University of Mumbai

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

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

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

परिपत्रक:-

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

मुंबई – ४०० ०३२
२७ मे, २०२५

(डॉ. प्रसाद कारंडे)
कुलसचिव

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8	The Deputy Registrar, Executive Authorities Section (EA) eau120@fort.mu.ac.in He is requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to the above circular.
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AC–20/5/2025

Item No.–6.48 (N)

As Per NEP 2020

University of Mumbai

Syllabus for Major Vertical – 1 , 4, 5 & 6		
Name of the Programme –B.E. (Automation and Robotics)		
Faculty of Engineering		
Board of Studies in Mechanical Engineering		
U.G. Second Year Programme	**Exit Degree**	**U.G. Diploma in Engineering- Automation and Robotics**
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. (Automation and Robotics)**
2	**Exit Degree**	**U.G. Diploma in Engineering- Automation and Robotics.**
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-665C** **R. TEU-665D**	**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**

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BoS-Chairman-Mechanical Engg
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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 Information Technology Branch of engineering in the learner. Keeping this in view, a pool of courses is offered in Core Courses covering fundamentals required to understand core and modern engineering practices and emerging trends in technology. Considering the shift in pedagogy and the convenience of a stress-free learning process, a choice-based subject pool is offered in the coursework under the heads of Information Technology in Engineering for open electives and multidisciplinary minor courses in the third and fourth semesters. Essentially, to give a glimpse of trends in the industry under vocational and enhanced skill practices, the pool is offered to nurture and develop creative skills in contemporary industrial practices. Criteria met in the structure is the opportunity for learners to choose the course of their interest in all disciplines.

Program Core Course Cover Information Technology 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 <u>Engineering- Automation and Robotics.</u>

Credit Structure (Sem. III & IV)

	R. TEU-665C								
Level	**Semester**	**Major**		**Minor**	**OE**	**VSC,SEC (VSEC)**	**AEC, VEC, IKS**	**OJT, FP, CEP, CC, RP**	**Cum. Cr. / Sem.**	**Degree/ Cum. Cr.**
		Mandatory	**Electives**							
5.0	III	2033111 2033112 2033113 2033114 2033115 2033116	--	--	OE:2	--	VEC:2 HSL: 2	CEP:2	22	**UG Diploma45**
	R. TEU-665D									
	IV	2034111 2034112 2034113 2034114 2034115 2034116	--	MDM: 4	OE:2	VSEC:2	VEC:2 EEM:2	--	23	
	Cum Cr.	25	--	4	4	2	***2+2+2+2***	2	45	

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

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

Sem. - III

S.E.
Automation and Robotics Scheme

Program Structure for Second Year of Automation and Robotics

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
2033111	Engineering Mathematics III	2	--	1	2	1	–	3
2033112	Strength of Materials	3	–	--	3	–	–	3
2033113	Sensors and Actuators	3	--	--	3	–	–	3
2033114	Digital Electronics	3	--	--	3	–	–	3
OEC301	To be taken from the bucket provided by the University from other Faculty	2	--	--	2	–	–	2
2033115	Material Testing Lab	--	2	–	–	–	1	1
2033116	Sensors and Actuators Lab	--	2	–	–	–	1	1
2033611	Mini Project (group project)	--	4	–	–	–	2	2
2993511	Entrepreneurship Development (Syllabus common to all Branches).	--	2*+2	---	–	–	2	2
2993512	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)					
2033111	Engineering Mathematics III	20	20	40	60	2	25	--	125
2033112	Strength of Materials	20	20	40	60	2	--	--	100
2033113	Sensors and Actuators	20	20	40	60	2	--	--	100
2033114	Digital Electronics	20	20	40	60	2	--	--	100
OEC301	To be taken from the bucket provided by the University from other Faculty	20	20	40	60	2	--	--	100
2033115	Material Testing Lab	--	--	--	--	--	25	25	50
2033116	Sensors and Actuators Lab	--	--	--	--	--	25	25	50
2033611	Mini Project (group project)	--	--	--	--	--	50	25	75
2993511	Entrepreneurship Development (Syllabus common to all Branches).	--	--	--	--	--	50	--	50
2993512	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 Automation and Robotics

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
2034111	Finite Element Analysis	3	--	–	3	–	–	3
2034112	Embedded System	3	–	--	3	–	–	3
2034113	Modern Control Systems -	3	--	--	3	–	–	3
203	Multidisciplinary minor	3	–	--	3	–	–	3
203	To be taken from the bucket provided by the University from other Faculty	2	–	--	2	–	–	2
2034114	Embedded System Lab	–	2	–	–	–	1	1
2034115	Modern Control Systems - Lab	–	2	–	–	–	1	1
203	Multidisciplinary minor	–	2	–	–	–	1	1
2034411	CNC Programming Lab	–	4	–	–	–	2	2
2994511	Business Model Development (Syllabus common to all Branches).	–	2*+2	–	–	–	2	2
2994512	Design Thinking (Syllabus common to all Branches).	–	2*+2	–	–	–	2	2
Total		**14**	**18**	**--**	**14**	**--**	**09**	**23**

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

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

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

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

Course Code	Course Description	Examination scheme							
		Internal Assessment Test (IAT)			End Sem. Exam Marks	End Sem. Exam Duration (Hrs)	Term Work (Tw)	Oral & Pract.	Total
		IAT-I	IAT-II	Total (IAT-I) + IAT-II)					
2034111	Finite Element Analysis	20	20	40	60	2	25	--	125
2034112	Embedded System	20	20	40	60	2	--	--	100
2034113	Modern Control Systems	20	20	40	60	2	--	--	100
203	Multidisciplinary minor	20	20	40	60	2	--	--	100
203	To be taken from the bucket provided by the University from other Faculty	20	20	40	60	2	--	--	100
2034114	Embedded System Lab	--	--	--	--	--	25	25	50
2034115	Modern Control Systems Lab	--	--	--	--	--	25	25	50
203	Multidisciplinary minor	--	--	--	--	--	25	--	25
2034411	CNC Programming Lab	--	--	--	--	--	50	25	75
2994511	Business Model Development (Syllabus common to all Branches).	--	--	--	--	--	50	--	50
2994512	Design Thinking (Syllabus common to all Branches).	--	--	--	--	--	50	--	50
Total		**100**	**100**	**200**	**300**	**10**	**250**	**75**	**825**

Vertical –1
Major

Course Code	Course Name	Contact Hours			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
2033111	Engineering Mathematics-III	02	-	01	02	-	01	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment Test (IAT)			End Sem. Exam	Duration of End Sem. Exam	TW	PR	OR	
IAT-I	IAT-II	IAT-I + IAT-II (Total)						
20	20	40	60	02	25	-	-	125

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

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

Course Objectives:

1. To familiarize with the Laplace transform, Inverse of various functions, its applications.
2. To familiarize with the Inverse Laplace transform of various functions, its applications.
3. To acquaint with the concept of Fourier series of periodic functions with various period.
4. To familiarize with the concept of complex variables, C-R equations with applications.
5. To introduce concepts and fundamentals Matrix algebra for engineering problems.
6. To study the application of the knowledge of matrices and numerical methods in complex engineering problems.

Course Outcomes: Learner will be able to….

