AC–

Item No.–

As Per NEP 2020

University of Mumbai

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

University of Mumbai

(As per NEP 2020)

Sr. No.	Heading	Particulars
1	**Title of program** **O:_____**	**B.E. (Mechatronics Engineering)**
2	**Exit Degree**	**U.G. Diploma in Engineering-Mechatronics 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**	**2025-26**

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 Mechatronics Engineering Branch of engineering in the learner. Keeping this in view, a pool of courses is offered in Core Courses covering fundamentals required to understand coreand 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 Mechatronics Engineering 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 enhancedskill 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 Mechatronics 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 2054-26. Subsequently, this system will be carried forward for Third Year and Final Year Engineering in the academic years 2026-27, and 2027-28, respectively.

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Under Graduate Diploma in Engineering- Mechatronics Engineering.

Credit Structure (Sem. III & IV)

Level	Semester	Major		Minor	OE	VSC,SEC (VSEC)	AEC, VEC, IKS	OJT, FP,CEP, CC,RP	Cum.Cr. / Sem.	Degree/Cum.Cr.
		Mandatory	Electives							
	R:_____C									
5.0	III	2413111 2413112 2413113 2413114 2413115 2413116	--	--	OE:2	--	VEC:2 HSL: 2	CEP:2	22	UG Diploma45
	R:_____D									
	IV	2414111 2414112 2414113 2414114 2414115	--	MDM: 4	OE:2	VSEC:2	VEC:2 EEM:2	--	23	
	CumCr.	25	--	4	4	2	2+2+2+2	2	45	

Exitoption: 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 8 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.
Mechatronics
Engineering
Scheme

Program Structure for Second Year of Mechatronics Engineering

UNIVERSITY OF MUMBAI (With Effect from 2025-2026)

SEMESTER III

Course Code	Course Description	Teaching Scheme (Contact Hours)			Credit Assigned			
		Theory	Practical	Tutorial	Theory	Tutorial	Practical	Total Credits
2413111	Engineering Mathematics III	2	--	1-	2	1	--	3
2413112	Electronics and Digital Circuit Design	3	–	--	3	--	--	3
2413113	Engineering Materials	3	--	--	3	--	--	3
2413114	Theory of Machines	3	--	--	3	--	--	3
2413311	To be taken from the bucket provided by the University from other Faculty	2#	--	--	2	--	--	2
2413115	Electrical and Electronics Workshop	--	2	--	--	--	1	1
2413116	CAD Modeling Lab	--	2	--	--	--	1	1
2413611	Mini Project (group project)	--	2*+2	--	--	--	2	2
2413511	Entrepreneurship Development (Syllabus common to all Branches).	--	2*+2	---	--	--	2	2
2413512	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.

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)					
2413111	Engineering Mathematics III	20	20	40	60	2	25	--	125
2413112	Electronics and Digital Circuit Design	20	20	40	60	2	--	--	100
2413113	Engineering Materials	20	20	40	60	2	--	--	100
2413114	Theory of Machines	20	20	40	60	2	--	--	100
2413311	To be taken from the bucket provided by the University from other Faculty	20	20	40	60	2	--	--	100
2413115	Electrical and Electronics Workshop	--	--	--	--	--	25	25	50
2413116	CAD Modeling Lab	--	--	--	--	--	25	25	50
2413611	Mini Project (group project)	--	--	--	--	--	50	25	75
2413511	Entrepreneurship Development (Syllabus common to all Branches).	--	--	--	--	--	50	--	50
2413512	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 Mechatronics Engineering

UNIVERSITY OF MUMBAI (With Effect from 2025-2026)

SEMESTER IV

Course Code	Course Description	Teaching Scheme (Contact Hours)			Credit Assigned			
		Theory	Practical	Tutorial	Theory	Tutorial	Practical	Total Credits
2414111	Engineering Mathematics IV	2	--	1	2	1	–	3
2414112	Automotive Mechatronics	3	–	--	3	–	–	3
2414113	Application of Integrated Circuits	3	--	--	3	–	–	3
2414211	Multidisciplinary minor	3	–	--	3	–	–	3
2414311	To be taken from the bucket provided by the University from other Faculty	2#	–	--	2	–	–	2
2414114	Automotive Mechatronics Lab	–	2	–	–	–	1	1
2414115	Applied Electronics Lab	–	2	–	–	–	1	1
2414212	Multidisciplinary minor	–	2	–	–	–	1	1
2414411	Machine Shop Practice Lab	–	2*+2	–	–	–	2	2
2414511	Business Model Development (Syllabus common to all Branches).	–	2*+2	–	–	–	2	2
2414512	Design Thinking (Syllabus common to all Branch).	–	2*+2	–	–	–	2	2
Total		**13**	**18**	**01**	**13**	**01**	**09**	**23**

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

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

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

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

Course Code	Course Description	Examinationscheme							
		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)					
2414111	Engineering Maths IV	20	20	40	60	2	25	--	125
2414112	Automotive Mechatronics	20	20	40	60	2	--	--	100
2414113	Application of Integrated Circuits	20	20	40	60	2	--	--	100
2414211	Multidisciplinary minor	20	20	40	60	2	--	--	100
2414311	To be taken from the bucket provided by the University from other Faculty	20	20	40	60	2	--	--	100
2414114	Automotive Mechatronics Lab	--	--	--	--	--	25	25	50
2414115	Applied Electronics Lab	--	--	--	--	--	25	25	50
2414212	Multidisciplinary minor	--	--	--	--	--	25	--	25
2414411	Machine Shop Practice Lab	--	--	--	--	--	50	25	75
2994511	Business Model Development (Syllabus common to all Branches).	--	--	--	--	--	50	--	50
2994512	Design Thinking (Syllabus common to all Branch).	--	--	--	--	--	50	--	50
Total		**100**	**100**	**200**	**300**	**10**	**250**	**75**	**825**

Vertical –1
Major

Detail Syllabus

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2413111	Engineering Mathematics III	2	-	1	2	-	1	3

		Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Total					
2413111	Engineering Mathematics III	20	20	40	60	2	--	--	100

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

Rationale:.

Including Engineering Mathematics III in the Semester 3 syllabus of Mechatronics Engineering is essential for developing advanced analytical skills required for solving complex engineering problems. This subject introduces key mathematical tools such as Laplace and Inverse Laplace transforms, crucial for modeling and analyzing control systems, signals, and dynamic systems. The study of Fourier series aids in understanding signal processing and vibration analysis. Concepts of complex variables and Cauchy-Riemann equations support fluid mechanics and electromagnetics. Matrix algebra and numerical methods equip students with techniques to solve systems of equations, perform transformations, and handle large data sets efficiently

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 complex engineering problems.
4. Find analytic function by using basic concepts of complex variable theory.
5. Apply Matrix algebra to solve the engineering problems.
6. Solve Partial differential equations by applying numerical solution and analytical methods for one dimensional heat and wave equations.

Module	Detailed Contents	Hrs.	CO
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 (without proof) 4.2 Milne-Thomson method to determine analytic function *f*(z) when real part (u) or Imaginary part (v) is given. 4.3 Harmonic function, Harmonic conjugate. **Self-learning Topics:** 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	

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 20 marks:

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

End Semester Theory Examination:

Question paper format

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

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

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2413112	Electronics and Digital Circuit Design	3	-	-	3	-	-	3

		Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Total					
2413112	Electronics and Digital Circuit Design	20	20	40	60	2	--	--	100

Rationale:
This course is designed to provide students with a comprehensive understanding of the fundamental concepts and principles of electrical and electronics engineering. It focuses on essential topics such as semiconductor devices, digital logic design, and number systems, which serve as the foundation for more advanced studies in electrical and electronic engineering fields. By equipping students with the theoretical knowledge and practical applications of these principles, the course aims to develop critical thinking and problem-solving skills necessary for modern electrical and electronic systems design.

