Sem. - IV

Vertical – 1
Major

Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2094111	**Applied Mathematics for Civil Engineering-II**	**2**	**-**	**1**	**2**	**-**	**1**	**3**

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Total					
2094111	**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-I.

Course 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.

Course Outcomes:

On completion of the course students will be able to:

1. Apply the concept of Vector calculus to evaluate line integrals, surface integrals using Green's theorem, Stoke's 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 concept of parametric and nonparametric tests for analysing practical problems

Detailed Syllabus

Module	Course Module / Contents		Hrs	CO
1	**Vector Calculus**		05	CO1
	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.			
2	**Complex Integration**		05	CO2
	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.			
3	**Statistical Techniques**		04	CO3
	3.1	Karl Pearson's Coefficient of correlation (r) and related concepts with problem.		
	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.			
4	**Probability Theory**		04	CO4
	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.			
5	**Probability Distribution and Sampling Theory-I**		05	CO5
	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.		

Module	Course Module / Contents		Hrs	CO
	5.3	Students' 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.			
6	**Sampling theory-II**		04	CO6
	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.			

Text Books:

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,

References:

1. Vector Analysis, Murray R. Spiegel, Schaum Series
2. Complex Variables and Applications, Brown and Churchill, McGraw-Hilleducation
3. Probability Statistics and Random Processes, T. Veerarajan, Mc. GrawHilleducation.

Online References:

Sr. No.	Website Name
1.	**NPTEL (National Program on Technology Enhanced Learning)** Website: https://nptel.ac.in/ Relevant Courses

Assessment:

Internal Continuous Assessment: 40%

Internal Assessment Test (IAT) for 20 marks each:

IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of the syllabus content must be covered in the IAT-I and the remaining 40% to 50% of the syllabus content must be covered in the IAT-II.

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 the 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

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2094112	Surveying	3	-	-	3	-	-	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Total					
2094112	Surveying	20	20	40	60	2	--	--	100

Rationale:

As it is always said "well begun is half done". All civil engineering projects such as buildings, roads, bridges, railways, airports, dams, water treatment plants, sewage treatment plants begin with surveying. Knowledge of surveying is thus fundamental and very useful to all civil engineers. In this course, the students are well informed about the principles and methods of surveying. The students are made conversant with various instruments which are used in the field to take measurements for preparation of drawings. The course introduces the advancements in instruments and methods of surveying. The study deals with the methods of computing land areas and volume of earthworks. The course also covers horizontal and vertical curves.

Course Objectives:

The Student will be able to learn:

1. The basic principles and classification of surveying.
2. Various methods of measurements in surveying.
3. The appropriate techniques of surveying and skills of collecting field data for preparingdrawings.
4. Advancements in instruments and methods of surveying.
5. The methods of computing areas and volumes using the site specific data for variouspurposes.
6. The setting out techniques of curves.

Course Outcomes:

On completion of the course students will be able to:

1. Apply the principles of surveying and field procedures for linear and angular measurements including legal aspects.
2. Use various methods for levelling and contouring.
3. Calculate precise angles of traverse and balancing using various methods
4. Explain the advancements in surveying instruments and methods
5. Calculate the area of land and volume of earthwork
6. Calculate the data require for setting out simple circular curves

