural Analysis Lab	-	2	-	-	1	-	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		IAT-I	IAT-II	Total				
2084115	Structural Analysis Lab	-	-	-	-	25	25	50

Lab Objectives:

The students will be able to learn:

1. To analyze for axial force in the Coplanar, perfect trusses and evaluate deflection in trusses using energy methods.
2. To study the concept of Influence Line Diagrams and rolling loads.
3. To understand to differentiate determinate and indeterminate structures.
4. To learn methods for evaluating rotation and displacement of frames and trusses.
5. To analyze the indeterminate structures using Flexibility methods and Stiffness method.
6. To understand Plastic analysis including plastic hinge and plastic moment capacity.

Lab Outcomes:

On completion of this course, the students will be able to:

1. Calculate axial forces in the Coplanar trusses by using Method of joints and method of sections and also calculate deflection in truss at various joints using energy methods.
2. Draw Influence Line Diagrams for axial forces in trusses, Reactions, SF and B M in beams and find their values when rolling loads are passing over them.
3. To compute static and kinematic indeterminacy (degrees of freedom) of the structures such as beams & rigid and pin jointed frames.
4. Evaluate rotation and displacement at a joint of frames and deflection at any joint of truss and will be able to compute static and kinematic indeterminacy of structure.
5. Analyze the indeterminate structures such as beams & simple rigid jointed frames using Flexibility methods and direct stiffness method.
6. Evaluate the behavior of various statically indeterminate beams under plastic state.

DETAILED SYLLABUS

List of Experiments.

Sr No	List of Experiments	Hrs	LO Mapping
1	Analysis of Trusses. (Numericals based on this Module will be solved in tutorial room.)	2	LO1
2	1) Analysis of Trusses 2) Solve set of questions given by the course instructor (or) 3) Write a report on use of arches in civil engineering (or) 4) Difference in behaviour of trusses and arches if used in bridges (or) 5) Write a report on limitations of trusses /arches (or) 6) Report Famous Truss structures / arch structures in world (or) 7) Write a report on use of trusses in Civil Engineering	2	LO2
3.	Influence line diagrams and rolling loads (Numericals based on this Module will be solved in tutorial room.)	2	LO2
4	Influence line diagrams and rolling loads 1) Solve set of questions given by the course instructor (or) 2) Write a report on use of arches in civil engineering (or) 3) Design an experiment for ILD of reactions of beam. (or) 4) Design an experiment for ILD of axial forces of a multi-bay truss (or) 5) write a report on IRC and classes of rolling loads	2	LO3
5	Determinate and Indeterminate structure (Numericals based on this Module will be solved in tutorial room.)	2	LO4
6	Determinate and Indeterminate structure 1) Solve set of questions given by the course instructor (or) 2) Prepare a chart explaining static and kinematic indeterminacy (or) 3) Write a computer program in C++ or MS-excel or similar for ILD of reactions. (or) 4) Write a computer program in C++ or MS-excel or similar for ILD for axial forces in Truss members.	2	LO5
7	Analysis of indeterminate structures by Flexibility method (Numerical based on this Module will be solved in tutorial room.)	2	LO6
8	Analysis of indeterminate structures by Flexibility method 1) Solve set of questions given by the course instructor (or) 2) Prepare a poster on Flexibility and Stiffness approach (or) 3) Solve a set of 4-5 questions given by the course instructor on Flexibility methods and validate the same using relevant Structural Analysis or design software.	2	LO5
9	Analysis of indeterminate structures by Direct stiffness method (Numericals based on this Module will be solved in tutorial room).	2	LO6
10	Analysis of indeterminate structures by slope and deflection method 1) Solve set of questions given by the course instructor (or) 2) Write a report on Stiffness methods in civil engineering (or) 3) Prepare a poster on Clapeyron_s theorem for continuous beam. (or)	2	LO6

	4) Solve a set of 4-5 questions given by the course instructor on direct stiffness method and validate the same using relevant Structural Analysis or design software.		
11	Moment distribution method, Plastic analysis of structures (Numerical based on this Module will be solved in tutorial room.)	2	LO5
12	Moment distribution method, Plastic analysis of structures 1. Solve set of questions given by the course instructor (or) 2. Write a report on Plastic analysis of structures (or) 3. Solve a set of 4-5 questions given by the course instructor on Moment distribution method and validate the same using relevant Structural Analysis or design software.	2	LO6

