Sri Chandrasekharendra Saraswathi Viswa Mahavidyalaya (SCSVMV)

(University U/S 3 of UGC Act 1956)
(Accredited with "A" Grade by NAAC)
Enathur, Kanchipuram - 631 561

DEPARTMENT OF MECHANICAL ENGINEERING

CURRICULUM AND SYLLABUS
(Regulation – 2024)

B.E. (Mechatronics Engineering)

Choice Based Credit System

(Students Admitted from AY-2024-25)

PROGRAM OUTCOMES [PO's]	
PO 1	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex Mechanical engineering problems
PO 2	Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PO 3	Design/development of solutions: Design solutions for complex Mechanical engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
PO 4	Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, 5analysis and interpretation of data, and synthesis of the information to provide valid conclusions
PO 5	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools that are relevant to Mechanical engineering, including prediction and modeling to complex engineering activities with an understanding of the limitations
PO 6	The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the Mechanical engineering practice
PO 7	Environment and sustainability: Understand the impact of the Mechanical engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development
PO 8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the Mechanical engineering practice
PO 9	Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
PO 10	Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions
PO 11	Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments
PO 12	Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

PROGRAM SPECIFIC OUTCOME (PSO's) – Mechanical Engineering	
PSO 1	Apply modern engineering tools such as CAD/CAM, Finite Element Analysis (FEA), Computational Fluid Dynamics (CFD), and automation technologies to analyze and solve complex problems in mechanical and interdisciplinary engineering domains.
PSO 2	Demonstrate technical competencies and innovative problem-solving abilities to address real-world challenges in sectors like automotive, aerospace, energy, and manufacturing through internships, industry-driven projects, and collaborative engagements

PROGRAM SPECIFIC OUTCOME (PSO's) – Mechatronics Engineering	
PSO 1	Graduates will be able to apply the integrated knowledge of mechanical, electrical, electronics, and computer engineering to design, develop, and implement intelligent mechatronic systems and automation solutions for real-world applications.
PSO 2	Graduates will be capable of designing and deploying embedded systems, control algorithms, and real-time interfaces to address challenges in automation, robotics, and various industrial domains.

CREDIT ASSIGNMENT

1 Hour Lecture (L) per week	**1 Credit**
1 Hour Tutorial (T) per week	**1 Credit**
1 Hour Practical (P) per week	**0.5 Credit**
2 Hours Project Per week	**1 Credit**

PROCEDURE FOR AWARDING MARKS FOR CONTINUOUS ASSESSMENT

Internal Assessment Marks for Theory Courses

- ✓ First internal test : 15 marks
- ✓ Second internal test : 15 marks
- ✓ Assignment : 10 marks

TOTAL MARKS : 40 marks

Internal Assessment Marks for Laboratory Courses

- ✓ Weekly lab performance : 15 marks
- ✓ Model lab Exam : 15 marks
- ✓ Record : 10 marks

TOTAL MARKS : 40 marks

Internal Assessment for Laboratory Integrated Theory Course

- ✓ First Internal test : 10 marks
- ✓ Second Internal test : 10 marks
- ✓ Internal lab Exam / Project work : 15 marks
- ✓ Assignment : 05 marks

TOTAL MARKS : 40 marks

CURRICULUM
B.E. Mechatronics Engineering (Full Time)

SEMESTER - I (First year)										
SL. No	**Course Category**	**Course Code**	**Course Type**	**Name of the Course**	**Hours per week**			**Credit**	**IA**	**EA**	**TM**
					L	**T**	**P**				
1.	HSMC	CHSEN24T10	T	English	2	-	-	**2**	40	60	100
2.	BSC	CBSMAA8T20	T	Mathematics – I	3	1	-	**4**	40	60	100
3.	BSC	CBSPH24T30	T	Engineering Physics	3	-	2	**4**	40	60	100
4.	HSMC	CBSMC24T40	T	Universal Human Values	3	-	-	**3**	100	-	100
5.	MC*	CMCCH24T50	T	Environmental Science and Engineering*	2	-	-	**-**	100	-	100
6.	ESC	CBSME24T60	T	Design Thinking	3	-	2	**4**	40	60	100
7.	BSC	CBSPH24P60	L	Engineering Physics Lab	-	-	4	**2**	40	60	100
8.	ESC	CBSEE24P80	L	Idea Workshop Lab	-	-	4	**2**	40	60	100
* Not considered for GPA Calculations											
Total					**18**	**01**	**04**	**18**			

SEMESTER - II (First year)										
SL. No	**Course Category**	**Course Code**	**Course Type**	**Name of the Course**	**Hours per week**			**Credit**	**IA**	**EA**	**TM**
					L	**T**	**P**				
1.	BSC	CBSMAB4T20	T	Mathematics –II	3	1	-	**4**	40	60	100
2.	BSC	CBSCH24T20	T	Engineering Chemistry	3	-	2	**4**	40	60	100
3.	ESC	CESEE24T30	T	Basic Electrical Engineering	2	1	-	**3**	40	60	100
4.	ESC	CESCS24T40	T	Programming for Problem Solving	3	-	-	**3**	40	60	100
5.	ESC	CESME24P50	L	Engineering Graphics & Design (Theory & Practical)	2	-	2	**3**	40	60	100
6.	BSC	CESEE24P70	L	Basic Electrical Engineering Lab	-	-	4	**2**	40	60	100
7.	BSC	CBSCH24P60	L	Engineering Chemistry Lab	-	-	4	**2**	40	60	100
8.	ESC	CESCS24P60	L	Programming for Problem-Solving Lab		-	4	**2**	40	60	100
9.	HSMC	BETF24MC01	-	Soft Skills	2	-	-	**1**	100	-	100
Total					**13**	**02**	**12**	**21**			
Total Credits (First year)								**39**			

[**L**-Lecture, **T**-Theory, **P**-Practical, **C**-Credit, **IA**-Internal Assessment, **EA**-External Assessment, **TM**-Total Marks]

Course Type: T – Theory, L – Laboratory Course, L / T – Laboratory Integrated Theory

SEMESTER - III (Second year)										
SL. No	Course Category	Course Code	Course Type	Name of the Course	Hours per week			Credit	IA	EA	TM
					L	T	P				
1.	BSC	BMTF243 T10	T	Mathematics III	3	1	-	**4**	40	60	100
2.	ESC	BMEF243 T20	T	Engineering Mechanics[$]	3	-	-	**3**	40	60	100
3.	PCC	BMTF243 T30	T	Materials Engineering[#]	3	-	-	**3**	40	60	100
4.	PCC	BMTF243 T40	L / T	Electronic Devices[•]	3	-	2	**4**	40	60	100
5.	PCC	BMEF243 T50	L / T	Digital Electronics[•]	3	-	2	**4**	40	60	100
6.	AEC	BMTF243 P80	L	Programming Using Python lab[#]	1	-	2	**2**	40	60	100
7.	MC*	BMTF243 MC0	L	Skill Development Course – I*	-	-	-	**1***	100	-	100
Total					**16**	**01**	**06**	**20+1***			

SEMESTER - IV (Second year)										
SL. No	Course Category	Course Code	Course Type	Name of the Course	Hours per week			Credit	IA	EA	TM
					L	T	P				
1.	ESC	BMTF24 4T10	L / T	Solid and Fluid Mechanics	3	-	2	**4**	40	60	100
2.	PCC	BMEF24 4T20	L / T	Thermal Engineering	3	-	2	**4**	40	60	100
3.	PCC	BMTF24 4T30	L / T	Manufacturing Technology for Mechatronics	3	-	2	**4**	40	60	100
4.	PCC	BMTF24 4T40	T	Industrial Instrumentation	3	-	-	**3**	40	60	100
5.	PCC	BMTF24 4T50	T	Sensors and Actuators	3	-	-	**3**	40	60	100
6.	AEC	BMTF24 4P80	L	Programming Using MATLAB[#]	1	-	2	**2**	40	60	100
7.	MC*	BMTF24 4MC05	T	Sanskrit and Indian Culture	1*	-	-	**1***	100	-	100
8.	MC*	BMTF24 4IC02	-	Skill Development Course – II*	-	-	-	**1***	100	-	100
9.	MC*	BMEF24 4MC0	-	Summer Training Internship	-	-	-	**1***	100	-	100
Total					**16**	**0**	**08**	**20+3***			
Total Credits (First year)								**40**			

[$]Common to Mechanical, Mechatronics & Civil Engineering

[#]Common to Mechanical & Mechatronics Engineering

• Common to Mechatronics & Electronics Communication Engineering

* Not accountable for GPA calculation

Course Type: T – Theory, L – Laboratory Course, L / T – Laboratory Integrated Theory

SEMESTER - V (Third year)											
SL. No	**Course Category**	**Course Code**	**Course Type**	**Name of the Course**	**Hours per week**			**Credit**	**IA**	**EA**	**TM**
					L	**T**	**P**				
1.	PCC	BMTF245 T10	L / T	Theory of Machines	3	-	2	**4**	40	60	100
2.	PCC	BMEF245 T20	L / T	System Dynamics and Control	3	-	2	**4**	40	60	100
3.	PCC	BMTF245 T30	L / T	Microprocessor and Microcontroller	3	-	2	**4**	40	60	100
4.	PCC	BMTF245 T40	T	Analytical Instrumentation	3	-	-	**3**	40	60	100
5.	PCC	BMTF245 T50	T	Industrial Data Communication	3	-	-	**3**	40	60	100
6.	OEC	-	T	Open Elective – I	3	-	-	**3**	40	60	100
7.	PCC	BMEF245 P60	L	Machine Drawing Practical	-	-	4	**2**	40	60	100
8.	VSEC	BMEF24 MC08	T	Entrepreneurship and Start-ups[#]	1	-	-	**1***	100	-	100
Total					**19**	**-**	**10**	**23+1***			

SEMESTER - VI (Third year)											
SL. No	**Course Category**	**Course Code**	**Course Type**	**Name of the Course**	**Hours per week**			**Credit**	**IA**	**EA**	**TM**
					L	**T**	**P**				
1.	HSMC	BMEF246 T10	L / T	Operation Research & Management	3	-	2	**4**	40	60	100
2.	PCC	BMEF246 T20	T	Fluid Power Systems	3	-	-	**3**	40	60	100
3.	PCC	BMEF246 T30	L / T	CAD / CAM[#]	3	-	2	**4**	40	60	100
4.	PCC	BMTF246 T40	L / T	PLC and Distributed Control Systems	3	-	2	**4**	40	60	100
5.	PCC	BMEF246 T50	T	Autotronics[#]	3	-	-	**3**	40	60	100
6.	PEC	-	T	PEC – I	3	-	-	**3**	40	60	100
7.	VSEC	BETF246M C09	-	Soft Skill	-	-	-	**1***	100	-	100
8.	VSEC	BMTF246S I01	-	Summer Internship	-	-	-	**1***	100	-	100
Total					**18**	**-**	**06**	**21+2***			
Total Credit in the third year								**44+3***			

[#] Common to Mechanical & Mechatronics Engineering

* Not accountable for GPA calculation

Course Type: T – Theory Course, L – Laboratory Course, L / T – Laboratory Integrated Theory Course

SEMESTER - VII (Fourth year)											
SL. No	**Course Category**	**Course Code**	**Course Type**	**Name of the Course**	**Hours per week**			**Credit**	**IA**	**EA**	**TM**
					L	**T**	**P**				
1.	PCC	BMTF247 T10	T	Industrial Electronics	3	-	-	**3**	40	60	100
2.	PCC	BMTF247 T20	L / T	Fundamentals of Robotics	3	-	2	**4**	40	60	100
3.	PCC	BMTF247 T30	L / T	Virtual Instrumentation	3	-	2	**4**	40	60	100
4.	PEC	-	T	PEC - II	3	-	-	**3**	40	60	100
5.	PEC	-	T	PEC - III	3	-	-	**3**	40	60	100
6.	OEC	-	T	Open Elective - II	3	-	-	**3**	40	60	100
7.	PSC	BMEF247 Z10	L	Design and Fabrication Project	-	-	6	**3**	40	60	100
8.	VSEC	BETF247 MC10	-	Presentation / Publication in Conference / Seminar /Competitions	-	-	-	**1***	100	-	100
Total					**18**	**-**	**10**	**23+1***			