Course Objectives: The course aims

1 To study working operation of transistors

2 To understand different biasing techniques of transistors

3 To learn different applications of transistors

4 To study various number systems, their conversion and arithmetic operations

5 To learn the fundamentals of digital logic design

6 To conceptualize data representation techniques

Course Outcomes: On successful completion of course, student will be able to:

1. Describe working of BJT in different biasing modes and its applications- L1, L2

2. Conceptualize operation of FET and their applications- L1, L2

3. Practice different number systems and their arithmetic operations – L3

4. Design and analyze combinational logic circuits- L4, L6

5. Design and describe sequential logic circuits – L2, L6

6. Represent and evaluate integer and floating point data- L2, L5

Prerequisite:
DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Basics of Electrical Engineering; Fundamentals of Electronics Principles	2	
I	BJT	BJT construction; BJT operation; BJT Configurations and characteristics- Common Base, Common Emitter and Common Collector; Transistor Biasing: Need of biasing; Voltage divider bias configuration; Common base configuration; Applications: BJT as a switch; BJT as an amplifier	7	1

II	FET	Junction Field Effect Transistor (JFET): Construction, operation and characteristics; transfer characteristics; Application: JFET as switch; JFET as an amplifier; Metal-Oxide Effect Transistor (MOSFET): Construction, Operation and Characteristics of Depletion & Enhancement type MOSFET; Application: MOSFET as a switch in CMOS inverter	7	2
III	Number Systems	Introduction to Number systems; Binary, Octal, Decimal and Hexadecimal number systems and their conversions; Signed Binary Numbers- 1's and 2's complement; Binary subtraction using 2's complement;Binary Code: Binary Coded Decimal, Gray Code, ASCII code and their conversions	4	3
IV	Combinational Logic Circuits	NOT, AND, OR, NAND, NOR, EX-OR, EX-NOR Gates; NAND and NOR as a universal logic gates; Sum of products and products of sum form;5Reduction of Boolean functions using K6-map method (2,3,4 Variable) and Realization using gates; Design of Half & Full Adder; Half & Full subtractor; Multiplexers & De-multiplexers; Encoders & Decoders; Comparator; Analysis of combinational logic circuits	8	4
V	Sequential Logic Circuits	NAND based SR latch; NAND based SR, D, JK, T and Master-slave JK Flip-Flops and their function table;Conversion of flip flops; Shift registers; Universal Shift Register; Design and analysis of asynchronous & synchronous up, down and up-down Counters; Mod Counters; Ring Counters	8	5
VI	Data Representation	Basics of floating-point representation; IEEE 754 floating point (Single & double precision) number representation.	3	6

Text Books:

1. Electronic Devices and Circuit Theory by Robert Boylestad& Louis Nashelsky, 11th Edition, Pearson Education

2. Modern Digital Electronics by R. P. Jain, 4th Edition, McGraw Hill Education

References:

1. Electronic Circuits: Analysis and Design by Donald A. Neamen, 3rdEdition, McGraw Hill Education

2. Electronic Principles by Albert Paul Malvino, David J. Bates & Patrick E. Hoppe, 9th Edition, McGraw Hill Education

3. Digital Design by M. Morris Mano, 6th Edition, Pearson Education

4. Fundamentals of Digital Circuits by A. Anandkumar, 4th Edition, PHI

5. Digital: Principles and applications by Leach, Malvino&Saha,8th Edition, McGraw Hill Education

Online References:

1.https://nptel.ac.in/courses/108101091

2. https://nptel.ac.in/courses/117106114

3. https://nptel.ac.in/courses/117103063

Assessment:

Internal Assessment (IA) for 20 marks:

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

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marks. Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **Three questions** need to be answered
- Give proportionate weightage to each chapter based on number of hours allotted.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2413113	Engineering Materials	3	-	-	3	-	-	3

	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Total					
2413113	Engineering Materials	20	20	40	60	2	--	--	100

Rationale :

Engineering Materials and Metallurgy in Semester 3 equips Mechatronics Engineering students with essential knowledge of material properties, behavior, and selection. Topics like crystal structures, alloys, heat treatment, ceramics, polymers, and composites support informed design choices. Understanding fracture, fatigue, and creep aids in predicting failures, while exposure to electronic, photonic, and nano-structured materials encourages innovation in sensors and smart systems. This subject builds a strong foundation for reliable, high-performance, and modern mechatronic applications across diverse industries

Course Objectives: Six Course Objectives

1. To emphasis on the importance of materials for emerging technologies
2. To prepare the students with knowledge of basic engineering materials, their properties and their applications.
3. To acquaint the students with the concepts of Nanomaterials
4. To prepare the students acquire basic understanding of advanced materials, their functions and properties for technological applications.
5. To familiarize the students with various types and causes of failure of components in different engineering applications.

Course Outcomes: Students will be able to:

1) Identify the various classes of materials and comprehend their properties
2) Apply phase diagram concepts to engineering applications and suggest particular heat treatment for required property development
3) Suggest newer materials for conventional and modern applications
4) Identify the probable mode of failure in materials and suggest measures to prevent them
5) Compare and contrast electronic and magnetic materials
6) Apply smart materials as well as nanomaterials for different applications

Prerequisite: Applied Chemistry,Applied Physics

Module	Detailed Contents	Hrs.	CO
01	**1.1 Introduction:** Classification of materials, functional classification and classification based on structure. **1.2 Crystal Structure:** Crystal, Crystal lattice, crystal system, Bravais space lattices, Types of cubic crystal, crystal directions, crystal planes, Miller indices, Interplaner spacing, planner density. **1.3 Crystal Imperfection:** point, line, surface defects and volume imperfection. Role of dislocations in deformation and strengthening. Effect of grain boundaries on mechanical properties of materials.	6	CO1
02	**2.1 Classification of Alloys based on phases and phase diagram:** Solid solutions and intermediate phases,Binary alloy phase diagram – Isomorphous, Eutectics type I and II, Peritectic. The Iron-Iron Carbide Phase Diagram. Classification of Plain Carbon Steels and Cast Irons. Effect of alloying elements in steels. TTT diagram & CCT diagram. **2.2 Heat Treatment:**Annealing, normalizing, tempering, hardening and surface-case hardening processes. **2.3 Powder Metallurgy:** Powder Metallurgy Process. Applications such as oil impregnated Bearings and Cemented Carbides. Limitations of Powder Metallurgy.	10	CO2
03	**3.1 Ceramics:** Definition, comparative study of structure and properties of Engineering Ceramics with reference to metallic materials. Engineering application of Ceramics**.** **3.2 Polymers:** Classification of polymers. Thermoplastics, effect of temperature on thermoplastics, mechanical properties of thermoplastics. Thermosetting polymers. **3.3 Composites:** Definition; Classification; Particle-reinforced composites and fibre-reinforced composites. Rule of mixtures; Sandwich structures. Classification of composites on basis of matrix materials.	7	CO3
04	**4.1 Fracture:** Definition and types of facture. Brittle fracture and Ductile fracture. Ductility transition. **4.2 Fatigue Failure:** Definition of fatigue and significance of cyclic stress. Mechanism of fatigue. S.N. Curve and its interpretation. Influence of important factors on fatigue. **4.3 Creep:** Definition and significance of creep. Effect of temperature and creep on mechanical behaviour of materials.	4	CO4
05	**5.1 Electronic Materials:** Band structure of solids. Conductivity of metals and alloys. Semiconductors and superconducting materials. Insulators and dielectric properties. **5.2 Photonic Materials:** Refraction, reflection, absorption and transmission. Luminescence**,** Photoconductivity, Lasers, optical fibres in communications. **5.3 Magnetic Materials:** classification of magnetic materials. Diamagnetic, paramagnetic, ferromagnetic, ferromagnetic and super paramagnetic materials. Metallic and ceramic magnetic materials. Applications of magnetic materials.	6	CO5

DETAILED SYLLABUS:

06	**6.1 Nano-structured Materials:** Definition and Introduction to nanotechnology. Unique features of nano-structured materials. Typical applications. **6.2 Modern Engineering Materials:** Smart materials, Shape memory alloys, Chromic materials (Thermo, Photo and Electro), Rheological fluids, Metallic glasses.	**6**	**CO6**

Assessment:

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests. First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I) consisting of **20 marks each**. Duration of each test shall be one hour.

