AC –
Item No. –

As Per NEP 2020

University of Mumbai

Syllabus for Major Vertical – 1 , 4, 5 & 6		
Name of the Programme – B.E. (Aeronautical Engineering)		
Faulty of Engineering		
Board of Studies in Mechanical Engineering		
U.G. Second Year Programme	**Exit Degree**	**U.G. Diploma in Engineering- Aeronautical Engineering.**
Semester		**III & IV**
From the Academic Year		**2026-27**

University of Mumbai

(As per NEP 2020)

Sr. No.	Heading	Particulars
1	**Title of program** **O:_____**	**B.E. (Aeronautical Engineering)**
2	**Exit Degree**	**U.G. Diploma in Engineering- Aeronautical 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: _____**	**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**	**2026-27**

Sd/-	**Sd/-**	**Sd/-**
Dr. S. M. Khot	**Dr. Deven Shah**	**Prof. Shivram S. Garje**
BoS-Chairman-Mechanical 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 Information Technology Branch of 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 Information Technology in 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 Aeronautical 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 First 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 2026-27. Subsequently, this system will be carried forward for Third Year and Final Year Engineering in the academic years 2027-28, and 2028-29, respectively.

Sd/-	**Sd/-**	**Sd/-**
Dr. S. M. Khot **BoS-Chairman-Mechanical Engineering** **Faculty of Technology**	**Dr. Deven Shah** **Associate Dean** **Faculty of Science & Technology**	**Prof. Shivram S. Garje** **Dean** **Faculty of Science & Technology**

Under Graduate Diploma in Engineering - Aeronautical Engineering.

Credit Structure (Sem. III & IV)

	R: _____C								
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:_____D									
	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]

Sem. - III

S.E. Aeronautical Scheme

Program Structure for Second Year of Aeronautical Engineering

UNIVERSITY OF MUMBAI (With Effect from 2026-2027)

SEMESTER III

Course Code	Course Description	Teaching Scheme (Contact Hours)			Credit Assigned			
		Theory	Practical	Tutorial	Theory	Tutorial	Practical	Total Credits
2523111	**Engineering Mathematics III**	2	--	1	2	1	–	3
2523112	**Strength of Materials**	3	–	--	3	–	–	3
2523113	**Thermodynamics**	3	--	--	3	–	–	3
2523114	**Material Science**	3	--	--	3	–	–	3
2523311	To be taken from the bucket provided by the University from other Faculty	2	--	--	2	–	–	2
2523115	**Material Testing Lab**	--	2	–	–	–	1	1
2523116	**Strength of Materials Lab**	--	2	–	–	–	1	1
2523611	Mini Project (group project)	--	4	–	–	–	2	2
2523511	**Entrepreneurship Development** (Syllabus common to all Branches).	--	2*+2	---	–	–	2	2
2523512	**Environmental Science for Engineers** (Syllabus common to all Branches).	--	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.

Syllabus is common for Mechanical and Aeronautical Engineering.

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)					
2523111	**Engineering Mathematics III**	20	20	40	60	2	25	--	125
2523112	**Strength of Materials**	20	20	40	60	2	--	--	100
2523113	**Thermodynamics**	20	20	40	60	2	--	--	100
2523114	**Material Science**	20	20	40	60	2	--	--	100
2523311	To be taken from the bucket provided by the University from other Faculty	20	20	40	60	2	--	--	100
2523115	**Material Testing Lab**	--	--	--	--	--	25	25	50
2523116	**Strength of Materials Lab**	--	--	--	--	--	25	25	50
2523611	Mini Project (group project)	--	--	--	--	--	50	25	75
2523511	**Entrepreneurship Development** (Syllabus common to all Branches).	--	--	--	--	--	50	--	50
2523512	**Environmental Science for Engineers** (Syllabus common to all Branches).	--	--	--	--	--	50	--	50
Total		**100**	**100**	**200**	**300**	**10**	**225**	**75**	**800**

Program Structure for Second Year of Aeronautical Engineering

UNIVERSITY OF MUMBAI (With Effect from 2026-2027)

SEMESTER IV

Course Code	Course Description	Teaching Scheme (Contact Hours)			Credit Assigned			
		Theory	Practical	Tutorial	Theory	Tutorial	Practical	Total Credits
2524111	**Engineering Mathematics - IV**	3	--	--	2	1	–	3
2524112	**Fluid Mechanics**	3	–	--	3	–	–	3
2524113	**Low speed Aerodynamics**	3	--	--	3	–	–	3
2524211	Multidisciplinary minor	3	–	--	3	–	–	3
2524311	To be taken from the bucket provided by the University from other Faculty	2	–	--	2	–	–	2
2524114	**Aerodynamics - Laboratory**	-	2	-	-	-	1	1
2524115	**Fluid Mechanics Lab**	–	2	–	–	–	1	1
2524411	**CAD Modeling Lab**	–	4	–	–	–	2	2
2524212	Multidisciplinary minor	–	2	–	–	–	1	1
2524511	**Business Model Development** (Syllabus common to all Branches).	–	2*+2	–	–	–	2	2
2524512	**Design Thinking** (Syllabus common to all Branch).	–	2*+2	–	–	–	2	2
Total		**14**	**18**	**--**	**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

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.

Syllabus is common for Mechanical and Aeronautical Engineering Except Low speed Aerodynamics & Aerodynamics –Laboratory.

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)					
2524111	**Engineering Mathematics - IV**	20	20	40	60	2	25	--	125
2524112	**Fluid Mechanics**	20	20	40	60	2	--	--	100
2524113	**Low speed Aerodynamics**	20	20	40	60	2	--	--	100
2524211	Multidisciplinary minor	20	20	40	60	2	--	--	100
2524311	To be taken from the bucket provided by the University from other Faculty	20	20	40	60	2	--	--	100
2524114	**Aerodynamics -Laboratory**	--	--	--	--	--	25	25	50
2524115	**Fluid Mechanics Lab**	--	--	--	--	--	25	25	50
2524411	**CAD Modeling Lab**	--	--	--	--	--	50	25	75
2524212	Multidisciplinary minor	--	--	--	--	--	25		25
2524511	**Business Model Development** (Syllabus common to all Branches).	--	--	--	--	--	50	--	50
2524512	**Design Thinking** (Syllabus common to all Branch).	--	--	--	--	--	50	--	50
Total		**100**	**100**	**200**	**300**	**10**	**250**	**100**	**825**

Vertical – 1
Major

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2523111	**Engineering Mathematics-III**	**02**	**-**	**01**	**02**	**-**	**01**	**03**

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Total					
2523111	**Engineering Mathematics-III**	**20**	**20**	**40**	**60**	**02 hrs**	**25**	**-**	**125**

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

Rationale: Engineering has always been the backbone of modern industries and civilization Now, new technologies like Artificial Intelligence (AI) in engineering are entirely changing existing engineeringfields and creating new ones. Mechanical engineering concern with the responsible development of products, processes, and power, at scales ranging from molecules to large and complex systems. Mechanical engineering principles and skills are involved at some stage during the conception, design, development, and manufacture of every human-made object with moving parts.

Course Objectives:

1. To familiarize with the Laplace transform, Inverse of various functions, its applications.
2. To familiarize with the Inverse Laplace transform of various functions, its applications.
3. To acquaint with the concept of Fourier series of periodic functions with various period.
4. To familiarize with the concept of complex variables, C-R equations with applications.
5. To introduce concepts and fundamentals Matrix algebra for engineering problems.
6. 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 omplex engineering problems.
4. Find analytic function by using basic concepts of complex variable theory.
5. Apply Matrix algebra to solve the engineering problems.

   Solve Partial differential equations by applying numerical solution and analytical methods for one dimensional heat and wave equations.