Sr. No.	List of Assignments / Tutorials	CO Mapping
1	Analysis of truss and deflection of truss joints	CO1
2	Influence line diagrams and rolling loads	CO2
3	Determinate and Indeterminate structures	CO3
4	Analysis of indeterminate structures by Force method	CO4
5	Analysis of indeterminate structures by displacement methods	CO5
6	Plastic analysis of structures	CO6

Text Books:

1. Basic Structural Analysis: C. S. Reddy, Tata McGraw Hill NewDelhi.
2. Mechanics of Structures: Vol-I: S. B. Junnarkar and H.J.Shah, Charotar Publishers, Anand.
3. Analysis of Structures: Vol.I and II, Vazirani and Ratwani.
4. Strength of Materials: S. Ramamrutham, Dhanpatrai and Publishers, Delhi
5. Theory of Structures: S. Ramamrutham, Dhanpatrai and Sons, Delhi
6. Structural AnalysisI: Hemant Patil, Yogesh Patil, Jignesh Patel,Synergy knowledge Mumbai.
7. Elementary Structural Analysis: Jindal
8. Structural Analysis: L.S. Negi and R. S. Jangid, TataMc-Graw Hill India
9. Structural Analysis: T.S. Thandavamoorthy, Oxford University Press.
10. Structural Analysis: Manmohan Das, BharghabMohan Pentice Hall International.

References:

1. Structural Analysis: Hibbler, Pentice Hall International.
2. Structural Analysis: Chajes, ElBS London.
3. Theory of Structures: Timoshenko and Young, Tata Mc Graw Hill New Delhi.
4. Structural Analysis: Kassimali, TWS Publications.
5. Element of Structural Analysis: Norrisand Wilbur, McGraw Hill.
6. Structural Analysis: Laursen H.I, McGraw Hill Publishing Co.
7. Structural theorem and their application :B.G.Neal, PergamanPress.

Assessment:

Term Work:
Term work will include Tutorial work and Assignments both, Distribution of marks for Term Work shall be as follows:

Tutorial work- : 10 Marks
Assignments- : 10 Marks
Attendance : 05 Marks

Total Term work: 25 Marks
Further, while giving weightage of marks on the attendance, following guidelines shall be resorted 75% - 80%: 03 Marks; 81% - 90%: 04 Marks; 91% onwards: 05 Marks.

Oral Exam: An Oral exam will be held based on the above syllabus.

Vertical – 4

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2084411	Computer Aided Architectural Design Lab Course-1	-	4	-	-	2	-	2

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical / Oral	Total
		Internal assessment			End Sem. Exam			
		IAT-I	IAT-II	Total				
2084411	Computer Aided Architectural Design Lab Course-1	-	-	-	-	50	25	75

Lab Objectives:

The students will be able to learn:

1. To remember and recall the intricate details of building design and drawing.
2. To gain an understanding of the basic concepts of building design and drawing.
3. To learn how to apply professional ethics and act responsibly pertaining to the norms of building design and drawing practices.
4. To identify, analyze, research literate and solve complex building design and drawing problems.
5. To have new solutions for complex building design and drawing problems.
6. To effectively communicate ideas, related to building design and drawing, both orally as well as in written format like reports & drawings.

Lab Outcomes:

Upon completion of the course, students shall have ability to:

1) Design and drawing of floor plan, elevation, section plan site plan, foundation plan, roof plan, schedule of opening of building.
2) Design and drawing of site plan, foundation plan, roof plan, schedule of opening of building.
3) Draw one-point perspective views of various building.
4) Prepare various working and detailed drawing of the buildings in CAD software.
5) Draw two point perspectives drawing of various building.
6) Prepare service plan of a building.

DETAILED SYLLABUS

List of Experiments

Sr No.	List of Drawings	Hrs.	LO Mapping
1	Ground floor plan, first floor plan, elevation, section passing through at least one sanitary unit & staircase, of a residential building(bungalow or apartment) to be constructed as a (G+1) R.C.C framed structure (only manual drawing)	06	LO1
2	Site plan, foundation plan and details of one footing, roof plan, schedule of opening and construction notes of a residential building(bungalow or apartment) to be constructed as a (G+1) R.C.C. framed structure (only manual drawing)	04	LO2
3	One-point perspective drawing for any residential structure (only manual drawing)	04	LO3
4	Ground floor plan, first floor plan, elevation, section passing through at least one sanitary unit & staircase, schedule of opening and construction notes of a public building(education/health related) be constructed as a (G+1) R.C.C. framed structure (only CAD drawing Sheet)	06	LO4,LO1,LO2
5	Two-Point perspective drawing for any one public building (only CAD drawing Sheet)	04	LO5,LO4,LO2
6	Service plan of any one building project in CAD software (Residential/public)	02	LO6,LO4

Project Work :
Students should visit any Residential building/Public building physically and take Measurements inside of all rooms & over all outside of the building & can submit a small drawing sheet with the help of CAD.