SEMESTER - VIII (Fourth year)											
SL. No	**Course Category**	**Course Code**	**Course Type**	**Name of the Course**	**Hours per week**			**Credit**	**IA**	**EA**	**TM**
					L	**T**	**P**				
1.	HSMC	BMTF248 T10	T	Principles of Management and Professional Ethics	3	-	-	**3**	40	60	100
2.	PEC	-	T	PEC - IV	3	-	-	**3**	40	60	100
3.	PROJ-ME	BMTF248 Z20	L	Project Work	-	-	16	**8**	40	60	100
Total					**06**	**-**	**16**	**14**			
Total Credit in Fourth year								**37+1***			

#Common to Mechanical & Mechatronics Engineering

*Not accountable for GPA calculation

Course Type: T – Theory Course, L – Laboratory Course, L / T – Laboratory Integrated Theory Course

PROFESSIONAL ELECTIVE COURSES							
SL. No	**Category**	**Code**	**Course Title**	**Hours per week**			**Credit**
				L	**T**	**P**	
1.	**PEC-I** (Product Design & Manufacturing)	BMEF246E1A	Sustainable Manufacturing	**3**	**-**	**-**	**3**
2.		BMEF246E1B	Product Design & Development				
3.		BMEF246E1C	Composite Materials				
4.		BMEF246E1D	Tribology in Design				
5.		BMEF246E1E	Geometric Dimensioning and Tolerancing				
1.	**PEC-II** (Robotics)	BMTF247E2A	Medical Robotics	**3**	**-**	**-**	**3**
2.		BMTF247E2B	Mobile Robotics				
3.		BMTF247E2C	Humanoid Robotics				
4.		BMTF247E2D	Robot Operating Systems				
5.		BMTF247E2E	Agricultural Robotics				
6.		BMTF247E2F	Robot Kinematics				
7.		BMTF247E2G	Robot Dynamics and Control				
1.	**PEC-III** (Sensor and Control Technologies)	BMEF247E3A	Machine Vision	**3**	**-**	**-**	**3**
2.		BMTF247E3B	Power Plant Instrumentation				
3.		BMTF247E3C	Medical Sensors				
4.		BMTF247E3D	Aircraft Instrumentation				
5.		BMTF247E3E	Process Control				
6.		BMTF247E3F	Digital Control System				
7.		BMTF247E3G	Smart Sensors				
1.	**PEC-IV** (Intelligent Automation)	BMTF248E4A	IoT in Automation	**3**	**-**	**-**	**3**
2.		BMTF248E4B	Advanced Industrial Automation				
3.		BMTF248E4C	Data Analytics for IoT				
4.		BMTF248E4D	Computer-Integrated Manufacturing				
5.		BMTF258E4E	Embedded Systems				
6.		BMTF258E4F	Machine Learning				
7.		BMTF258E4G	Robot Control Using ROS				

OPEN ELECTIVE COURSES							
SL. No	**Category**	**Code**	**Course Title**	**Hours per week**			**Credit**
				L	**T**	**P**	
1.	**OEC – I**	BMET245OEA	Cloud Computing	**3**	**-**	**-**	**3**
2.		BMET245OEB	Web Design				
3.		BMET245OEC	Digital Image Processing				
4.		BMET245OED	Data Science for Engineers				
5.		BMET245OEE	Astro-Physics				
6.		BMET245OEF	Business Administration				
7.		BMET245OEG	Drone Technology				
8.		BMET245OEH	Safety Engineering				
9.		BMET245OEI	Bio-fuels				
10.		BMET245OEJ	Cyber Security				
11.		BMET245OEK	French Primer				
12.		BMET245OEL	Japanese				
13.		BMET245OEM	German Primer				
14.		BMET245OEN	Communication Skills				
15.		BMET245OEO	Hindi Literatures				
16.	**OEC - II**	BMET247OEA	Vocal Music	**3**	**-**	**-**	**3**
17.		BMET247OEB	Green Electronics				
18.		BMET247OEC	Nano Technology & Surface Engineering				
19.		BMET247OED	Disaster Management & Mitigation				
20.		BMET247OEE	Rainwater Harvesting Techniques				
21.		BMET247OEF	HR Management				
22.		BMET247OEG	Nuclear and particle physics				
23.		BMET247OEH	Solar PV Fundamentals and Applications				
24.		BMET247OEI	Psychology				
25.		BMET247OEJ	Statistical methods with excel				
26.		BMET247OEK	Key Board				
27.		BMET247OEL	Logistics and Supply Chain				
28.		BMET247OEM	Panini Grammar				
29.		BMET247OEN	Violin				

SYLLABUS
B.E. Mechatronics Engineering (Full Time)
SEMESTER - I

Course Code	Course Name	Semester	Credits	L T P C
	ENGLISH	1		2 0 0 2

COURSE OBJECTIVES

- Learn technical vocabulary and use it while speaking and writing in the professional arena.
- Help the students to understand the nuances of Grammar.
- To make learners acquire listening and help them to comprehend lectures and presentation.
- Develop strategies and skills to enhance students' ability to read and comprehend.
- Strengthen their proficiency in speaking and writing effectively which will help them comprehend lectures and talks in their areas of specialization.
- To make them acquire language skills at their own pace by using e-materials and language lab components.

UNIT-I: Vocabulary Building — **9**

1.1 The concept of Word Formation
1.2 Root words from foreign languages and their use in English
1.3 Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives.
1.4 Synonyms, antonyms, and standard abbreviations.

UNIT-II: Basic Writing Skills — **9**

2.1 Sentence Structures
2.2 Use of phrases and clauses in sentences
2.3 Importance of proper punctuation
2.4 Creating coherence
2.5 Organizing principles of paragraphs in documents
2.6 Techniques for writing precisely

UNIT-III: Identifying Common Errors in Writing — **9**

3.1 Subject-verb agreement
3.2 Noun-pronoun agreement
3.3 Misplaced modifiers
3.4 Articles
3.5 Prepositions
3.6 Redundancies
3.7 Clichés

UNIT-IV: Nature and Style of sensible Writing — **9**

4.1 Describing
4.2 Defining
4.3 Classifying
4.4 Providing examples or evidence
4.5 Writing introduction and conclusion

UNIT-V: Writing Practices — **9**

5.1 Comprehension
5.2 Précis Writing
5.3 Essay Writing

PRACTICE: ORAL COMMUNICATION

(This unit involves interactive practice sessions in Language Lab)

- Listening Comprehension
- Pronunciation, Intonation, Stress and Rhythm
- Common Everyday Situations: Conversations and Dialogues
- Communication at Workplace
- Interviews
- Formal Presentations

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Understand the nuances of grammar and vocabulary in speaking and writing.
2.	Listen and comprehend different spoken excerpts critically, infer and implied meanings.
3.	Speak convincingly, express their opinions clearly, initiate a discussion, negotiate, argue using appropriate communicative strategies.
4.	Read different genres of texts, infer implied meanings and critically analyse and evaluate them for ideas as well as for method of presentation.
5.	Write effectively and persuasively and by using different techniques of writing such as narration, description, exposition and argument as well as creative, critical, analytical and evaluative writing.

TEXT BOOK

1.	Practical English Usage. Michael Swan. OUP. 1995
2.	Remedial English Grammar. F.T. Wood. Macmillan.2007

REFERENCES

1.	On Writing Well. William Zinsser. Harper Resource Book. 2001
2.	Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006
3.	Communication Skills. Sanjay Kumar and PushpLata. Oxford University Press. 2011
4.	Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02
CO1														
CO2														
CO3														
CO4														
CO5														

Course Code	Course Name	Semester	Credits	L T P C
	Engineering Mathematics – I (Calculus, Ordinary Differential Equations, and Complex Variables)	**1**	**Credits**	**3 1 0 4**

COURSE OBJECTIVES

- To equip students with techniques to solve ordinary differential equations using analytical and numerical methods.
- To develop an understanding of partial differential equations and methods of finding their general and particular solutions.
- To introduce Fourier series and their applications in representing periodic functions.
- To familiarize students with Laplace transforms and their use in solving differential equations.
- To provide a foundation in Fourier transforms and their properties for analyzing signals and systems.

UNIT- I DIFFERENTIAL EQUATIONS **9**

Method of variation of parameters - Equations reducible to linear equations with constant coefficients: Cauchy's homogeneous linear equation.- solving of Ordinary differential equations using Numerical methods: Taylor's series, Runge-Kutta method of fourth order for solving first order equations - Milne's predicator corrector methods.

UNIT-II PARTIAL DIFFERENTIAL EQUATIONS **9**

Formation of partial differential equations – Solution of a partial differential equation – Equations solvable by direct integration – Linear equations of first order – Non linear equations of the first order – Charpit's method - Homogeneous linear equations with constant coefficients – Rules for finding complementary functions – Rules for finding particular integral – Solution of homogeneous linear equation of any order.

UNIT-III FOURIER SERIES **9**

Introduction - Euler's Formulae - Conditions for a Fourier expansion - Functions having points of discontinuity - Change of interval - Odd and even function - Expansions of odd or even periodic functions - Half-range series - Typical wave-forms - Parseval's formula

UNIT-IV LAPLACE TRANSFORMS **9**

Definition, Properties of Laplace transforms: Linearity Property, First shifting property, Change of scale property – Transforms of derivatives - Transforms of integrals - Multiplication by t^n - Division by t - Evaluation of integrals by Laplace transform - Inverse transforms: Method of partial fractions – Other methods of finding inverse - Convolution theorem (without proof) Application to differential equations

UNIT-V FOURIER TRANSFORMS **9**

Fourier integral theorem (without proof) - Fourier Sine and Cosine integrals – Complex form of Fourier integral - Fourier transform – Fourier sine and Cosine transforms – Properties of Fourier Transforms: Linear property, Change of scale property, Shifting property -Parseval's identity for Fourier transforms (without proof)

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Solve ordinary differential equations using analytical methods and numerical techniques such as Taylor's series, Runge-Kutta, and Milne's methods.
2.	Formulate and solve partial differential equations using appropriate methods including Charpit's method.
3.	Represent periodic functions using Fourier series and apply them to solve engineering problems
4.	Apply Laplace transforms and their properties to solve differential equations and evaluate integrals
5.	Use Fourier transforms to analyze signals and solve problems involving integral transforms

TEXT BOOK	
1.	B.S. Grewal, Higher Engineering Mathematics, 42nd Edition, Khanna Publishers.
REFERENCES	
1.	Coddington, E. A, An Introduction to Ordinary Differential Equations. United Kingdom: Dover Publication. (2012)
2.	Simmons, G. F. Differential Equations: With Applications and Historical Notes. India: Tata McGraw-Hill. (2003)
3.	John, F. Partial Differential Equations. Germany: Springer New York(2013)
4.	Evans, L. C. Partial Differential Equations. United States: American Mathematical Society(2022)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PS01**	**PS02**
CO1														
CO2														
CO3														
CO4														
CO5														

Course Code	Course Name	Semester	Credits	L T P C
	APPLIED PHYSICS FOR ENGINEERS	1		3 0 2 4

COURSE OBJECTIVES

- Elastic properties of materials and their applications in beams, cantilevers and metallic ropes under torsion.
- Various acoustical effects in buildings and designing of auditorium for better acoustics.
- Einstein's theory on matter-radiation interaction, Laser principle and Properties, Nd:YAG and CO2 lasers, applications of lasers – IR thermography, light propagation in optical fiber, fiber parameters, types and applications, fiber losses
- Black body radiation, wave particle duality, De Broglie matter waves, physical significance of wave function, Schrodinger time wave equations.
- Dielectric materials, internal field, Superconductors, nanomaterial, methods of synthesis, shape memory alloys (SMA) and Biomaterials

UNIT- I PROPERTIES OF MATTER — **9**

Stress – Strain – Hooke's law – Elastic Behavior of Material – Young's modulus by cantilever depression – Non-uniform bending. Torsional Pendulum – Couple per unit twist of a wire-Time period-Application- Determination of Rigidity Modulus.