Module	Detailed Contents	Hrs.	CO Mapping
01	**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 integrals (Properties without proof). 1.3 Evaluation of integrals by using Laplace Transformation. **Self-learning topics:** Laplace Transform of derivatives, Heaviside's Unit Step function, Laplace Transform of Periodic functions, Dirac Delta Function, Second Shifting Theorem.	05	CO1
02	**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
03	**Module: Fourier Series:** 3.1 Dirichlet's conditions, Definition of Fourier series. Fourier series of periodic function with period 2π and $2l$ (No questions should be ask on split function) 3.2 Fourier series of even and odd functions. (No question should be ask 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, Parseval's Identity.	05	CO3
04	**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 (withoutproof) 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:** Milne-Thomson method to determine analytic function *f*(z) when (u+v or u-v) is given, Conformal mapping, linear,bilinear mapping, cross ratio, fixed points and standard transformations,orthogonal trajectories.	04	CO4

05	**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
06	**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 equations. (only problems) 6.2 Crank Nicholson method 6.3 Bender Schmidt method **Self-learning Topics:** Analytical method for one dimensional wave equations,Analytical methods of solving two and three dimensional problems.	04.	CO6
	Total Hours	26	

References:

1 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 Advanced Engineering Mathematics, H.K. Das, S. Chand Publication
5 Higher Engineering Mathematics B.V. Ramana, McGraw Hill Education
6 Complex Variables and Applications, Brown and Churchill, McGraw-Hill Education,
7 Text book of Matrices, Shanti Narayan and P K Mittal, S. Chand Publication
8 Laplace transforms, Murray R. Spiegel, Schaum's Outline Series

Term Work:

General Instructions:

1 Batch wise tutorials are to be conducted. The number of student's 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 Engineering 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 40 marks:

IA will consist of Two Compulsory Internal Assessment Tests each test for 20 marks. 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 Examination:

- 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** need to be answered.

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2523112	**Strength of Materials**	**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					
2523112	**Strength of Materials**	**20**	**20**	**40**	**60**	**2**	**--**	**--**	**100**

Course Objectives:

1. To introduce students to the fundamental concepts of stress, strain, and mechanical properties of materials, including the analysis of principal stresses and strains under different loading conditions.
2. To equip students with the ability to analyze structural members subjected to axial, torsional, and bending loads, using theoretical formulations such as torsion equations, bending theory, and stress-strain relationships.
3. To develop the skills in students to construct shear force and bending moment diagrams and evaluate beam deflections using methods such as double integration and Maxwell's reciprocal theorem.
4. To explain failure theories related to columns, and to enable students to compute critical buckling loads and stress distributions in thin shells.

Course Outcomes: Learner will be able to…

1. Identify and compute different types of stresses and strains and determine principal stresses and planes using analytical and graphical methods.
2. Analyze torsional stresses in solid and hollow shafts and evaluate strain energy under various loading conditions.
3. Construct shear force and bending moment diagrams for statically determinate beams and apply area moment of inertia concepts.
4. Determine bending and shear stress distributions in beams and analyze stresses in thin cylindrical and spherical shells.
5. Calculate deflections and slopes of beams under various loading.
6. Evaluate buckling loads for columns with different end conditions.

Module	Detailed Contents	Hrs	CO Mapping
	Pre-requisites: Concepts of equilibrium in beams, support reactions; Centroid		
1.	**1.1 Introduction-Concept of Stress** Deformation in solids- Hooke's law, stress and strain- tension, compression and shear stresses, Stress Strain Diagram, elastic constants and their relations- volumetric, linear and shear strains. Thermal stress and strain.	**05**	**CO1**
	1.2 Principal Stresses Principal stresses and Principal planes- Mohr's circle.	**03**	

2.	**2.1 Area Moment of Inertia** Area Moment of Inertia about centroidal axes, Parallel Axes theorem, Polar Moment of Inertia.	**02**	**CO2**
	2.2 Torsion: Torsion equation, Torsion of circular shafts-solid and hollow, stresses in shafts when transmitting power	**05**	
	2.3 Strain Energy: Strain energy stored in the member due to gradual, sudden and impact loads, Strain energy due to bending and torsion.	**03**	
3.	**Shear Force and Bending Moment Diagrams in Beams**	**05**	**CO3**
	Introduction to types of beams, supports and loadings. Definition of bending moment and shear force, relationship between load intensity, bending moment and shear force. Shear force and bending moment diagrams for statically determinate beams subjected to point load, uniformly distributed loads, couple and their combinations.		
4.	**Stresses in Beams and Thin Shells**		**CO4**
	4.1 Bending and Shear Stresses in Beams Theory of bending of beams, bending stress distribution, shear stress distribution for point and distributed loads in simply supported and cantilever beams.	**04**	
	4.2 Thin Shells Stresses and deformation in Thin Cylindrical and Spherical Shells subjected to internal pressure.	**02**	
5.	**Deflection of Beams** Deflection of a beam: Double integration method, Macauley's method for computation of slopes and deflection in beams for point and distributed loads.	**05**	**CO5**
6.	**Columns** Buckling load, Types of end conditions for column, Euler's column theory and its limitations and Rankine formula.	**05**	**CO6**
	Total Hours	**39**	

Textbooks

1. James M. Gere and Barry J. Goodno: Mechanics of Materials, 2nd Edition, Cengage Learning (2009)
2. S. Ramamrutham: Strength of Materials, 14th Edition, Dhanpat Rai Pvt. Ltd. (2014)
3. S. B. Junnarkar: Mechanics of Structures, 24th Edition, Charotar Publication. (2015)
4. S. S. Ratan: Mechanics of Materials, 2nd Edition, Tata McGraw Hill Pvt. Ltd. (2011)

Reference Books

1. W. Nash, Schaum's Outline Series: Strength of Materials, 5th Edition, McGraw Hill Publication, Special Indian Edition. (2015)
2. Beer, Johnston, DeWolf and Mazurek: Mechanics of Materials, 8th Edition, TMH Pvt Ltd, New Delhi. (2020)
3. Ryder: Strength of Materials, 3rd Edition, Macmillan (Publisher) (1969)
4. Irwin H. Shames: Introduction to Solid Mechanics, 3rd Edition, Pearson Publisher (2015)
5. R. Subramanian: Strength of Materials, 3rd Edition, Oxford University Press (2016)

Web Resources

1 https://swayam.gov.in/nd1_noc20_ce34 – Swayam Course Material.
2 https://nptel.ac.in/courses/112107146 – NPTEL Course Material.
3 https://archive.nptel.ac.in/courses/105/105/105105108 – NPTEL Course Material.

Assessment:

Internal Assessment (IA) for 40 marks:

IA will consist of Two Compulsory Internal Assessment Tests each test for 20 marks. First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. 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
2. 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)
3. A total of Four questions need to be answered.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2523113	**Thermodynamics**	**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					
2523113	**Thermodynamics**	**20**	**20**	**40**	**60**	**2**	**--**	**--**	**100**

Rationale :

Thermodynamics concepts are useful in understanding and designing systems involving energy transfer and energy transformation.

Course Objectives: Six Course Objectives

1. To familiarize the concepts of Energy in general and Heat and Work in particular
2. To study the fundamentals of quantification and grade of energy
3. To study the effect of energy transfer on properties of substances in the form of charts and diagrams
4. To familiarize with the application of the concepts of thermodynamics in vapour power and gas power cycles.
5. To study the concepts of compressible fluid flow
6. To study the concepts of reactive systems

Course Outcomes: Six Course outcomes (Based on Blooms Taxonomy)

1. Demonstrate application of the laws of thermodynamics to a wide range of systems.
2. Compute heat and work interactions in thermodynamic systems
3. Demonstrate the interrelations between thermodynamic functions to solve practical problems.
4. Compute thermodynamic interactions using the steam table and Mollier chart
5. Compute efficiencies of heat engines, power cycles.
6. Apply the fundamentals of compressible fluid flow to the relevant systems

DETAILED SYLLABUS: Total six module for each subject (13 Weeks)