Recommended Books:

1. Building Drawing with an Integrated Approach to Built Environment by M. G. Shah, C. M. Kale, S.Y. Patki (Tata McGraw-Hill Education)
2. Civil Engineering Drawing (including Architectural aspect) by M. Chakraborti (MonojitChakraborti Publications, Kolkata)
3. Planning and Designing Buildings by Y. S. Sane (Modern Publication House, Pune)
4. Building Drawing and Detailing by B.T.S. Prabhu, K.V. Paul and C. V. Vijayan (SPADES Publication, Calicut)
5. Building Planning by Gurucharan Singh (Standard Publishers & Distributors, New Delhi)

References:

1. IS 962: 1989 – Code of Practice for Architectural and Building Drawings.
2. National Building Code of India – 2005 (NBC 2005)
3. Development Control Regulations for Mumbai Metropolitan Region for 2016 – 2036 (https://mmrda.maharashtra.gov.in)
4. Development Control Regulations for Navi Mumbai Municipal Corporation – 1994 (https://www.nmmc.gov.in/development-control-regulations)
5. Development Plan and Control Regulation KDMC, https://mmrda.maharashtra.gov.in

Reference Codes:

1. National Building Code of India, 2005
2. IS 779-1978Specification for water meter
3. IS 909-1975 Specification for fire hydrant • IS 1172-1983 Code of basic requirement for water supply ,drainage & sanitation
4. IS 1742-1983 code of practice for building drainage

The term work shall consist of:
Drawings -

1. Ground floor plan, first floor plan, elevation, section passing through at least one sanitary unit & staircase, Site plan, Foundation Plan and details of one FOOTING, Roof Plan ,schedule of opening and construction notes of a residential building(bungalow or apartment) to be constructed as a (G+1) R.C.C. framed structure (only Manual Drawing)
2. One-Point Perspective drawing for any Residential structure (only Manual drawing)
3. Ground floor plan, first floor plan, elevation, section passing through at least one sanitary unit & staircase, schedule of opening and construction notes of a public building(Education/Health related) be constructed as a (G+1) R.C.C. framed structure (only CAD drawing Sheet)
4. Two-Point perspective drawing for any one public building (only CAD drawing Sheet)

Distribution of the Term Work Marks:

The marks of term-work shall be judiciously awarded depending upon the quality of the term work. The final certification acceptance of term-work warrants the satisfactorily the appropriate completion of the required quality & quantity of work for the minimum passing marks to be obtained by the students. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Drawing Sheet (Manual)	:	15 Marks
Drawing Sheet (CAD Based)		15 Marks
Project Work	:	15 Marks
Attendance	:	5 Marks
Total	:	**50 Marks**

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to. 75% 80%: 03 Marks; 81% 90%: 04 Marks 91% onwards: 05 Marks (Consider Practical attendance

Practical Examination (Oral & sketching) –

Practical Examination will consist of sketching & oral examination based on the entire syllabus.

Vertical – 5

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2994511	Business Model Development	-	2*+2	-	-	2*+2	-	2

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	Total					
2994511	Business Model Development	-	-	-	-	-	50	-	50

Note: * Two hours of practical class to be conducted for full class as demo/discussion/theory.

Lab Objectives:

1. To introduce a learner to entrepreneurship and its role in economic development.
2. To familiarize a learner with the start-up ecosystem and government initiatives in India.
3. To explain the process of starting a business.
4. To familiarize a learner with the building blocks of a business.
5. To teach a learner to plan their own business with the help of Business Model Canvas.
6. To teach a learner to have financial plan for a business model.