End Semester Theory Examination for 60 marks:

Question paper format

- Question Paper will comprise of a total of **six questions each carrying 20 marksQ.1** will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **Three questions** need to be answered

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. The Science and Engineering of Materials (6 th Edition), by Donald R. Askeland, Pradeep P. Fulay, Wendelin J. Wright, Cengage Learning, Inc., Stanford, USA., (2010)
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.
6.A Text Book of Nanoscience and Nanotechnology, by Pradeep. T, Tata McGraw Hill, New Delhi, (2012).
7. Electronic Properties of Materials (4th Edition), by Rolf.E. Hummel, Springer, New York,(2011).
8. Photonic Crystals: Theory, Applications, and Fabrication, by Dennis W Prather, John Wiley &Sons, Hoboken, (2009).
9. SPRINGER HANDBOOK OF ELECTRONIC AND PHOTONIC MATERIALS

Links:

1. NPTEL :: Mechanical Engineering - NOC:Smart Materials and Intelligent System Design
2. NPTEL :: Metallurgy and Material Science - NOC:Introduction to Materials Science and Engineering
3. https://youtu.be/-wcqPMw8N1Y
4. https://youtu.be/-wcqPMw8N1Y

Online References:

Sr. No.	Website Name
1.	https://iisc.ac.in/outreach/publications/iisc-lecture-notes-series/
2.	https://www.usna.edu/NAOE/_files/documents/Courses/EN380/Course_Notes/Ch11_Fracture.pdf
3.	https://ocw.mit.edu/courses/3-012-fundamentals-of-materials-science-fall-2005/pages/lecture-notes/
4.	Electronic, Optical and Magnetic Properties of Materials | Materials Science and Engineering | MIT OpenCourseWare

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2413114	Theory of Machines	3		-	3		-	3

		Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Total					
2413114	Theory of Machines	20	20	40	60	2	--	--	100

Rationale :

This subject introduces students to the fundamentals of kinematics, enabling them to analyze and understand the motion of machine elements. By studying motion and power transmission elements, students gain practical insights into gears, cams, belts, and chains, which are crucial for mechanical system integration. Additionally, learning the working principles of governors and gyroscopes helps in understanding control, stability, and navigation. This subject strengthens the mechanical core of mechatronics and supports multidisciplinary design and innovation.

Course Objectives:

1. To acquaint with basic concept of kinematics of machine elements
2. To familiarize with basic and special mechanisms
3. To study the functioning of motion transmission machine elements
4. To study the functioning of power transmission machine elements
5. To acquaint with working principles and applications of Governors
6. To acquaint with working principles and applications of Gyroscope

Course Outcomes:

1. Identify various components of mechanisms and develop mechanisms to provide specific motion
2. Draw and analyze velocity and acceleration diagrams for various mechanisms
3. Development of cam profile for the specific follower motion.
4. Predict conditions for maximum power transmission in the case of a belt drive
5. Illustrate requirements for an interference-free gear pair
6. Demonstrate working Principles of different types of governors and Gyroscopic effects on the mechanical systems

Prerequisite:

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Introduction**	Basic Kinematics Kinematic link & its types, Kinematic pairs, Types of Kinematic pairs, Kinematic chains, Types of constrained motions, Mechanism, Machine, Structure, Types of joints, Degree of freedom (mobility), Kutzbach mobility criterion, Grűbler's criterion & its limitations. Four bar chain and its inversions, Slider crank chain and its inversions, Double slider crank chain and its inversions. Hooks Joint (Single and double)	06	1
II	**Velocity and Acceleration Analysis**	Velocity Analysis of Mechanisms (mechanisms up to 6 links) 2.1 Velocity analysis by relative velocity method (Graphical approach) 2.2 Acceleration Analysis of Mechanisms (mechanisms up to 6 links) Acceleration analysis by relative method (Graphical approach).	08	2
III	**Cam and Follower Mechanism**	3.1 Cam and follower; Classification Cam and follower terminology; 3.2 Motions of the follower: Uniform Velocity, SHM, Constant acceleration and deceleration (parabolic), Cycloidal (Displacement, Velocity and acceleration Plots)	06	3
IV	**Power Transmission**	Power Transmission Belts, Chains: 4.1 Belts: Introduction, Types, Dynamic analysis –belt tensions, condition of maximum power transmission 4.2 Chains: Introduction to Chain Drives, Classification of chains, length of chain. Types of brakes Introduction and Classification.(No Numerical)	06	5
V	**Gears**	Gears: Law of gearing, Forms of tooth, Details of gear terminology, Path of contact, Arc of contact, Contact ratio, Interference in involutes gears, Minimum number of teeth for interference free motion	06	5
VI	**Governors and Gyroscopes**	6.1 Governors: Introduction to Centrifugal and Inertia governors, Study and Force analysis of Porter and Hartnell governors. 6.2 Gyroscope: Introduction, Gyroscopic couple and its effect on spinning bodies, naval ship during steering, pitching, rolling and their stabilization.	08	6

Text Books:

1. S.S. Ratan, “Theory of Machines”, Tata McGraw Hill
2. Ghosh and A.K. Mallik, “Theory of Mechanisms and Machines”, East-West Press
3. Theory of Machines by Jagdish Lal Metropolitan Book New Delhi, Company, Daryaganj, Delhi

References:

1 1.J.J. Uicker, G.R. Pennock, and J.E. Shigley, "Theory of Machines and Mechanism", Oxford Higher Education

2 P.L. Ballaney, "Theory of Machines", Khanna Publishers

3 M.A. Mostafa, "Mechanics of Machinery", CRC Press

4 R.L. Norton, "Kinematics and Dynamics of Machinery", McGraw Hill

5 A.G. Erdman, G.N. Sander, and S. Kota, "Mechanism Design: Analysis and Synthesis Vol I", Pearson

6 Theory of Machines Thomas Bevan CSB Publishers & Distributor

Online References:

Sr. No.	Website Name
1.	https://nptel.ac.in/courses/112/105/112105268/
2.	https://www.youtube.com/playlist?list=PLYRGB44zNZWVibVLmWANp-7obQzOhJLRt
3.	http://www.nptelvideos.in/2012/12/kinematics-of-machines.html

Assessment:

Internal Assessment (IA) for 20 marks:

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

➢ **Question Paper Format:**

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 total six questions, **each carrying 20 marks**
- **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
- **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)
- A total of **three question** need to be answered.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2413115	Electrical and Electronics Workshop	-	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				
2413115	Electrical and Electronics Workshop	--	--	--	--	25	25	50

Lab Objectives:

1. To introduce the basic laboratory instruments (eg. CRO, Signal Generator, Multimeter etc) and Circuit Elements (eg. Resistor, Capacitor, Inductor)
2. To introduce household electrical & electronic equipments and wiring system
3. To introduce Computer hardware.
4. To design PCB and develop small circuit
5. To introduce speed control of DC Motors and IM
6. To introduce In-Circuit and Function testing of PCB

Lab Outcomes:

1) Understand working of different lab equipment & Demonstrate skills in handling electrical components
2) Repair and do maintenance of household appliances.
3) Understand working of different parts of Computer
4) Demonstrate PCB design and soldering skills
5) Implement speed control of DC Motors / IM
6) Explain In-Circuit and Function Testing fixtures in PCB mass production.