1. Apply the concept of Laplace transform to solve the real integrals in engineering problems.
2. Apply the concept of inverse Laplace transform of various functions in engineering problems.
3. Expand the periodic function by using Fourier series for real life problems and 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 mapping
01	**Module: Laplace Transform** 1.1 Definition of Laplace transform, Condition of Existence of Laplace transform, Laplace Transform (L) of Standard Functions like e^{at}, $sin(at)$, $cos(at)$, $sinh\,(at)$, $cosh\,(at)$ and , $where\ n \geq 0$. 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

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

a. 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**

b. **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)

c. 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

Course Code	Course Name	Contact Hours			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
2473112	Strength of Materials	03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment Test (IAT)			End Sem. Exam	Duration of End Sem. Exam	TW	PR	OR	
IAT-I	IAT-II	IAT-I + IAT-II (Total)						
20	20	40	60	02 hrs	-	-	-	100

Objectives:

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

Outcomes: Learner will be able to…

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

Module	Detailed Contents	Hrs	CO mapping
	Pre-requisites: Concepts of equilibrium in beams, support reactions; Centroid		
1.	**1.1 Introduction-Concept of Stress** Deformation in solids- Hooke's law, stress and strain- tension, compression and shear stresses, Stress Strain Diagram, elastic constants and their relations-volumetric, linear and shear strains. Thermal stress and strain.	**05**	**CO1**
	1.2 Principal Stresses Principal stresses and Principal planes- Mohr's circle.	**03**	
2.	**2.1 Area Moment of Inertia** Area Moment of Inertia about centroidal axes, Parallel Axes theorem, Polar Moment of Inertia.	**02**	**CO2**
	2.2 Torsion: Torsion equation, Torsion of circular shafts-solid and hollow, stresses in shafts when transmitting power	**05**	
	2.3Strain Energy: Strain energy stored in the member due to gradual, sudden and impact loads, Strain energy due to bending and torsion.	**03**	
3.	**Shear Force and Bending Moment Diagrams in Beams**	**05**	**CO3**
	Introduction to types of beams, supports and loadings. Definition of bending moment and shear force, relationship between load intensity, bending moment and shear force. Shear force and bending moment diagrams for statically determinate beams subjected to point load, uniformly distributed loads, couple and their combinations.		
4.	**Stresses in Beams and Thin Shells**		**CO4**
	4.1 Bending and Shear Stresses in Beams	**04**	

	Theory of bending of beams, bending stress distribution, shear stress distribution for point and distributed loads in simply supported and cantilever beams.		
	4.2 Thin Shells Stresses and deformation in Thin Cylindrical and Spherical Shells subjected to internal pressure.	**02**	
5.	**Deflection of Beams** Deflection of a beam: Double integration method, Macauley's method for computation of slopes and deflection in beams for point and distributed loads.	**05**	**CO5**
6.	**Columns** Buckling load, Types of end conditions for column, Euler's column theory and its limitations and Rankine formula.	**05**	**CO6**
	Total Hours	**39**	

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

a. 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**

b. **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)

c. A total of **Four questions** need to be answered.

Textbooks

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

4. S. S. Ratan: Mechanics of Materials, 2nd Edition, Tata McGraw Hill Pvt. Ltd. (2011)

Reference Books

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

Web Resources

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

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2033113	Sensors and Actuators	3	-	-	3	-	-	3

		Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Total					
2033113	Sensors and Actuators	20	20	40	60	2	--	--	100

Rationale:

The rationale behind this curriculum is to incorporating transducer studies into engineering education is vital for preparing students to meet the demands of modern technology-driven industries. It ensures that graduates possess the necessary knowledge and skills to develop, implement, and maintain systems that rely on accurate and reliable measurements.

Course Objectives:

1. To explain the measurement systems, errors of measurement and understanding of the operation of sensors and transducers
2. To familiarize the student with the Identification, classification, construction, working principle and application of various transducers used in Industry for Temperature measurement
3. To familiarize the student with the Identification, classification, construction, working principle and application of various transducers used in Industry for Pressure & Vacuum, Level measurement
4. To familiarize the student with the Identification, classification, construction, working principle and application of various transducers used in Industry for Flow measurement
5. To study the working principles, characteristics, and applications of various types of actuators
6. To develop the ability to select appropriate signal conditioning circuits tailored to different types of temperature and Pressure sensors.

Course Outcomes:

1. Explain the measurement systems, errors of measurement. List and compare various standards used for selection of transducers/sensors.

2. Describe the working principles of Temperature transducers and their applications.
3. Understand the working principles of Pressure & Vacuum Gauges and level transducers and their applications.
4. Identify types of Flow and understand working of different transducers for Flow measurement.
5. To study the working principles, characteristics, and applications of various types of actuators used in industrial automation systems
6. To analyze design considerations and applications for temperature and pressure transducer signal conditioning.

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	To understand this subject, student should have a foundational understanding of physics, especially regarding energy conversion and measurement. You should also be familiar with basic concepts of electronics and electrical signals.		
I	**Introduction to Measurement Systems & Sensors**	1.1. Introduction, Block diagram, Functional elements of measurement system, Static and Dynamic characteristics of transducers. Errors, Remedies for Errors. 1.2. Definition of Sensor & Transducer, classification, selection criteria, transducer specifications.	4	CO1
II	**Transducers for Temperature Measurement**	2.1 Definition and units of temperature 2.2 Different temperature scales (^{0}C,^{0}F, ^{0}K,^{0}R,^{0}R') and their conversions 2.3 Resistance Temperature Detector (RTD): Working Principle (PT 100), 2 wire, 3 wire and 4 wire RTD Element, Lead wire compensation in RTD, self-heating effect, Specifications, advantages, disadvantages and applications of RTD 2.4 Thermocouple: Working principle, thermo electric effect, See-beck effect, Peltier effect, Laws of thermocouple, types of thermocouples, cold junction compensation method, thermopile, Thermowell material of construction. Specifications, advantages, disadvantages and applications of Thermocouple 2.5 Thermistor, NTC & PTC Types, Specifications, advantages, disadvantages and applications of Thermistor 2.6 Pyrometers: Principle, construction and working of radiation and optical Pyrometers and its applications	8	CO2
III	**Transducers for Pressure**	3.1 Pressure scales, units and relations, classification 3.2 Primary pressure sensors – elastic elements like bourdon tube, diaphragm, bellows, capsule properties	8	CO3

	and Vacuum Measurement	and selection of elastic materials, Calibration using Dead Weight Tester 3.3 Electrical/secondary Pressure Transducers: a) Bourdon tube with LVDT, b) Bellow with LVDT , c) Diaphragm with Strain gauge 3.4 Differential pressure measurement: construction & working of DP Cell 3.5 Pressure measurement using manometer: U – Tube types, well type, inclined type, micro manometer 3.6 Pneumatic transducer: Flapper – nozzle transducer. 3.7 Vacuum Measurement: Units and relations, Mcleod gauge, Pirani gauge, thermocouple gauge. 3.8 Calibration of Pressure Gauge 3.9 Level and units of Level, Classification ,construction, working, applications of : a) Direct method : methods- Sight glass, Hydrostatic type (air purge). b) Indirect measurement method: Float type with linear and rotary potentiometer, Capacitive type , Ultrasonic type, Nuclear Radiation type, Radar type Transducer.		
IV	**Transducers for Flow Measurement**	4.1 Introduction to fluid flow: properties of fluid, types of fluid, Reynolds number, types of fluid flow, continuity equation. Bernoulli's equation 4.2 Head type: Orifice, Venturi, nozzle, pitot tube, annubar, characteristics of Head type flow meters, Variable area type: Rotameter 4.3 Velocity and Inertia based flowmeters: Turbine, electromagnetic, ultrasonic, positive displacement meter -nutating disc type, anemometers, Coriolis Mass flow metermass flow meters.	6	CO4
V	**Actuators**	5.1 Definition and Classification: linear; rotary; Logical and Continuous Actuators 5.2 Pneumatic actuator- Electro-Pneumatic actuator; cylinder, rotary actuators, 5.3 Mechanical actuating system: Hydraulic actuator - Control valves; Construction, Characteristics and Types, Selection criteria. 5.4 Electrical actuating systems: Solid-state switches, Solenoids, Electric Motors- Principle of operation and its application: D.C motors , AC motors - Single phase & 3 Phase Induction Motor; Synchronous Motor; Stepper	8	CO5

		motors - Piezoelectric Actuators: working and applications.		
VI	**Case studies**	6.1 Temperature Transducer signal conditioning Design: design considerations and application for RTD, Thermistor and thermocouple temperature sensor. 6.2 Pressure Transducer signal conditioning Design: design considerations and applications for various pressure sensors	5	CO6
		Total Hours	**39**	

Text Books:

1. B.C Nakra, K.K. Chaudhary, Instrumentation, Measurement and Analysis, Tata McGraw-Hill Education, 01-Oct-2003 - Electronic instruments - 632 page.
2. Patranabis D, Sensors and Transducers, Prentice Hall India Learning Private Limited; 2 edition (2003) - 344 pages.
3. A. K. Sawhney, Puneet Sawhney, A course in Electrical and Electronic Measurement and Instrumentation, Dhanpat Rai and Co. Rai, 1996.
4. Rangan, Mani, Sharma. Instrumentation systems and Devices, 2nd EdTata McGraw Hill.
5. D.V.S. Murthi, Instrumentation and Measurement Principles‖, PHI, New Delhi, 2nd ed. 2003.