Lab Outcomes:

The learner will be able to:

1. Discuss the role of entrepreneurship in the economic development of a nation and describe the process of starting a business.
2. Describe start-up ecosystems in Indian and global context.
3. Identify different types of business models.
4. Identify customer segments, channels and customer relationship components for a particular business.
5. Identify key activities, key partners and key resources for a particular business.
6. Develop a financial plan for a business with the help of cost structure and revenue model.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	Basic Design Thinking principles	01	-
I	Introduction to Entrepreneurship	**Introduction to Entrepreneurship**: Definition, the role of entrepreneurship in the economic development, the entrepreneurial process, Women entrepreneurs, Corporate entrepreneurship, Entrepreneurial mindset **Self-learning Topics:** Case studies: Henry Ford https://www.thehenryford.org/docs/default-	04	L1, L2

		source/default-document-library/default-document-library/henryfordandinnovation.pdf?sfvrsn=0 The Tatas: How a Family Built a Business and a Nation by Girish Kuber, April 2019, Harper Business		
II	**Entrepreneurship Development**	**Entrepreneurship Development**: Types of business ownerships: Proprietorship, Public and Private Companies, Co-operative businesses, Micro, Small and Medium Enterprises (MSME): Definition and role of MSMEs in economic development	**05**	**L2, L3, L4**
III	**Start-up financing**	**Start-up financing:** Cost and revenue models, Sources of start-up fundings: Angel investors, Venture capitalists, Crowd funding, Government schemes for start-up funding **Self-learning Topics:** Successful business pitching	**04**	**L2, L3, L4, L5**
IV	**Intellectual Property Rights (IPR)**	**Intellectual Property Rights (IPR):** Types of IPR: Patents, trademarks and copyrights, Patent search and analysis, Strategies for IPR protection, Ethics in technology and innovation	**04**	**L2, L3, L4**
V	**Business Model Development**	**Business Model Development:** Types of business models, Value proposition, Customer segments, Customer relationships, Channels, Key partners, Key activities, Key resources, Prototyping and MVP **Self-learning Topics:** The Art of the Start 2.0: The Time-Tested, Battle-Hardened Guide for Anyone Starting Anything by Guy Kawasaki	**04**	**L3, L4, L5, L6**
VI	**Digital Business Management**	**Digital Business Management:** Digital Business models (Subscription, Freemium *etc*), Digital marketing: Search Engine Optimization (SEO), Search Engine Marketing (SEM), Social media and influencer marketing, Disruption and innovation in digital business **Self-learning Topics:** Case study: Airbnb https://www.prismetric.com/airbnb-business-m	**04**	**L2, L3**

Textbooks:

1. Entrepreneurship: David A. Kirby, McGraw Hill, 2002
2. Harvard Business Review: Entrepreneurs Handbook, HBR Press, 2018
3. Business Model Generation; Alexander Ostlewalder and Yves Pigneur, Strategyzer, 2010
4. E- Business & E– Commerce Management: Strategy, Implementation, Practice – Dave Chaffey, Pearson Education

Reference books:

1. Entrepreneurship: New venture creation by David Holt, Prentice Hall of India Pvt. Ltd.
2. E- Business & E– Commerce Management: Strategy, Implementation, Practice – Dave Chaffey, Pearson Education

Online Resources:

Sr. No.	Website Name
1	Entrepreneurship by Prof. C Bhaktavatsala Rao https://onlinecourses.nptel.ac.in/noc20_mg35/preview
2	Innovation, Business Models and Entrepreneurship by Prof. Rajat Agrawal, Prof. Vinay Sharma https://onlinecourses.nptel.ac.in/noc21_mg63/preview
3	Sarasvathy's principles for effectuation https://innovationenglish.sites.ku.dk/model/sarasvathy-effectuation/

List of Experiments.

The lab activities are to be conducted in a group. One group can be formed with 4-5 students. A group has to develop a Business Model Canvas and a digital prototype (Web App/ mobile app). Weekly activities are to be conducted as follows:

Sr. No.	Lab activities	Hrs.
01	Problem identification (Pain points, Market survey)	2
02	Design a digital solution for the problem (Ideation techniques)	2
03	Preparing a business model canvas: Value proposition, Key partners, Key resources, Key activities	2
04	Preparing a business model canvas: Customer segment, Customer relationships and channels	2
05	Preparing a business model canvas: Cost and Revenue structure	2
06	Prototype development: Low fidelity	2
07	Prototype development: Customer feedback	2
08	Prototype development: High fidelity	2
09	Presentation of high-fidelity prototype	2

Sr. No.	List of Assignments / Tutorials	Hrs.
01	Presentation on case study of a failed business model	2
02	Presentation on case study of a woman entrepreneur	2

Assessment:

Term Work: Term Work shall consist of 09 lab activities based on the above list. Also, Term work journal must include any 2 assignments from the above list.