UNIT-II TECHNICAL ACOUSTICS — **9**

Acoustics of buildings – Reverberation- Weber Fechner law- Factors affecting acoustics of a building and remedies –Sabine's formula for reverberation time- Absorption coefficient. Ultrasonic waves - Properties - Generation – Piezoelectric method, Detection – Kundt's tube method, Applications – NDT.

UNIT-III LASER PHYSICS — **9**

Einstein's theory of matter - radiation interaction and A and B coefficients; Properties of laser- spontaneous and stimulated emission, amplification of light by population inversion, different types of lasers: solid-state laser(Nd:YAG), gas lasers (CO2), applications –IR Thermography.

UNIT-IV FIBRE OPTICS — **9**

Optical fibre- structure – core and cladding - principle [TIR] - types- material, mode, refractive index profile - Fibre losses -Expression for acceptance angle and numerical aperture. Application-optical fiber- Endoscope, Optical Fiber Communication.

UNIT-V ENGINEERING MATERIALS — **9**

Dielectric materials- Definition– Dielectric loss – Internal field – Claussius Mossotti relation. **Superconducting materials** -Introduction – Properties-Meissner effect – Type I & Type II superconductors – BCS theory. **Nanomaterial**- Introduction – Synthesis of nano materials – Top down and Bottom up approach- Ball milling- PVD method. **Smart materials**- Shape memory alloys-Biomaterials (properties and applications).

LIST OF EXPERIMENTS FOR LABORATORY COURSE

1.	Determination of Rigidity Modulus & Moment of Inertia using Torsional Pendulum
2.	Determination of Young's Modulus.
3.	Determination of Wavelength of Laser light using transmission grating
4.	Determination of particle size using LASER
5.	Measurement of numerical aperture of an optical fiber.
6.	Determination of wavelength of light using Newton's Rings apparatus
7.	Determination of Velocity of sound waves in liquid using Ultrasonic interferometer
8.	Determination of wavelength of prominent colours of mercury spectrum using grating
9.	Determination of number of lines per meter of the grating using normal incidence method
10.	Determination of refractive index of the given prism using minimum deviation method

11.	Determination of emissivity of the surface of a black body
12.	Basic logic gates- Verification of truth tables
13.	NAND-Universal building block
14.	NOR-Universal building block
15.	Zener diode- I-V characteristics
16.	Study of LCR circuit
CO	**COURSE OUTCOMES**
At the end of the course, the student will gain adequate knowledge about	
1.	Young's modulus, bulk modulus and rigidity modulus of materials, cantilevers and metallic ropes under torsion
2.	Various acoustical problems in buildings and designing of auditorium for better acoustics
3.	Spontaneous and stimulated emissions, basic principles and properties of Laser, designing and working of Nd: YAG and CO2 lasers, applications, IR thermograph, optical fiber, fiber parameters, types and applications, fiber losses
4.	Black body radiation, wave particle duality, De Broglie matter waves, physical significance of wave function, Schrodinger time wave equations
5.	Dielectric materials, Superconductors, nanomaterials, Ball milling and PVD method of synthesis, shape memory alloys (SMA) and Biomaterials their nature and applications
TEXT BOOKS	
1.	V. Devanathan, "Quantum Mechanics", Narosa, 2011
2.	M.N. Avadhanulu, "Engineering Physics", S Chand & Co, 2007
3.	Charles Kittel , "Introduction to Solid state Physics", Wiley Student Edition, 2019
4.	D. Halliday, R. Resnick and J. Walker, "Fundamentals of Physics", Wiley, 2001
5.	Arthur Beiser, Shobhit Mahajan, S. Rai Choudhury, "Concepts of Modern Physics", McGraw Hill, 2017
REFERENCES	
1.	K.Venkatramanan, R.Raja, M.Sundarrajan, "Applied Physics for Engineers", Scitech, 2014 [units I, III-V]
2.	Sathyaprakash, "Quantum Mechanics", Pragati Prakashan, 2016 [unit IV]

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02
CO1														
CO2														
CO3														
CO4														
CO5														

Course Code	Course Name	Semester	Credits	L T P C
	UNIVERSAL HUMAN VALUES	**1**		**3 0 0 3**

COURSE OBJECTIVES

- To help the students appreciate the complementarity between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
- To facilitate the development of a Holistic perspective among students towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence.
- To highlight Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behaviour and mutually enriching interaction with Nature.
- This course is intended to provide a much-needed orientation input in value education to the young enquiring minds.

Unit – I: Introduction to Value Education | **9**

Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education) Understanding Value Education, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity – the Basic Human Aspirations, Happiness and Prosperity – Current Scenario, Method to Fulfill the Basic Human Aspirations

Unit - II: Harmony in the Human Being | **9**

Understanding Human being as the Co-existence of the Self and the Body, Distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in the Self, Harmony of the Self with the Body, Programme to ensure self-regulation and Health

Unit III: Harmony in the Family and Society | **9**

Harmony in the Family – the Basic Unit of Human Interaction, 'Trust' – the Foundational Value in Relationship, 'Respect' – as the Right Evaluation, Other Feelings, Justice in Human-toHuman Relationship, Understanding Harmony in the Society, Vision for the Universal Human Order

Unit – IV : Harmony in the Nature/Existence : | **9**

Understanding Harmony in the Nature, Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature, Realizing Existence as Co-existence at All Levels, The Holistic Perception of Harmony in Existence

Unit - V: Implications of the Holistic Understanding – a Look at Professional Ethics | **9**

Natural Acceptance of Human Values, Definitiveness of (Ethical) Human Conduct, A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Competence in Professional Ethics Holistic Technologies, Production Systems and Management Models-Typical Case Studies, Strategies for Transition towards Value-based Life and Profession

CO	COURSE OUTCOMES
At the end of the course the students will be able to	
1.	They would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind
2.	They would have better critical ability.
3.	They would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society)
4.	It is hoped that they would be able to apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction

TEXT BOOK	
1.	The Textbook A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 97893-87034- 47-1
2.	The Teacher"s Manual for A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G

REFERENCES

References:

1. Jeevan Vidya: EkParichaya, A Nagaraj, Jeevan Vidya Prakashan, Amar kantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas.
5. Karamchand Gandhi [5]. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews.
7. Economy of Permanence - J C Kumarappa.
8. Bharat Mein Angreji Raj – Pandit Sunderlal.
9. Rediscovering India - by Dharampal.
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi.
11. India Wins Freedom - Maulana Abdul Kalam Azad.
12. Vivekananda - Romain Rolland (English).
13. Gandhi - Romain Rolland (English).
14. Sussan George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986, 1991.
15. Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III, 1972, Limits to Growth – Club of Rome's report, Universe Books.
16. A Nagraj, 1998, JeevanVidya EkParichay, Divya Path Sansthan, Amarkantak.
17. P L Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Publishers.
18. A N Tripathy, 2003, Human Values, New Age International Publishers.
19. Subhas Palekar, 2000, How to practice Natural Farming, Pracheen (Vaidik) KrishiTantra Shodh, Amravati.
20. E G Seebauer& Robert L. Berry, 2000, Fundamentals of Ethics for Scientists & Engineers , Oxford University Press.
21. M Govindrajran, S Natrajan & V.S. Senthil Kumar, Engineering Ethics (including Human Values), Eastern Economy Edition, Prentice Hall of India Ltd.
22. B P Banerjee, 2005, Foundations of Ethics and Management, Excel Books.
23. B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.

Web links and Video Lectures (e-Resources):

- Value Education websites,
- https://www.uhv.org.in/uhv-ii,
- http://uhv.ac.in,
- http://www.uptu.ac.in
- Story of Stuff,
- http://www.storyofstuff.com
- Al Gore, An Inconvenient Truth, Paramount Classics, USA
- Charlie Chaplin, Modern Times, United Artists, USA
- IIT Delhi, Modern Technology – the Untold Story
- Gandhi A., Right Here Right Now, Cyclewala Productions
- https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw
- https://fdp-si.aicte-india.org/8dayUHV_download.php
- https://www.youtube.com/watch?v=8ovkLRYXIjE
- https://www.youtube.com/watch?v=OgdNx0X923I
- https://www.youtube.com/watch?v=nGRcbRpvGoU
- https://www.youtube.com/watch?v=sDxGXOgYEKM

Course Code	Course Name	Semester	Credits	L T P C
	ENVIRONMENTAL SCIENCE AND ENGINEERING	1		2 0 0 0

COURSE OBJECTIVES

- To familiarize the students with basic concepts of environment
- To understand their role and responsibility of an individual in the environmental conservation.

UNIT-I: Introduction to environment and environmental studies	**9**

Introduction to environment – components – nature of environment - need of awareness –reason for environmental problems – anthropocentric and eco centric views.
Environmental studies - multidisciplinary nature – scope and aim – sustainable development- principles – RRR concept-Indian environmental movements – environmental calendar.

UNIT-II: Ecosystem and Biodiversity	**9**

Ecosystem – structure – functions – simplified ecosystem models (food chain and food webs and their types,energy flow) - forest – grassland – pond –ecosystems – ecological succession - ecological pyramids – Bio-geochemical cycles of water – oxygen-carbon-phosphorous and sulphur.
Biodiversity – definition – types – species – genetic and ecosystem diversities- values of biodiversity – threats to biodiversity – conservation of biodiversity – endemism – biodiversity hotspots – Indian biodiversity– endemic species of India – IUCN lists -red-green and blue data books.

UNIT-III: Natural resources	**9**

Natural resources – definition – types – forest resources – uses –deforestation- reasons - effects –water resources – dams – effects of dams - food resources – modern agriculture– ill effects -energy resources- types – hydel –nuclear – solar –wind and biomass energy - world scenario – Indian scenario.
Population and environment – reasons for over exploitation of resources – population – demography – population curves – population explosion – effects – consumerism – effects – urbanization – reasons and effects- role of an individual.

UNIT-IV: Environmental Pollution	**9**

Pollution – definition – types – air pollution – causes and effects – effects of CO_2 – CO – NOx –SOx – particulates – control of air pollution – water pollution – causes – effects – remedies – soil pollution – solid waste management – e waste – ill effects of e-waste – proper recycling- Noise pollution – reasons – effects – control – nuclear pollution – causes – effects and control –thermal pollution - causes – effects and remedies.
Legal provisions for protecting environment – article 48 A – 51 A (g) – Environment act 1986 – Air act 1981 – Water act 1974 – wild life protection act – Forest act 1980- problems in implementation–reasons.

Unit-V: Social issues and environmental ethics	**9**

Present environmental scenario – green house effect – climate change – The Kyoto Protocol – ozone layer depletion-The Montreal Protocol - acid rain – causes – effects - disparity among the nations – The Copenhagen UNFCCC summit – carbon currency- virtual water- genetically modified organisms, Disaster management.
Environmental ethics – introduction – people getting affected - resettlement and rehabilitation – issues involved –Sardhar Sarovar project – Tawa Matsya sang - Melting icebergs of Arctic.

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Understand the individual responsibility towards environment
2.	Create Eco-centrism approach towards sustainable society
3.	Enable the learners to understand, think and evolve strategies for management and conservation of environment for sustaining life on earth.
4.	Develop a new solution towards various environmental problems
5.	Understand the current environmental trends of India and the world and about environmental legislation
TEXT BOOK	
1.	Anubha Kaushik and C.P. Kaushik, "Prospects of Environmental Science", New Age International publishers, 2013
REFERENCES	
1.	Environmental Studies, N. Nandini, N. Sunitha and Sucharita Tandon, Sapna Book House, 2007
2.	Text book of Environmental Science, Ragavan Nambiar, Scitech Publications, 2009
3.	Text book of Environmental Chemistry and Pollution Control, S.S.Dara, S.Chand and Co., 2002
4.	Environmental Chemistry, Colin Baird, W.H.Freeman and company, New York,1999
5.	Environmental Chemistry, Gary W. VanLoon and Stephen J.Duffy, Oxford University Press, 2000
6.	New Trends in Green Chemistry, V.K. Ahluwalia and M. Kidwai, Anamaya Publishers, 2006

Course Title	DESIGN THINKING AND IDEA LAB	Semester	Credits	L T P C
Course Code		1		3 0 2 4

OBJECTIVES

- To understand various learning process, understanding the problems and enhancement techniques on innovative engineering products.
- To understand the importance of the design thinking tools.
- To learn about the problem-solving techniques and gain the knowledge about Empathy methods.
- To develop skills in ideation, product design tools and prototyping.
- To develop skills in testing, innovations, and collaboration on novel products.