References:

1. Doeblin E.D., Measurement system, Tata McGraw Hill., 4th ed, 2003.
2. Bela G. Liptak, Instrument Engineers' Handbook, Fourth Edition, Volume One: Process Measurement and Analysis, June 27, 2003.
3. W.G.Andrew, H.B.Williams, Applied Instrumentation in the Process Industries, Volume II – Gulf Publication Company , Paris, Tokyo.
4. Neubert Hermann K. P., Instrument Transducer, 2nd ed., Oxford University Press, New Delhi, 2003.
5. Johnson Curtis D., Process Control Instrumentation Technology, 8th Ed., 2005
6. S.P. Sukhatme, Heat Transfer, 3rd edition, University Press.
7. Chortle Keith R., Fundamentals of Test, Measurement Instrument Instrumentation, ISA Publication.
8. Alan S Morris, Measurement and Instrumentation Principles; 3rd Edition
9. Sawhney A.K., ―Mechanical Measurement‖, Dhanpatrai and Co.
10. Bansal R.K., ―Fluid Mechanics and Hydraulic Machines‖, Laxmi publications.
11. David W. Spitzer, ―Industrial Flow Measurement‖, ISA Publication

Online References:

Sr. No.	Website Name
1.	https://onlinecourses.nptel.ac.in/noc23_ee105/

2.	https://archive.nptel.ac.in/courses/112/107/112107242/
3.	https://archive.nptel.ac.in/courses/108/105/108105064/

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
2033114	Digital Electronics	3	-	-	3	-	-	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Total					
2033114	Digital Electronics	20	20	40	60	2	--	--	100

Rationale:

The rationale behind this curriculum is to provide a comprehensive and practical understanding of digital electronics, empowering students to design, analyze, and implement digital systems effectively.

This syllabus is designed to provide students with a foundational understanding of digital electronics, a core discipline essential for numerous fields, including computer engineering, electronics, telecommunications, and embedded systems.

Course Objectives: Six Course Objectives

1. How to apply Number Systems and Boolean Algebra in Digital systems.
2. Analyze and Simplify Combinational Logic Circuits.
3. Design and Implement Combinational Logic Functions.
4. Comprehend and Design Sequential Logic Circuits.
5. Evaluate and Compare Digital Integrated Circuit Technologies.
6. Develop Digital Systems using Programmable Logic Devices and Hardware Description Languages.

Course Outcomes:

1) Explain the conversion between different number systems (decimal, binary, octal, hexadecimal) and apply Boolean algebra theorems to simplify logic expressions. (Bloom's Taxonomy: Understand, Apply)
2) Analyze and simplify complex combinational logic circuits using Karnaugh maps and Quine-McCluskey methods to derive minimal sum-of-product or product-of-sum expressions. (Bloom's Taxonomy: Analyze, Evaluate)
3) Design and implement various combinational logic circuits such as decoders, encoders, multiplexers, adders, and comparators to solve specific digital design problems. (Bloom's Taxonomy: Apply, Create)

4) Describe the operation of flip-flops, counters, and registers, and develop sequential logic \ circuits using these components for specific applications. (Bloom's Taxonomy: Understand, Create)
5) Compare and contrast the characteristics of different digital logic families (TTL, CMOS, ECL) based on parameters like propagation delay, power dissipation, and noise margin. (Bloom's Taxonomy: Analyze, Evaluate)
6) Implement basic digital circuits using VHDL or Verilog on programmable logic devices (PLDs) like PLA, PAL, CPLDs, and FPGAs, and evaluate the functionality of memory devices. (Bloom's Taxonomy: Apply, Evaluate)

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

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
	Prerequisite:	Logic gates- Basic gates- AND, OR and NOT, Universal Gates- NAND and NOR, Derived Gates- EX-OR and EX-NOR		
I	Number Systems & Boolean Algebra:	Decimal, binary, octal, hexadecimal number system and conversion, binary weighted codes, signed numbers, 1s and 2s complement codes, Binary arithmetic Binary logic functions, Boolean laws, truth tables, associative and distributive properties, De-Morgans theorems, realization using logic gates.	07	CO1
II	Combinational Logic	Switching equations, canonical logic forms, sum of product & product of sums, Karnaugh maps- two, three and four variable, simplification of expressions, don't care conditions K-map, Quine-McCluskey minimization technique, mixed logic combinational circuits, multiple output functions.	06	CO2
III	Analysis & design of Combinational Logic:	Adders, Subtractors, Code conversion, Parity checker, BCD adder, Multiplexer, Demultiplexer, Encoder and Decoder. Implementation of combinational logic circuits using Multiplexer and Demultiplexer. Hazards in logic circuits and its elimination.	06	CO3
IV	Sequential Logic:	Flip flops- SR, JK, D, T and Master slave JK, Realization of one flip flop	08	CO4

		using other flip flops, Shift registers, Universal Shift Register, Asynchronous & Synchronous counters, Modulus of counters.		
V	Digital integrated circuits:	Logic levels, propagation delay time, power dissipation fan-out and fan-in, noise margin, logic families and their characteristics TTL, CMOS and ECL integrated circuits and their performance comparison, open collector and tristate gates and buffers.	06	CO5
VI	Memory and programmable logic devices:	PROM / EPROM / EEPROM / EAPROM Programmable Logic Devices – Programmable Logic Array (PLA), Programmable Array Logic (PAL), Introduction to Complex Programmable Logic Device (CPLD), Introduction and basic concepts of FPGA, VHDL and Verilog – Implementation of AND, OR, Adders using VHDL and Verilog	06	CO6
		Total Hours	**39**	

Text Books:

1. A.S. Sedra & K.C.Smith, Microelectronics Circuits, Oxford University Press (1997)
2. A.P. Malvino, Electronic Principles, Tata Mcgraw Hill Publications
3. Robert L. Boylestad & Louis Nashelsky, Electronic Devices & Circuit Theory
4. William Kleitz, Digital Electronics, Prentice Hall International Inc.

References:

1. M. S. Tyagi, Introduction to Semiconductor Materials and Devices, John Wiley & Sons Inc.
2. Michael Shur, Introduction to Electronic Devices, John Wiley & Sons Inc., 2000.
3. R. T. Howe and C. G. Sodini, Microelectronics: An Integrated Approach, PrenticeHall Inc. 1997.
4. Jacob Millman, and C.C. Halkias, "Electronic devices and circuits", TMH Publications.
5. Ben G. Streetman, Solid State Electronic Devices, PHI, 5th Ed, 2001.**3.**

Online References:

Sr. No.	Website Name
1.	https://archive.nptel.ac.in/courses/108/105/108105132/
2.	https://www.tpointtech.com/digital-electronics
3.	https://www.geeksforgeeks.org/digital-electronics-logic-design-tutorials/

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
2033115	Material Testing 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				
2033115	Material Testing Lab	--	--	--	--	25	25	50

Lab Objectives:

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

Lab Outcomes: After completion of this laboratory course, the students will be able to

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

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

Expt. No.	Description	No. of Hours
	Group A	
1.	Study of Characterization techniques and Metallographic sample preparation and etching.	**02**
2.	Comparison of Microstructures and hardness before and after Annealing, Normalizing and Hardening in medium carbon steel.	**02**
3.	Study of tempering characteristics of hardened steel.	**02**
4.	Determination of hardenability of steel using Jominy end Quench Test (Using different hardness testers to measure the Hardness)	**02**
5.	Fatigue test using Rotating Beam Specimen.	**02**
	Group B	
1.	Tension test on mild steel bar (stress-strain behaviour, Determination of yield strength and modulus of elasticity)	**02**
2.	Torsion test on mild steel bar/cast iron bar	**02**
3.	Impact test on metal specimen (Izod/Charpy Impact test)	**02**
4.	Hardness test on metals—(Brinell/Rockwell Hardness Number	**02**
5.	Flexural test on beam(central loading)	**02**

Sr No	**Group C. List of Assignments / Tutorials**(At least ***two*** problems on each of the following topics)	Hrs
01	Simple Stress and Strain	
02	Torsion and Strain Energy	
03	SFD and BMD	
04	Stresses in Beams and Thin Shells	
05	Deflection of Beams	
06	Buckling of Columns	

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

Assessment:

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

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

Practical& Oral Exam: An Oral & Practical exam should be conducted.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2033116	Transducers 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				
2033116	Transducer Lab	--	--	--	--	25	25	50

Lab Objectives:

1. To understand the principle of various Transducers
2. To experimentally verify the characteristics of Temperature transducers
3. To experimentally verify the characteristics of Pressure, vacuum and level transducers.
4. To experimentally verify the characteristics of flow transducers.
5. To explore and analyze various types of actuators
6. To design and implement signal conditioning circuits for temperature and pressure transducers.