Detailed Syllabus

Module	Course Module / Contents		Hours	CO
1	**Introduction**		**6**	**CO1**
	1.1	Introduction to Survey of India Department; Department of Registration and Stamps, Maharashtra. Role of revenue department in maintaining survey records, introduction to local survey terminologies like tehsildar, 7/12 utara, namuna 8, etc.		
	1.2	Chaining, Ranging and offsetting: Definitions, Principles, Instruments required, Obstacles, conventional signs and symbols.		
	1.3	Bearings – Different types, dip, declination and local attraction, compass traversing		
2	**Levelling and Contouring**		**8**	**CO2**
	2.1	Definitions, basic terms, types of instruments-dumpy level and Auto level, principal axes of dumpy level, temporary and permanentadjustments		
	2.2	Booking and reduction of levels, plane of collimation (HI) and rise-fall methods, computation of missing data, distance to the visible horizon, corrections due to curvature and refraction, reciprocal levelling, Numerical problems		
	2.3	Differential levelling, profile levelling, fly levelling, check levelling, precise levelling, sources of errors, difficulties in levelling work,corrections and precautions work in levelling		
	2.4	Contouring: terms, contour, contouring, contour interval, horizontal equivalent Direct and indirect methods of contouring, interpolation of contours, uses of Contours and characteristics of contour lines. Grade contour		
3	**Theodolite Surveying**		**8**	**CO3**
	3.1	Various parts and axes of transit, technical terms, temporary and permanent adjustments of a transit, measurement of horizontal andvertical angles, Methods of repetition and reiteration.		
	3.2	Different methods of running a theodolite traverse, Latitudes and departures, rectangular coordinates, Traverse adjustments by Bowditch's,transit and Modified transit rules, Gales Traverse Table, Numerical Problems.		
	3.3	Miscellaneous use of theodolite for various works such as prolongationof a straight line, setting out an angle, bearing measurements. Omitted measurements, Problems in using theodolite traversing, errors in theodolite traversing.		
4	**Indirect and Advanced Methods of Measurement**		**7**	**CO4**
	4.1	Tacheometry-Principle, Objective, Suitability and different methods of tacheometry, Stadia formula, Radial contouring, numerical on stadiamethod only		

Module	Course Module / Contents		Hours	CO
	4.2	Electronic Distance Measurement: Working Principles, types, applications in surveying		
	4.3	Total Station- Working Principles, applications in surveying		
	4.4	Introduction to GPS, GIS and Remote Sensing		
5	**Plane Table Surveying, Areas and Volumes**		**5**	**CO5**
	5.1	Definition, principle, accessories required for plane table surveying,merits and demerits, temporary adjustments, Different methods of plane table surveying		
	5.2	Areas: Area of an irregular figure by trapezoidal rule, average ordinate rule, Simpson's 1/3 rule, various coordinate methods. Planimeter: types including digital planimeter, area of zero circle, uses of planimeter.		
	5.3	Volumes: Computation of volume by trapezoidal and prismoidal formula, volume from spot levels, volume from contour plans.		
6	**Curves**		**5**	**CO6**
	6.1	Horizontal Curves-Definitions of different terms, necessity and types of curves. Methods of setting out Simple circular curves- linear methodsand Angular methods (Numericals on simple circular curves only)		
	6.2	Introduction to Vertical curves – Definitions, geometry and types.		

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, Pune Vidyarthi Griha, 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. (ISBN 9789332901537)

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 Surveying: Theory and Practice, James Anderson, Edward M. Mikhail, Tata Mcgraw Hill

Online References:

Sr. No.	Website Name
1.	**NPTEL (National Program on Technology Enhanced Learning)** Website: https://nptel.ac.in/ Relevant Courses1

Assessment:

Internal Continuous Assessment: 40%

Internal Assessment Test (IAT) for 20 marks each:

IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of the syllabus content must be covered in the IAT-I and the remaining 40% to 50% of the syllabus content must be covered in the IAT-II.

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 the 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

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2094113	Structural Analysis	3	-	-	3	-	-	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Total					
2094113	Structural Analysis	20	20	40	60	2	--	--	100

Rationale:

This syllabus outlines a comprehensive course on structural analysis, covering various aspects related to the behaviour of structures subjected different loading. It aims to equip students with the knowledge and skills necessary to analyze and design complex structures. Different components of civil 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 and so there are different analysis methods. These will be learnt in this course. Their application on solids and mechanisms, the action of force systems is studied and further extended in this subject. Learners will learn to apply these to the analysis of various members of structural systems such as beams, trusses, portal frames. These analyses will further be used while designing Steel and RCC structures.

Course Objectives:

1. To introduce and familiarize students with the concepts of slope, deflection, strain energy, and virtual work in statically determinate structures.
2. To enable students to construct and use influence line diagrams for structural analysis and calculate shear forces and bending moments under different loading conditions, including rolling loads.
3. To develop an understanding of determinate and indeterminate structures, including material behaviours, and methods to assess determinacy and indeterminacy.
4. To equip students with the ability to analyse indeterminate structures using force methods.
5. To equip students with the ability to analyse indeterminate structures using displacement methods
6. To provide knowledge of plastic analysis techniques and enable students to determine collapse loads for beams using static and kinematic methods.