UNIT - I BASICS OF LEARNING, UNDERSTANDING AND ENHANCEMENT TECHINIQUES **9**

Principles and Dimensions of Learning Process – Learning Styles - Human Centered Design – Assessing and Interpreting – Learning Retention process – Memory Enhancement Techniques – Emotions and Psychology – Importance of Peer Learning.

UNIT - II DESIGN THINKING TOOLS & TECHNIQUES **9**

Design Thinking process – Need of Design Thinking – Objectives of Design Thinking – Design Thinking Frameworks – Design Thinking Mindsets – Design Thinking Tools – Empathize, Define, Ideate, Prototype and Test.

UNIT - III EMPATHY **9**

Role of Empathy – Methods and tools of Empathy – Defining the problem – Analysis and Synthesis – Empathy Mapping & its types – Double diamond design thinking -Ethical reasoning.

UNIT - IV IDEATION, PROTOTYPING & TESTING **9**

Ideation methods – Brainstorming techniques - Prototype – Need of Prototype – Types of Prototype – Rapid Prototyping – Testing: Purpose of testing – Types of testing - Designing for business growth

UNIT - V ETHICS & SUSTAINABILITY **9**

Values of morals – Five ways of ethical thinking – Ethical issues – Sources of ethics – Universal principle of Ethics – Ethical design test – Sustainability and sustainable futures – Pillers of sustainability – Sustainable design – Desing thinking for 2030 agenda.

CASE STUDIES (Practical only)

Real life case studies – Karnataka health promotion trust – Shriram life insurance corporation – Government of Odisha – Kotak Mahindra Bank - Design Thinking for Patient waiting in Hospitals - Design Thinking for Higher Education – Design Thinking for developing the application / Technology – Design Thinking for Patient waiting in Hospitals - Design Thinking for Seat confirmation in Train/Flight transport - Design Thinking for reducing effect of Global warming.

LIST OF EXPERIMENTS FOR LABORATORY COURSE

1.	To study the working principles and operation of normal lathe machine.
2.	To study the, working and operation of different welding equipment's.
3.	To study the working principles and operation of wood lathe machine.
4.	To study the machining of 3D geometry on soft material such as soft wood or modelling wax.
5.	To study the 2D profile cutting on plywood /MDF (6-12 mm) for press fit designs.
6.	To study the 3D 2D profile cutting of press fit box/casing in acrylic (3 or 6 mm

	thickness)/cardboard, MDF (2 mm) board using laser cutter & engraver
7.	Scanning of computer mouse geometry surface. 3D printing of scanned geometry using FDM or SLA printer.
8.	Schematic and PCB layout design of a suitable circuit, fabrication and testing of the circuit.
9.	Embedded programming using Arduino and/or Raspberry Pi.
10.	Design and implementation of a capstone project involving embedded hardware, software and machined or 3D printed enclosure.
❖ Discussion and Implementations of a Mini Project ❖ Documentation of the Mini Project (Report & Video)	
CO	**COURSE OUTCOMES**
Upon completion of this course, Students should be able to	
1.	Classify the various learning principles and styles, memory technologies, and assess the emotional experience when examining emotional expressions in engineering education in order to create novel products.
2.	Discover the importance of brainstorming and how to apply design thinking tools to produce new products through innovative thinking.
3.	Propose the suitable problem-solving techniques through different Empathy tools and methods on defining problem statement on new products.
4.	Generate new ideation techniques applied on new product design and evaluate prototype effectiveness on different suitable developed prototype models.
5.	Apply diffusive and convective mass transfer equations and correlations to solve problems for different applications.
TEXT BOOKS	
1.	Balaguruswamy, E., "Design Thinking", Mc Graw Hill, First Edition, January 2024.
2.	Idris Mootee, Design thinking for strategic innovation, Wiley publications, 2013.
3.	Hasso Plattner, Christoph Meinel and Larry Leifer (eds), "Design Thinking: Understand – Improve – Apply", Springer, 2011.
4.	Michael Lewrick, Patrick Link, and Larry Leifer, The Design Thinking Playbook: Mindful Digital Transformation of Teams, Products, Services, Businesses and Ecosystems, 2018, John Wiley & Sons.
REFERENCES	
1.	Tom Kelley, The Art of Innovation: Lessons in Creativity from IDEO, America's Leading Design Firm, Currency/Doubleday, 2001
2.	Tim Brown, Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation, HarperCollins Publishers Ltd, 2009
3.	Ulrich & Eppinger, Product Design and Development, 3rd Edition, McGraw Hill, 2004.
4.	Kevin Otto, Kristin Wood, Product Design: Techniques in Reverse Engineering and New Product Development, Pearson publications, 2001.
5.	All-in-One Electronics Simplified, A.K. Maini; 2021. ISBN-13: 978-9386173393, Khanna Book Publishing Company, New Delhi.
6.	3D Printing & Design, Dr. Sabrie Soloman, ISBN: 978-9386173768, Khanna Book Publishing Company, New Delhi.
7.	The Big Book of Maker Skills: Tools & Techniques for Building Great Tech Projects. Chris Hackett. Weldon Owen; 2018. ISBN-13: 978-1681884325.

SEMESTER - II

Course Code	Course Name	Semester	Credits	L T P C
	ENGINEERING MATHEMATICS - II	2		3 1 0 4

COURSE OBJECTIVES

- To understand matrix theory, including eigenvalues, eigenvectors, and quadratic forms, for solving engineering problems
- To apply numerical methods for solving algebraic and transcendental equations using both direct and iterative techniques
- To learn interpolation, numerical differentiation, and integration methods for approximating functions and values.
- To evaluate multiple integrals and use Beta and Gamma functions in engineering applications.
- To apply vector calculus concepts and theorems to solve problems in physics and engineering fields

UNIT- I MATRICES — **9**

Eigen Value and Eigen Vectors – Properties of Eigen Values – Cayley-Hamilton Theorem – Reduction to Diagonal Form – Reduction of Quadratic Form to Canonical Form – Nature of Quadratic Forms.

UNIT-II NUMERICAL SOLUTIONS TO ALGEBRAIC EQUATIONS — **9**

Introduction – Solution of Algebraic and Transcendental Equations – Bisection Method, Method of False Position, Newton's Method – Solution of Linear Simultaneous Equations – Direct Methods of Solution – Gauss Elimination, Gauss-Jordan Method – Indirect Methods of Solution – Jacobi's Method, Gauss-Seidel Method.

UNIT-III INTERPOLATION, NUMERICAL DIFFERENTIATION AND INTEGRATION — **9**

Finite Differences – Newton's Interpolation Formula – Interpolation with Unequal Intervals – Lagrange's Formula – Divided Differences – Newton's Divided Difference Formula. Numerical Differentiation – Formulae for Derivatives – Numerical Integration – Newton-Cote's Quadrature Formula – Trapezoidal Rule – Simpson's 1/3rd Rule – Simpson's 3/8th Rule.

UNIT-IV MULTIPLE INTEGRALS AND BETA-GAMMA FUNCTIONS — **9**

Double Integrals – Change of Order of Integration – Double Integrals in Polar Coordinates – Area enclosed by Plane Curves – Triple Integrals – Volume of Solids – Beta Function – Gamma Function – Relation between Beta Function and Gamma Function

UNIT-V VECTOR CALCULUS — **9**

Scalar and Vector Point Functions-Vector Operator del. – Del applied to Scalar Point Functions-Gradient – Del applied to Vector Point Functions-Divergence and Curl – Del applied twice to Point Functions – Del applied to Product of Point Functions – Integration of Vectors – Line Integrals-Circulation-Work – Surface Integral-Flux – Green's Theorem in the Plane – Stoke's Theorem – Volume Integral – Divergence Theorem – Irrotational and Solenoidal Fields.(statement only for theorems).

CO	COURSE OUTCOMES
After successful completion of this course, students will be able to	
1.	Solve problems involving eigenvalues, eigenvectors, and reduce matrices and quadratic forms to canonical forms.
2.	Apply numerical methods to find approximate solutions of algebraic and transcendental equations.
3.	Use interpolation techniques and numerical integration/differentiation for estimating values from data.
4.	Evaluate double and triple integrals, and apply Beta and Gamma functions in engineering contexts.
5.	Compute gradient, divergence, and curl, and apply vector integral theorems in physical applications.

TEXT BOOK

1. B.S. Grewal, Higher Engineering Mathematics, 42nd Edition, Khanna Publishers.

REFERENCE

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PS01**	**PS02**
CO1														
CO2														
CO3														
CO4														
CO5														

ourse Code	Course Name	Semester	Credits	L T P C
	ENGINEERING CHEMISTRY	2		3 0 2 4

COURSE OBJECTIVES

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UNIT- I MOLECULAR ENGINEERING AND NANOTECHNOLOGY	9

Review of chemical bonding - MO theory – formation of H2,He2,O2,N2,CO and HF – hybridization definition- CH4,C2H4 and C2H2 - Supramolecular chemistry definition – types of molecular assemblies - molecular machines (concepts only) – Nanomaterials-differences between bulk and nanophases - synthesis (top-down and bottom-up) - Applications: sensors, energy devices, coatings

UNIT-II ENGINEERING MATERIALS – POLYMERS, CERAMICS & COMPOSITES	9

Polymers – introduction – types - advanced functional polymers -conducting polymers - biodegradable plastics – PLA and cellulose derivatives - Engineering ceramics – properties – types – oxide (Alumina and zirconia) non-oxide (SiC) and composite ceramics (metal cements) - applications - Composite materials: classification and uses.

UNIT-III ELECTROCHEMISTRY AND CORROSION CONTROL	9

Electrodes – types of electrodes – SEP – Nernst equation -Electrochemical cells, EMF, Nernst equation for cells -Batteries- Ni-Cd and Li-ion batteries - supercapacitors – introduction only - fuel cells introduction and types - Corrosion: types of corrosion - mechanisms, protection strategies.

UNIT-IV WATER TREATMENT TECHNOLOGY	9

Water as universal solvent – hardness-types - units of hardness -estimation of hardness - disadvantages of hard water – scale and sludges – water softening methods - ion exchange method, RO methods - Wastewater treatment: primary to tertiary methods - water pollutants types- heavy metals, microplastics and pesticide residues – effects. Domestic water treatment.

UNIT-V INTRODUCTION TO GREEN CHEMISTRY	9

Introduction to Green Chemistry – definition, scope, and significance - Twelve Principles of Green Chemistry – Atom Economy – definition, calculation, and applications, Carbon Footprint and Water Footprint – concepts and relevance in chemical industries -LCA – introduction- imporatnace- Green Synthetic Methodologies – use of green solvents, supercritical fluids, and ionic liquids - Solvent- Free Reactions – techniques and advantages - Microwave-Assisted and Sonochemical Reactions – principles, mechanisms, and applications.

LIST OF EXPERIMENTS FOR LABORATORY COURSE

1.	Kinetics of Green synthesis of silver nanoparticles-Colorimetry
2.	Determination of hardness of water (EDTA method)
3.	Estimation of DO of water samples
4.	Estimation of COD of water samples
5.	Verification of Nernst equation for an electrode
6.	Electrochemical cell construction and EMF measurement
7.	Corrosion studies of metals
8.	Prediction of Feasibility of cells.
9.	Bioplastic preparation and testing.
10.	Ion exchange water purification
11.	Green synthesis of b*is*-naphthol
12.	Air particulate analysis using filter method

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	
2.	
3.	
4.	
5.	
TEXT BOOK	
1.	Jain & Jain, Engineering Chemistry, Dhanpat Rai Publishing, Latest Edition.
REFERENCES	
1.	P.C. Jain & Monika Jain, *Engineering Chemistry*, Dhanpat Rai Publishing
2.	Shashi Chawla, *A Textbook of Engineering Chemistry*, Dhanpat Rai & Co
3.	S.S. Dara & S.S. Umare, *Engineering Chemistry*, S. Chand & Company
4.	R. Mukhopadhyay, *Advanced Engineering Chemistry*, New Age International
5.	Anastas & Warner, *Green Chemistry: Theory and Practice*, Oxford University Press

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PS01**	**PS02**
CO1														
CO2														
CO3														
CO4														
CO5														

Course Code	Course Name	Semester	Credits	L T P C
	BASIC ELECTRICAL ENGINEERING	2		2 1 0 3

COURSE OBJECTIVES

- To understand and analyze basic electric and magnetic circuits.
- To study the working principles of electrical machines and power converters.
- To introduce the components of low voltage electrical installations.