Lab Outcomes

1. Understand the fundamental principles and classifications of various transducers, including their working mechanisms and applications in measuring physical parameters..
2. Experimentally analyze the characteristics of temperature transducers such as RTDs, thermistors, and thermocouples, and interpret their response to temperature variations.
3. Experimentally analyze the characteristics of pressure, vacuum, and level transducers through practical experiments, understanding their behavior under different conditions.
4. Experimentally analyze the characteristics of flow transducers, interpreting their output in relation to varying flow rates..
5. Analyze various types of actuators, including linear, rotary, logical, and continuous actuators, understanding their construction, operation, and applications in Automation..

6. Design and implement signal conditioning circuits tailored for temperature and pressure transducers, ensuring accurate signal processing for reliable measurements.

List of Experiments: Minimum ***eight*** experiments to be performed

List of Experiments.

Sr No	List of Experiments	Hrs
01	Demonstrate the basic measurements techniques and Measuring Instruments.	2
02	Plot response curve for Flapper Nozzle system and validate the results with stand values.	2
03	Plot and validate the LVDT characteristics.	2
04	Plot and validate the strain gauge characteristics	2
05	Plot and validate the characteristics of RTD	2
06	Draw and validate the characteristics of various Thermocouples.	2
07	Draw and validate the characteristics of Thermistors.	2
08	Test and compare temperature measurement with and without Thermo-well.	2
09	Plot and validate performance characteristics of Hydrostatic type (air purge) system.	2
10	Identify constant head type flow sensors such as Orifice, Venturi tube and study the applications.	2
11	Identify variable area such as Rotameter and study the applications.	2
12	Study of Linear and Rotary Actuators	2
13	Operation of Directional Control Valves	2
14	Speed and Direction Control of DC Motor	2

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Sr No	List of Assignments / Tutorials	Hrs

01	Assignment based on classification, specification and selection criteria of tranducer	
02	Assignment based on types of temperature transducers	
03	Assignment based on types of Pressure and vacuum transducers	
04	Assignment based on types of level transducers	
05	Assignment based on types of flow transducers	
06	Assignment based on types of Actuators	

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.

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

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

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

Lab Objectives:

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

Lab Outcomes:

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

1. Understand the fundamental concepts of entrepreneurship and business models.
2. Conduct market research and develop business plans.

3. Utilize financial planning and cost analysis for startups.
4. Apply entrepreneurial skills to identify and solve business challenges.
5. Develop prototypes using open-source software for business operations.
6. Pitch business ideas effectively with structured presentations.

DETAILED SYLLABUS

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

VI	**Business Pitching & Prototype Development**	Pitch Deck Preparation & Presentation Techniques. Prototyping with Open-source Tools. Elevator Pitch & Investor Pitch. Case Studies of Successful Start-ups	**05**	**LO6**

Text Books:

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

References:

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

Online Resources:

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

List of Experiments.

Sr No	**List of Experiments**	**Hrs**

01	Business Idea Generation using Mind Mapping.	02
02	Conducting Market Research & Customer Validation.	02
03	Preparing a Business Model Canvas for a Startup Idea.	02
04	Developing a Financial Plan & Break-even Analysis.	02
05	Creating a Website using WordPress/Wix.	02
06	Social Media Marketing Campaign using Open-source Tools.	02
07	Digital Prototyping using Figma/Inkscape.	02
08	Business Pitch Deck Preparation & Presentation.	02
09	Exploring Government Schemes for Startups.	02
10	Legal Compliance & IPR Basics (Case Study).	02
Sr No	**List of Assignments / Tutorials**	**Hrs**
01	a. Write a report on any successful entrepreneur and their startup journey. b. Conduct SWOT analysis for a real-life startup.	02
02	Develop a business idea and create a one-page business plan.	02
03	Conduct market research using surveys & present findings.	02
04	Design a simple logo and branding strategy for a startup.	02
05	Create a financial model and cost estimation for a startup.	02
06	Make a case study report on startup failure analysis.	02

List of Open-Source Software
1. Canva – Designing pitch decks, social media posts, and branding materials. 2. Trello / Asana – Project management for startups. 3. GIMP / Inkscape – Graphic design and logo creation. 4. WordPress / Wix – Website development for startups. 5. OpenCart / PrestaShop – E-commerce website setup. 6. Figma – UI/UX design and prototyping. 7. LibreOffice Calc – Financial planning and budgeting.

8. Google Suite (Docs, Sheets, Slides) – Documentation and presentations.
9. Python (Pandas, Flask, Django) – Data analytics and web application development.
10. MailChimp – Email marketing and customer engagement.

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

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

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

Rationale:

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

Lab Objectives:

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

Lab Outcomes:

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

DETAILED SYLLABUS:

Unit Name	Topic Name	Topic Description	Hours	LO Mapping
I	**The Multidisciplinary Nature of Environmental Studies**	Definition, scope and importance. Need for public awareness, Role of 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:	**05**	

		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.		LO3
IV	**Biodiversity and its Conservation**	Introduction-Definition: genetic species and ecosystem diversity. Bio-geographical classification of India Value of biodiversity : Consumptive use, productive use, social, ethical, aesthetic and option values, Bio-diversity at global, national, local levels India as a mega diversity nation Case study on Bio diversity in India.	**05**	LO4
V	**Environmental Pollution Definition**	Causes, effects and control measures of: a) Air pollution b) Water pollution c) Soil pollution. Solid waste management: Causes, effect and control measures of urban and industrial wastes. Role of an individual in prevention of pollution, Case study on Pollution Disaster management: floods, earthquake, cyclone and landslides. Carbon Credits for pollution prevention	**05**	LO5
VI	**Social Issues and Environment**	From unsustainable to sustainable development Urban problems related to energy, Water conservation, rain water harvesting, watershed management. Environmental ethics: issues and possible solution. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies. Consumerism and waste products. Environment protection act. Public awareness Case study on Environmental Ethics	**04**	LO6

Textbooks

1. Environmental Science: Towards a Sustainable Future, G. Tyler Miller and Scott Spoolman, 13th Edition, Cengage Learning 2021
2. Environmental Management: Text and Cases, Bala Krishnamoorthy, 3rd Edition, PHI Learning, Publication Year: 2016

3. Green IT: Concepts, Technologies, and Best Practices, Markus Allemann, Springer 2008
4. Sustainable IT: Slimming Down and Greening Up Your IT Infrastructure, David F. Linthicum, IBM Press 2009
5. Environmental Modelling: Finding Solutions to Environmental Problems, David L. Murray, Cambridge University Press 2016
6. Remote Sensing and Image Interpretation, Thomas M. Lillesand, Ralph W. Kiefer, and Jonathan W. Chipman, 9th Edition, John Wiley & Sons 2020
7. Business Ethics: Concepts and Cases, Manuel Velasquez, Pearson 2012

Reference Books

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

Online References:

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

List of Experiments.

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

Sr No	List of Assignments / Tutorials	Hrs
01	Prepare a report on Renewable and Non-Renewable Resources.	2
02	Write a case study on Ecosystem Types in India	2
03	Write a report on Biodiversity in India.	2
04	Prepare a report on Pollution Types and Control Measures.	2

05	Prepare a report on Environmental Ethics and Sustainability.	2
06	Prepare a case study report on Global Warming and Climate Change.	2
07	Report on Role of an Individual in Environmental Protection.	2
08	Write a report on Disaster Management Techniques.	2
09	Prepare a report on Environmental Laws and Acts in India.	2
10	Case Study on E-waste Management and Recycling Techniques.	2

Assessment :

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

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

SEM 4

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2034111	Finite Element Analysis	3	-	-	3	-	-	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Total					
2034111	Finite Element Analysis	20	20	40	60	2	--	--	100

Rationale:

Finite Element Analysis (FEA) is a numerical method used to predict how a product or structure will behave under various conditions, such as stress, strain, and thermal effects, without needing physical prototypes.