Course Outcomes:

1. Classify structures into determinate and indeterminate categories, considering their static and kinematic behaviour, material properties (linear and non-linear), and geometric non-linearity.
2. Apply analytical methods to calculate slopes and deflections in statically determinate beams, rigid jointed frames, and pin-jointed trusses to solve real-world structural problems.
3. Construct and interpret influence line diagrams to evaluate the criteria for maximum shear force and bending moment under rolling loads.

4. Analyze indeterminate structures by applying force methods to evaluate structural behaviour.
5. Apply displacement methods to analyze indeterminate structures and evaluate their internal forces and deformations under various loading conditions.
6. Evaluate the collapse load of single and multiple-span beams by applying plastic analysis techniques

Prerequisite: Applied Mathematics, Engineering Mechanics and Mechanics of Solids

Detailed Syllabus

Module	Course Module / Contents		Hours	CO Mapping
1	**Determinate and Indeterminate Structures.**		03	CO1
	1.1	Types of structures occurring in practice and their classification, Linear and non-linear behaviour of materials, geometric non-linearity.		
	1.2	Static and Kinematic determinacy and indeterminacy of structures.		
2	**Slope and Deflections in Statically Determinate Structures**		08	CO2
	2.1	Concept of Strain Energy, Slope and deflection in beams, Principle of Superposition, Principle of Virtual work, Castigliano's theorems, Betti's theorem and Maxwell's reciprocal theorem.		
	2.2	Macaulay's Method, Moment Area Method, Application of Unit Load Method for calculating slope and deflection for rigid jointed frames and Pin jointed truss.		
3	**Rolling Loads and Influence Line Diagrams**		06	CO3
	3.1	Influence lines for support reactions, shear force and bending moment at a section for a cantilever, simply supported and overhanging beams without internal hinges.		
	3.2	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 (UDL and series of point loads) for simply supported girder.		
4	**Analysis of indeterminate structures by Force methods.**		08	CO4
	4.1	Clapeyron's theorem of three moments to fixed beam and continuous beam.		
	4.2	Flexibility coefficients and their use in formulation of compatibility equations. Application of flexibility method to propped cantilevers, fixed beams, continuous beams, and Simple rigid jointed frames. (Degree of static indeterminacy not more than 3).		
5	**Analysis of indeterminate structures by Displacement Methods**		11	CO5
	5.1	Introduction to the concept of slope deflection equation. Stiffness coefficients for prismatic members and their use for formulation of equilibrium equations.		
	5.2	Application of direct stiffness method to indeterminate beams & simple rigid jointed frames (only single		

		translation degree of freedom including the effect of support settlement and kinematic indeterminacy not more than 3)		
	5.3	Moment distribution method: Application to indeterminate beams & simple rigid jointed frames (only single translation degree of freedom including the effect of support settlement and Kinematic indeterminacy not more than 3)		
6	**Plastic Analysis of Structures.**		06	CO6
	6.1	Plastic analysis of structures: Introduction to plastic analysis, the concept of a plastic hinge, plastic moment carrying capacity, shape factor.		
	6.2	Static and kinematic method of plastic analysis. Determination of collapse load for single and multiple span beams.		

Text Books:

1. Basic Structural Analysis: C.S. Reddy, Tata McGraw Hill New Delhi.
2. Mechanics of Structures: Vol-I and II: S. B. Junnarkar and H.J. Shah, Charotar Publishers, Anand.
3. Theory of Structures: S. Ramamrutham, Dhanpatrai and Sons Publishers, Delhi
4. Structural Analysis I: Hemant Patil, Yogesh Patil, Jignesh Patel, Synergy Knowledge ware, Mumbai.
5. Strength of Materials: Rajput, S. Chand Publications, Delhi
6. Structural Analysis I and II: Bhavikatti, Vikas Publisher House Pvt. Ltd.
7. Structural Analysis: Devdas Menon, Narosa Publishing House.
8. Comprehensive Structural Analysis: Vol-I and II by Vaidyanathan R. and Perumal R. Laxmi Publications.
9. Structural Analysis: L.S. Negi and R.S Jangid, Tata Mc-Graw Hil, India
10. Fundamentals of Structural Analysis: Sujit Kumar Roy and Subrota Chakrabarty, S. Chand Publications.
11. Structural Analysis: T.S Thandavamoorthy, Oxford University Press.
12. Structural Analysis: Manmohan Das, Bharghab Mohan, Prentice Hall International.

