

University of Mumbai

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

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

क्र.वि.प्रा.स.से./आयसीडी/२०२५-२६/३७

दिनांक : २७ मे, २०२५

परिपत्रक:-

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

मुंबई - ४०० ०३२
२७ मे, २०२५


(डॉ. प्रसाद कारंडे)
कुलसचिव

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As Per NEP 2020

University of Mumbai



Syllabus for Major Vertical – 1, 4, 5 & 6

Name of the Programme –B.E. (Mechatronics Engineering)

Faculty of Engineering

Board of Studies in Mechanical Engineering

U.G. Second Year Programme

**Exit
Degree**

**U.G. Diploma in
Mechatronics
Engineering**

Semester

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. (<u>Mechatronics Engineering</u>)
2	Exit Degree	U.G. Diploma in <u>Mechatronics Engineering.</u>
3	Scheme of Examination R: _____	NEP 40% Internal 60% External, Semester End Examination Individual Passing in Internal and External Examination
4	Standards of Passing R: _____	40%
5	Credit Structure R. TEU-585C R. TEU-585D	Attached herewith
6	Semesters	Sem. IV
7	Program Academic Level	5.00
8	Pattern	Semester
9	Status	New
10	To be implemented from Academic Year	2025-26

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Dr. Deven Shah
Associate Dean
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Sd/-
Prof. Shivram S. Garje
Dean
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 core and modern engineering practices and emerging trends in technology. Considering the shift in pedagogy and the convenience of a stress-free learning process, a choice-based subject pool is offered in the coursework under the heads of 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 enhanced skill practices, the pool is offered to nurture and develop creative skills in contemporary industrial practices. Criteria met in the structure is the opportunity for learners to choose the course of their interest in all disciplines.

Program Core Course Cover 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 2024-25. Subsequently, this system will be carried forward for Third Year and Final Year Engineering in the academic years 2025-26, and 2026-27, respectively.

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Dean
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Under Graduate Diploma in Engineering- Mechatronics Engineering.
Credit Structure (Sem. III & IV)

	R. TEU-585C									
Level	Semester	Major		Minor	OE	VSC,SEC (VSEC)	AEC, VEC, IKS	OJT, FP,CE P, CC,RP	Cum.C r. / Sem.	Degree/Cu m.Cr.
		Mandatory	Electives							
5.0	III	2413111 2413112 2413113 2413114 2413115 2413116	--	--	OE:2	--	VEC:2 HSL: 2	CEP:2	22	UG Diploma45
	R. TEU-585D									
	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]

S.E.

**Mechatronics
Engineering
Scheme**

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
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
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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: 4.1 Discrete and Continuous random variables, Probability mass and density function, Probability distribution for random variables, 4.2 Expectation, Variance, Co-variance. 4.3 Moments, Moment generating functions, (Four moments about the origin & about the mean). Self- learning Topics: Conditional probability, Total Probability and Baye’s Theorem. Properties variance and covariance.	04	CO4
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	
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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.

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. “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 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

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, Burkousen'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 monostable multivibrator 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, 4th Edition, 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, 6th Edition, Pearson Education.
3. Operation Amplifiers and Linear Integrated Circuits by R. F. Coughlin and F. F. Driscoll, 6th Edition, Pearson Education India.
4. Design with operational amplifiers and analog integrated circuits by Sergio Franco, 3rd Edition, 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 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
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/ Monostable 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/ Monostable 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			
		Test	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.Kalpakkjian 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
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: <i>Says, Thinks, Feels, and Does</i> . 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/-

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