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Thermodynamics system and types, Microscopic and Macroscopic approach, System, Boundary and Surrounding, Thermodynamic properties, Zeroth Law of Thermodynamics First law of thermodynamics, Internal Energy, Concept of Enthalpy and Entropy		
I	**Basic Concepts :**	**Introduction and Basic Concepts of Thermodynamics :** Thermodynamic state, path, process and cycle, Point and Path functions, Quasi-static process & Equilibrium, Characteristic gas equation, Heat and Work. Concept of PdV work. **First Law of Thermodynamics:** Statement & Equation, First law for Cyclic process (Joule's experiment), Perpetual Motion Machine of the First Kind, Application of first law to non-flow systems (Ideal gas processes with numerical) First law applied to flow system: Concept of flow process and flow energy, Concept of the steady flow process, Energy balance in a steady flow, Application of steady flow energy equation to nozzle, turbine, compressor, pump, boiler, condenser, heat exchanger, throttling device. Steady flow work, Significance of – VdP work, Relation between flow and non-flow work	8	CO1
II	**Second Law of Thermodynamics:**	**Second Law of Thermodynamics:** Limitation of the first law of thermodynamics, Thermal reservoir, Concept of heat engine, Heat pump and Refrigerator, Statement of the second law of thermodynamics, Reversible and irreversible Process, Causes of irreversibility, Perpetual Motion Machine of the second kind,Carnot cycle, Carnot theorem. **Entropy:** Clausius theorem, Entropy is property of a system, Temperature-Entropy diagram, Clausius inequality, Increase of entropy principle, T ds relations, Entropy change During a process.	9	CO2
III	**Availability:**	**Availability:** Highgradeandlow-gradeenergy,AvailableandUnavailableenergy,DeadState, Useful work, Irreversibility, Availability of closed system& steady flow process, Helmholtz & Gibbs function **(Only Theory)** **Thermodynamic Relations:** Maxwell relations, Clausis-Clapeyron Equation, Mayer relation, Joule-Thomson coefficient **(Only Theory)**	4	CO3

IV	**Properties of Pure Substance:**	**Properties of Pure Substance:** Advantages and applications of steam, Phase change process of water, Saturation pressure and temperature, Terminology associated with steam, Different types of steam. Property diagram: T-v diagram, p-v diagram, p-T diagram, Critical and triple point, T-s and an h-s diagram for water, Calculation of various properties of wet, dry and superheated steam using the steam table and Mollier chart**.** **Vapour Power cycle:** Principal components of a simple steam power plant, Carnot cycle and its limitations as a vapour cycle, Rankine cycle with different turbine inlet conditions, Mean temperature of heat addition, Reheat Rankine Cycle.	7	CO4
V	**Gas Power cycles:**	**Gas Power cycles:** Nomenclature of a reciprocating engine, Mean effective pressure, Assumptions for Air Standard Cycle, Otto cycle, Diesel Cycle and Dual cycle, Comparison of Otto and Diesel cycle for same compression ratio, Brayton Cycle. Sterling Cycle, Ericsson Cycle, Lenoir cycle, and Atkinson cycle (Only theory).	6	CO5
VI	**Compressible Fluid flow:** **Reactive Systems**	**Compressible Fluid flow:** Propagation of sound waves through compressible fluids, Sonic velocity and Mach number; Stagnation properties, Application of continuity, momentum and energy equations for steady-state conditions; Steady flow through the nozzle, Isentropic flow through ducts of varying cross-sectional area, Effect of varying back pressure on nozzle performance, Critical pressure ratio **(Only Theory)** **Reactive Systems:** Combustion, theoretical and actual combustion processes, enthalpy of formation and enthalpy of combustion, Adiabatic flame temperature, first law analysis of reactive system **(Only Theory)**	5	CO6

Text Books:

1. Thermodynamics by P K Nag, 6thEdition,TMH

2. Thermodynamics by Onkar Singh, 4th Edition New Age International

3. Thermodynamics by C P Arora,1stEditionTMH

References:

1. Thermodynamics: An Engineering Approach by Yunus A. Cengel and Michael A. Boles, 9thedition, TMH
2. Basic Engineering Thermodynamics by Rayner Joel, 5thedition, Longman Publishers
3. Engineering Thermodynamics by P Chattopadhyay, 2ndedition, Oxford University Press India
4. Engineering Thermodynamics Through Examples by Y V C Rao, Universities Press (India) Pvt Ltd
5. Fundamentals of Thermodynamics by Moran &Shapiro, Eighth Edition, Wiley
6. Fundamentals of Classical Thermodynamics by Van Wylen G.H. & Sonntag R.E., 9th Edition John Wiley& Sons
7. Thermodynamics by W.C. Reynolds, McGraw-Hill &Co
8. Thermodynamics by J P Holman, 4th Edition McGraw-Hill & Co

Online References:

Sr. No.	Website Name
1.	https://nptel.ac.in/courses/112/105/112105266
2.	https://nptel.ac.in/courses/112/103/112103275
3.	https://nptel.ac.in/courses/112/105/112105220
4	https://nptel.ac.in/courses/101/104/101104063

Assessment:

Internal Assessment (IA) for 40 marks:

- IA will consist of Two Compulsory Internal Assessment Tests each test 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

➢End Semester Examination:

- 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 need to be answered.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2523114	**Material Science**	**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					
2523114	**Material Science**	**20**	**20**	**40**	**60**	**2**	**--**	**--**	**100**

Rationale:
Materials are the basis for all technologies and hence is relevant to engineering.

Course Objectives: Six Course Objectives

1. To familiarize with the concept of crystal formation and imperfections
2. To understand the concept of effect of temperature on deformability of metals.
3. To acquaint with the mechanism of crystallization and phase transformations
4. To make understand the phase transformations of Iron-Iron carbide system
5. To familiarize with the heat treatment processes
6. To Understand mechanism of failure in materials.

Course Outcomes: Six Course outcomes (Based on Blooms Taxonomy)

1) Identify the various classes of materials and comprehend their properties
2) Differentiate between concepts of hot and cold working.
3) Able to interpret solidification behavior and phase transformation.
4) Apply phase diagram concepts to engineering applications
5) Apply particular heat treatment for required property development
6) Identify the probable mode of failure in materials and suggest measures to prevent them

Prerequisite:
DETAILED SYLLABUS: total six module for each subject (13 Weeks)

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite			
I	Introduction to Crystals and Imperfections	Classification of materials: Introduction to engineering materials, significance of structure property correlations in all classes of engineering materials. Concepts of crystals- Crystalline and Non-crystalline Materials Unit cell, Crystal structures of metals, Crystal systems, Crystallographic planes and directions, Crystal Defects: Crystal Imperfections- definition, classification and significance of imperfections ,point defects, line defects, Surface defects and volume defects. Importance of dislocations in deformation and its mechanisms. Critical resolved shear stress, Slip systems and deformability of FCC, BCC and HCP lattice systems.	08	1
II	Hot -Cold Working mechanisms	Concept of Recrystallization, effects and mechanism of cold work and hot work, Need for Recrystallization Annealing, the stages of recrystallization annealing and factors affecting.	05	2
III	Crystallization & Phase Transformations	Nucleation-Homogeneous and Heterogeneous Nucleation and Growth. Solidification of metals and alloys, Cooling curves. Classification of Alloys based on phases and phase -diagrams Binary alloy phase diagrams – ,Isomorphous, Eutectics type I and II, Peritectic.	07	3
IV	Iron-Iron carbide phase diagram	Invariant reactions, microstructural changes of hypo and hyper-eutectoid steel, Solidification of different alloys from the Iron-Iron carbide diagram, TTT and CCT diagram-Hardenability and its tests, Graphitization in cast irons.	08	4
V	Heat treatment & Alloy Steel	Objectives, Thorough treatments: Annealing and types, normalizing, hardening and tempering. Isothermal treatments austempering and martempering. Surface hardening processes: Carburizing , Nitriding ,Cyaniding and Carbonitriding, induction and flame hardening. Alloy steels-Stainless steels, Tool steels, Maraging steels and Ausformed steels	06	5
VI	Fracture & Failure Mechanism	Fracture of metals, Ductile Fracture, Brittle Fracture, Ductile to Brittle Transition Temperature (DBTT), Griffith's criteria and Orowan's modification. Fatigue/Endurance limit of ferrous and non-ferrous metals, Fatigue test, S-N curves, factors affecting fatigue, structural changes accompanying fatigue. Creep, mechanism of creep, stages of creep and creep test, creep resistant materials.	05	6

Text Books:

1. Callister's Materials Science and Engineering, 2nd edition by R.Balasubramanium Wiley India Pvt. Ltd
2. Introduction to Engineering Materials, B K Agrawal, Tata Mcgraw Hill
3. Materials Science and Engineering : A First Course, RaghavanV , Prentice Hall India
4. MATERIAL SCIENCE AND METALLURGY FOR ENGINEERS by Dr. V.D Kodgire and S.V Kodgire.Everest Publishing House

References:

1. . Introduction to Physical Metallurgy, SidneyH. Avner, Tata McgrawHill
2. Introduction to Materials Science for Engineers; 8th Edition by James F. Shackelford Pearson
3. Fundamentals of Materials Science and Engineering: An Integrated Approach, 5th Edition by William D. Callister, Jr., David G. Rethwisch , Wiley & Sons.
4. Materials Science and Engineering, 5th edition by V.Raghavan, Prentice Hall India
5. R. A. Higgins ENGINEERING METALLURGY Part I R.A.Higgins (Higgins, Raymond A.)