UNIT-I DC CIRCUITS — **9**

Electrical circuit elements (R, L and C), voltage and current sources, Kirchoff current and voltage laws, analysis of simple circuits with dc excitation-Superposition, Thevenin and Norton Theorems.

UNIT-II AC CIRCUITS — **9**

Representation of sinusoidal waveforms, peak and rms values, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series), series resonance -Three-phase balanced circuit-voltage and current relationship in star and delta connections.

UNIT-III ELECTRICAL MACHINES (STATIC) — **9**

Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, transformer losses, regulation and efficiency. Auto-transformer and three-phase transformer connections.

UNIT-IV ELECTRICAL MACHINES (ROTATING) — **9**

Construction and working principle – DC motor, Three-phase induction motor and Single- phase induction motor - torque –slip characteristics (three phase)-starting and speed control of three phase induction motor – Construction and working principle of DC generator and Three phase alternator.

UNIT-V POWER CONVERTER AND ELECTRICAL INSTALLATIONS — **9**

DC-DC buck and boost converters – Single phase voltage source inverters – Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Cables - Earthing - Types of Batteries - Power factor improvement.

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Explain the basic electrical quantities and laws
2.	Explain the construction, types and applications of electrical machines
3.	Study the working principles of power converters
4.	Show the tariff or a given load and energy consumption
5.	Introduce the components of low voltage electrical installations and its applications

TEXT BOOK

1.	D. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2010.
2.	D. C. Kulshreshtha, "Basic Electrical Engineering", Tata McGraw Hill, 2009.

REFERENCES

1.	L. S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press, 2011.
2.	E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.
3.	V. D. Toro, "Electrical Engineering Fundamentals", Prentice Hall India, 1989.

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02
CO1	✓	✓	✓	✓	✓	✓	✓	-	✓	✓	-	✓		
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
CO3	✓	✓	✓	✓	✓	✓	✓	-	✓	✓	-	✓		
CO4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		

Course Code	Course Name	Semester	Credits	L T P C
	PROGRAMMING FOR PROBLEM SOLVING	2		3 0 0 2

COURSE OBJECTIVES

- The course is designed to provide complete knowledge of C and basic of C++.
- To provide students an exposure to gain the knowledge
- To ensure that students begin to learn the concepts of basic programming
- To design a creative solution for real world problems.
- To develop awareness of learning the basic concepts and creating algorithms.

UNIT - I COMPUTER BASICS	**9**
Introduction to components of computer system - Generation of programming languages - Types of Computers - Organization of Computers - Types of memory , Number systems - Idea of Algorithm -Pseudo code - Flow Chart with examples.	
UNIT - II DATA TYPE & CONTROL STRUCTURES	**9**
Introduction to C - Character set, Constants, Variables, Data Types – Operators –Arithmetic expressions and precedence – Decision Making statement - Looping statements.	
UNIT - III ARRAY, STORAGE CLASS, FUNCTIONS	**9**
Arrays and its types - Basic searching–Linear and Binary, Basic sorting, Storage class, Functions–Parameter passing in functions - call by value - call by reference – Passing array to functions-Recursive function.	
UNIT - IV STRUCTURE, UNION, STRINGS AND POINTER	**9**
Structure, array of structures, Union, array of union, String operations. Dynamic Memory Allocation, Introduction to Pointer, basic programs for Pointer arithmetic.	
UNIT - V FILE HANDLING, ,PREPROCESSORAND COMMAND LINE ARGUMENTS	**9**
Introduction to File –Reading File content to display in console, writing console content to file, read the content from file to the writing to another file, overwriting and appending file, random access file handing, Preprocessor directives, basics programs for Command line arguments.	

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Makes students gain a broad perspective about the uses of computers in the engineering industry.
2.	Develops a basic understanding of computers, the concept of algorithm and algorithmic thinking.
3.	Develops the ability to analyze a problem, develop an algorithm to solve it.
4.	Develops the use of the C programming language to implement various algorithms, and develops the basic concepts and terminology of programming in general.
5.	Introduces the features of data structures in this C Programming language.

TEXT BOOK	
1.	Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill
2.	Balagurusamy. E, "Programming in ANSI C", Tata McGraw Hill, Third edition, 2006
3.	Robert Lafore, "Object-Oriented Programming in C++" Pearson Education India, Fourth Edition
REFERENCES	
1.	Let Us 'C' - Yashawant Kanetkar, (Unit-II to V), BPB publications, 10th Edition, 2010
2.	Ashok N Kamthane, "Computer Programming", Pearson education, Second Impression, 2008
WEB SOURCE REFERENCES	
3.	https://www.it.iitb.ac.in/lakshya/workshopContent.html?workshopid=FHf3Ht5njLv Vww7Tz3f8xg
4.	https://nptel.ac.in/courses/106104074

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02
CO1														
CO2														
CO3														
CO4														
CO5														

Course Code	Course Name	Semester	Credits	L T P C
	ENGINEERING GRAPHICS & DESIGN (Theory & Practical)	**2**		**2 0 2 3**

OBJECTIVES

- To introduce and develop the students towards the graphical skills for effective communication of concepts, ideas and design of engineering products.
- To make the students aware of existing national and international standards practiced in technical drawings, drafting and presentations.
- To introduce drafting software and its uses in design and detailing by using AutoCAD.

UNIT – I Introduction to Engineering Drawing	**5**

Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid and Involute; Scales – Plain, Diagonal and Vernier Scales;

UNIT – II Orthographic Projections	**5**

Principles of Orthographic Projections-Conventions - Projections of Points and lines inclined to both planes; Projections of planes inclined Planes - Auxiliary Planes;

UNIT – III Projections of Regular Solids	**5**

Inclined to HP & VP - Auxiliary Views; Draw simple annotation, dimensioning and scale. Floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc

UNIT – IV Sections and Sectional Views of Right Angular Solids	**5**

Prism, Cylinder, Pyramid, Cone – Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone; Draw the sectional orthographic views of geometrical solids, objects from industry and dwellings (foundation to slab only)

UNIT – V Isometric Projections	**5**

: Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa, Conventions;

UNIT – VI	**5**

Overview of Computer Graphics-theory of CAD software-Drawing Area, Dialog boxes and windows- Different methods of zoom as used in CAD-Isometric Views of lines, Planes, Simple and compound Solids-Customisation & CAD Drawing-ISO and ANSI standards for coordinate dimensioning and tolerancing; dimensions to objects-various ways of drawing circles, Annotations, layering & other functions-Setting up and use of Layers, layers to create drawings-color coding according to building drawing practice; Drawing sectional elevation showing foundation to ceiling-Introduction to Building Information Modelling (BIM)

LIST OF EXPERIMENTS

- Introduction to engineering design (CAD)
- Introduction to Auto CAD
- Introduction to BIM

1.	Drafting and modelling with co-ordinate systems
2.	Creation of a simple machined component
3.	Creation of title block
4.	Creation of orthographic views of a cone, cylinder and hexagon
5.	Creation of sectional views of a cone, cylinder and hexagon
6.	Creation of orthographic views
7.	Creation of isometric view of a V-block.
8.	Conversion of 3D to 2D drawings

9.	Creation of 3D solid machine component
10.	Creation of 3D solid V block
11.	Building plan of a simple office
12.	Building plan of a simple home
13.	Creation of simple steel truss

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Draw orthographic projections of lines, planes and solids
2.	Draw projections of solids including cylinder, prism and pyramid.
3.	Draw section of solids including cylinder, prisms and pyramids.
4.	Draw the development of surfaces including cylinder, pyramid and prism
5.	Draw projection of lines, planes, solids, orthographic projection, Isometric projection, and section of solids including cylinder, cone, prism, pyramid and building drawing using Auto CAD.
TEXT BOOK	
1.	Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar Publishing House.
2.	Shah, M.B. & Rana B.C. (2010), Engineering Drawing and Computer Graphics, Pearson Education.
REFERENCES	
1.	Agrawal B. & Agrawal C. M. (2017), Engineering Graphics, TMH Publishers.
2.	Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers.
3.	AUTO CAD User Manual.

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	✓	✓	✓	✓	✓								✓	✓
CO2	✓	✓	✓	✓	✓								✓	✓
CO3	✓	✓	✓	✓	✓								✓	✓
CO4	✓	✓	✓	✓	✓								✓	✓
CO5	✓	✓	✓	✓	✓								✓	✓

Course Code	Course Name	Semester	Credits	L T P C
	BASIC ELECTRICAL ENGINEERING LAB	2		0 0 2 2

COURSE OBJECTIVES

- To study the working of AC and DC drives.
- To measure the basic electrical parameters.
- To experimentally verify the networks theorems.
- To study the basic power conversion circuits.
- To study the working of basic electrical measuring instruments.

LIST OF EXPERIMENTS

1.	Study of Electric Motors (AC & DC Motors).
2.	Load Test on Single Phase Induction Motor.
3.	Load Test on Three Phase Induction Motor.
4.	Load Test on Single Phase Transformer.
5.	Load Test on Three Phase Alternator.
6.	Speed Control of DC Motor.
7.	Speed Control of Three Phase Induction Motor (Pole Changing Method).
8.	Study of Multi meter, CRO and LCR Meter.
9.	Measurement of Voltage, Current and Power.
10.	Verification of Kirchoff's Law.
11.	Verification of Thevenin's Theorem.
12.	B-H Curve of a Magnetic Material.
13.	Rectifier Circuit Analysis (AC – DC).
14.	Inverter Circuit Analysis (DC – AC).
15.	Chopper Circuit Analysis (DC – DC).
16.	Series and Parallel RLC Circuit Analysis.

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Study the various electrical parameters and the measuring instruments.
2.	Study the working of AC and DC drives.
3.	Design and experiment the various network theorems.
4.	Measure the power and power factor in AC circuit.
5.	Understand the three phases balanced and unbalanced supply.

TEXT BOOK

1.	D. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2010.
2.	D. C. Kulshreshtha, "Basic Electrical Engineering", Tata McGraw Hill, 2009.

REFERENCES

1.	L. S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press, 2011.
2.	E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.
3.	V. D. Toro, "Electrical Engineering Fundamentals", Prentice Hall India, 1989.

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02
CO1														
CO2														
CO3														
CO4														
CO5														

Course Code	Course Name	Semester	Credits	L T P C
	PROGRAMMING FOR PROBLEM SOLVING LAB	2		0 0 2 2

COURSE OBJECTIVES

- The course aims to provide exposure to problem-solving through programming.
- To ensure that students begin to understand the fundamentals of Computer programming.
- To be able to effectively choose programming components to solve computing problems in real-world.
- To be able to formulate problems and implement in Computer programming.
- Learning the basic programming constructs them easily switch over to any other language in future.

LIST OF EXPERIMENTS

1.	Basic programs in data types.
2.	Problems in Decision making statements. a. Find the Biggest among 3 numbers. b. Find Even or odd. c. Arithmetic operations using Switch - Case Statements
3.	Problems in looping statements. a. Find the Sum of digits using (i) For loop (ii) While loop b. Generate the Fibonacci series c. Check whether the number is prime or not
4.	Matrix Manipulation-Addition, Subtraction and Multiplication
5.	String operations-string copy, string reverse, string concatenate
6.	Swapping of numbers using call by value, call by reference
7.	Find factorial using recursive functions
8.	Display the student information & marks using Structure & Unions
9.	Evaluate Expressions using library Function using C++ a. πr^2 b. (A+B+(2C/3A)+A2+2B) c. $\sqrt{S(S-A)\ (S-B)\ (S-C)}$ d. LOG $(x^3+y^3+z^3)$
10.	Numerical Methods-Quadratic Equation using C++
11.	Class and object
12.	To implement Constructor and Destructor
13.	To implement Inheritance.