References:

1. Structural Analysis: Hibbler, Prentice Hall International.
2. Structural Analysis: Chajes, ElBS, London.
3. 3 Theory of Structures: Timoshenko and Young, Tata McGraw Hill New Delhi.
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. Fundamentals of structural Analysis: K.M. Leet, C. M. Uang and A.M. Gilbert, Tata McGraw Hill, New Delhi.
8. Elementary Theory of Structures: Hseih Prentice Hall

Online References:

Sr. No.	Website Name
1.	https://archive.nptel.ac.in/courses/105/101/105101085/
2.	https://www.coursera.org/learn/materials-structures
3.	http://digimat.in/nptel/courses/video/105105166/105105166.html

Assessment:

Internal Continuous Assessment: 40%

Internal Assessment Test (IAT) for 20 marks each:

IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of the syllabus content must be covered in the IAT-I and the remaining 40% to 50% of the syllabus content must be covered in the IAT-II.

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 the 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

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2094114	Surveying Lab	-	2	-	-	2	-	2

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Total				
2094114	Surveying Lab	--	--	--	--	25	25	50

Lab Objectives:

The students will be able to learn:

1. Various surveying instruments, their least counts, various parts and suitable uses.
2. Methods of measurements in the field.
3. Skills for collecting, recording and analysing the field data.
4. Advanced instruments and methods.
5. First hand practical experience by receiving field exposure to collect site specific data.
6. Setting out techniques.

Lab Outcomes: Student will be able to

1. Perform basic linear and angular surveying using chain, cross-staff, and prismatic compass to determine bearings and compute angles
2. Conduct leveling operations including simple and compound leveling to measure elevation differences accurately
3. Measure horizontal and vertical angles using theodolites and apply tachometry for computing heights and distances.
4. Utilize advanced surveying instruments such as total stations for precise distance measurement and data collection.
5. Apply graphical and computational methods in surveying through Plane Table Surveying and planimeter-based area measurement.
6. Set out curves and alignments using Rankine's method for practical field applications in road and railway projects.

Text Books:

1. Surveying and Levelling: R. Agor, Vol.-I, 11th Edition, Khanna Publishers (ISBN 8174 092358)
2. Surveying and Levelling: 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 4th Edition, Laxmi Publications (ISBN9788170088530)
4. Surveying and Levelling: N N Basak, 2nd Edition, Tata McGraw Hill, New Delhi. (ISBN 9789332901537)

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 Surveying: Theory and Practice, James Anderson, Edward M. Mikhail, Tata Mcgraw Hill

Online Resources:

Sr. No.	Website Name
1.	**NPTEL (National Program on Technology Enhanced Learning)** Website: https://nptel.ac.in/ Relevant Courses

List of Experiments.

Perform minimum **six** practical's out of 01 to 09 and all the projects are **mandatory**

Sr. No.	List of Experiments	Hrs	LO
01	Chain and cross staff surveying.	02	LO1
02	Measuring bearings of a closed traverse with prismatic compass and computation of interior angles.	02	LO1
03	Simple and compound levelling	02	LO2
04	Measurement of horizontal and vertical angles.	02	LO3
05	Finding constants, heights and distances using tachometry.	02	LO3
06	Measurement of distances using total station.	02	LO4
07	Plane Table Surveying by intersection method.	02	LO5
08	Find an area of irregular figure using a conventional planimeter	02	LO5
09	Setting out a simple curve by Rankine's method.	02	LO6

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.