Course Objectives:

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

Course Outcomes: Learners will be able -

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

Prerequisites:

Knowledge of:

- Differential equations (Formulation and solution, Types-Ordinary, Partial, Order and degree of the DE and the boundary conditions)
- Matrix algebra (Matrix operations, gauss elimination method to get the inverse of matrix)
- Basics of the core field (Governing laws, relationship between the various variables and constants–like in structural field stress-strain, Thermal field-temp, heat transfer rate etc.

DETAILED SYLLABUS:

Sr. No.	**Name of Module**	**Detailed Content**	**Hours**	**CO Mapping**
0	Prerequisite	Differential Equations, Matrix Algebra, Basics of strength of materials and heat transfer.	---	---
I	**Introduction** :	Brief History of FEM, Finite Element Terminology (nodes, elements, domain, continuum, Degrees of freedom, loads & constraints). Application, Advantages, Steps of FEM, Stress and Equilibrium, Boundary conditions, Strain Displacement Relations, Stress-strain Relations, Von mises stress, Temperature effect, Potential Energy & Equilibrium, Gelerkin's Method, stiffness (Displacement) Method.	**07**	**CO1**

		Home Exercise 1: Introduction to Ansys Tools(Pre-Processing, Processing and Post-Processing)		
II	**Matrix Algebra &Gaussian Elimination:**	Matrix Multiplication, Transposition, Diagonal Matrix, Symmetric Matrix, Upper Triangular Matrix, Determinant of Matrix, Matrix Inversion Eigen values & Eigen vectors, Gaussian elimination. **Home Exercise 2:** Finite Element Analysis (element selection, assigning properties, meshing, assigning loads, and boundary conditions, analysis and result interpretation).	**06**	**CO2**
III	**1D ELEMENT:**	Types of 1D element: Displacement function, Global and local coordinate systems, Order of element, primary and secondary variables, shape functions and its properties. Formulation of elemental stiffness matrix and load vector for spring, bar, beam, truss and Plane frame. Transformation matrix for truss and plane frame, Assembly of global stiffness matrix and load vector, Properties of stiffness matrix, half bandwidth, Boundary conditions elimination method and penalty approach, Symmetric boundary conditions, Stress calculations. **Home Exercise 3**:Any two problems using bar element	**07**	**CO3**
IV	**1D Steady State Heat Transfer Problems :**	Introduction, Governing differential equation, steady-state heat transfer formulation of 1D element for conduction and convection problem, boundary conditions and solving for temperature distribution. **Home Exercise 4:**Any one problem on steady state heat conduction	**06**	**CO4**
V	**Dynamic Analysis:**	Types of dynamic analysis, General dynamic equation of motion, point and distributed mass, lumped and Consistent mass, Mass matrices formulation of bar and beam element. Undamped-free	**06**	**CO5**

		vibration- Eigen value problem, Evaluation of eigen values and eigenvectors (natural frequencies and mode shapes). **Home Exercise 5:**Any one problem of free vibration analysis using bar element		
VI	**2D ELEMENTS:**	Second Order 2D Equations involving Scalar Variable Functions — Variation formulation –Finite Element formulation — Triangular elements — Shape functions and element matrices and vectors. Application to Field Problems —Torsion of Non circular shafts –Quadrilateral elements. Stress analysis of CST. **Home Exercise 6:**Any two problems using CST element	**07**	**CO6**

Text Books:

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

References:

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

Online References:

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

Assessment:

Internal Assessment (IA) for 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
2034112	Embedded System	3	-	-	3	-	-	3

		Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Total					
2034112	Embedded System	20	20	40	60	2	--	--	100

Rationale:

The study of embedded systems equips engineers with the skills and knowledge necessary to design and develop intelligent, connected devices that are transforming our world.

Course Objectives: Six Course Objectives

1. **To understand** the fundamental concepts of embedded systems, including their characteristics, applications, and the distinction from general-purpose computing.
2. **To describe** the architecture and features of the 8051 microcontroller, and **compare** it with microprocessors. (Bloom's Taxonomy: Understand, Analyze)
3. **To apply** the 8051 instruction set and addressing modes to **develop** assembly language programs for basic arithmetic operations. (Bloom's Taxonomy: Apply, Create)
4. **To design** and **implement** interfacing solutions for the 8051 microcontroller with memory and various peripheral devices. (Bloom's Taxonomy: Apply, Create)
5. **To analyze** and **evaluate** the characteristics, advantages, and applications of the different Cortex processor families, with a focus on Cortex-M processors. (Bloom's Taxonomy: Analyze, Evaluate).
6. **To analyze** real-world embedded system applications, such as automotive ECUs, robotics control systems, and IoT sensor networks, and **explain** their design and functionality. (Bloom's Taxonomy: Analyze, Understand)

Course Outcomes:

1. Distinguish between embedded systems and general-purpose computing, and illustrate the characteristics and applications of embedded systems using relevant examples. (Bloom's Taxonomy: Understand, Apply).
2. Describe the internal architecture and pin configuration of the 8051 microcontroller, and compare its features with those of a microprocessor. (Bloom's Taxonomy: Understand, Analyze).
3. Implement assembly language programs for the 8051 microcontroller, utilizing appropriate instruction sets and addressing modes to perform arithmetic operations. (Bloom's Taxonomy: Apply, Create)
4. Design and demonstrate interfacing techniques for the 8051 microcontroller with memory and various peripheral devices, including sensors, displays, and actuators. (Bloom's Taxonomy: Apply, Create)
5. Analyze the differences between the Cortex-A, Cortex-R, and Cortex-M processor families, and summarize the key features, advantages, and applications of Cortex-M processors. (Bloom's Taxonomy: Analyze, Evaluate)
6. To analyze real-world embedded system applications, such as automotive ECUs, robotics control systems, and IoT sensor networks, and explain their design and functionality. (Bloom's Taxonomy: Analyze, Understand)

Prerequisite:

1. Basic Digital Logic
2. Basic Computer Architecture
3. Programming Fundamentals
4. Basic Electronics

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	**Prerequisite:**	1. Basic Digital Logic 2. Basic Computer Architecture 3. Programming Fundamentals 4. Basic Electronics		
I	**Introduction to Embedded Systems & Fundamentals**	1. Defining embedded systems: characteristics, applications, and examples. 2. Basic Components of an Embedded System 3. Differences between general-purpose computing and embedded systems.	4	**CO1**
II	**8051 Microcontroller**	1. CPU architecture (ALU, registers, control unit, RAM, ROM, registers, I/O ports) 2. Comparison between Microprocessor and Microcontroller. 3. Features, architecture and pin configuration.	7	**CO2**

III	**Artificial Intelligence and Machine Learning for Embedded Systems (Edge AI/TinyML)**	**Advanced Embedded Architectures and Processors:** 1. RISC-V Architecture 2. System-on-Package (SiP) and Chiplets: Introduction to advanced packaging technologies **Advanced Communication and Networking for Embedded Systems:** **1.** Low-Power Wide-Area Networks (LPWANs) **2.** Wireless Sensor Networks (WSNs) 1. Cellular IoT (LTE-M)	8	**CO3**
IV	**Introduction to ATmega328P**	1. ATmega328P architecture: CPU, memory organization (Flash, SRAM, EEPROM), registers 2. Pin configuration and functions 3. Data types, variables, operators, and control structures 4. Configuring GPIO pins as input and output 1. Controlling LEDs, switches, Sensors	8	**CO4**
V	**Cortex Processors Family**	1. Introduction to Cortex Processors 2. Cortex familyCortex-A Cortex-R,Cortex-M 3. Features of Cortex-M Processors. 4. Advantages & Applications of Cortex Processors	6	**CO5**
VI	**Case Study**	1. Automotive: Engine Control Unit (ECU) 2. Industrial Automation: Robotics Control System 3. Internet of Things (IoT): Smart Agriculture Sensor Network	6	**CO6**

Text Books:

1. Mazidi M.A., The 8051 Microcontroller & Embedded systems, Pearson Education Second edition.2006
2. Kenneth Ayala, The 8051 Microcontroller, Thomson Delmar Learning, Third Edition.2005
3. Steve Heath, Embedded Systems Design, Newness publication, Second edition, ISBN 0 7506 5546
4. The Definitive Guide to ARM® Cortex®-M0 and Cortex-M0+ Processors, 2nd Edition

References:

1. David Simon, Embedded Software Primer, Pearson Education, ISBN 81-7808-045

2. Tony Givargis, Embedded System Design: A Unified Hardware/Software Introduction, Wiley Student Edition. ISBN No.812650837X

3. P.S. Manoharan, P. S. Kannan, Microcontroller based system design, SciTech Publications (India)Pvt. Ltd. ISBN No. 8183715982

4. ATmega328P Datasheet

5. Microcontrollers-Architecture, Programming, Interfacing and System Design, Pearson Education India; Second edition (2011), ISBN-10: 8131759903.