CO	COURSE OUTCOMES	PO
Upon completion of this course, Students should be able to		
1.	Know the basic concepts in problem solving	**PO1, PO5**
2.	Demonstrate the algorithm and flow chart for the given problem	**PO2, PO4**
3.	Design and develop the program to evaluate simple expressions and logical operations.	**PO3**
4.	Write creative solutions using C &C++language	**PO3, PO4**
5.	Design and develop solutions to real world problems.	**PO5**

TEXT BOOK	
1.	Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill
2.	Balagurusamy. E, "Programming in ANSI C", Tata McGraw Hill, Third edition, 2006
3.	Robert Lafore, "Object-Oriented Programming in C++" Pearson Education India, Fourth Edition
REFERENCES	
1.	Let Us 'C' - Yashawant Kanetkar, (Unit-II to V), BPB publications, 10th Edition, 2010
2.	Ashok N Kamthane, "Computer Programming", Pearson education, Second Impression, 2008
3.	Venugopal.K and Kavichithra.C, "Computer Programming", New Age International Publishers, First Edition, 2007
4.	Kernighan B.W and Ritchie,D.M , The C programming language: second edition, Pearson education,2006

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02
CO1														
CO2														
CO3														
CO4														
CO5														

SEMESTER - III

Course Code	Course Name	Semester	Credits	L T P C
	MATHEMATICS – III (Probability and Statistics)	**3**		**3 1 0 4**

COURSE OBJECTIVES

- The objective of this course is to familiarize the students with statistical and probability techniques. It aims to equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling various problems in the discipline.

UNIT - I BASIC PROBABILITY **9**

Probability spaces, conditional probability, Independent random variables, sums of independent random variables, Bayes' Theorem,Discrete and Continuous one dimensional random variables - Expectations, Moments, Variance of a sum, Moment generating function, Tchebyshev's Inequality.

UNIT - II PROBABILITY DISTRIBUTIONS **9**

Discrete Distributions – Binomial, Poisson and Negative Binomial distributions, Continuous Distributions - Normal, Exponential and Gamma distributions.

UNIT - III BASIC STATISTICS **9**

Measures of Central tendency: Averages, mean, median, mode, Measures of dispersion – Range, Mean deviation, Quartile deviation and Standard deviation, Moments, skewness and Kurtosis, Correlation and regression – Rank correlation.

UNIT - IV APPLIED STATISTICS **9**

Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas and more general curves. Test of significance: Large sample test for single proportion, difference of proportions, single mean, difference of means, and difference of standard deviations.

UNIT V SMALL SAMPLES **9**

Test for single mean, difference of means and correlation coefficients, test for ratio of variances - Chi-square test for goodness of fit and independence of attributes.

CO	COURSE OUTCOMES
1.	Basic probability axioms and rules and the moments of discrete and continuous random variables as well as be familiar with common named discrete and continuous random variables.
2.	How to derive the probability function of transformations of random variables and use these techniques to generate data from various distributions.
3.	How to calculate and apply measures of location and measures of dispersion in grouped and ungrouped data cases.
4.	Test of Hypothesis as well as calculate confidence interval for a population parameter for single sample and two sample cases.
5.	How to translate real-world problems into probability models. Also how to collect data, analyze and deduce information from a real time survey without any unwilling bias.

TEXT BOOKS	
1.	T. Veerarajan, "Probability, Statistics and Random Processes", Fourth edition, Tata McGraw-Hill, New Delhi, 2015.
2.	S.P. Gupta, "Statistical Methods, 46th Revised Edition, Sultan chand and sons", New Delhi, 2023.
3.	Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, John Wiley & Sons, 2010.
4.	B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 45th Edition, 2024.
5.	S. Ross, "A First Course in Probability", 10th Ed., Pearson Education India, 2019.
6.	W. Feller, "An Introduction to Probability Theory and its Applications", Vol. 1, 3rd Ed.Wiley, 1968
7.	N.P. Bali and Manish Goyal, "A text book of Engineering Mathematics", 14th Edition, Laxmi Publications, Reprint, 2023.

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	√	√											√	
CO2	√	√											√	
CO3	√	√		√			√				√		√	
CO4	√	√		√			√				√		√	
CO5	√	√		√			√				√		√	

Course Code	Course Name	Semester	Credits	L T P C
	ENGINEERING MECHANICS	3		3 0 0 3

COURSE OBJECTIVES

- To familiarize the basics laws of physics, vector operations and forces.
- To understand the principles of beams, supports and equilibrium of rigid bodies.
- To know the area and mass property calculations of various sections and solids.
- To study and analyse the dynamics of particles by various methods.
- To understand the applications of friction and rigid body dynamics.

UNIT-I STATICS OF PARTICLES **9**

Introduction – Laws of Mechanics – Lami's theorem, Parallelogram and triangular Law of forces, Principle of transmissibility, Vectors – Vectorial representation of forces and moments – Vector operations: additions, subtraction, dot product, cross product – Coplanar Forces – Resolution and Composition of forces – Equilibrium of a particle – Forces in space – Equilibrium of a particle in space – Equivalent systems of forces – Single equivalent force.

UNIT-II EQUILIBRIUM OF RIGID BODIES **9**

Free body diagram – Types of supports and their reactions – requirements of stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis – Vectorial representation of moments and couples – Scalar components of a moment – Varignon's theorem – Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in three dimensions – Examples

UNIT-III PROPERTIES OF SURFACES AND SOLIDS **9**

Determination of Area and Volume – First moment of area and the Centroid of sections – Rectangle, circle, triangle from integration – T section, I section, - Angle section, Hollow section by using standard formula – second and product moments of plane area – Rectangle, triangle, circle from integration – T section, I section, Angle section, Hollow section by using standard formula – Parallel axis theorem and perpendicular axis theorem – Polar moment of inertia – Principal moments of inertia of plane areas – Principal axes of inertia – Mass moment of inertia – Derivation of mass moment of inertia for rectangular section, prism, sphere from first principle – Relation to area moment of inertia.

UNIT-IV DYNAMICS OF PARTICLES **9**

Displacements, Velocity and acceleration, their relationship – Relative motion – Curvilinear motion – Newton's law – Work Energy Equation of particles – Impulse- Momentum principle – Impact of elastic bodies.

UNIT-V FRICTION AND RIGID BODY DYNAMICS **9**

Frictional force – Laws of Coloumb friction – simple contact friction – Rolling resistance – Belt friction-Ladder friction- Translation and Rotation of Rigid Bodies – Velocity and acceleration – General Plane motion of bodies.

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Get familiarized with the basic laws of physics, vector operations and forces.
2.	Understand the principles of beams, supports and equilibrium of rigid bodies.
3.	Calculate the area and mass properties of various sections and solids.
4.	Know about dynamics of particles and their analysis by various methods.
5.	Know about the applications of friction and rigid body dynamics.

TEXT BOOKS

1.	Rajasekaran, S, Sankarasubramanian, G., "Fundamentals of Engineering Mechanics", Vikas Publishing House Pvt. Ltd., (2007), 3rd Edition.
2.	Beer, F.P and Johnson Jr. E.R. "Vector Mechanics for Engineers", Vol. 1 Statics and Vol. 2 Dynamics, Tata McGraw-Hill International Edition, 2017, 11th edition

REFERENCES	
1.	Hibbeler, R.C., "Engineering Mechanics", Vol. 1 Statics, Vol. 2 Dynamics, Pearson Education Asia Pvt. Ltd., (2017).
2.	Palanichamy, M.S., Nagam, S., "Engineering Mechanics – Statics & Dynamics", Tata McGraw-Hill, (2001).
3.	Irving H. Shames, "Engineering Mechanics – Statics and Dynamics", IV Edition – Pearson Education Asia Pvt. Ltd.,(2008).
4.	Ashok Gupta, "Interactive Engineering Mechanics – Statics – A Virtual Tutor (CDROM)", Pearson Education Asia Pvt., Ltd., (2002).
5.	K.L. Kumar, "Engineering Mechanics" Tata McGraw-hill, 2017, 4th Edition
6.	S.S. Bhavikatti, " Engineering Mechanics", New Age International Publishers, 2006
7.	R. S. Khurmi, " Engineering Mechanics", S. Chand Publishers, 2018.

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	√	√	√		√								√	√
CO2	√	√	√		√								√	√
CO3	√	√	√		√								√	√
CO4	√	√	√		√								√	√
CO5	√	√	√		√								√	√

Course Code	Course Name	Semester	Credits	L T P C
	MATERIALS ENGINEERING	**3**	**3**	**3 0 0 3**

COURSE OBJECTIVES

- Understanding of the correlation between the internal structure of materials, their mechanical properties and various methods to quantify their mechanical integrity and failure criteria.
- To provide a detailed interpretation of equilibrium phase diagrams.
- Learning about different phases and heat treatment methods to tailor the properties of Fe-C alloys.

UNIT-I CRYSTAL STRUCTURE **9**

Unit cells, Metallic crystal structures, Ceramics. Imperfection in solids: Point, line, interfacial and volume defects; dislocation strengthening mechanisms and slip systems, critically resolved shear stress.

UNIT-II MECHANICAL PROPERTY MEASUREMENT **9**

Tensile, compression and torsion tests; Young's modulus, relations between true and engineering stress-strain curves, generalized Hooke's law, yielding and yield strength, ductility, resilience, toughness and elastic recovery; Hardness: Rockwell, Brinell and Vickers and their relation to strength. Fracture mechanics: Introduction to Stress-intensity factor approach and Griffith criterion. Fatigue failure: High cycle fatigue, Stress-life approach, SN curve, endurance and fatigue limits, Introduction to nondestructive testing (NDT).

UNIT-III ALLOYS, SOLID SOLUTIONS AND PHASE DIAGRAMS **9**

Interpretation of binary phase diagrams and microstructure development; eutectic, peritectic, peritectoid and monotectic reactions. Iron-carbon phase diagram and microstructure aspects of ledeburite, austenite, ferrite and cementite, cast iron.

UNIT-IV HEAT TREATMENT OF STEEL **9**

Annealing, tempering, normalizing and spheroidising, isothermal transformation diagrams for Fe-C alloys and microstructure development. Continuous cooling curves and interpretation of final microstructures and properties- austempering, martempering, case hardening, carburizing, nitriding, cyaniding, carbo-nitriding, flame and induction hardening, vacuum and plasma hardening.

UNIT-V METALS AND ALLOYS **9**

Introduction to Nano Materials Alloying of steel, properties of stainless steel and tool steels, maraging steels-cast irons; grey, white, malleable and spheroidal cast irons- copper and copper alloys; brass, bronze and cupro-nickel; Aluminum and Al-Cu – Mg alloys- Nickel based super alloys and Titanium alloys.

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Identify crystal structures for various materials and understand the defects in such structures.
2.	Understand how to tailor material properties of ferrous and non-ferrous alloys and how to quantify mechanical integrity and failure in materials
3.	Understand the micro structural aspects and phases of Fe-C systems.
4.	Understand the various heat treatment process.
5.	properties and applications of ferrous and non ferrous metals.

TEXT BOOKS

1.	W. D. Callister, 2006, "Materials Science and Engineering-An Introduction", 6th Edition, Wiley India.
2.	Kenneth G. Budinski and Michael K. Budinski, "Engineering Materials", Prentice Hall of India Private Limited, 4th Indian Reprint, 2002.
3.	V. Raghavan, "Material Science and Engineering', Prentice Hall of India Private Limited, 2004, 5th Edition.
4.	U. C. Jindal, "Engineering Materials and Metallurgy", Pearson, 2011.

REFERENCES	
1.	W. D. Callister, 2006, "Materials Science and Engineering-An Introduction", 6th Edition, Wiley India.
2.	Kenneth G. Budinski and Michael K. Budinski, "Engineering Materials", Prentice Hall of India Private Limited, 4th Indian Reprint, 2002.
3.	V. Raghavan, "Material Science and Engineering', Prentice Hall of India Private Limited, 2004, 5th Edition.
4.	U. C. Jindal, "Engineering Materials and Metallurgy", Pearson, 2011.