Links:

1 https://archive.nptel.ac.in/courses/113/102/113102080/
2 https://www.youtube.com/watch?v=JOQpbJIakRM
3. https://www.youtube.com/watch?v=2F9NEoXvkQE
4. https://www.youtube.com/watch?v=XUB1wiKfbUk
5 https://www.youtube.com/watch?v=MoiJSjwjbxs
6. https://www.youtube.com/watch?v=Yx-bIKo-_wg

Online References:

Sr. No.	Website Name
1.	https://iisc.ac.in/outreach/publications/iisc-lecture-notes-series/
2.	https://ocw.mit.edu/courses/3-012-fundamentals-of-materials-science-fall-2005/pages/lecture-notes/
3.	https://www.usna.edu/NAOE/_files/documents/Courses/EN380/Course_Notes/Ch11_Fracture.pdf

Assessment:

Internal Assessment (IA) for 40 marks:

- IA will consist of Two Compulsory Internal Assessment Tests each test for 20 marks.. 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

➢End Semester Examination:

- 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 need to be answered.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2523115	**Materials Testing Lab**		**2**	**-**		**1**	**-**	**1**

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Avg. of 2 Tests				
2523115	**Materials Testing Lab**	**--**	**--**	**--**	**--**	**25**	**25**	**50**

Course Objectives:

1. To familiarize students with examination techniques of microstructure in ferrous and or non-ferrous metals to make them understand a correlation between microstructure and mechanical properties.
2. To introduce students to fundamentals of testing methods used to evaluate the mechanical properties of engineering materials.
3. To familiarize the students about fatigue test and S-N curve.
4. To introduce to the students simple tension test to analyze the stress - strain behaviour of materials
5. To develop hands-on skills in students in conducting standard material tests such as impact, hardness, torsion, and compression.
6. To cultivate the ability in students to interpret and analyze test results in relation to properties and behavior of materials under different loading conditions.

Course Outcomes:

1. Prepare metallic samples for studying its microstructure following the appropriate procedure.
2. Identify effects of heat treatment on microstructure of medium carbon steel and hardenability of steel using Jominy end quench test.
3. Perform fatigue test and draw S-N curve.
4. Perform simple tension test to analyze the stress - strain behaviour of materials.
5. Measure torsional strength, hardness and impact resistance of the material.
6. Perform flexural test with central and three-point loading conditions.

Prerequisite: Material Science & Strength of Materials Course

DETAILED SYLLABUS: Syllabus related Lab experiment must be considered and mapped with Blooms Taxonomy.
Total six module for each subject lab (13 weeks) to be distributed among six modules.

A. List of Experiments: Minimum ***eight*** experiments to be performed (***Four*** Experiments each from both the groups):.

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	**Comment** (Prerequisite syllabus should not be considered for paper setting)		
1.		Metallographic characterization involves preparing and analyzing metal samples to reveal their microstructure. This process includes sample preparation steps like cutting, mounting, grinding, and polishing, followed by etching to enhance structural details.	**02**	**LO1**
2.		This experiment investigates the changes in microstructure and hardness of medium carbon steel after annealing, normalizing, and hardening heat treatments. The study focuses on how these treatments affect the steel's mechanical properties, particularly hardness and ductility	**02**	**LO2**
3.		Experimental studies on tempering hardened steel demonstrate that increasing the tempering temperature leads to a decrease in hardness and an increase in toughness. Tempering also reduces brittleness and improves ductility.	**02**	**LO2**
4.		The Jominy end quench test is a standard method for determining the hardenability of steel, which is the ability of steel to transform from austenite to martensite upon cooling from a high temperature. The test involves heating a cylindrical steel sample, then quenching one end with water to create a cooling gradient. Hardness measurements are then taken along the sample's length to determine the depth of hardening.	**02**	**LO2**
5.		Rotating beam fatigue testing involves applying a bending stress to a cylindrical specimen while it rotates, inducing alternating tensile and compressive stresses on its surface. This method simulates the fatigue conditions experienced by components like axles or shafts under cyclic loading. The test is run until the specimen fails or a predetermined number of cycles is reached, allowing for the determination of fatigue endurance limits and life cycles.	**02**	**LO3**
		Group B		

6.		A tension test on a mild steel bar is a destructive test used to determine its mechanical properties like stress-strain behavior, yield strength, and modulus of elasticity. The test involves applying a tensile force to the specimen, measuring the resulting elongation, and analyzing the load-elongation data to create a stress-strain curve. This curve reveals the material's elastic and plastic behavior, including the yield point where permanent deformation begins, and the ultimate tensile strength.	**02**	**LO4**
7.		A torsion test on mild steel or cast iron bars involves twisting a bar to induce shear stress, measuring the resulting angle of twist, and recording the torque applied. This test is used to determine material properties like modulus of rigidity (G) and shear strength.	**02**	**LO5**
8.		Impact tests, like Izod and Charpy, evaluate a material's resistance to sudden impact loads by measuring the energy absorbed during fracture. These tests, often using a notched specimen and a swinging pendulum, provide insights into a material's toughness and ductility. The Charpy test, for example, is typically performed with the specimen supported horizontally, while the Izod test uses a vertical specimen.	**02**	**LO5**
9.		The Brinell and Rockwell hardness tests are two methods used to determine the hardness of metals by measuring the resistance to indentation. The Brinell test uses a steel or carbide ball pressed into the metal surface, and the hardness is determined by measuring the diameter of the indentation. The Rockwell test measures the depth of indentation produced by a diamond cone or hardened steel ball under a specific load.	**02**	**LO5**
10		A flexural test on a beam with central loading, also known as a three-point bending test, is a method to determine the material's resistance to bending stresses. In this test, a beam is placed on supports, and a load is applied at the center (mid-span). The test measures the load required to cause a specific deflection or fracture, allowing the calculation of flexural strength and modulus.	**02**	**LO6**

Text Books:

1. Callister's Materials Science and Engineering, 2nd edition by R.Balasubramanium Wiley India Pvt. Ltd

References:

1. Introduction to Materials Science for Engineers; 8th Edition by James F. Shackelford Pearson
2. Introduction to Physical Metallurgy,2nd edition by Sidney Avner, TataMcGrawHill
3. Mechanical Metallurgy, 3rd edition by GH Dieter,TataMcGraw Hill
4. Fundamentals of Materials Science and Engineering: An Integrated Approach, 5th Edition by William D. Callister, Jr., David G. Rethwisch, Wiley & Sons.
5. Materials Science and Engineering,5th edition by V.Raghavan, Prentice Hall India

Online Resources:

Sr. No.	Website Name
1	https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-mm09
2	https://nptel.ac.in/courses/113/102/113102080/
3	https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-mm09/
4	https://nptel.ac.in/content/storage2/courses/112108150/pdf/PPTs/MTS_09_m.pdf
5	https://nptel.ac.in/content/storage2/courses/112108150/pdf/PPTs/MTS_08_m.pdf
6	https://nptel.ac.in/courses/112/104/112104229/
7	https://nptel.ac.in/courses/118/104/118104008/
8	https://nptel.ac.in/content/storage2/courses/112104173/Mod_1_smart_mat_lec_6.pdfhttps://nptel.ac.in/courses/112/104/112104229/
9	https://nptel.ac.in/courses/118/104/118104008/
10	https://nptel.ac.in/content/storage2/courses/112104173/Mod_1_smart_mat_lec_6.pdf

List of Experiments.