6. Cortex-M0+ Technical Reference Manual r0p1

7. ARMv6-M Architecture Reference Manual

8. Steve Furber, "ARM System on chip Architecture", Pearson,2nd edition.

9. James A. Langbridge, "Professional Embedded Arm Development", Wrox, John Wiley Brand& Sons Inc., Edition 2014

Online References:

Sr. No.	Website Name
3.	https://nptel.ac.in/courses/108102045
4.	https://archive.nptel.ac.in/courses/106/105/106105193/
3.	http://www.digimat.in/nptel/courses/video/106105159/L01.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

- 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
2034113	Modern Control Systems	3		-	3	-	-	3

		Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Total					
2034113	Modern Control Systems	20	20	40	60	2	--	--	100

Rationale:

Most of the engineering branches are being off-spring to achieve increased efficiency in processes by minimizing human error using desired operational parameters through automated monitoring to improved productivity and cost reduction, making them ideal for complex industrial applications.

Course Objectives:

1) The students should be able to learn the type of System, dynamics of physical systems, classification of control system, analysis and design objective.
2) The students should learn how to represent system by transfer function and block diagram reduction method and Mason ‘s gain formula.
3) The students can be able to learn stability analysis of systems using Root locus.
4) The students can be able to learn frequency response using polar plot, Bode plot, Nyquist plot.
5) The students should be able to learn state models for different physical systems
6) The students should be able to learn practical working of various systems.

Course Outcomes:

1. Identify open and closed loop control system and formulate mathematical model for the physical systems.
2. Simplify representation of complex systems using reduction techniques.

3. Use standard test signals to identify performance characteristics of first and second-order systems.
4. Apply root locus technique for stability analysis.
5. Analyze performance characteristics of system using Frequency response
6. Analyze performance of different systems.

Prerequisite: Basic components of control system, mathematical foundation- complex variable, differential equation, Laplace transform, inverse, Laplace transform, matrix

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Basic of Control System and Mathematical Models of Physical Systems**	Definition of control system, open loop and closed loop system, examples. Development of control systems. Definition of physical systems, principle of superposition and homogeneity, linear/non-linear, time variant/time invariant systems, Types of dynamic models, linear elements of electrical and mechanical system	**06**	**CO1**
II	**Transfer function**	Definition of transfer function, transfer functions of physical (electrical and mechanical) systems, block diagram algebra, Rules for block diagram reduction (numerical), Signal flow graphs-definition, construction, properties and Mason's gain formula (numerical)	**08**	**CO2**
III	**Time Response Analysis**	Standard test signals, steady state errors in feedback control systems and their types, transient and steady state behavior of first and second order systems (numerical)	**08**	**CO3**
IV	**Stability Analysis and Root Locus**	Concepts of Stability: Concept of absolute, relative stability, Routh stability criterion. Root-locus concepts, general rules for constructing root-locus, root-locus analysis of control systems,	**06**	**CO4**

V	**Frequency Response and Stability Analysis**	Frequency Domain Specifications, Correlation between time and frequency response, Bode plots, stability analysis using-bode, Magnitude and phase plot, Concept of polar plot, Nyquist stability criterion, definitions and significance of gain margin and phase margin.	**07**	**CO5**
VI	**Case studies**	Robotic Arm Control in Manufacturing, Automatic Train Control (ATC), Traffic Light Control Systems, Temperature Control in a Furnace, Cruise Control in Cars, Smart Home Lighting	**04**	**CO6**

Textbooks:

1. Nagrath I. G., Gopal M., Control System Engineering, New Age International (P) Ltd. Publishers, 2021
2. Kuo Benjamin C., ―Automatic Control Systems‖,10th Edition, Prentice Hall of India, New Delhi, 2017.

References:

1. Gopal M. ―Control Systems Principles and Design‖, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1998.
2. Nise Norman S.―Control Systems Engineering, 3rd.Edition, John Wiley and Sons, Inc.-2000.
3. K. Ogata, Modern Control Engineering, Prentice Hall of India, 4th edition, 2002.
4. Lewis Paul H., Chang Yang, ―Basic Control Systems Engineering‖, Prentice Hall International, Inc. 1997.
5. Raymond T. Stefani, Bahram Shahian, late Clement J. Savant and, late Gene H. Hostetter, ―Design of Feedback Control Systems, 4th Edition., Oxford, University Press, New Delhi, 2001.

Online References:

Sr. No.	**Website Name**
1.	https://onlinecourses.nptel.ac.in/noc24_me06/
2.	https://www.tutorialspoint.com/control_systems/control_systems_introduction.htm ntrol Systems - Part I: Block Diagrams and Transfer Functions
3.	https://www.tutorialspoint.com/control_systems/control_systems_introduction.htm

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
2034114	Embedded System 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				
2034114	Embedded System Lab	--	--	--	--	25	25	50

Lab Objectives:

1. **Remembering:** Identify the fundamental components of the Arduino Integrated Development Environment (IDE) and recognize the basic electronic components (LED, push button, RGB LED, potentiometer, photoresistor, LM35, servo motor, buzzer, relay, ultrasonic sensor, DC motor).
2. **Understanding:** Explain the relationship between digital and analog signals in the context of Arduino input and output, and describe how each interfaced component interacts with the Arduino board.
3. **Applying:** Implement basic Arduino sketches to control individual LEDs with a push button, vary the blink rate of an LED using a potentiometer, and read sensor values from a photoresistor and LM35 temperature sensor.
4. **Analyzing:** Break down the process of interfacing and controlling more complex components like an RGB LED (controlling individual color channels), a servo motor (controlling angular position), an active buzzer (generating sound), and a relay (switching external circuits).

5. **Evaluating:** Determine the appropriate components and develop a logical sequence of operations required to build an intrusion detection system using an Arduino and an ultrasonic sensor, and justify the chosen approach for directional control of a DC motor.
6. **Creating:** Design and construct a functional prototype of the intrusion detection system and develop an Arduino sketch to achieve directional control of a DC motor based on specific input conditions.

Lab Outcomes:

1. **CO1 (Remembering):** Recall and identify the fundamental components of the Arduino Integrated Development Environment (IDE) and recognize the basic electronic components and sensors used in the course (LED, push button, RGB LED, potentiometer, photoresistor, LM35, servo motor, buzzer, relay, ultrasonic sensor, DC motor).
2. **CO2 (Understanding):** Explain the principles of digital and analog input/output as implemented on the Arduino platform and describe the operational characteristics of each interfaced component.
3. **CO3 (Applying):** Develop and implement Arduino sketches to control individual LEDs using push buttons, regulate LED blink rates with potentiometers, and read sensor data from photoresistors and LM35 temperature sensors.
4. **CO4 (Analyzing):** Investigate and differentiate the control mechanisms for more complex peripherals such as RGB LEDs (color mixing), servo motors (positional control), active buzzers (sound generation), and relays (circuit switching).
5. **CO5 (Evaluating):** Select and justify the appropriate hardware and software components and design a logical flow for building an intrusion detection system utilizing an Arduino and an ultrasonic sensor, and for implementing directional control of a DC motor based on specific requirements.
6. **CO6 (Creating):** Design, build, and test a functional prototype of a basic intrusion detection system using an Arduino and an ultrasonic sensor, and develop and implement an Arduino program to achieve bidirectional control of a DC motor.

List of Experiments.