Term Work Marks: 50 Marks (Total marks) = 25 Marks (Experiment) + 10 Marks (Assignments) + 5 Marks (Attendance)+10 Marks (Report).

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2994512	Design Thinking	-	2*+2	-	-	2*+2	-	2

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	Total					
2994512	Design Thinking	-	-	-	-	-	50	-	50

Note: * Two hours of practical class to be conducted for full class as demo/discussion/theory.

Lab Objectives:

1. To introduce a learner to the principles of Design Thinking.
2. To familiarize a learner with the process (stages) of Design Thinking.
3. To introduce various design thinking tools.
4. Study of the techniques for generation of solutions for a problem.
5. To expose a learner to various case studies of Design Thinking.
6. Create and test a prototype.

Lab Outcomes:

Students will be able to …

1. Compare traditional approach to problem solving with the Design Thinking approach and discuss the principles of Design Thinking
2. Define a user persona using empathy techniques
3. Frame a problem statement using various Design Thinking tools
4. Use ideation techniques to generate a pool of solutions for a problem
5. Create prototypes using different techniques
6. Test the prototypes and gather feedback for refining the prototype

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	No perquisites	-	-
I	**Introduction to Design Thinking**	**Introduction to Design Thinking:** Definition, Comparison of Design Thinking and traditional problem-solving approach, Need for Design Thinking approach, Key tenets of Design Thinking, 5 stages of Design Thinking (Empathize, Define, Ideate, Prototype, Test) **Self-learning Topics:** Design thinking case studies from various domains https://www.design-thinking-association.org/explore-design-thinking-	**05**	**L1, L2**

		topics/external-links/design-thinking-case-study-index		
II	**Empathy**	**Empathy:** Foundation of empathy, Purpose of empathy, Observation for empathy, User observation technique, Creation of empathy map **Self-learning Topics:** Creation of empathy maps https://www.interaction-design.org/literature/topics/empathy-mapping	**05**	**L2, L3**
III	**Define**	**Define:** Significance of defining a problem, Rules of prioritizing problem solving, Conditions for robust problem framing, Problem statement and POV **Self-learning Topics:** Creating a Persona – A step-by-step guide with tips and examples https://uxpressia.com/blog/how-to-create-persona-guide-examples	**05**	**L2, L3**
IV	**Ideate**	**Ideate:** What is ideation? Need for ideation, Ideation techniques, Guidelines for ideation: Multi-disciplinary approach, Imitating with grace, Breaking patterns, Challenging assumptions, Looking across value chain, Looking beyond recommendation, Techniques for ideation: Brainstorming, Mind mapping **Self-learning Topics:** How To Run an Effective Ideation Workshop: A Step-By-Step Guide https://uxplanet.org/how-to-run-an-effective-ideation-workshop-a-step-by-step-guide-d520e41b1b96	**05**	**L3**
V	**Prototype**	**Prototype:** Low and high-fidelity prototypes, Paper prototype, Story board prototype, Scenario prototype	**03**	**L6**
VI	**Test**	**Test:** 5 guidelines of conducting test, The end goals of test: Desirability, Feasibility and Viability, Usability testing	**03**	**L4, L5**

Textbooks:

1. Design Your Thinking: The Mindsets, Toolsets, and Skill Sets for Creative Problem-solving, Pavan Soni, Penguin Random House India Private Limited
2. Design Thinking: Methodology Book, Emrah Yayichi, 2016
3. Handbook of Design Thinking: Christian Mueller-Roterberg, 2018

Reference books:

1. Design Thinking for Strategic Innovation: What They Can't Teach You at Business or Design School, Idris Mootee, Wiley, 2013
2. Change by Design, Tim Brown, Harper Business, 2009

Online Resources:

Sr. No.	Website Name
1.	Design Thinking and Innovation by Ravi Poovaiah https://onlinecourses.swayam2.ac.in/aic23_ge17/preview
2.	Introduction to Design Thinking by Dr. Rajeshwari Patil, Dr. Manisha Shukla, Dr. Deepali Raheja, Dr. Mansi Kapoor https://onlinecourses.swayam2.ac.in/imb24_mg37/preview
3.	Usability Testing https://www.interaction-design.org/literature/topics/usability-testing

List of Experiments :-

The experiments are to be performed in groups. A practical batch may be divided into groups of 4-5 students.