Sr No	List of Experiments	Hrs
01	Study of Characterization techniques and Metallographic sample preparation and etching.	02
02	Comparison of Microstructures and hardness before and after Annealing, Normalizing and Hardening in medium carbon steel.	02
03	Study of tempering characteristics of hardened steel.	02
04	Determination of hardenability of steel using Jominy end Quench Test (Using different hardness testers to measure the Hardness)	02
05	Fatigue test using Rotating Beam Specimen.	02
	Group B	
06	Tension test on mild steel bar (stress-strain behaviour, determination of yield strength and modulus of elasticity)	02
07	Torsion test on mild steel bar / cast iron bar	02
08	Impact test on metal specimen (Izod/Charpy Impact test)	02
09	Hardness test on metals — (Brinell/ Rockwell Hardness Number	02
10.	Flexural test on beam (central loading)	02

Project Based Learning may be incorporated by judiciously reducing number of assignments. For example, project on topics like, Preparation and Testing of parts made of composite material/s, testing of components made using 3D Printing, etc. ***may be*** considered.

Assessment :

Term Work: Term Work shall consist of at least 8 to 9 practical based on the above list. Also, Term work Journal must include at least 2 assignments.

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

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

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2523116	**Strength of Materials**	-	2	-	-	1	-	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg. of 2 Tests				
2523116	**Strength of Materials**	--	--	--	--	25	25	50

Course Objectives:

1. Understand basic knowledge on the mechanical behavior of materials like aluminum, mild steel, and cast iron.
2. Adopt with the experimental methods to determine the mechanical properties of materials.

Course Outcomes:

1. Analyse and design structural members subjected to tension, compression, torsion, bending and combined stresses.
2. Understand the basic concepts of stress, strain, deformation, and material behaviour under different types of loading (axial, torsion, bending).
3. Perform stress analysis and design of beams subjected to bending and shearing loads using several methods.
4. Calculate the stresses and strains in axially-loaded members subject to flexural loadings.
5. Ability to conduct compression tests and Fatigue of cast iron and steel.

List of Experiments:

Sr No	List of Experiments	Hrs
01	**Brinell Hardness Test:** Determination of Brinell number of a given test specimen.	2
02	**Rockwell Hardness Test:** Determination of hardness number of different specimens such as steel, brass, copper and aluminum.	2
03	**Tension Test:** Study the behavior of mild steel and various materials under different loads. To determine a) Tensile b) Yield strength c) Elongation d) Young ‘s modulus	2
04	**Torsion Test:** Determine of Modulus of rigidity of various specimens.	2
05	**Izod Impact Test:** Determination the toughness of the materials like steel, copper, brass and other alloys using Izod test.	2
06	**Charpy Impact Test:** Determine the toughness of the materials like steel, copper, brass and other alloys using Charpy test.	2

07	**Compression Test on Short Column:** Determine the compressive stress on material.	2
08	**Compression Test on Long Column:** Determine Young ‘s modulus of the given long column.	2
09	**Testing of Springs: Determine** the stiffness of the spring and the Modulus of rigidity of wire material.	2
10	**Deflection Test For SSB And Cantilever Beam: Determine** the Young‘s modulus of the given material with the help of deflection of SSB and cantilever beam.	2

Note: Total 8 Experiments are to be conducted.

Assessment :

Term Work: Term Work shall consist of at least 8 to 9 practical based on the above list. Also, Term work Journal must include at least 2 assignments.

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

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

REFERENCE BOOKS:

1. Gere, Timoshenko, ―Mechanics of Materials‖, McGraw Hill, 3rd Edition, 1993.
2. R. S Kurmi, Gupta, ―Strength of Materials‖, S. Chand, 24th Edition, 2005.

Vertical – 5

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2523511	**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			
		Test1	Test 2	Avg. of 2 Tests				
2523511	**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 9 to 10 practical's based on the above list. Also, Term work Journal must include at least 5 to 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
2523512	**Environmental Science**	--	2*+2	-	--	2*+2	-	2

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test1	Test 2	Avg. of 2 Tests					
2523512	**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 information technology 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 Definition**	Causes, effects and control measures of: 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	**05**	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
2523611	**Mini Project (Group Project)**	--	4	-	-	2	-	2

Course Code		Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Total					
2523611	**Mini Project (Group**	--	--	--	--	50	25	75	--

Course Objectives:

1. To acquaint yourself with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint yourself with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Course Outcomes: Learner will be able to

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as a member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyze the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life-long learning.
9. Demonstrate project management principles during project work.

Guidelines for Minor 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 surveys and identify needs, which shall be converted into a problem statement for minor-project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Student groups shall submit an implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of the minor project.
- A log book has to be prepared by each group, wherein the group can record weekly work progress, and the guide/supervisor can verify and record notes/comments.
- Faculty supervisors may give inputs to students during minor project activity; however, focus shall be on self-learning.
- Students in a group shall understand the problem effectively, propose multiple solutions and select the best possible solution in consultation with the guide/supervisor.
- Students shall convert the best solution into a working model using various components of their domain areas and demonstrate.
- The solution has to be validated with proper justification and the report has to be compiled in the standard format.
- With the focus on self-learning and innovation, addressing societal problems and entrepreneurship quality development within the students through the Minor Projects, it is preferable that a single project of appropriate level and quality be carried out by all the groups of the students.

Guidelines for Assessment of Minor Project –Continuous assessment and Term Work:

- The review/ progress monitoring committee shall be constituted by heads of departments of each institute. The progress of the minor project to be evaluated on a continuous basis, Minimum two reviews in each semester- 50 marks.
- 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 the semester shall be as below:
    - Quality of project report and presentation- **25 marks**
    - Development of prototype/scaled model for project- **25 marks**

Review/progress monitoring committee may consider following points for assessment based on either one year or 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 solutions.

Assessment criteria of Minor Project:

1. Quality of survey/need identification
2. Clarity of problem definition based on need
3. Innovativeness/uniqueness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness/uniqueness
8. Cost effectiveness and societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual as member or leader
13. Clarity in written and oral communication

Sample Minor Projects: Tensegrity Structures for Mechanical applications, Computer Aided Beam Analysis, Catapult etc Minor Project topics should involve the core subjects of semester 3.

Guidelines for Assessment of Minor Project - Practical/Oral Examination: 25 marks

- Report should be prepared as per the guidelines issued by the Department.
- Minor project shall be assessed through a presentation and demonstration of working model or the execution of programme code by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by the Head of Institution.
- Students shall be motivated to publish a paper based on the work in conferences or student competitions.

Semester – IV

Vertical –1

Major

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2524111	**Engineering Mathematics - IV**	**3**	**-**	**-**	**3**	**-**	**-**	**3**

Course Code		Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Total					
2524111	**Engineering Mathematics - IV**	**20**	**20**	**40**	**60**	**2**	**25**	**--**	**125**

Rationale :

Most of the engineering branches are being off-spring of…….

Course Objectives: Six Course Objectives

1. To study the concept of FEM and various methods in it
2. To understand the knowledge of application of Matrix Algebra & Gaussian Elimination.
3. To study the finite element modeling approaches and understands the concept of boundary conditions.
4. To study 2D problems for Constant strain triangle, temperature effects, problem modeling and boundary conditions.
5. To study the concept of heat transfer and fluid flow.
6. It provides a bridge between hand calculations based on mechanics of materials and machine design and numerical solutions for more complex geometries and loading states

Course Outcomes: Six Course outcomes (Based on Blooms Taxonomy)

1. Apply the knowledge of principal of FEA, its types, governing equation, fundamental concept of solid mechanics.
2. Remember the mathematical understanding required for FEA and finite difference techniques.
3. Understand the knowledge of application of FEA such as related to stress on beams, three dimensional frames, and heat transfer.
4. Apply the knowledge of FEA in project work
5. Derive and use 1-D and 2-D element stiffness matrices and load vectors from various methods to solve for displacements and stresses.
6. Apply mechanics of materials and machine design topics to provide preliminary results used for testing the reasonableness of finite element results.