Sr No	List of Experiments	Hrs
1	Introduction to Arduino (Integrated Development Environment)	02
2	Controlling the Light Emitting Diode (LED) with a push button	02
3	Interfacing the RGB LED with the Arduino	02
4	Controlling the LED blink rate with the potentiometer interfacing with Arduino	02
5	Detection of the light using photo resistor	02
6	Interfacing of temperature sensor LM35 with Arduino	02
7	Interfacing Servo Motor with the Arduino	02
8	Interfacing of the Active Buzzer with Arduino.	02
10	Interfacing of the Relay with Arduino.	02
11	Building Intrusion Detection System with Arduino and Ultrasonic Sensor	02
12	Directional Control of the DC motor using Arduino	02

Sr No	List of Assignments / Tutorials	Hrs
01	Design and implement an Arduino circuit where a push button controls the state of an LED. When the button is pressed, the LED should turn ON, and when released, the LED should turn OFF.	4
02	Interface an RGB LED with the Arduino and write a program that cycles through a sequence of at least five distinct colors (e.g., red, green, blue, yellow, magenta). The duration for which each color is displayed should be adjustable within the code.	4
03	Interface a potentiometer with the Arduino and use its analog input value to control the blink rate of an LED. Turning the potentiometer in one direction should increase the blink rate, while turning it in the other direction should decrease it.	4
04	Design and build a simple light-sensitive alarm system using a photoresistor and an active buzzer interfaced with Arduino. The buzzer should sound when the light level falling on the photoresistor drops below a certain threshold.	4
05	Interface an LM35 temperature sensor and a servo motor with the Arduino. Write a program that reads the temperature from the LM35 and controls the angle of the servo motor based on the temperature reading. For example, the	4

	servo motor could rotate to different positions for low, medium, and high temperature ranges.	

Assessment:

Term Work: Term Work shall consist of at least 10 to 12 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.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2034115	Modern Control Systems - 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				
2034115	Modern Control Systems - Lab	--	--	--	--	25	25	50

Lab Objectives:

1. The students should be able to examine time and frequency response of first-order system
2. The students should be able to examine steady-state and frequency response second order electrical systems.

3. The students should be able to examine transfer function, validate transient and steady-state response
4. The students should be able to examine steady-state and frequency response of the Type 0, 1, and 2 systems.
5. Students should inspect the stability of the system using Root locus
6. Students should inspect the stability of the system using Polar plot, Bode plot, Nyquist plot.

Lab Outcomes:

1. Plot time and frequency response of first-order electrical system.
2. Plot time response of second-order system.
3. Demonstrate the way to obtain the transfer function and validate transient and steady-state response using test signals such as step, ramp, and parabolic.
4. Understand the effect of the damping factor on system response.
5. Inspect the time response specifications of systems by using root-locus.
6. Inspect the frequency response specifications of systems by using bode-plot, Polar plot, Nyquist-plot techniques, and comment on the stability of the system.

List of Experiments

Sr No	List of Experiments	Hrs
01	To plot the effect of time constant on first – order systems response.	2
02	To plot the frequency response of first-order systems.	2
03	To plot the time response of second- order systems.	2
04	To obtained poles, zeroes and Gain of Transfer Function	2
05	To study the block diagram reduction technique by using simulation software	2
06	To examine steady state errors for Type 0, 1, 2 systems	2
07	To interpret the effect of the damping factor on the performance of the second order system.	2
08	To inspect the relative stability of systems by Root-Locus using simulation software.	2
09	To study the effect of addition of zeros or poles to the forward path transfer function of a control system.	2
10	To inspect the stability of systems by Bode plot using simulation software	2
11	To determine the frequency response specifications from Polar plot of system	2
12	To inspect the stability of systems by Nyquist plot using simulation software.	2

Sr No	List of Assignments / Tutorials	Hrs
01	Assignment based on open loop system and closed loop system, Mathematical Models of physical system.	2
02	Assignment based on transfer function, block diagram reduction, Signal flow graphs, Mason's gain formula	3
03	Assignment based on steady state errors, transient and steady state behavior of first and second order systems	2
04	Assignment based on Routh stability criterion, Root-locus concepts.	3
05	Assignment based on stability analysis using-bode, Magnitude and phase plot, Concept of polar plot, Nyquist stability criterion,	4

Assessment :

Term Work: Term Work shall consist of at least 8-10 practical's 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.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2034411	CNC Programming Lab	-	4	-	-	4	-	4

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Avg. of 2 Tests				
2034411	CNC Programming Lab	--	--	--	--	50	25	75

Course Objectives:

1. To familiarize with subtractive manufacturing process in particular CNC systems.
2. To acquaint with basic part programing process for specific operations.

3. Understanding CNC Machines and Programming Fundamentals
4. Development of Practical Programming Skills
5. Familiarize with CNC programming languages, especially G-codes and M-codes
6. Equip with troubleshooting skills to address common issues in CNC programming and machining.

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

1. Understand the fundamentals of CNC machines and their operation.
2. Understand the basics of G-code programming, linear and circular interpolation concepts
3. Apply advanced G-code programming techniques to complex machining operations.
4. Analyze and troubleshoot CNC programs.
5. Understand CNC programming concepts for turning, milling, and grinding operations.
6. Apply advanced CNC programming techniques to improve machining efficiency and accuracy

DETAILED SYLLABUS: Syllabus related Lab experiment must be considered and mapped with Blooms Taxonomy.

Total six modules for each subject lab (13 weeks) to be distributed among six modules.

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**CNC Fundamentals and Machine Operation**	**Introduction to CNC machines**: Definition and history of CNC machines, Types of CNC machines (lathe, milling, grinding, etc.), **CNC machine components: -** Overview of CNC machine components (spindle, axes, control system, etc.), Functions and operations of each component **CNC machine operation:** Understanding CNC machine controls and interfaces, Setting up and operating a CNC machine, Safety procedures and best practices. **CNC machine calibration:** Importance of calibration in CNC machining, Types of calibration (axis calibration, spindle calibration, etc.), Calibration procedures and troubleshooting.	08	CO1
II	**G-Code Programming Basics**	**Introduction to G-code programming:** Definition and history of G-code, Basic syntax and structure of G-code programs **G-code programming basics**: Understanding G-code commands (G00,	08	CO2

		G01, G02, etc.), Writing simple G-code programs, Using G-code to control CNC machine axes. **Linear interpolation**: Understanding linear interpolation concepts, Writing G-code programs for linear interpolation **Circular interpolation**: Understanding circular interpolation concepts, Writing G-code programs for circular interpolation		
III	**Advanced G-Code Programming Techniques**	**Canned cycles**: Understanding canned cycle concepts, Writing G-code programs for canned cycles **Subprograms:** Understanding subprogram concepts, Writing G-code subprograms **Advanced G-code programming techniques**: Using G-code to control CNC machine spindle and coolant, Writing G-code programs for complex machining operations	06	CO3
IV	**CNC Programming Software and Program Analysis**	**Introduction to CNC programming software**: Overview of CNC programming software (CAM systems, CNC editors, etc.), Features and functions of CNC programming software **CNC programming software applications**: Using CNC programming software to create, edit, and simulate CNC programs, Importing and exporting CNC programs. **Program analysis and troubleshooting**, Understanding CNC program structure and syntax, Analyzing and troubleshooting CNC programs.	06	CO4
V	**CNC Programming for Manufacturing Operations**	**CNC programming for turning operations**: Understanding turning operations and CNC programming concepts, Writing G-code programs for turning operations **CNC programming for milling operations**: Understanding milling operations and CNC programming concepts, Writing G-code programs for milling operations **CNC programming for grinding operations**: Understanding grinding operations and CNC programming concepts, Writing G-code programs for grinding operations	05	CO5

VI	**Advanced CNC Programming and Optimization**	**CNC programming for complex shapes**: Understanding complex shape machining concepts, Writing G-code programs for complex shapes (curves, splines, etc.) **CNC program optimization**: Understanding CNC program optimization concepts, Applying optimization techniques to reduce cycle times and improve accuracy **Advanced CNC programming techniques**: Using G-code to control CNC machine advanced features (e.g., high-speed machining, precision machining), Writing G-code programs for advanced machining operations	06	CO6

Text Books:

1. Peter Smid, CNC Programming Handbook, Industrial Press Inc.
2. P. M. Agrawal and Dr. V. J, CNC Fundamentals and Programming, Tata McGraw-Hill Education (2015)
3. P. N. Rao, CNC Programming for Machining, Tata McGraw-Hill Education
4. John Stenerson, CNC Programming and Technology, Prentice Hall Publications.