Prerequisite:
BSC102: Applied Physics
ESC102: Basic Electrical and Electronics Engineering
VSEC101: Engineering Workshop I
VSEC201: Engineering Workshop II

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	**Revision of electrical circuits, Semiconductor and Engineering workshop**	–	–
I	**Examination of the construction and operation of various lab equipment**	Introduction to different equipment in the lab (multi-meter, CRO, DSO, power supplies, function generators); Resistors, presets, potentiometers, inductors (iron core and ferrite core), capacitors of different ratings.	02	LO1
II	**Introduction to Household electrical System and equipments**	Wiring materials, selection of wire, different switching and protection. Repair of household appliances and machines: Testing, fault finding, Dismantling, assembling.	02	LO2
III	**Introduction to Computer hardware.**	Functional block diagram, unmounting computer CPU, study internal structure of Computer parts.	02	LO3
IV	**Hardware implementation of Electronics circuits**	Soldering techniques and equipment, PCB Layout (artwork) design using software and Fabrication etching process. Testing and debugging process of assembled circuits. Making small Switching circuits using electronic components.	02	LO4
V	**Introduction of DC Motors & Single phase IM**	Working Principle and practical applications of Machines with speed control methods	04	LO5
VI	**Electronic component testing using microcontroller based multifunction tester**.	Identification and characterization of various electronic components (Transistors, Capacitors etc) using automated microcontroller based multifunction tester.	02	LO6

References:

1. J. B. Gupta “Electrical Installation Estimating & costing” S. K. Kataria& Sons, 2009

2. K.B. Raina, S.K. Bhattacharya “Electrical Design Estimating and Costing”, New Age Inter. 2018 3. Alagappan N. & Ekambaram S. Electrical Estimating & costing Tata McGraw hill Ltd.

4. S.L. Uppal and G.C. Garg “Electrical Wiring Estimating and Costing” Khanna Publishers 1987 5. Surjit Singh “Electric Estimating and Costing” Dhanpat Rai & Co. (P) Limited (2016) 6. K B. Bhatia “Study of Electrical Appliances and Devices” Khanna Publishers 7. John T. Bateson “In Circuit Testing” Springer 2012

5. K B. Bhatia “Study of Electrical Appliances and Devices” Khanna Publishers

6. Bimbhra P. S., Electric Machinery, Khanna Publisher,

7. Karl-Heinz Kubbeler “Transistor Tester with AVR microcontroller. A device for determining and measuring electronic components and a little more” .Version 1.13k March 20, 2021

Online Resources:

Sr. No.	Website Name
1.	https://nptel.ac.in/courses/122/106/122106025/
2.	https://nptel.ac.in/courses/108/101/108101091/
3	https://swayam.gov.in/nd2_aic20_sp59/
4	https://nptel.ac.in/courses/108/108/108108076/

List of Experiments.

Sr No	List of Experiments	Hrs
01	Examine construction and operation of different lab equipment & Components. Behavior of RLC circuits	
02	Introduction to household electrical wiring.	
04	Repair of house hold appliances and machines (Fan)	
05	Speed control methods of DC Motor / IM	
06	Assembly and disassembly of computer hardware.	
07	Hardware implementation of electronic circuits	
08	Electronic component testing using microcontroller based multifunction tester	
09	Circuit simulation of simple circuits on simulation software	

Assessment :

Part B

One compulsory visit to any Electrical Machines or Electronics Equipments Manufacturing Industry

Term Work: It comprises both part A and B

Term Work shall consist of at least 8 practicals' based on the above list.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Industrial Visit Report) + 5 Marks (Attendance)

End Semester Examination: Pair of Internal and External Examiner should conduct Oral on the entire syllabus of the laboratory.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2413116	**CAD Modeling Lab**	-	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				
2413116	**CAD Modeling Lab**	--	--	--	--	25	25	50

Lab Objectives:

1. To familiarize geometric modelling techniques
2. To impart 2D sketching skills using CAD software
3. To impart the 3D Solid and Surface Modelling skills for the development of 3D models of engineering components.
4. To impart Geometric Dimensioning and Tolerance skills
5. To impart the 3D modelling skills for assembling different parts made in 3D modelling software.
6. To introduce Product data exchange among CAD systems.

Lab Outcomes:

Learner will be able to…

7. Use appropriate technique for geometric modelling.
8. Apply 2D sketching tools to prepare sketch of a given object using 3D CAD software.
9. Create solid and Surface model of the object using 3D CAD software.
10. Apply Geometric Dimensioning and Tolerancing (GD&T) for working drawing of parts.
11. Generate assembly of given objects using assembly tools of a 3D CAD software
12. 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:

Sr. No.	Module	Detailed Content	Hours	LO (Lab Outcomes) Mapping
0	Prerequisite			
I	**Introduction to CAD**	Different modelling techniques (solid modelling, surface modelling, parametric modelling, feature based modelling) for creation of CAD models, creation of CAD models from different perspectives.	02	**1**
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.	04	**2**

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. Introduction to surface modeling.	06	**3**
IV	**Working Drawings**	Creating Multi-view Drawings from 3D CAD Models: part drawings with tolerance Geometric Dimensioning and Tolerance (GD&T) Dimensioning with tolerances indicating various types of fits, GD&T symbols indicating forms, profile , Orientation , Run out , Location etc.	04	**4**
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.	08	**5**
VI	**Data Exchange**	CAD data exchange formats Like IGES, PDES, PARASOLID, DXF and STL along with their comparison and applicability.	02	**6**

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

3. Geometrical Dimensioning and Tolerancing for Design, Manufacturing and Inspection A Handbook for Geometrical Product Specification using ISO and ASME Standards Second edition Georg Henzold 2006

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)**	10
03	Working drawing of Mechanical component showing Form, Profile, Orientation, Runout and location using GD&T Symbols. **(Note: Any Two Drawings)**	4
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. OR 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 of above)**	10

Using the knowledge and skills acquired through six modules, students should complete minimum seven assignments/experiments from the given sets of assignments using standard CAD modeler like – SolidWorks/ PTC Creo/CATIA /UG /any other suitable software.

Assessment:

Term Work: Term Work shall consist of at least 7 practicals 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.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2414111	Engineering Mathematics IV	2	-	1	2	-	1	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Total					
2413114	Engineering Mathematics IV	20	20	40	60	2	--	--	100

Pre-requisite:

- Applied Mathematics-I,
- Applied Mathematics-II,
- Engineering Mathematics-III

Rationale:

Engineering Mathematics IV syllabus of Mechatronics Engineering is essential for developing advanced mathematical tools required for modeling, analysis, and decision-making in engineering systems. The study of vector calculus supports applications in electromagnetics and robotics. Line and contour integrals, along with complex function series expansions, are vital in solving complex integrals and analyzing system behaviors. Introducing statistics equips students with skills for data analysis, quality control, and performance evaluation. Concepts of probability, random variables, distributions, and sampling theory are fundamental for handling uncertainties, making informed predictions, and optimizing processes in real-world engineering problems.

Course Objectives:

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

Course Outcomes: Learner will be able to….

1. Apply the concept of Vector calculus to evaluate line integrals, surface integrals using Green's theorem, Stoke's theorem & Gauss Divergence theorem.
2. Use the concepts of Complex Integration for evaluating integrals, computing residues & evaluate various contour integrals.
3. Apply the concept of Correlation, Regression and curve fitting to the engineering problems in data science.
4. Illustrate understanding of the concepts of probability and expectation for getting the spread of the data and distribution of probabilities.
5. Apply the concept of probability distribution to engineering problems& Testing hypothesis of small samples using sampling theory
6. Apply the concepts of parametric and nonparametric tests for analysing practical problems.