DETAILED SYLLABUS: total six module for each subject (13 Weeks)

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Strength of materials, Engineering Graphics.		
I	**Introduction** :	Brief History of FEM, Finite Element Terminology (nodes, elements, domain, continuum, Degrees of freedom, loads & constraints). Application, Advantages, Steps of FEM, Stress and Equilibrium, Boundary conditions, Strain Displacement Relations, Stress-strain Relations, Von mises stress, Temperature effect, Potential Energy & Equilibrium, Gelerkin's Method, stiffness (Displacement) Method. **Home Exercise 1:** Introduction to Ansys Tools(Pre-Processing, Processing and Post-Processing)	**07**	**CO1**
II	**Matrix Algebra & Gausian Elimination:**	Matrix Multiplication, Transposition, Diagonal Matrix, Symetric Matrix, Upper Triangular Matrix, Determinant of Matrix, Matrix Inversion Eligen values & Elgen vectors, Gaussian elimination. **Home Exercise 2:** Finite Element Analysis (element selection, assigning properties, meshing, assigning loads, and boundary conditions, analysis and result interpretation).	**06**	**CO2**
III	**1D ELEMENT:**	Types of 1D element: Displacement function, Global and local coordinate systems, Order of element, primary and secondary variables, shape functions and its properties. Formulation of elemental stiffness matrix and load vector for spring, bar, beam, truss and Plane frame. Transformation matrix for truss and plane frame, Assembly of global stiffness matrix and load vector, Properties of stiffness matrix, half bandwidth, Boundary conditions elimination method and penalty approach, Symmetric boundary conditions, Stress calculations. Home Exercise 3: Any two problems using bar element	**07**	**CO3**

IV	**1D Steady State Heat Transfer Problems :**	Introduction, Governing differential equation, steady-state heat transfer formulation of 1D element for conduction and convection problem, boundary conditions and solving for temperature distribution. **Home Exercise 4:** Any one problem on steady state heat conduction	**06**	**CO4**
V	**Dynamic Analysis:**	Types of dynamic analysis, General dynamic equation of motion, point and distributed mass, lumped and Consistent mass, Mass matrices formulation of bar and beam element. Undamped-free vibration- Eigen value problem, Evaluation of eigen values and eigenvectors (natural frequencies and mode shapes). **Home Exercise 5:** Any one problem of free vibration analysis using bar element	**06**	**CO5**
VI	**2D ELEMENTS:**	Second Order 2D Equations involving Scalar Variable Functions — Variation formulation –Finite Element formulation — Triangular elements — Shape functions and element matrices and vectors. Application to Field Problems —Torsion of Non circular shafts – Quadrilateral elements. Stress analysis of CST. **Home Exercise 6:** Any two problems using CST element	**07**	**CO6**

Text Books:

1. Introduction to Finite Element Engineering – T.R.Chandrupatla,Belegunda; PHI
2. A First course in Finite Element Method- Darya Logon, ThompsonLearning (TL Publisher)
3. Concepts and Applications of Finite Element Analysis, R. D. Cook, et al. Wiley, India

References:

1. Seshu P., —Text book of Finite Element Analysis‖, PHI Learning Private Ltd. New Delhi, 2010.
2. Bathe K. J., —Finite Element Procedures‖, Prentice-Hall of India (P) Ltd., New Delhi.
3. Fagan M. J., —Finite Element Analysis, Theory and Practice‖, Pearson Education Limited.
4. Kwon Y. W., Bang H., —Finite Element Method using MATLAB‖, CRC Press, 1997
5. S. Moaveni, —Finite element analysis, theory and application with Ansys‖,
6. Fundamental of Finite Element Analysis, David V. Hutton, Tata McGraw-Hill
7. TheFiniteElement Method in Engineering- S.S.Rao, Elsveir Pub.
8. An Introduction to FiniteElement Method-J.N.Reddy, Tata Mc-graw Hil

Online References:

Sr. No.	**Website Name** (NPTEL/SWAYAM Courses)
1.	https://nptel.ac.in/courses/112/104/112104193/
2.	https://nptel.ac.in/courses/105/106/105106051/
3.	https://nptel.ac.in/courses/112/104/112104115/
4.	https://nptel.ac.in/courses/112/103/112103295/
5.	https://nptel.ac.in/courses/112/106/112106135/
6.	https://nptel.ac.in/courses/112/106/112106130/
7.	https://nptel.ac.in/courses/105/105/105105041/
8.	https://nptel.ac.in/courses/112/104/112104116/

Assessment:

Internal Assessment (IA) for 40 marks:

- IA will consist of Two Compulsory Internal Assessment Tests each test 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

➢ **End Semester Examination:**

- 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 need to be answered.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2524112	**Fluid Mechanics**	**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					
2524112	**Fluid Mechanics**	**20**	**20**	**40**	**60**	**2**	**--**	**--**	**100**

Course Objectives:

1. To study Fluid Statics and Fluid Dynamics.
2. To acquaint with dimensional analysis of Thermal and Fluid systems.
3. To familiarize with application of mass, momentum and energy equations in fluid Flow.
4. To study various flow measurement techniques.
5. To familiarize with the dynamics of fluid flows and the governing no dimensional Parameters.

Course Outcomes: Learner will be able to

1. Define properties of fluids, classify fluids and evaluate hydrostatic forces on Various surfaces.
2. Illustrate understanding of dimensional analysis of Thermal and Fluid systems.
3. Differentiate velocity potential function and stream function and solve for velocity and acceleration of a fluid at a given location in a fluid flow.
4. Formulate and solve equations of the control volume for fluid flow systems and Apply Bernoulli's equation to various flow measuring devices.
5. Calculate pressure drop in laminar and turbulent flow, evaluate major and minor Losses in pipes.
6. Calculate resistance to flow of incompressible fluids through closed conduits and Over surfaces.

Prerequisite: Illustrate about the basic properties of a fluid.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Illustrate about the basic properties of a fluid.		–
I	Fluid Properties & Fluid Statics	Density, specific weight, specific gravity, surface tension and capillarity, Newton‘s law of viscosity, incompressible and compressible fluid, numerical problems; Hydrostatic forces on submerged bodies - Pressure at a point, Pascal's law, pressure variation with temperature and height, center of pressure plane, vertical and inclined surfaces; Manometers – simple and differential Manometers, inverted manometers, micro manometers, pressure gauges and numerical problems. Buoyancy - Archimedes principle, metacenter, Meta centric height calculations; Stability	**07**	CO1
II	Fluid Kinematics and Basic Equations of Fluid Flow Analysis	Stream line, path line, streak line, stream surface, stream tube, classification of flows, steady, unsteady, uniform, non-uniform, laminar, turbulent flows, one dimensional approximation, examples of real 1-D flows, two dimensional approximation, 2-D flow in wind tunnel; Continuity equations for 1-D and 2-D flows both compressible and incompressible, stream function for two dimensional incompressible flows; Vortices, irrotational flow, velocity potential function	**06**	CO2
III	Fluid Dynamics	Basic laws for a system in integral form: Reynolds transport theorem, Conservation of mass, Newton‘s 2nd law; Application of the basic laws for a control volume; Kinematics; Motion of a fluid particle; Fluid deformation; Differential analysis of fluid motion: Continuity equation, Differential momentum equation, Surface and body forces, substantive derivative, local derivative and convective derivative, momentum equation, Euler's and Bernoulli's equation, phenomenological basis of Naviersstokes equation, introduction to vortex flows, flow measurements : pressure, velocity and mass flow rate, viscosity, pivot-static tube, venture meter and orifice meter, viscometers. Statement of Buckingham‘s π- theorem, similarity parameters - Reynolds number, Froude number, concepts of geometric, kinematic and dynamic similarity,	**07**	CO3

		Reynolds number as a very approximate measure of ratio of inertia force and viscous force.		
IV	Boundary Layer Theory	Boundary layer - introductory concepts of boundary layer,large Reynolds number flows and Prandtl's boundary layer hypothesis Pressure drag and skin friction drag;	**06**	CO4
V	Flow through pipes	Reynolds experiment, Head loss in pipes due to friction (Darcy-Weisbach equation), Loss of energy in pipe (major and minor), Hydraulic gradient and Energy gradient line, Pipes in series and parallel, concept of equivalent pipe.	**06**	CO5
VI	Turbo Machinery	Introduction and classification of fluid machines: Turbo machinery analysis; The angular momentum principle; Euler turbo machine equation; Velocity triangles; Application to fluid systems - Working principle overview of turbines, fans, pumps and compressors.	**07**	CO6

TEXT BOOKS:

1. Shames I H, ―Mechanics of Fluids‖, Kogakusha, Tokyo, 7th Edition, 2007.
2. R. K Bansal, ―Fluid mechanics and hydraulic machines‖, Laxmi publications ltd, 9th Edition, 2011.
3. Robert W Fox, Alan T McDonald, ―Introduction to fluid Mechanics‖, John Wiley and Sons, 6th Edition, 1995.
4. Streeter V. L, Wylie, E.B., ―Fluid Mechanics‖, McGraw-Hill, 9th Edition, 1983.