Sr. No.	List of Experiments	LO
01	**Project I:** Road project using Auto level for a minimum length of 300 m including fixing of alignment, profile levelling, cross-sectioning at 20m interval, plotting of 'L'section and 'C' section. (Two full imperial sheets, the first sheet with key plan and 'L' section and the second sheet covering any three typical Cross-sections)	LO2
02	**Project II:** Block Contouring project using Auto level for minimum 50m × 50m area and generating contours by MS Excel. (Take contour interval as 0.2 meter)	LO2
03	**Project III:** Tachometric contouring project on a hilly area with at least two instrument stations about 50 m to 80 m apart and generating contours by taking contour intervals as 1 meter.	LO3

Assessment:
Term Work: Term Work shall consist of practical work, projects and assignments based on the above list.

Term Work Marks: 25 Marks (Total marks) = 09 Marks (Experiment) + 06 Marks (Project work) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical& Oral Exam: 25 Marks (Total marks) = 10 Marks (Practical exam) + 15 Marks (Oral exam)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2094115	Structural Analysis Lab	-	2	-	-	2	-	2

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Total				
2094115	Structural Analysis Lab	--	--	--	--	25	25	50

Lab Objectives:

1. To develop an in-depth understanding of structural components by considering the degree of indeterminacy.
2. To compute the distribution of shear stress, flexural (bending) stress and twisting moment across the cross section of structural members
3. To learn methods for evaluating rotation and displacement of statically determinate structure.
4. To study the concept of Influence Line Diagrams and rolling loads.
5. To analyse the indeterminate structures using Force and Displacement methods.
6. To study Plastic Analysis.

Lab Outcomes: Student will be able to

1. Classify structural components and evaluate their degree of indeterminacy based on span, loading, support conditions, etc.
2. Determine the rotation and displacement of statically determinate structures using different theorems and principles.
3. Construct and interpret influence line diagrams to analyse the effects of rolling loads on statically determinate structures
4. Analyse indeterminate structures using force Methods and displacement Methods.
5. Apply knowledge of plastic analysis by evaluating collapse load and Plastic moments.
6. To comprehend substantial conclusions by conducting various test on materials.

Text Books:

1. Basic Structural Analysis: C.S. Reddy, Tata McGraw Hill New Delhi.
2. Mechanics of Structures: Vol–I and II: S. B. Junnarkar and H.J. Shah, Charotar Publishers, Anand.
3. Strength of Materials: S. Ramamrutham, Dhanpat Rai and Sons Publishers, Delhi
4. Theory of Structures: S. Ramamrutham, Dhanpat Rai and Sons Publishers, Delhi
5. Structural Analysis I: Hemant Patil, Yogesh Patil, Jignesh Patel, Synergy Knowledge ware, Mumbai.
6. Strength of Materials: Rajput, S. Chand Publications, Delhi

7. Structural Analysis I and II: Bhavikatti, Vikas Publisher House Pvt. Ltd.
8. Structural Analysis: Devdas Menon, Narosa Publishing House.
9. Basic Structural Analysis: K.U. Muthu, Azmi Ibrahim, M. Vijyanand, Maganti Janadharn and. International Publishing House Pvt. Ltd.
10. Comprehensive Structural Analysis: Vol-I and II: Vaidyanathan R. and Perumal R. Laxmi Publications.
11. Structural Analysis: L.S. Negi and R.S Jangid, Tata Mc-Graw Hil, India
12. Fundamentals of Structural Analysis: Sujit Kumar Roy and Subrota Chakrabarty, S. Chand
13. Publications.
14. Structural Analysis: T.S Thandavamoorthy, Oxford University Press.
15. Structural Analysis: Manmohan Das, Bharghab Mohan Prentice Hall International.

References:

1. Structural Analysis: Hibbler, Prentice Hall International.
2. Structural Analysis: Chajes, ElBS, London.
3. Theory of Structures: Timoshenko and Young, Tata McGraw Hill New Delhi.
4. Structural Analysis: Kassimali, TWS Publications.
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6. Structural Analysis: Laursen H.I, McGraw Hill Publishing Co.
7. Fundamentals of structural Analysis: K.M. Leet, C. M. Uang and A.M. Gilbert, Tata McGraw Hill, New Delhi.
8. Elementary Theory of Structures: Hseih Prentice Hall

Online Resources:

Sr. No.	Website Name
1.	https://archive.nptel.ac.in/courses/105/101/105101085/
2.	https://www.coursera.org/learn/materials-structures
3.	http://digimat.in/nptel/courses/video/105105166/105105166.html

List of Experiments.