Module	Detailed Contents	Hours	CO

01	**Module : Vector Calculus** 1.1 Solenoidal and irrotational (conservative) vector fields. 1.2 Line integrals – definition and problems. 1.3 Green's theorem (without proof) in a plane, Stokes' theorem (without Proof) only evaluation problems, Gauss' Divergence theorem (without proof) and problems (only evaluation). **Self Learning Topics**: Problems on scalar potential & work done ,Identities connecting Gradient, Divergence and Curl, Angle between surfaces. Verifications of Green's theorem, Stoke's theorem & Gauss- Divergence theorem, related identities & deductions.	**05**	CO1
02	**Module: Complex Integration** 2.1 Line Integral, Cauchy's Integral theorem for simple connected and multiply connected regions (without proof), Cauchy's Integral formula (without proof). 2.2 Taylor's and Laurent's series (without proof). 2.3 Definition of Singularity, Zeroes, poles of *f(z)*, Residues, Cauchy's Residue Theorem (without proof) **Self-learning Topics:** Application of Residue Theorem to evaluate real integrations.	**05**	CO2
03	**Module: Statistical Techniques** 3.1 Karl Pearson's Coefficient of correlation (r) and related concepts with problems 3.2 Spearman's Rank correlation coefficient (R) (Repeated & non repeated ranks problems) 3.3 Lines of regression. **Self-learning Topics:** Covariance, fitting of exponential curve, Fitting of first and second degree curves.	**04**	CO3
04	**Module: Probability Theory:** 4.1Discrete and Continuous random variables, Probability mass and density function, Probability distribution for random variables, 4.2 Expectation, Variance, Co-variance. 4.3 Moments, Moment generating functions, (Four moments about the origin & about the mean). **Self- learning Topics:** Conditional probability, Total Probability and Baye's Theorem. Properties variance and covariance.	**04**	CO4
05	**Module Probability Distribution and Sampling Theory-I** 5.1 Probability Distribution: Poisson and Normal distribution 5.2 Sampling distribution, Test of Hypothesis, Level of Significance, Critical region, One-tailed, and two-tailed test, Degree of freedom. 5.3 Students' t-distribution (Small sample). Test the significance of single sample mean and two independent sample means) **Self -learning Topics:** Paired t-test, Test of significance of large samples, Proportion test, Survey based project.	**05**	CO5
06	**Module: Sampling theory-II** 6.1 Chi-square test: Test of goodness of fit and independence of attributes (Contingency table) . 6.2 Analysis of variance: F-test (significant difference between variances of two samples) **Self- learning Topics:** ANOVA**:** One way classification, Two-way classification (short- cut method), Yate's Correction.	**04**	CO6

	Total	**26**	

Term Work:

General Instructions:

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

The distribution of Term Work marks will be as follows –

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

Assessment:

Internal Assessment (IA) for 20 marks:

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

End Semester Theory Examination:

Question paper format

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

References:

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

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2414112	Automotive Mechatronics	3	-	-	3	-	-	3

		Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Total					
2414112	Automotive Mechatronics	20	20	40	60	2	--	--	100

Rationale :

This subject introduces vehicle system architecture, Electronic Control Units (ECUs), sensors, and actuators that form the backbone of automotive automation. Topics like electronic transmission, power steering, and anti-lock braking systems provide insights into advanced driver-assistance systems. Networking protocols and the study of electric and hybrid vehicles prepare students for the evolving landscape of smart, sustainable automotive technologies.

Course Objectives:

1. Introduce the learners to application of mechatronics in automobiles
2. Study sensors and actuators commonly used in automobile industry
3. Introduce Electronic Transmission Control
4. To develop understanding of working of various mechatronic systems in automobiles
5. To introduce vehicle networking and communication and Diagnostics
6. To introduce Electric and Hybrid Vehicles

Course Outcomes:

1) Understand applications of Mechatronics in Automobiles
2) Characterize Sensors and Actuators used in Automobiles
3) Explain working of electronic transmission in Passenger Cars
4) Elaborate different Mechatronic Systems used in automobiles
5) Compare working of vehicular networks and fault diagnostics
6) Understand functioning of electric and hybrid vehicles.

Prerequisite:

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite			
I	**Introduction to Automotive Mechatronics**	What is Mechtronics ? Introduction to Automotive Mechatronics (definition, scope, and benefits), Mechatronic Systems in Vehicles (engine management, fuel injection, transmission control, and brake systems), Future Trends and Challenges in Automotive Mechatronics (X-by-wire systems, driver-assistance systems, and system integration). **Vehicle system architecture:** Functional structure, Levels in the vehicle motion domain. Software architecture, Network architecture	6	CO1

		Electronic Control Unit: Operating conditions, Design, Data processing, Digital modules in the control unit.		
II	**Sensors and Actuator Application in Vehicles**	Introduction to Sensors and Actuators Features of vehicle sensors, Sensor classification , Error types and tolerance requirements ,Reliability Main requirements, Hall Effect, hot wire, thermistor, piezoelectric and piezoresistive based sensors. Introduction, basic sensor arrangement, types of sensors, oxygen concentration sensor, lambda sensor, crankshaft angular position sensor, cam position sensor , Torque sensor. Mass air flow (MAF) rate, Manifold absolute pressure (MAP), Throttle plate angular position, engine oil pressure sensor, vehicle speed sensor, detonation sensor, emission sensors **Actuators:** **Electromechanical actuators:** Electrodynamic and Electromagnetic, Characteristics and application, **Fluid-mechanical actuators**, Electrohydraulic Actuators typical characteristics for switching and proportional valves	6	CO2
III	**Passenger Car Electronic Transmission Control**	**Passenger Car Transmissions,** Manual Passenger Car Transmissions (MT), Automated Manual Passenger Car Transmissions (AMT), Dual Clutch Passenger Car Transmissions (DCT) Automatic Passenger Car Transmissions (AT) ,Passenger Car Hybrid Drives ,Continuously Variable Passenger Car Transmissions (CVT) **Electronic Transmission Control** Networked Systems, Electronic Transmission Control Unit (TCU), TCU Structure, Operating Conditions and Construction Technologies, Control Systems, Transmission Actuator, Clutch Actuator, Transmission Control Functions, Software ,Further Examples of Transmission Control Systems,	8	CO3
IV	**Vehicle Mechatronic Systems**	**Power Steering System** Basic Principles of the Steering Process, Lateral Control of Vehicles , Closed loop driver—vehicle, Steering Behavior and Steering-Feel, Guidance Behavior, Response Behavior, Requirements of Ideal Steering Behavior and Steering-Feel, Electric Power Steering Systems, Analogies of EPS and HPS, Designs of EPS Systems Steering Functions (• power-assistance • friction compensation,• inertia compensation • damping), Introduction to Active Steering. **Antilock Braking System (ABS)** System overview, Requirements placed on ABS, Dynamics of a braked wheel, ABS control loop, Deceleration Threshold Based Algorithms, Typical control cycles **Other Mechatronic Systems:** (Introduction Only) Traction Control System (TCS) , Electronic Stability Program (ESP), Power windows, Power sunroofs, Seat and steering column adjustment.	8	CO4

V	**Networking and Fault Diagnostics**	**Basic principles of networking:** Network topology, Network organization, OSI reference model, Control mechanisms Requirements for bus systems, Classification of bus systems Applications in the vehicle **Bus systems:** CAN bus, LIN bus , Bluetooth **Fault diagnostics:** Monitoring during vehicle operation (on-board diagnosis)	6	CO5
VI	**Electric and Hybrid Vehicles**	**Electric and Hybrid Vehicles** Layout of an electric vehicle, traction motor characteristics, tractive effort Transmission requirements, vehicle performance, energy consumption, advantage and limitations, specifications, system components, electronic control system **Introduction to Autonomous Vehicles.**	5	CO6