REFERENCE BOOKS:

1. Yuan S W, ―Foundations of fluid Mechanics‖, Prentice-Hall, 2nd Edition, 1987.
2. Milne Thompson L M, ―Theoretical Hydrodynamics‖, MacMillan, 5th Edition, 1968.
3. Ratha krishnan. E, ―Fundamentals of Fluid Mechanics‖, Prentice-Hall, 5th Edition, 2007.
4. Som S. K, Biswas. G ―Introduction to fluid mechanics and fluid machines‖, Tata McGraw-Hill, 2nd Edition, 2004

Assessment:

Internal Assessment (IA) for 40 marks:

IA will consist of Two Compulsory Internal Assessment Tests each test for 20 marks.

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weight age of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.Question paper will comprise of total **six questions**, **each carrying 15 marks**

1. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
2. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
3. Only **Four questions need to be solved**.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2524113	**Low speed Aerodynamics**	**3**	**2**	**-**	**3**	**2**	**-**	**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					
2524113	**Low speed Aerodynamics**	**20**	**20**	**40**	**60**	**2**	**--**	**--**	**100**

Rationale :

Course Objectives:

1. Provide students with a fundamental understanding of the physical principles governing low speed aerodynamics and propellers, enabling them to analyze and predict their performance.
2. Effectively communicate technical concepts related to low speed aerodynamics and propellers in written and oral presentations, and Present analysis results and conclusions clearly and concisely

Course Outcomes (CO's):

After successful completion of this course, the student will be able to,

1. Define, illustrate and explain the key terms related to aerodynamics, propellers, wing design parameters and propeller design variables.
2. Analyze ideal flow over a circular cylinder, including understanding D'Alembert's paradox and the Magnus effect and Compare real and ideal flow over smooth and rough cylinders.
3. Demonstrate the use of Kutta-Joukowski theorem and methods like superposition, thin airfoil theory, source and vortex methods for airfoil analysis.
4. Demonstrate and Analyze potential flow over lifting wings using lifting line theory, vortex lattice method, slender body theory, and panel method.
5. Calculate boundary layer thickness, displacement thickness, momentum thickness, energy thickness, and shape parameter, and Analyze boundary layer growth over a flat plate.
6. Apply Froude's momentum theory and blade element theory to predict propeller performance and analyze common propeller types and their characteristics.

Prerequisite: Fluid properties, kinematics and dynamics of fluid

DETAILED SYLLABUS: total six module for each subject (13 Weeks)

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Fluid properties, kinematics and dynamics of fluid		
I	**Introduction to Aerodynamics :**	Flow regimes (Reynolds Number and Mach No), Airfoils, Wings and their nomenclature, Lift, Drag and Pitching moment coefficients, Center of pressure and Aerodynamic center. Flow over cylinder and aerofoil.	6	CO1
II	**Potential Flow Theory:**	Streamline, stream function, irrotational flow, potential function, Equipotential lines,Elementary flows and their combinations. D' Alembert's paradox, Magnus effect, Kutta Joukowski's theorem,starting vortex, Kutta condition, real flow over a smooth and rough cylinder.	7	CO2
III	**Aerofoil Theory:**	Scalar and vector fields, velocity potential, line, surface and volume integrals, Green's lemma and Stoke's theorem, Kelvin's theorem, Circulation and lift generation, Kutta-Joukowski theorem. Method of superposition, thin airfoil theory, source, and vortex methods.	7	CO3
IV	**Subsonic Wing Theory:**	Vortex filament, Biot and Savart law, bound vortex and trailing vortex, horseshoe vortex, Potential flow over lifting wing, lifting line theory and its limitations, vortex lattice method, slender body theory, panel method. Subsonic compressible flow past airfoils, Critical Mach number, drag divergence Mach number, supercritical airfoils, effect of sweep, area rule. Prandtl-Glauert compressibility corrections.	**7**	CO4
V	**Boundary Layer Theory:**	Boundary layer and boundary layer thickness, displacement thickness, momentum thickness, energy thickness, shape parameter, boundary layer equations for a steady, two-dimensional incompressible flow, boundary layer growth over a flat plate, critical Reynolds number, Blasius solution, basics of turbulent flow.	**6**	**CO5**
VI	**Propeller Theory:**	Propeller Nomenclature, Tip Speed and Helical Motion, Thrust and Torque, Forces Acting on a Propeller, Propeller Design Variables, Types of Propellers, Froude's Momentum Theory, Blade Element Theory	**8**	**CO6**

Text Books:

1. Fundamentals of Aerodynamics, John Anderson, McGrawHill, 07edition 2024.
2. Aerodynamics for Engineering students,Steven H. Collicott, Daniel T. Valentine,E. L. Houghton,P. W. Carpenter, Butterworth, 07edition 2016.
3. Theoretical Aerodyiamics, Ethirajan Rathakrishnan, John Wiley, 01st2013.

References:

Sr.No	Title	Author	Publisher	Edition	Year
1	Low-Speed Aerodynamics	Joseph Katz Allen Plotkin	Cambridge University Press	2nd	2012
2	Aerodynamics. Aeronautics. and Flight Mechanics	Barnes W. McCormick	John Wiley& Sons	2nd	1994
3	Fluid Mechanics	Frank M. White Henry Xue	McGraw-Hill	9th	2022

Assessment:

Internal Assessment (IA) for 40 marks:

- IA will consist of Two Compulsory Internal Assessment Tests each test 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

➢ End Semester Examination

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 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 need to be answered.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2524114	Aerodynamics Laboratory	-	2	-	-	1	-	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		Test	Test 2	Avg. of 2 Tests				
2524114	Aerodynamics Laboratory	--	--	--	--	50	25	75

Pre-Requisites: Aerodynamics-1 and Low Speed Aerodynamics

Course Objectives:

- Understand the behavior of flow properties over different models using subsonic wind tunnel.
- Demonstrate experimentally the pressure distribution over circular, symmetric and cambered
- airfoils and evaluate lift and drag.
- Illustrate flow visualization studies at low speeds over different aerodynamic bodies.

Course Outcomes:

- Point out the pressure distribution of symmetrical and unsymmetrical airfoil and 2D cylinder.
- Calibrate and operate subsonic wind tunnel equipment for aerodynamic experimentation.
- Evaluate aerodynamic forces such as lift and drag using wind tunnel balance techniques.
- Conduct wake analysis of cylinders and airfoils to study aerodynamic performance and flow separation.
- Analyze the working and efficiency characteristics of axial flow and centrifugal flow compressors.
- Examine flow visualization of airfoil and bluff bodies

List of Experiments:

Sr No	List of Experiments	Hrs
01	Calibration of subsonic wind tunnel.	2
02	Pressure Distribution-Cylinder	2
03	Pressure Distribution-Symmetric Airfoil	2
04	Pressure Distribution-Cambered Airfoil	2
05	Force measurement using wind tunnel balance.	2
06	Flow over a Flat Plate.	2
07	Flow visualization studies in low speed over cylinder.	2

08	Flow Visualization Studies - Airfoil Flow visualization studies in low speed over airfoil at Different angles of incidence.	2
09	Wake analysis over a cylinder and airfoils.	2
10	Blower Test Rig; Efficiency of blower test rig for 3 different vane settings.	2
11	Axial Flow Compressor; Efficiency of axial flow compressor.	2
12	Centrifugal Flow Compressor	2

REFERENCE BOOKS:

1. L. J. Clancy, ―Aerodynamics", Pitman, 1st Edition, 1986.
2. Alan pope, ― Low Speed Wind Tunnel Testing‖, John Wiley, 2nd Edition, 1999.
3. N. M. Komerath, ―Low Speed Aerodynamics‖, Extrovert, 1st Edition, 2012.

Assessment:

Term Work: Term Work shall consist of at least 8 to 10 practicals based on the above list.

Term Work Marks: 25 Marks (Total marks) = 20 Marks (Experiment/Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & Practical 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
2524115	Fluid Mechanics	-	2	-	-	1	-	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg. of 2 Tests				
2524115	Fluid Mechanics	--	--	--	--	25	25	50

Course Objectives:

- Gain knowledge on working of centrifugal pumps, positive displacement pumps, hydraulic
- Turbines centrifugal blowers and steam turbines.
- Compare performance of various machines at different operating points.
- Knowledge of various flow meters and the concept of fluid mechanics.