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	√	√	√					√			√	√	√	√
CO2	√	√	√	√			√		√	√	√	√	√	√
CO3	√					√					√	√	√	√
CO4	√		√		√	√	√	√	√	√	√	√	√	√
CO5	√						√			√	√	√	√	√

Course Code	Course Name	Semester	Credits	L T P C
	ELECTRONIC DEVICES	3		3 0 2 4

COURSE OBJECTIVES

The course should enable the students:

- To know about semiconductor materials and their types.
- To design and construct diode circuits.
- To learn fundamentals of transistor and its variants.
- To study frequency response of amplifiers under small signal conditions.
- To understand construction and characteristics of JFET and MOSFET.

UNIT-I SEMICONDUCTOR MATERIALS **9**

Elemental & compound semiconductor materials , Bonding forces and Energy bands in intrinsic and extrinsic silicon, Charge carrier in semiconductors , carrier concentration, Junction properties, Equilibrium condition, biased junction, Steady state condition, breakdown mechanism (Rectifying Diodes, Zener Diodes), Metal Semiconductor Junction. Special diodes: Tunnel diodes, Varactor diodes, Schottky diode, Photo diodes, Photo detector, LED, Solar cell

UNIT-II DIODE CIRCUITS **9**

Ideal and Practical diode, Clipper, Clamper. Power Supply: Rectifiers-Half wave, Full wave, Bridge rectifier, filter circuits, Voltage regulation using shunt & series regulator circuits, Voltage regulation using IC 723

UNIT-III FUNDAMENTALS OF BJT **9**

Construction, basic operation, current components and equations, CB, CE and CC configuration, input and output characteristics, Early effect, Region of operations: active, cut-off and saturation region. BJT as an amplifier and switch - Photo transistor, Uni-junction Transistor (UJT) and Thyristors: UJT: Principle of operation, characteristics, UJT relaxation oscillator

UNIT-IV SMALL SIGNAL ANALYSIS **9**

Small signal Amplifier, Amplifier Bandwidth, Hybrid model, analysis of transistor amplifier using h-parameter, Multistage Amplifier: Cascading amplifier, Boot-strapping Technique, Darlington
amplifier and Cascode amplifier, Coupling methods in multistage amplifier, Low and high frequency response, Hybrid π model, Current Mirror circuits

UNIT-V FET CONSTRUCTION **9**

JFET Construction, n-channel and p-channel, transfer and drain characteristics, parameters, Equivalent model and voltage gain, analysis of FET in CG, CS and CD configuration. Enhancement and Depletion MOSFET drain and transfer Characteristics.
Integrated Circuit Fabrication Process: oxidation, diffusion, ion implantation, photolithography, etching, Chemical vapor deposition, sputtering, twin-tub CMOS process

LIST OF EXPERIMENTS FOR LABORATORY COURSE

1.	Study of LabVIEW / Multisim / PSPICE / ELVIS
2.	CRO Operation and its Measurements.
3.	P-N Junction Diode Characteristics (Forward bias & Reverse bias)
4.	Zener Diode Characteristics a. Part A: V-I Characteristics b. Part B: Zener Diode act as a Voltage Regulator
5.	BJT Characteristics (CE Configuration) a. Part A: Input Characteristics b. Part B: Output Characteristics

6.	FET Characteristics (CS Configuration) a. Part A: Drain (Output) Characteristics b. Part B: Transfer Characteristics
7.	LED and PHOTO DIODE Characteristics
8.	SCR Characteristics
9.	UJT Characteristics
10.	Clipper and Clamper Circuits
11.	Design and Simulate basic Common Source / Common Gate / Common Drain Amplifier
12.	BJT- CE Amplifier
13.	FET- CS Amplifier

CO	COURSE OUTCOMES
On completion of the course, the student will be able to	
1.	Characterize the types of semiconductors.
2.	Design and construct circuits using various diodes.
3.	Design and construct circuits using BJT.
4.	Design and construct transistor amplifiers using h-parameters.
5.	Understand the characteristics of JFET and MOSFET.

TEXT BOOK	
1.	Donald .A. Neamen, "Electronic Circuit Analysis and Design" , 3 rd Edition, Tata Mc Graw Hill, 2019.
REFERENCES	
1.	Salivahanan, Kumar &Vallavaraj, "Electronic Devices and Circuits", 5 th Edition, Tata Mc Graw Hill, 2022.
2.	Theodore F. Bogart, Jeffrey S. Beasley, "Guillermo Rico Electronic Devices & Circuits", 6 th Edition,PHI, 2014.
3.	Millman & Halkias, "Electronic Devices and Circuits", 4 th Edition, Tata Mc Graw Hill, 2015.

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	✓	✓									✓			
CO2	✓	✓	✓	✓							✓	✓		✓
CO3	✓	✓		✓							✓	✓		✓
CO4	✓	✓	✓	✓							✓	✓	✓	✓
CO5	✓	✓									✓			✓

Course Code	Course Name	Semester	Credits	L T P C
	DIGITAL ELECTRONICS	3		3 0 2 4

COURSE OBJECTIVES

Course Objectives:

The course should enable the students -

- To introduce basic postulates of Boolean algebra and shows the correlation between Boolean expressions.
- To introduce the methods for simplifying Boolean expressions.
- To outline the formal procedures for the analysis and design of combinational circuits and Sequential circuits.
- To introduce the concept of memories and programmable logic devices.
- To illustrate the concept of synchronous and asynchronous sequential circuits.

UNIT-I MINIMIZATION TECHNIQUES AND LOGIC GATES **9**

Minimization Techniques: Boolean postulates and laws – De-Morgan's Theorem - Principle of Duality - Boolean expression - Minimization of Boolean expressions –– Minterm – Maxterm - Sum of Products (SOP) – Product of Sums (POS) – Karnaugh map Minimization – Don't care conditions –Quine- McCluskey method of minimization.

Logic Gates: AND, OR, NOT, NAND, NOR, Exclusive–OR and Exclusive–NOR Implementations of Logic Functions using gates, NAND –NOR implementations – Multilevel gate implementations- Multi output gate implementations. TTL and CMOS Logic and their characteristics – Tristate gates.

UNIT-II COMBINATIONAL CIRCUITS **9**

Design procedure – Half adder – Full Adder – Half subtractor – Full subtractor – Parallel binary adder, parallel binary Subtractor – Fast Adder - Carry Look Ahead adder – Serial Adder/Subtractor - BCD adder – Binary Multiplier – Binary Divider - Multiplexer/ Demultiplexer - decoder - encoder – parity checker – parity generators – code converters - Magnitude Comparator

UNIT-III SEQUENTIAL CIRCUITS **9**

Latches, Flip-flops - SR, JK, D, T, and Master-Slave – Characteristic table and equation – Application table – Edge triggering – Level Triggering – Realization of one flip flop using other flip flops – serial adder/subtractor Asynchronous Ripple or serial counter – Asynchronous Up/Down counter - Synchronous counters – Synchronous Up/Down counters – Programmable counters – Design of Synchronous counters: state diagram- State table –State minimization –State assignment -Excitation table and maps-Circuit implementation - Modulo–n counter, Registers – shift registers - Universal shift registers – Shift register counters – Ring counter – Shift counters - Sequence generators

UNIT-IV MEMORY DEVICES **9**

Classification of memories – ROM - ROM organization - PROM – EPROM – EEPROM – EAPROM, RAM – RAM organization – Write operation – Read operation – Memory cycle - Timing wave forms – Memory decoding – memory expansion – Static RAM Cell- Bipolar RAM cell – MOSFET RAM cell – Dynamic RAM cell – Programmable Logic Devices – Programmable Logic Array (PLA) - Programmable Array Logic (PAL) – Field Programmable Gate Arrays (FPGA) - Implementation of combinational logic circuits using ROM, PLA, PAL.

UNIT-V SYNCHRONOUS AND ASYNCHRONOUS SEQUENTIAL CIRCUITS **9**

Synchronous Sequential Circuits**:** General Model – Classification – Design – Use of Algorithmic State Machine – Analysis of Synchronous Sequential Circuits Asynchronous Sequential Circuits**:** Design of fundamental mode and pulse mode circuits – Incompletely specified State Machines – Problems in Asynchronous Circuits – Design of Hazard Free Switching circuits. Design of Combinational and Sequential circuits using VERILOG

LIST OF EXPERIMENTS FOR LABORATORY COURSE	
1.	Study of Multisim and LT spice.
2.	Study of Gates & Flip-flops.
3.	Half Adder and Full Adder.
4.	Encoders and Decoders.
5.	Multiplexer and De-multiplexer.
6.	Magnitude Comparator (2-Bit) and Code Converter.
7.	Synchronous Counters.
8.	Ripple Counter and Mod–N Counter.
9.	Shift Register–SISO/SIPO/PIPO/PISO
10.	Design of Memory Devices
11.	Design of Hazard Free Switching circuits.
12.	Design of Mealy and Moore Circuits

CO	COURSE OUTCOMES
On completion of the course, the student will be able to	
1.	Explain the basic theorems and properties of Boolean algebra .
2.	Utilize K- Map for gate level minimization of the given Boolean function.
3.	Construct combinational logic circuits for the given requirement and determine their performance.
4.	Illustrate the Classifications of memories and programmable logic devices.
5.	Design synchronous and asynchronous sequential circuits using VERILOG.

TEXT BOOK	
1.	M. Morris Mano, "Digital Design", 6e, Prentice Hall of India Pvt. Ltd.,2018/PearsonEducation (Singapore) Pvt. Ltd., New Delhi.

REFERENCES	
1.	John F.Wakerly, "Digital Design", Fifth Edition, Pearson/PHI, 2021.
2.	John Yarb rough, "Digital Logic Applications and Design", Thomson Learning, 2016.
3.	Charles H.Roth. "Fundamentals of Logic Design", 7th Edition, Thomson Learning, 2015.
4.	Donald P.Leach and Albert Paul Malvino, "Digital Principles and Applications", 8th Edition, TMH, 2015.
5.	Thomas L. Floyd, "Digital Fundamentals", 13th Edition, Pearson Education Inc, 2024.
6.	Donald D.Givone, "Digital Principles and Design", TMH, 2003.
7.	A.Ananda Kumar, Fundamentals of digital circuits, 4 th edition, PHI learning private Limited, 2016.

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	✓	✓	✓	✓							✓	✓		✓
CO2	✓	✓	✓	✓	✓						✓	✓		✓
CO3	✓	✓	✓	✓	✓						✓	✓		✓
CO4	✓	✓	✓	✓	✓							✓		✓
CO5	✓	✓	✓	✓	✓							✓		✓

Course Code	Course Name	Semester	Credits	L T P C
	PROGRAMMING USING PYTHON LAB	**3**		**1 0 2 2**

COURSE OBJECTIVES

- Learn the syntax and semantics of the Python programming language
- Illustrate the process of structuring the data using lists, tuples and dictionaries.
- Demonstrate the use of file operations and searching pattern
- Interpret the concepts of Object-Oriented Programming as used in Python
- Appraise the need for working with various documents like Excel, PDF, Word and others file formats.