Sr. No.	List of Experiments	Hrs.
01	Customer Journey Mapping: Visualize the steps users take to interact with a product or service. Map out the customer journey from discovering a product to making a purchase and using the product. Identify pain points and opportunities for improvement.	2
02	Stakeholder mapping: Identify all relevant stakeholders in a project. Create a stakeholder map, categorizing stakeholders based on their influence and interest. Include management of relationships with key stakeholders.	2
03	"How Might We" Problem Framing: Transform user insights into actionable problem statements. After empathizing with users, turn challenges into "How Might We" statements that define the problem without prescribing a solution.	2
04	Brainstorming Session: Generate a pool of ideas in a creative, non-judgmental environment. Using ideation techniques like mind mapping and brainwriting, students brainstorm as many solutions as possible to their "How Might We" problem statements.	2
05	Affinity Diagramming: Organize group ideas to find patterns and insights. After brainstorming, students will categorize their ideas into themes by placing sticky notes on a wall and moving them into groups based on similarities.	2
06	Rapid Prototyping: Create quick, low-fidelity versions of solutions. Use materials like paper, cardboard, and markers to build a prototype of their solution within 30 minutes. The focus is on speed and functionality, not aesthetics.	2
07	Wireframing: Create a visual guide for digital interfaces for mobile app / web app for the problems identified in earlier lab sessions. Students will sketch	2

	wireframes of the user interface for their product or service. Use tools like Balsamiq or paper and pen for low-fidelity wireframes.	
08	Role-Playing: Walk through a prototype from the user's perspective. Students act as both users and designers, role-playing scenarios where they interact with their prototype (Developed in earlier lab sessions). Gather feedback from participants on how to improve the experience.	2
09	Usability Testing: Evaluation of the effectiveness and user-friendliness of a prototype (developed in earlier lab sessions). Students will have peers or target users test their prototypes, observe how they interact with it, and collect feedback on any issues or improvements needed.	2
10	Feedback Loop and Iteration: Refine solutions based on user feedback. After usability testing, students will refine their prototypes. Document changes made based on feedback and discuss how continuous iteration improves the design.	2

Sr No	List of Assignments (Any two)	Hrs.
01	Create an empathy map for a target user group. Break them into four sections: Says, Thinks, Feels, and Does. Interview users or research their experiences to fill in the map.	3
02	Based on research, students will create user personas including demographic details, motivations, pain points, and goals. Each group will present their persona to the class.	3
03	Consider 3 examples of real-life products which have good design and bad design. Write down reasons why do you think they are good or bad designs. May take user survey to support your work.	3
04	Study any open-source design thinking tool and write a brief report about it.	3

Assessment:

Term Work: Term Work shall consist of 08 to 10 lab activities based on the above list. Also, Term work journal must include any 2 to 4 assignments from the above list.

Term Work Marks: 50 Marks (Total marks) = 25 Marks (Experiment) + 10 Marks (Assignments) + 5 Marks (Attendance)+ 10 Marks (Report).

Letter Grades and Grade Points:

Semester GPA/ Programme CGPA Semester/ Programme	% of Marks	Alpha-Sign/ Letter Grade Result	Grading Point
9.00 - 10.00	90.0 – 100	O (Outstanding)	10
8.00 - < 9.00	80.0 - < 90.0	A+ (Excellent)	9
7.00 - < 8.00	70.0 - < 80.0	A (Very Good)	8
6.00 - < 7.00	60.0 - < 70.0	B+ (Good)	7
5.50 - < 6.00	55.0 - < 60.0	B (Above Average)	6
5.00 - < 5.50	50.0 - < 55.0	C (Average)	5
4.00 - < 5.00	40.0 - < 50.0	P (Pass)	4
Below 4.00	Below 40.0	F (Fail)	0
Ab (Absent)	-	Ab (Absent)	0

Sd/-
Dr. Rajendra B. Magar
BoS-Chairman-Civil Engineering
Faculty of Technology

Sd/-
Dr. Deven Shah
Associate Dean
Faculty of Science & Technology

Sd/-
Prof. Shivram S. Garje
Dean
Faculty of Science & Technology