Text Books:

1. 1. "Automotive Mechatronics, Automotive Networking, Driving Stability Systems, Electronics" Bosch Professional Automotive Information Springer 2015

References:

1. Harald Naunheimer · Bernd Bertsche Joachim Ryborz · Wolfgang Novak "Automotive Transmissions Fundamentals, Selection, Design and Application" Springer-Verlag Berlin Heidelberg 2011
2. John turner "Automotive Sensors" Momentum Press®, LLC, 2009
3. Manfred Harrer, Peter Pfeffer Editors "Steering Handbook" Springer International Publishing Switzerland 2017
4. Rajesh Rajamani "Vehicle Dynamics and Control" Second Edition Springer 2012
5. Nicolas Navet and Françoise Simonot-Lion "Automotive Embedded Systems Handbook" by Taylor & Francis Group, LL 2009
6. Julian Happian-Smith "An Introduction to Modern Vehicle Design"Reed Educational and Professional Publishing Ltd 2002
7. Mehrdad Ehsani, Yimin Gao, sebastien E. Gay and Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", CRS Press, 2004
8. William B.Riddens -Understanding Automotive Electronics, 5th edition- Butter worth Heinemann Woburn- 1998.

Online References:

Sr. No.	Website Name
1.	https://onlinecourses.nptel.ac.in/noc21_de02/preview

Assessment:

Internal Assessment (IA) for 20 marks:

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

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marksQ.1** will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from

Module 3 then part (b) must be from any other Module randomly selected from all the modules)

- A total of **Three questions** need to be answered

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2414113	Application of Integrated Circuits	3	-	-	3	-	-	3

		Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Total					
2414113	Application of Integrated Circuits	20	20	40	60	2	--	--	100

Rationale:
This course is designed to provide students with an in-depth understanding of advanced concepts in both analog and digital electronics, with a particular emphasis on operational amplifiers, their applications, and various analog signal processing techniques. By exploring the fundamental components, configurations, and systems in electronic circuits, this course equips students with the practical knowledge required to design and analyze a wide range of circuits that are foundational for modern electronics.

Course Objectives: The course aims to enable students

1) To understand the fundamental concepts of operational amplifiers.
2) To design and analyze various linear applications of operational amplifiers.
3) To describe and develop various non-linear applications of operational amplifiers.
4) To provide an understanding of data converters.
5) To get acquainted with the working principles, design and applications of various special purpose integrated circuits.
6) To analyze the functional block diagrams and design aspects of different types of voltage regulators.

Course Outcomes: On successful completion of course, student will be able to

1) Explain the fundamental characteristics and configurations of operational amplifiers.
2) Design and analyze linear applications of operational amplifiers.
3) Describe and Develop non-linear operational amplifier-based circuits.
4) Analyze and compare different types of data converters based on their performance parameters and applications.
5) Demonstrate knowledge of special-purpose integrated circuits by designing circuits using them.
6) Design and analyze voltage regulators for various electronic applications.

Prerequisite: PCC302 Basic Electronics and Digital Circuit Design,

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Fundamentals of electronics engineering, Basic laws and theorems	1	
I	Fundamentals of Operational Amplifier	Op-amp basics, block diagram of Op Amp, Op-amp parameters, ideal and practical characteristics of Op-amp, open loop and closed loop configurations of Op-amp, Negative feedback, Inverting and non-inverting amplifier, voltage follower, summing amplifier, difference amplifier and instrumentation amplifier using Op-amp	7	1
II	Linear Applications of Operational Amplifier	Current to voltage converters, voltage to current converters, Integrator, differentiator, Active Filters: First order low pass, high pass, band pass and band reject filters, Positive feedback, Burkhousen's criteria, RC phase shift oscillator	7	2

		and Wien bridge oscillator.		
III	Non-Linear Applications of Operational Amplifier	Inverting and non-inverting comparator, zero crossing detector, window detector, level detector, Inverting and non-inverting Schmitt trigger, Square wave generator and triangular wave generator, Half wave and full wave precision rectifiers, clipper, clamper, Peak Detectors, Sample & Hold Circuits, log and antilog amplifier	8	3
IV	Data Converters	Performance parameters of ADC, Single Ramp ADC, ADC using DAC, Dual Slope ADC, Successive Approximation ADC, Flash ADC. Performance parameters of DAC, Binary weighted register DAC, R/2R ladder DAC, Inverted R/2R ladder DAC	5	4
V	Special Purpose Integrated Circuits	Functional block diagram and working of Timer IC 555, Design of Astable and monostablemultivibrator using IC 555, Functional block diagram, working and applications of VCO IC 566,	5	5
VI	Voltage Regulators	Functional block diagram, specifications, working and design of three terminal fixed (78XX, 79XX series) and three terminal adjustable (LM 317) voltage regulators, Functional block diagram, working and design of general purpose IC 723 (LVLC, LVHC, HVLC and HVHC), Switching regulator topologies	6	6

Text Books:

1.Op-Amps and Linear Integrated Circuits by Ramakant A. Gayakwad, 4thEdition, Pearson Education.

References:

1.Operation Amplifiers and Linear Integrated Circuits by David A. Bell, Oxford University Press, Indian Edition.

2. Operational Amplifiers with Linear Integrated Circuits by William D. Stanley, 6thEdition, Pearson Education.

3.Operation Amplifiers and Linear Integrated Circuits by R. F. Coughlin and F. F. Driscoll, 6thEdition, Pearson Education India.

4.Design with operational amplifiers and analog integrated circuits by Sergio Franco, 3rdEdition, McGraw-Hill Education.

Online References:

Sr. No.	Website Name
1.	https://nptel.ac.in/courses/108108111
2.	https://nptel.ac.in/courses/108103378
3.	https://nptel.ac.in/courses/108101091

Assessment:

Internal Assessment (IA) for 20 marks:

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

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marksQ.1** will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from

Module 3 then part (b) must be from any other Module randomly selected from all the modules)

- A total of **Three questions** need to be answered
- Give proportionate weightage to each chapter based on number of hours allotted.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2414114	Automotive Mechatronics Lab	-	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				
2414114	Automotive Mechatronics Lab	--	--	--	--	25	25	50

Lab Objectives:

1. Introduce Battery Management systems used in automobiles
2. Introduce Sensors used in automotive industry
3. Introduce Actuators used in automotive industry
4. Introduce communication used in automobiles
5. Introduce Electronic transmission
6. Introduce driver assistance systems

Lab Outcomes:

1. Demonstrate working of battery management
2. Characterize working of automotive sensors
3. Characterize working of automotive actuators
4. Demonstrate networking and communication used in automobile systems
5. Analyze working of electronic transmission system
6. Analyse working of automotive mechatronic systems

Prerequisite: Electrical and Electronics Workshop

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite			
I	**Battery Management**	Battery types, charge/discharge testing, SoC/SoH estimation, protection, cell balancing, BMS architecture	**02**	**1**
II	**Automotive Sensors**	Sensor types, working principles, signal conditioning, calibration, noise analysis, response time, accuracy testing, data acquisition, diagnostics, and applications.	**04**	**2**
III	**Automotive Actuators**	Actuator types, operating principles, control methods, response analysis, force/speed testing, efficiency, thermal behavior, diagnostics, and real-time application testing	**04**	**3**

IV	**Networking and Communication**	CAN, LIN, FlexRay, Ethernet, protocol analysis, message framing, error handling, diagnostics, data logging, simulation, and real-time testing.	**04**	**4**
V	**Electronic Transmission Control**	Transmission types, sensors/actuators, shift logic, TCU architecture, solenoid control, diagnostics, fault simulation, real-time testing, and data analysis.	**04**	**5**
VI	**Driver Assistance**	Power steering, ABS, Adjustment systems, sensors/actuators, control logic, diagnostics, fault simulation, response testing, real-time testing and analysis.	**08**	**6**

Text Books:

1. "Automotive Mechatronics, Automotive Networking, Driving Stability Systems, Electronics" Bosch Professional Automotive Information Springer 2015

References:

9. John Turner "AUTOMOTIVE SENSORS" Momentum Press®, LLC, 2009
10. Harald Naunheimer · Bernd Bertsche Joachim Ryborz · Wolfgang Novak "Automotive Transmissions Fundamentals, Selection, Design and Application" Springer-Verlag Berlin Heidelberg 2011
11. Manfred Harrer · Peter Pfeffer Editors "Steering Handbook" Springer International Publishing Switzerland 2017
12. Mehrdad Ehsani, Yimin Gao, sebastien E. Gay and Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", CRS Press, 2004

List of Experiments.