References:

1. Michael Fitreman, Machining and CNC Technology, Cengage Learning (2018)
2. Alan Overby, CNC Machining Handbook, McGraw-Hill Education (2013)
3. Haas CNC Programming Manual, Haas Automation Inc. (2020)
4. Binit Kumar Jha, "CNC Programming Made Easy", PHI Learning Pvt. Ltd. (2017)

Online Resources:

Sr. No.	Website Name
1.	https://archive.nptel.ac.in/courses/112/105/112105211/
2.	https://www.coursera.org/
3.	https://www.cnccookbook.com/
4.	https://www.gcodetutor.com/

List of Experiments.

Sr No	List of Experiments	Hrs
1	Familiarize with CNC machine controls, axes, and safety features.	**CO1**
2	Understand CNC machine calibration procedures.	**CO1**
3	Write G-code programs for basic CNC operations, such as moving axes and executing dwell commands	**CO2**
4	Write program and execute linear interpolation commands (G01) to create simple shapes.	**CO2**
5	Write program and execute circular interpolation commands (G02, G03) to create circular shapes.	**CO2**
6	Write program and execute canned cycles (G81, G82, etc.) for drilling, tapping, and boring operations.	**CO3**
7	create and execute subprograms to perform repetitive tasks	**CO3**
8	Understand CNC programming software to create, edit, and simulate CNC programs	**CO4**
9	Analyze and troubleshoot CNC programs to identify errors and optimize performance	**CO4**
10	Write program and execute CNC turning operations, such as facing, turning, and threading operations.	**CO5**
11	Write program and execute CNC milling operations, such as face milling, slot milling, and drilling.	**CO5**
12	Write program and execute CNC grinding operations, such as surface grinding and cylindrical grinding.	**CO5**
13	Write program and execute CNC programs for complex shapes, such as curves and splines.	**CO6**
14	Analyze and optimize CNC programs to reduce cycle times, improve accuracy, and minimize errors.	**CO6**

Sr No	List of Assignments / Tutorials	Hrs
01	Understanding CNC machines, programming languages (G-code, M-code), and basic programming concepts.	2
02	Writing G-code and M-code programs for specific machining operations.	2
03	Various types of operations on CNC Lathe & CNC Milling Machines.	2
04	CNC lathe programming, including turning, facing, and threading operations	2
05	CNC milling programming, including pocketing, profiling, and drilling operations	2
06	Simulation and verification of CNC programs using software tools.	2

Assessment:

Term Work: Term Work shall consist of at least 10 practical's based on the above list. Also, Term work Journal must include at least 4 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.

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

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

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

Lab Objectives:

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

Lab Outcomes:

The learner will be able to:

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

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	**Prerequisite**	Basic Design Thinking principles	**01**	**--**
I	**Introduction to Entrepreneurship**	**Introduction to Entrepreneurship**: Definition, the role of entrepreneurship in the economic development, the entrepreneurial process, Women entrepreneurs, Corporate entrepreneurship, Entrepreneurial mindset **Self-learning Topics:** Case studies: Henry Ford https://www.thehenryford.org/docs/default-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,	**05**	**L2, L3, L4**

		Micro, Small and Medium Enterprises (MSME): Definition and role of MSMEs in economic development		
III	**Start-up financing**	**Start-up financing:** Cost and revenue models, Sources of start-up fundings: Angel investors, Venture capitalists, Crowd funding, Government schemes for start-up funding **Self-learning Topics:** Successful business pitching	**04**	**L2, L3, L4, L5**
IV	**Intellectual Property Rights (IPR)**	**Intellectual Property Rights (IPR):** Types of IPR: Patents, trademarks and copyrights, Patent search and analysis, Strategies for IPR protection, Ethics in technology and innovation	**04**	**L2, L3, L4**
V	**Business Model Development**	**Business Model Development:** Types of business models, Value proposition, Customer segments, Customer relationships, Channels, Key partners, Key activities, Key resources, Prototyping and MVP **Self-learning Topics:** The Art of the Start 2.0: The Time-Tested, Battle-Hardened Guide for Anyone Starting Anything by Guy Kawasaki	**04**	**L3, L4, L5, L6**
VI	**Digital Business Management**	**Digital Business Management:** Digital Business models (Subscription, Freemium *etc*), Digital marketing: Search Engine Optimization (SEO), Search Engine Marketing (SEM), Social media and influencer marketing, Disruption and innovation in digital business **Self-learning Topics:** Case study: Airbnb https://www.prismetric.com/airbnb-business-m	**04**	**L2, L3**

Textbooks:

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

Reference books:

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

Online Resources:

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

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

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

Assessment:

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

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

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

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

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

Lab Objectives:

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

Lab Outcomes:

Students will be able to …

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

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	No perquisites	-	-
I	**Introduction to Design Thinking**	**Introduction to Design Thinking:** Definition, Comparison of Design Thinking and traditional problem-solving approach, Need for Design Thinking approach, Key tenets of Design Thinking, 5 stages of Design Thinking (Empathize, Define, Ideate, Prototype, Test) **Self-learning Topics:** Design thinking case studies from various domains https://www.design-thinking-association.org/explore-design-thinking-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	**05**	**L2, L3**

		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		
IV	**Ideate**	**Ideate:** What is ideation? Need for ideation, Ideation techniques, Guidelines for ideation: Multi-disciplinary approach, Imitating with grace, Breaking patterns, Challenging assumptions, Looking across value chain, Looking beyond recommendation, Techniques for ideation: Brainstorming, Mind mapping **Self-learning Topics:** How To Run an Effective Ideation Workshop: A Step-By-Step Guide https://uxplanet.org/how-to-run-an-effective-ideation-workshop-a-step-by-step-guide-d520e41b1b96	**05**	**L3**
V	**Prototype**	**Prototype:** Low and high-fidelity prototypes, Paper prototype, Story board prototype, Scenario prototype	**03**	**L6**
VI	**Test**	**Test:** 5 guidelines of conducting test, The end goals of test: Desirability, Feasibility and Viability, Usability testing	**03**	**L4, L5**

Textbooks:

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

3. Handbook of Design Thinking: Christian Mueller-Roterberg, 2018

Reference books:

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

Online Resources:

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

List of Experiments.

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

Sr No	List of Experiments	Hrs
01	Customer Journey Mapping: Visualize the steps users take to interact with a product or service. Map out the customer journey from discovering a product to making a purchase and using the product. Identify pain points and opportunities for improvement.	2
02	Stakeholder mapping: Identify all relevant stakeholders in a project. Create a stakeholder map, categorizing stakeholders based on their influence and interest. Include management of relationships with key stakeholders.	2
03	"How Might We" Problem Framing: Transform user insights into actionable problem statements. After empathizing with users, turn challenges into "How Might We" statements that define the problem without prescribing a solution.	2

04	Brainstorming Session: Generate a pool of ideas in a creative, non-judgmental environment. Using ideation techniques like mind mapping and brainwriting, students brainstorm as many solutions as possible to their "How Might We" problem statements.	2
05	Affinity Diagramming: Organize group ideas to find patterns and insights. After brainstorming, students will categorize their ideas into themes by placing sticky notes on a wall and moving them into groups based on similarities.	2
06	Rapid Prototyping: Create quick, low-fidelity versions of solutions. Use materials like paper, cardboard, and markers to build a prototype of their solution within 30 minutes. The focus is on speed and functionality, not aesthetics.	2
07	Wireframing: Create a visual guide for digital interfaces for mobile app / web app for the problems identified in earlier lab sessions. Students will sketch wireframes of the user interface for their product or service. Use tools like Balsamiq or paper and pen for low-fidelity wireframes.	2
08	Role-Playing: Walk through a prototype from the user's perspective. Students act as both users and designers, role-playing scenarios where they interact with their prototype (Developed in earlier lab sessions). Gather feedback from participants on how to improve the experience.	2
09	Usability Testing: Evaluation of the effectiveness and user-friendliness of a prototype (developed in earlier lab sessions). Students will have peers or target users test their prototypes, observe how they interact with it, and collect feedback on any issues or improvements needed.	2
10	Feedback Loop and Iteration: Refine solutions based on user feedback. After usability testing, students will refine their prototypes. Document changes made based on feedback and discuss how continuous iteration improves the design.	2

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

Assessment:

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

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