Sr. No.	List of Experiments	Hrs	LO
01	Test of Shear Stress in Beams	2	LO6
02	Using Torsion Testing Machine, verify the torsion equation, find different Moduli of a material.	2	LO6
03	Charpy impact testing and Energy concept. OR Izod impact testing and Energy concept.	2	LO6
04	Using Universal Testing Machine perform experiments and verify slope and deflection equations, three points and four points loading. (performance) OR Deflection of Simply Supported Beams (Performance) OR Deflection of Cantilever Beams (Performance)	2	LO6

List of Assignments.

Sr. No.	List of Assignments	Hrs	LO
01	Numerical based on degree of indeterminacy (Beam, Rigid jointed frame and Truss)	2	LO1
02	1. Write a detail report/Poster on theorems such as Principle of Superposition, Principle of Virtual work, Castigliano's theorems, Betti's theorem and Maxwell's reciprocal theorem. 2. Minimum two numerical on each method for finding Slope and Deflection for Statically determinate structure and their validation by using any analysis software	2	LO2
03	1. Solve set of questions given by the course instructor **Or** 2. Design an experiment for ILD of reactions of beam. **Or** 3. Write a report on IRC and classification of rolling loads	2	LO3
04	1. Solve set of questions given by the course instructor on Clapeyron's theorem of three moments and validate the final output by using handy application tools or Software applications. 2. Solve set of questions given by the course instructor on Flexibility method and validate the final output by using handy application tools or Software applications.	2	LO4
05	1. Solve set of questions given by the course instructor for Analysis of Rigid joined frame structure using Direct stiffness method. 2. Solve set of questions given by the course instructor for Analysis of Rigid joined frame structure using Moment Distribution Method.	2	LO5
06	Solve set of questions given by the course instructor for Shape factor, Plastic Moment and Collapse load	2	LO5

Assessment:
Term Work: Term Work shall consist of practicals based on the above list. Also, Term work Journal must include at assignments based on above list.

Term Work Marks: 25 Marks (Total marks) = 05 Marks (Experiment) + 15 Marks (Assignments) + 5 Marks (Attendance)

Practical& 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
2094411	Computer Aided Architectural Planning, and Building Design (Capstone Mini-Project)	-	4	-	-	2	-	2

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Plotting & Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Total				
2094411	Computer Aided Architectural Planning, and Building Design (Capstone Mini-Project)	--	--	--	--	50	25	75

Lab Objectives:

1. To develop a comprehensive understanding of the principles, bye laws and techniques for architectural design of residential and public buildings
2. To apply building design and drawing skills to create functional, aesthetically pleasing, and sustainable building solutions for a variety of projects
3. To proficiently use CAD software for creating accurate 2D architectural drawings, including plans, elevations, sections etc.
4. To develop detailed building services drawings such as plumbing, electrical and HVAC using CAD software.
5. To generate 3D architectural drawings using CAD software.
6. To effectively utilize Building Information Modeling (BIM) software to create, manage, and visualize complex building projects.

Lab Outcomes:
Students will be able to:

1) Demonstrate a comprehensive understanding of architectural design principles, bye-laws, and techniques, as applied to residential and public buildings.
2) Apply architectural design principles to create functional, aesthetically pleasing, and sustainable building solutions for various project types.
3) Create accurate 2D architectural drawings, including plans, elevations, and sections using CAD software.
4) Apply their knowledge of building services to create detailed 2D drawings for plumbing, electrical, and HVAC systems using CAD software.
5) Create 3D architectural models using AutoCAD software to visualize and analyze building designs.
6) Understand effectively use of BIM software to create, manage, and visualize complex building projects, evaluating the impact of design decisions on various project parameters.

Prerequisite: Familiarity of various building elements, basic of drawing 2D shapes and perspectives.