Sr No	List of Experiments	Hrs
01	Experiment on Battery management system	02
02	Experiment on CAN bus training/Simulation system	04
03	Experiment on characterization of any one automotive sensor.	04
04	Experiment on characterization of any one automotive actuator.	04
05	Experiment on electronic transmission trainer/ simulator	04
06	Experiment on electric power steering demonstration setup	04
07	Experiment on Anti-lock braking system trainer/simulator	04
08	Experiment on Adjustment systems (Power Window , Seat etc)	04

Assessment :

Term Work: Term Work shall consist of at least 7 practicals' based on the above list.(First 5 practicals in the list are compulsory while any 2 practical's from the remaining 3 can be performed). Also, Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 20 Marks (Experiments) + 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
2414115	Applied Electronics Lab	2	-	-	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				
2414115	Applied Electronics Lab	--	--	--	--	25	25	50

Lab Objectives: The course aims

1) To introduce students to the fundamentals of logic gates.
2) To help student to design and verify different combinational logic circuits.
3) To introduce students to the sequential logic circuits.
4) To enable students to design and analyze fundamental Op-amp circuits.
5) To facilitate students to understand different data converters using Op-amp.
6) To explore the applications of various special purpose ICs in various analog circuits.

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

1. Evaluate functionalities of various logic gates.
2. Design and implement various combinational logic circuits.
3. Analyze different sequential logic circuits.
4. Analyze and construct various linear and non-linear applications of Op-amp.
5. Implement and evaluate data converters using Op-amp.
6. Use specialized ICs such as timer and voltage-controlled oscillators in real-world electronic applications.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	Demonstration of Various Instruments such as function generator, CRO, Power Supply.	2	
I	Fundamentals of logic gates	1. Verify the truth table of various logic gates (basic and universal gates) and implementation of a logic circuit for the given equation using basic gates. 2. Study of NAND and NOR gate as a universal logic gate.	4	1

II	Combinational Logic Circuits	1. Realization of adder and subtractor using different logic gates. 2. Study of Multiplexer and De-multiplexer.	4	2
III	Sequential Logic Circuits	1. Verification of function table of various Flip-flops. 2. Design and verify the functionality of register/counter.	2	3
IV	Applications of Op-amp	1. Study of a non-inverting and inverting amplifier. 2. Study of a voltage follower, summing amplifier and difference amplifier. 3. Study of comparator and Schmitt trigger circuit using Op-amp. 4. Study of integrator and differentiator using Op-amp. 5. Study of frequency response of first order low pass/high pass filter. 6. Study of RC phase shift/ Wein Bridge Oscillator using Op-amp. 7. Study of square wave/triangular wave generator using Op-amp.	8	4
V	Data Converters	1. Study of 2-bit R-2R DAC using Op-amp. 2. Study of 2-bit Flash ADC using OP-amp.	2	5
VI	Special Purpose Integrated Circuits	1. Study of Astable/ Monotstable Multivibrator using timer IC 555. 2. Study of Frequency Modulator using VCO IC 566.	2	6

References:

1. Op Amps: Design, Application, and Troubleshooting by David Terrell, 2nd edition, Newnes
2. Lessons in Electric Circuits: Volume VI – Experiments by Tony R. Kuphaldt

Online Resources:

Sr. No.	Website Name
1.	https://aec-iitkgp.vlabs.ac.in/
2.	https://ade-iitr.vlabs.ac.in/
3.	https://ade2-iitr.vlabs.ac.in/
4.	https://nptel.ac.in/courses/108108111

List of Experiments.

Sr No	List of Experiments	Hrs
01	Verify the truth table of various logic gates (basic and universal gates) and implementation of a logic circuit for the given equation using basic gates.	2
02	Realization of adder and subtractor using different logic gates.	2
03	Experiment on Multiplexer and De-multiplexer.	2
04	Verification of function table of various Flip-flops.	2
05	Experiment on non-inverting and inverting amplifier.	2
06	Experiment on voltage follower, summing amplifier and difference amplifier.	2
07	Experiment on comparator and Schmitt trigger circuit using Op-amp.	2
08	Experiment on 2-bit R-2R DAC using Op-amp.	2
09	Experiment on 2-bit Flash ADC using OP-amp.	2
10	Experiment on Astable/ Monotstable Multivibrator using timer IC 555.	2
11	Experiment on Frequency Modulator using VCO IC 566.	2

Sr No	List of Assignments / Tutorials	Hrs
01	Study of NAND and NOR gate as a universal logic gate.	2
02	.Design and verify the functionality of register/counter.	2
03	Study of integrator and differentiator using Op-amp.	2
04	Study of frequency response of first order low pass/high pass filter.	2
05	Study of RC phase shift/ Wein Bridge Oscillator using Op-amp.	2
06	Study of square wave/triangular wave generator using Op-amp.	2

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

Vertical - 4

Detail Syllabus

VSC

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2414411	Machine Shop Practice Lab	-	4	-	-	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				
2414411	Machine Shop Practice Lab	--	--	--	--	50	25	75

Lab Objectives:

1. Know the specifications, controls and safety measures related to machines and machining.
2. To familiarize use of precision measuring instruments, dimensional tolerances and its effect on product assembly.
3. To familiarize with basic machining processes , machine tools, mechanisms and accessories used in Manufacturing processes.
4. To familiarize with various cutting tools and their use in various cutting operations, nomenclature of single point cutting tool, Grinding machine and various grinding operations for single point cutting tool.
5. To familiarize with the use of welding as a joining process and use of metal arc welding as a representative joining process.
6. To familiarize on basic machine maintenance

Lab Outcomes:

1. Know the specifications, controls and safety measures related to machines and machining operations.
2. Use the measuring instruments during and after various machining operations.
3. Use of different types of machines for making various engineering jobs.