Course Outcomes:

- Obtain the necessary practical skills & real time knowledge
- Apply scientific method for analyzing the qualitatively & quantitatively to solve the problems.
- Flow behavior in various geometry of cross sectional
- Calibrate flow measuring devices such as Venturi meter and orifice meter and evaluate discharge characteristics of fluid flow systems.
- Analyze fluid flow behavior in pipes by determining major losses in circular and rectangular pipes and verifying Bernoulli's theorem experimentally.
- Conduct performance tests on centrifugal pumps and reciprocating pumps and determine their operating characteristics and efficiencies.

List of Experiments:

Sr No	List of Experiments	Hrs
01	**Calibration:** Calibration of Venturi meter and orifice meter.	2
02	**Pipe Flow Losses:** Determination of pipe flow losses in rectangular and circular pipes	2
03	**Bernoulli's Theorem:** Verification of Bernoulli's theorem.	2
04	**Reynolds Experiment:** Determination of Reynolds Number of fluid flow	2
05	**Impact of Jet on Vanes:** Study Impact of jet on Vanes.	2

06	**Centrifugal Pumps:** Performance test on centrifugal pumps.	2
07	**Reciprocating Pumps:** Performance test on reciprocating pumps.	2
08	**Pelton Wheel Turbine:** Performance test on piston wheel turbine.	2
09	**Francis Turbine:** Performance test on Francis turbine.	2
10	**Flow Through Weirs:** Rate of discharge Flow through Weirs	2
11	**Flow Through Notch:** Flow through rectangular and V-Notch	2
12	**Flow Though Orifice Mouth Piece:** Flow analysis of different shapes of mouth pieces.	2

REFERENCE BOOKS:

1. Yuan S W, ―Foundations of fluid Mechanics‖, Prentice-Hall, 2nd Edition, 1987.
2. Milne Thompson L M, ―Theoretical Hydrodynamics‖, MacMillan, 5th Edition, 1968.
3. Rathakrishnan. E, ―Fundamentals of Fluid Mechanics, Prentice-Hall, 5th Edition, 2007.
4. Som S. K., Biswas. G, ―Introduction to fluid mechanics and fluid machines, Tata McGraw-Hill, 2nd Edition, 2004.

Assessment:

Term Work: Term Work shall consist of at least 8 to 10 practical's based on the above list.

Term Work Marks: 25 Marks (Total marks) = 20 Marks (Experiment/Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & Practical 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
2524411	CAD Modeling Lab	-	4	-	-	2	-	2

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		Test	Test 2	Avg. of 2 Tests				
2524411	CAD Modeling Lab	--	--	--	--	50	25	75

Lab Objectives: Six Lab Objectives

1. To familiarize geometric modeling techniques
2. To impart 2D sketching skills using CAD software
3. To impart the 3D Solid Modeling skills for the development of 3D models of engineering components.
4. To impart the 3D surface modeling skills for development of 3D models of basic engineering components.
5. To impart the 3D modeling skills for assembling different parts made in 3D modeling software.
6. To introduce Product data exchange among CAD systems.

Lab Outcomes: Six Lab outcomes (Based on Blooms Taxonomy)
Learner will be able to…

1. Use appropriate technique for geometric modeling.
2. Apply 2D sketching tools to prepare sketch of a given object using 3D CAD software.
3. Create solid model of the object using 3D CAD software.
4. Develop the surface model of a given object using 3D CAD software.
5. Generate assembly of given objects using assembly tools of a 3D CAD software
6. Use product data exchange formats to perform product data exchange among CAD systems.

Prerequisite:

1. ESL201: Engineering Graphics laboratory
2. PLC 303: Working Drawing – GD & T laboratory

DETAILED SYLLABUS: Syllabus related Lab experiment must be considered and mapped with Blooms Taxonomy.
Total six modules for each subject lab (13 weeks) to be distributed among six modules.

Sr. No.	Module	Detailed Content	Hours	LO (Lab Outcomes) Mapping
0	Prerequisite	**Comment** (Prerequisite syllabus should not be considered for paper setting)	02	
I	**Introduction to CAD**	Different modeling techniques (solid modeling, surface modeling, parametric modeling, feature based modeling) for creation of CAD models, creation of CAD models from different perspectives.	02	**LO1**
II	**Sketching using 2D sketch tools**	Setting the sketch environment, creating sketch from a geometry using the sketching commands like- line, circle, arc, etc., modification in sketches using commands like- move, trim, rotate, etc.), use of viewing commands like- pan, zoom, rotate, etc., use of sketch constraints.	08	**LO2**
III	**Solid Modelling**	Settings environment for part modeling, creating machine/engineering parts/components using features like – extrude, revolve, mirror, threading, fillet, hole, bend, rib, patterns (rectangular, circular, etc.), etc.	12	**LO3**
IV	**Surface Modeling**	Generation of surfaces from open profiles using create tools like extrude, sweep, loft, trim, etc., path & guide surface option commands like – extend, trim, shell, patch, etc., mesh of curves, free form surfaces	10	**LO4**
V	**Assembly**	Constraints, exploded views, interference check, drafting (layouts, standard & sectional views, detailing & plotting), use of transformations and manipulation commands (translate, rotate, scale, etc.) to modify and assemble the created CAD models.	16	**LO5**
VI	**Data Exchange**	CAD data exchange formats Like IGES, PDES, PARASOLID, DXF and STL along with their comparison and applicability.	02	**LO6**

List of Experiments:

Sr No	List of Exercises	Hrs
01	3D modeling of basic Engineering components like - Nuts, Bolts, Keys, cotter, Screws, Springs etc. **(Note: Any two out of above)**	2
02	3D modeling of basic machine components like - Clapper block, Single tool post, Lathe and Milling tail stock, Shaper tool head slide, jigs and fixtures Cotter, Knuckle joint, Couplings: simple, muff, flanged Protected flange coupling, Oldham's coupling, Universal coupling, element of engine system and Miscellaneous parts. **(Note: Any two out of above)**	2
03	Generation of surface model of **any two** objects like - hull of a ship, aeroplane wing, etc. using various surface creation tools in CAD software.	2
04	1) Generation of an assembly model (minimum five child parts) along with working (production) drawing of the system, creation of 3D models with assembly constraints, interference check, exploded view, GD&T, tolerance table and fit table, bill of material. 2) Reverse Engineering of a physical model: disassembling of physical model having not less than five parts, measuring the required dimensions of each component, sketch the minimum views required for each component, convert these sketches into 3-D model and create an assembly drawing with actual dimensions **(Note: Any one out of above)**	2

Textbooks:

1. A textbook of Machine Drawing by Laxminarayan and M.L.Mathur, Jain brothers Delhi 3. Machine Drawing by Kamat and Rao

2. A text book of Machine Drawing by R.B.Gupta, Satyaprakashan, Tech. Publication

References:

1. Machine Drawing by N.D. Bhatt.

2. Machine Drawing by K.I. Narayana, P. Kannaiah, K.Venkata Reddy

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 7 exercises (prints) as mentioned above.
Term Work Marks: 25 Marks (Total marks) = 20 Marks (Experiment/Assignments) + 5 Marks (Attendance)

Practical& Oral Exam: An Oral & Practical 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
2524511	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)			
		Test1	Test 2	Avg. of 2 Tests					
2524511	Business Model Development	--	--	--	--	--	50	--	50

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

Course 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.

Course 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-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	**04**	**L1, L2**
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
3.	Entrepreneurship by Prof. C Bhaktavatsala Rao https://onlinecourses.nptel.ac.in/noc20_mg35/preview
4.	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
2524512	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)			
		Test1	Test 2	Avg. of 2 Tests					
2524512	Design Thinking	--	--	--	--	--	50	--	50

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

Course 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.

Course 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-topics/external-links/design-thinking-case-study-index	**05**	**L1, L2**

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
5.	Design Thinking and Innovation by Ravi Poovaiah https://onlinecourses.swayam2.ac.in/aic23_ge17/preview
6.	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. S. M. Khot
BoS-Chairman-Mechanical Engineering
Faculty of Technology

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

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