Sr No	List of Experiments	Hrs	LO
01	**Concepts & Discussions** • Classification of buildings: Residential –Individual Bungalows & Apartments/Flats. Public – Education (Schools, Colleges etc.) &Health (Primary Health Center, Hospital) related buildings • Principles of planning for Residential buildings • Study of sun path diagram, wind rose diagram and sun shading devices **Practical** • Planning of G+1 Bungalow and drawing plan for the same on A1 Sheet	04	LO1
02	**Concepts & Discussions** • Overview of structural components (beams, columns, foundations), Study of Section, Foundation plan, Roof plan, Site plan. • Calculation of setback distances, carpet area, built-up area and floor space index (FSI) • Study 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. **Practical** • Drawing Section, Foundation plan, Roof plan, Site plan for the Bungalow on A1 Sheet	04	LO1
03	**Concepts & Discussions** • Study of Principles of planning for public buildings: i) Residential building, ii) Building for education: schools, colleges, institutions etc. iii) Buildings for health: hospitals, primary health centers etc. **Practical** • Planning and drawing any 1 Public building on A1 Sheet	04	LO1
04	**Concepts & Discussions** • Introduction and Principles of Architecture • Importance of elevation drawings in architectural design • Concepts of perspective drawing. **Practical** • Developing Elevation with One-point and Two-point perspective of Bungalow.	04	LO2
05	**Concepts & Discussions** • Importance of Computer-Aided Design (CAD) in Civil Engineering and Architecture. • Overview of other commonly used software **Practical** • Familiarization with the CAD interface. • Basic operations in AutoCAD: creating lines, shapes, and modifying elements.	04	LO3

Sr No	List of Experiments	Hrs	LO
	• Generating CAD drawing of the plan of Bungalow, Implementing dimensioning and detailing standards.		
06	**Practical** • Generating Sectional view and Foundation plan for the Bungalow using AutoCAD. • Implementing dimensioning and detailing standards.	04	LO3
07	**Practical** • Generating Roof plan, site plan and Elevation for the Bungalow using AutoCAD	04	LO3
08	**Concepts & Discussions** • Introduction to building services: plumbing, electrical, and HVAC. • Integration of services in building design. **Practical** • Designing plumbing layouts, electrical wiring diagrams in CAD. • Introduction to layers for different services.	04	LO4
09	**Concepts & Discussions** • Introduction to 3D modeling and its role in architectural design. • Software tools for 3D modeling (AutoCAD 3D, Revit, SketchUp) **Practical** • Creating 3D models of buildings in AutoCAD. • Basic rendering and visualization techniques.	04	LO5
10	**Concepts & Discussions** • Advanced 3D modeling techniques: parametric modeling, complex geometries. • Using 3D models for design communication and presentations. **Practical** • Creating detailed 3D models with advanced elements (curved surfaces, complex shapes). • Exporting models for presentations and construction documentation.	04	LO5
11	**Concepts & Discussions** • Introduction to Building Information Modeling (BIM) concepts. • Benefits of BIM in the construction industry. **Practical** • Working with basic BIM tools in Revit. • Creating basic building information models: walls, floors, and structural components.	04	LO6
12	**Concepts & Discussions** • Advanced BIM concepts: clash detection, cost estimation, project collaboration. • Using BIM for construction management and lifecycle analysis. **Practical** • Developing detailed BIM models.	04	LO6

Sr No	List of Experiments	Hrs	LO
	• Performing clash detection and analyzing model data for project planning.		

Sr No	List of Drawings and outputs	Hrs	LO
01	A1 sheets showing plan, section, site plan, roof plan, foundation plan and elevation of bungalow (G+1).	08	LO1, LO2
02	A1 sheet showing plan of any one public building.	04	LO2
03	A1 sheet showing one point/ two-point perspective of bungalow.	04	LO2
04	GENERATING Print out of AutoCAD showing plan, section, site plan, roof plan, foundation plan and elevation of bungalow.	12	LO3
05	Print out of AutoCAD plan plumbing and electrical details for bungalow.	04	LO4
06	Print out of 3D model of bungalow.	08	LO5
07	Output from BIM software.	08	LO6

Recommended Books:

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

Reference Codes:

1. National Building Code of India, 2016
2. IS 962: 1989 – Code of Practice for Architectural and Building Drawings.
3. IS 779-1978Specification for water meter
4. IS 909-1975 Specification for fire hydrant
5. IS 1172-1983 Code of basic requirement for water supply ,drainage & sanitation
6. IS 1742-1983 code of practice for building drainage

Online Resources:

Sr. No.	Website Name
1.	https://mmrda.maharashtra.gov.in (Development Control Regulations for Mumbai Metropolitan Region for 2016 - 2036)
2.	https://www.nmmc.gov.in/development-control-regulations (Development Control Regulations for Navi Mumbai Municipal Corporation - 1994)
3.	https://mmrda.maharashtra.gov.in (Development Plan and Control Regulation KDMC)

Assessment :

Term Work: Term Work shall consist of drawings based on the above list.

Term Work Marks: 50 Marks based on distribution below:

15 Marks – Full Imperial Drawing sheets

20 Marks - CAD prints

10 Marks - BIM outputs

5 Marks - Attendance

Practical & Oral Exam: 25 Marks based on distribution below
10 Marks – Written test based on syllabus.
10 Marks - Plotting based on the practicals. (2 hours in batches).
05 Marks - Oral exam based on 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)			
		Test 1	Test 2	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:

Prerequisite:

Basic Design Thinking principles

Module	Course Module / Contents		Hours	LO Mapping
1	**Introduction to Entrepreneurship**		04	LO1, LO2
	1.1	Definition, the role of entrepreneurship in the economic development, the entrepreneurial process		
	1.2	Women entrepreneurs, Corporate entrepreneurship, Entrepreneurial mindset		

	Self-learning Topics: Case studies: Henry Ford https://www.thehenryford.org/docs/default-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			
2	**Entrepreneurship Development**		05	LO2, LO3, LO4
	2.1	Types of business ownerships: Proprietorship, Public and Private Companies, Co-operative businesses		
	2.2	Micro, Small and Medium Enterprises (MSME): Definition and role of MSMEs in economic development		
3	**Start-up financing**		04	LO2, LO3, LO4, LO5
	3.1	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			
4	**Intellectual Property Rights (IPR)**		04	LO2, LO3, LO4
	4.1	Types of IPR: Patents, trademarks and copyrights, Patent search and analysis		
	4.2	Strategies for IPR protection, Ethics in technology and innovation		
5	**Business Model Development**		04	LO3, LO4, LO5, LO6
	5.1	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			
6	**Digital Business Management**		04	LO2, LO3
	6.1	Digital Business models (Subscription, Freemium *etc*)		
	6.2	Digital marketing: Search Engine Optimization (SEO), Search Engine Marketing (SEM), Social media and influencer marketing		
	6.3	Disruption and innovation in digital business		
	Self-learning Topics: Case study: Airbnb https://www.prismetric.com/airbnb-business-m			

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 10 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)			
		Test 1	Test 2	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:

Module	Course Module / Contents		Hours	CO Mapping
1	**Introduction to Design Thinking**		05	LO1, LO2
	1.1	Definition, Comparison of Design Thinking and traditional problem-solving approach.		
	1.2	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-topics/external-links/design-thinking-case-study-index			

2	**Empathy**		05	LO2, LO3
	2.1	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			
3	**Define**		05	LO2, LO3
	3.1	Significance of defining a problem, Rules of prioritizing problem solving.		
	3.2	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			
4	**Ideate**		05	LO3
	4.1	What is ideation? Need for ideation, Ideation techniques, Guidelines for ideation		
	4.2	Multi-disciplinary approach, Imitating with grace, Breaking patterns, Challenging assumptions		
	4.3	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			
5	**Prototype**		03	LO6
	5.1	Low and high-fidelity prototypes, Paper prototype, Story board prototype, Scenario prototype		
6	**Test**		03	LO4, LO5
	6.1	5 guidelines of conducting test, The end goals of test: Desirability, Feasibility and Viability, Usability testing		

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
3.	Design Thinking and Innovation by Ravi Poovaiah https://onlinecourses.swayam2.ac.in/aic23_ge17/preview
4.	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 wireframes of the user interface for their product or service. Use tools like Balsamiq or paper and pen for low-fidelity wireframes.	2
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