4) Perform Tool Grinding

5) Perform welding operations

6) Perform basic machine maintenance (mechanical and electrical)

DETAILED SYLLABUS

Sr. No.	Module	Detailed Content	Hours	LO Mapping
1	1	Study of Controls and safety measures for machines, machining operations and welding	02	LO1
2	2	Study of precision measuring instruments – Vernier caliper and Micrometer screw gauge – Principle, Construction, least count, measurement procedure, applications.	02	LO2
3	3	One composite job consisting minimum two parts employing at least four operations performed of various machine tools.	34	LO3, LO4
4	4	Tool Grinding – To know basic tool Nomenclature	04	LO5
5	5	Application of Metal Arc Welding	08	LO6
6	6	Study of Maintenance of machines- need and its types	04	LO3

Text Books:

1. Elements of workshop technology. Vol. 1 & II by S K Hajra Choudhury
2 Production Technology by WAJ Chapman Vol I, II, III
3 Textbook of welding technology O. P. Khanna, Dhanpat Rai Publications

References:

1. Principles of manufacturing materials and processes- J.S.Campbell, Tata McGraw Hill.
2. Manufacturing Engineering and Technology, 4th Edition- S.Kalpakjian and S.R. Scsimid, Pearson Education.
3. Materials and processes in manufacturing- DeGarmo, Black and Kohser, Prentice Hall of India.
4. Maintenance Engineering Handbook – Lindley R. Higgins

Online Resources:

Sr. No.	Website Name
3.	NPTEL : https://nptel.ac.in/courses/112/103/112103248/

List of Experiments:

Sr No	List of Experiments	Hrs
01	Demonstration and use of precision measuring instruments : Vernier Calliper and micrometer screw gauge	02
02	One composite job consisting minimum two parts employing at least four operations such as taper turning, grooving, threading, keyway/slot machining, knurling performed of various machine tools like lathe, milling machine, shaping machine	34
03	Demonstrate and use of grinding machine for sharpening of single point cutting tool as per tool nomenclature and tool signature	04
04	One job of joining at least two components using metal arc welding machine	08
05	Exercise on Machine Maintenance: (Over 4 hours, students learn PPE and tool safety, perform mechanical inspections (belt and lubrication checks), conduct electrical tests (motor, continuity, cables), and practice condition monitoring with checklist reporting.)	04

Assessment :
Term Work:

1. Composite job mentioned above with work-shop Book giving details of drawing of the job and timesheet
2. Welding job as mentioned above
3. Report on measurement , grinding and maintenance exercises.

Term Work Marks:
The distribution of marks for Term work shall be as follows:

1. Job Work with complete workshop book …… .30 marks
2. Welding Job ……5 marks
3. Report on exercises on measurement, grinding and maintenance……... 5 marks
4. Attendance ……10 marks

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

SEC

Vertical – 5

Detailed syllabus

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2413511	Entrepreneurship Development		2*+2	-	-	2	-	2

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		IAT-I	IAT-II	IAT-I + IAT-II				
2413511	Entrepreneurship Development	--	--	--	--	50	--	50

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

Lab Objectives:

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

Lab Outcomes:

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

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

DETAILED SYLLABUS

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	**Prerequisite**	Fundamentals of communication and leadership skills.	01	--
I	**Introduction to Entrepreneurship**	Definition, Characteristics, and Types of Entrepreneurs. Entrepreneurial Motivation and Traits. Start-up Ecosystem in India. Challenges in Entrepreneurship	**02**	**LO1**
II	**Business Idea Generation & Validation**	Ideation Techniques: Design Thinking, Brainstorming, Mind Mapping. Business Model Canvas (BMC). Market Research & Customer Validation. Minimum Viable Product (MVP) Concept.	**04**	**LO2**

III	**Business Planning & Strategy**	Writing a Business Plan. SWOT Analysis and Competitive Analysis. Financial Planning and Budgeting. Risk Assessment and Management	**04**	**LO3**
IV	**Funding and Legal Framework**	Sources of Funding: Bootstrapping, Angel Investors, Venture Capital Government Schemes & Start-up India Initiatives. Business Registration & Legal Formalities. Intellectual Property Rights (IPR) & Patents	**05**	**LO4**
V	**Marketing & Digital Presence**	Branding and Digital Marketing. Social Media Marketing & SEO. Customer Relationship Management (CRM). E-commerce & Online Business Models	**05**	**LO5**
VI	**Business Pitching & Prototype Development**	Pitch Deck Preparation & Presentation Techniques. Prototyping with Open-source Tools. Elevator Pitch & Investor Pitch. Case Studies of Successful Start-ups	**05**	**LO6**

Text Books:

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

References:

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

Online Resources:

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

List of Experiments.

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

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

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

Assessment :

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

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

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2413512	Environmental Science		2*+2	-	-	2	-	2

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	IAT-I+IAT-II					
2413512	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:

4. Explain the significance of environmental studies and the role of IT in environment and health.
5. Describe resource types, associated problems, and conservation methods.
6. Classify ecosystems and explain their role in ecological balance
7. Analyze biodiversity levels and conservation strategies, especially in India.
8. Explain pollution impacts and suggest preventive measures.
9. 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
4.	Centre for Science and Environment (CSE), Website: cseindia.org
5.	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)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2414511	Business Model Development	--	2*+2	-	--	2*+2	-	2

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	IAT-I+IAT-II					
2414511	Business Model Development	--	--	--	--	--	50	--	50

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

Lab Objectives:

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

Lab Outcomes:

The learner will be able to:

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

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	**Prerequisite**	Basic Design Thinking principles	**01**	**--**
I	**Introduction to Entrepreneurship**	**Introduction to Entrepreneurship**: Definition, the role of entrepreneurship in the economic development, the entrepreneurial process, Women entrepreneurs, Corporate entrepreneurship, Entrepreneurial mindset **Self-learning Topics:** Case studies: Henry Ford https://www.thehenryford.org/docs/default-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
6.	Entrepreneurship by Prof. C Bhaktavatsala Rao https://onlinecourses.nptel.ac.in/noc20_mg35/preview
7.	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

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	IAT-I+IAT-II					
2414512	Design Thinking	--	--	--	--	--	50	--	50
2414512	Design Thinking		2*+2	-		2	-		2

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

Lab Objectives:

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

Lab Outcomes:

Students will be able to …

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

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	No perquisites	-	-
I	**Introduction to Design Thinking**	**Introduction to Design Thinking:** Definition, Comparison of Design Thinking and traditional problem-solving approach, Need for Design Thinking approach, Key tenets of Design Thinking, 5 stages of Design Thinking (Empathize, Define, Ideate, Prototype, Test) **Self-learning Topics:** Design thinking case studies from various domains https://www.design-thinking-association.org/explore-design-thinking-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
1.	Design Thinking and Innovation by Ravi Poovaiah https://onlinecourses.swayam2.ac.in/aic23_ge17/preview
2.	Introduction to Design Thinking by Dr. Rajeshwari Patil, Dr. Manisha Shukla, Dr. Deepali Raheja, Dr. Mansi Kapoor https://onlinecourses.swayam2.ac.in/imb24_mg37/preview
3.	Usability Testing https://www.interaction-design.org/literature/topics/usability-testing

List of Experiments.

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

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

Vertical – 6

Detailed Syllabus

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2414512	Mini Project		2*+2	--	--	--	2	2

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	IAT-I+IAT-II					
2414512	Mini Project	--	--	--	--	--	50	25	75

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

Objectives:

1. To acquaint 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 with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Outcome: 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 member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse 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 lifelong learning.
9. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.

- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- • However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.
  Guidelines for Assessment of Mini Project:
- **Term Work**
    - The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
    - In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
    - Distribution of Term work marks for both semesters shall be as below;
    - Marks awarded by guide/supervisor based on log book 10
    - Marks awarded by review committee 10
    - Quality of Project report 05

- Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.
- **One-year project:**

  In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
    - First shall be for finalisation of problem
    - Second shall be on finalisation of proposed solution of problem.

  In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
    - First review is based on readiness of building working prototype to be conducted.
    - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

- **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 finalisation of problem and proposed solution
- Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project

- Mini Project shall be assessed based on following criteria;
    1. Quality of survey/ need identification
    2. Clarity of Problem definition based on need.
    3. Innovativeness in solutions
    4. Feasibility of proposed problem solutions and selection of best solution
    5. Cost effectiveness
    6. Societal impact
    7. Innovativeness
    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's as member or leader
    13. Clarity in written and oral communication

- In one year project, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of half year project all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

Report should be prepared as per the guidelines issued by the University of Mumbai.

Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.

Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication

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-Information Technology
Faculty of Technology

Sd/-

Dr. Deven Shah
Associate Dean
Faculty of Science & Technology

Sd/-

Prof. Shivram S. Garje
Dean
Faculty of Science & Technology