LIST OF EXPERIMENTS

1.	**Calculation of Test Average:** Write a python program to find the best of two test average marks out of three test's marks accepted from the user.
2.	**Palindrome Check & Digit Occurrence Count:** Develop a Python program to check whether a given number is palindrome or not and also count the number of occurrences of each digit in the input number.
3.	**Fibonacci sequence:** Defined as a function F as Fn = Fn-1 + Fn-2. Write a Python program which accepts a value for N (where N >0) as input and pass this value to the function. Display suitable error message if the condition for input value is not followed.
4.	**Binary to Decimal & Octal to Hexadecimal Conversion:** Develop a python program to convert binary to decimal, octal to hexadecimal using functions.
5.	**Sentence Statistics:** Write a Python program that accepts a sentence and find the number of words, digits, uppercase letters and lowercase letters.
6.	**String Similarity:** Write a Python program to find the string similarity between two given strings.
7.	**Insertion Sort & Merge Sort on lists:** Write a python program to implement insertion sort and merge sort using lists.
8.	**Check Phone Number:** Write a function called isphonenumber () to recognize a pattern 415-555-4242 without using regular expression and also write the code to recognize the same pattern using regular expression.
9.	**Search Phone Number & Email:** Develop a python program that could search the text in a file for phone numbers (+919900889977) and email addresses (sample@gmail.com)
10.	**File Operations:** Write a python program to accept a file name from the user and perform the following operations 1. Display the first N line of the file 2. Find the frequency of occurrence of the word accepted from the user in the file
11.	**Zip operation on a folder:** Develop a program to backing up a given Folder (Folder in a current working directory) into a ZIP File by using relevant modules and suitable methods.
12.	**Inheritance:** By using the concept of inheritance write a python program to find the area of triangle, circle and rectangle.
13.	**Employee Details:** Write a python program by creating a class called Employee to store the details of Name, Employee_ID, Department and Salary, and implement a method to update salary of employees belonging to a given department.
14.	**Polymorphism and Inheritance:** Write a python program to find the whether the given input is palindrome or not (for both string and integer) using the concept of polymorphism and inheritance.
15.	**Spreadsheet Operations:** Demonstrate python program to read the data from the spreadsheet and write the data in to the spreadsheet
16.	**Merge selected pages from Multiple PDFs to a new PDF:** Write a python program to combine select pages from many PDFs
17.	**Fetch weather data from the JSON:** Write a python program to fetch current weather data from the JSON file

CO	COURSE OUTCOMES
At the end of the course the student will be able to:	
1.	Understand Python syntax and semantics and be fluent in the use of Python flow control and Functions
2.	Develop, run and manipulate Python programs using Core data structures like Lists, Dictionaries, and use of Strings Handling methods.
3.	Develop, run and manipulate Python programs using File Operations and searching pattern using regular expressions.
4.	Interpret the concepts of object oriented programming using Python.
5.	Determine the need for scraping websites and working with CSV, JSON and other file formats.
REFERENCES	
1.	https://moodle.sit.ac.in/blog/python-programming-laboratory-21csl46/

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	√	√	√		√							√	√	
CO2	√	√	√		√							√	√	
CO3	√	√	√		√							√	√	
CO4	√	√	√		√							√	√	
CO5	√	√	√		√							√	√	

SEMESTER - IV

Course Code	Course Name	Semester	Credits	L T P C
	SOLID AND FLUID MECHANICS	4		3 0 2 4

COURSE OBJECTIVES

At the end of the course, the student will be able to:

- To provide knowledge about stress distribution and strains in regular and composite structures subjected to axial loads
- To give input on shear force, bending moment diagrams and evaluate the bending stress in different beams under transverse loading
- To provide awareness on stresses on shafts and helical springs based on theory of torsion.
- To provide fundamental knowledge of fluids and its properties
- To apply the basic knowledge of fluid mechanics to real-world problems.

UNIT - I STRESS, STRAIN AND DEFORMATION OF SOLIDS **9**

Concept of stress - strain, Hooke's law, Tension, compression and shear, stress - strain diagram, Poisson's relation, volumetric strain, Elastic constants and their relation. Stress in simple and composite bars subjected to axial loading and temperature.

UNIT - II TRANSVERSE LOADING ON BEAMS, SHEAR FORCE AND BENDING MOMENT **9**

Types of Beams, Transverse loading on beams shear force and Bending moment in beams- cantilever, simply supported, overhanging beam subjected to concentrated load and UDL - maximum bending moment and point of contra flexure. Theory of simple bending and assumption.

UNIT - III TORSION **9**

Theory of torsion and assumption - Torsion of circular shafts, solid & hollow - strain energy in torsion. Power transmission, strength and stiffness of shafts.

UNIT - IV FLUID STATICS AND DYNAMICS **9**

Fluid - Properties of fluids, Pascal's Law, Hydrostatic Law, Pressure and its variation in astatic Fluid, Measurement of static fluid pressure: Manometers, hydrostatic pressure concept and distribution on plane surfaces. Continuity equation, Euler equations, Bernoulli's equations, Momentum equation - applications.

UNIT- V FLUID KINEMATICS, FLUID FLOW AND FLUID MACHINERY **9**

Fluid Kinematics, Types of flow, Velocity field and acceleration.
Fluid flow, Flow through pipes, Darcy-Weisbach equation, Friction factor, Major and Minor losses.
Turbines and pumps - classification and working principle.(Qualitative approach only).

LIST OF EXPERIMENTS FOR LABORATORY COURSE

1.	Tensile test on MS rod and twisted bar (Electronic UTM)
2.	Comparison of hardness value of steel, copper and aluminium using Rockwell and Brinell hardness measuring machines
3.	Estimation of notch toughness of steel using impact testing machine
4.	Estimation of spring constant under tension and compression
5.	Tension test on MS wire (Tensile Testing Machine)
6.	Torsion test on mild steel rod.
7.	Deflection Test on Steel and Wooden Beam
8.	Experimental Study of Bernoulli's Theorem
9.	Calibration of orifice meter, nozzle & Venturi Meter
10.	Flow through pipes and losses in pipes
11.	Flow through Notches

12.	Buoyancy experiment – Meta centric height
13.	Performance Characteristics of Centrifugal pump
14.	Performance Characteristics of Jet pump
15.	Performance Characteristics of Gear pump
16.	Performance Characteristics of Francis pump
CO	**COURSE OUTCOMES**
Upon completion of this course, Students should be able to	
1.	Find the stress distribution and strains in regular and composite structures subjected to axial loads
2.	Assess the shear force, bending moment and bending stresses in beams under transverse loading
3.	Apply torsion equation in design of circular shafts and helical springs
4.	Applying the fundamental laws of fluid statics and derive the fluid flow equations.
5.	Derive the equation for flow through pipes. Select a suitable pump and turbine for a given application and evaluate the operating characteristics of hydraulic pumps and turbines.
TEXT BOOKS	
1.	Ramamrutham S. and Narayanan .R. Strength of material, Dhanpat Rai Pvt. Ltd., New Delhi, 2001
2.	Bansal.R.K.StrengthofMaterial,LakshmipublicationsPvt.Ltd.,NewDelhi,1996
3.	Kumar .K.L., Engineering Fluid Mechanics, Eurasla publishers Home Ltd., New Delhi, 1995
4.	Bansal .R.K Fluid Mechanics and Hydraulic Machines Laxmi publications (P) Ltd., New Delhi, 1995
REFERENCES	
1.	Popov.E.P., Mechanics of Materials, Prentice Hall, 1982
2.	Timoshenko .S.P and Gere M.J., Mechanics of Materials, C.B.S. publishers,
3.	Ferdinand P. Beer and Russell Johnston. E Mechanics of Materials SI metric Edition McGraw Hill, 1992
4.	Srinath L.N. Advanced Mechanics of Solids Tata McGraw Hill Ltd., New Delhi
5.	Ramamrutham.S. Fluid Mechanics and Hydraulics Dhanpat Rai and Sons, Delhi.

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	✓	✓	✓			✓	✓	✓					✓	
CO2	✓	✓	✓			✓	✓	✓					✓	
CO3	✓	✓	✓			✓	✓	✓					✓	
CO4	✓	✓	✓			✓	✓	✓					✓	
CO5	✓	✓	✓			✓		✓		✓			✓	

Course Code	Course Name	Semester	Credits	L T P C
	THERMAL ENGINEERING	4		3 0 2 4

COURSE OBJECTIVES

The course should enable the students to:

- To learn and apply the basic concepts & laws of thermodynamics
- To analyse the different gas power cycles & to understand the various systems of I.C. Engines
- To apply the concept of thermodynamics to steam Nozzle & steam turbines
- To analyze the performance of reciprocating air compressors
- To apply the concepts of thermodynamics to refrigeration & Air conditioning

UNIT- I BASIC CONCEPTS AND LAWS OF THERMODYNAMICS **9**

Systems and control volume, properties of a system, state and equilibrium, quasi-static equilibrium, processes and cycles, forms of energy, pressure, work and heat transfer, temperature and the Zeroth law of thermodynamics.

First law of thermodynamics - application to closed and open systems – Statements of second law and its corollaries – Carnot theorem - Carnot cycle & Reversed Carnot cycle - Clausius inequality. Concept of entropy.

UNIT–II GAS POWER CYCLES AND I.C. ENGINES **9**

Air Standard Cycles - Otto, Diesel, Dual & Brayton cycle (Basic)- –Performance Calculations.

I.C. Engines Classification – Components and their function - Working Principle of four stroke and two stroke engines, Valve timing & port timing diagram. Simple Carburettor, Diesel pump and injector system - Ignition System, Lubrication and Cooling systems.

UNIT-III STEAM NOZZLES AND STEAM TURBINES **9**

Steam Nozzles – One-dimensional steady flow of steam through a convergent and divergent nozzle – Metastable flow.

Impulse and Reaction turbine Principles - Compounding – Types – Performance - Speed regulations – Governors.

UNIT- IV AIR COMPRESSORS **9**

Reciprocating Air Compressors – Classifications - Working principle – work done - Effect of clearance volume - Single and multi-stage compressors, Volumetric efficiency – calculation of power requirement – Rotary compressors (Working Principle).

UNIT V REFRIGERATION AND AIR CONDITIONING **9**

Refrigeration cycles- Reversed Carnot – Bell Coleman cycle - Vapour compression system –Super heating/Sub cooling - Vapour absorption refrigeration system- Properties of refrigerants. – Simple Problems on VCR system Principles of air-conditioning - Types of air-conditioning system and its working principles - Concept of GSHF – RSHF – ESHF.

LIST OF EXPERIMENTS FOR LABORATORY COURSE

1.	Performance test on single stage reciprocating Air Compressor.
2.	Performance test on constant speed centrifugal air blower
3.	Valve timing diagram on four stroke petrol engine
4.	Port timing diagram on two stroke petrol engine
5.	Load test on single cylinder diesel engine with mechanical loading
6.	Performance test on high-speed diesel engine with alternator loading
7.	Testing of fuels and lubricants using saybolt and redwood apparatus
8.	Flash and fire point of fuels and lubricating oil

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Apply the first law of thermodynamics for simple open and closed systems and second law of thermodynamics.
2.	Explain the functioning & features of I.C. Engines & analyse & solve the problems of air standard cycles.
3.	Analyse the problems of steam nozzles and steam turbines.
4.	Analyse the performance behaviour of single & multi stage reciprocating air compressors.
5.	Understand the different Refrigeration & A/C systems and solve the problems of VCR system.
TEXT BOOKS	
1.	Nag. P. K., "Engineering Thermodynamics", 6th edition, Tata McGraw-Hill, New Delhi, 2017.
2.	Kothandaraman.C.P.,Domkundwar. S,Domkundwar. A.V., "A course in thermal Engineering", Fifth Edition, "Dhanpat Rai & sons, 2016.
3.	Rajput. R. K., "Thermal Engineering" S. Chand Publishers, 2017.
REFERENCES	
1.	Arora.C.P, "Refrigeration and Air Conditioning," Tata McGraw-Hill Publishers 2017
2.	Ganesan V," Internal Combustion Engines",3rd Edition, Tata McGraw-Hill 2017
3.	Rudramoorthy, R, "Thermal Engineering ", Tata McGraw-Hill, New Delhi,2003
4.	Sarkar, B.K,"Thermal Engineering" Tata McGraw-Hill Publishers, 2007
5.	P. L. Ballaney, Thermal Engineering, Khanna Publishers, 2007, 24th Edition.
6.	Dr. K.S. Yadav, "Applied Thermodynamics", Vayu Education of India, 2012, 1st Edition.

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	✓	✓	✓			✓						✓	✓	
CO2	✓	✓	✓									✓	✓	
CO3	✓	✓	✓	✓			✓					✓	✓	
CO4	✓	✓	✓	✓			✓					✓	✓	
CO5	✓	✓	✓	✓			✓					✓	✓	

Course Code	Course Name	Semester	Credits	L T P C
	MANUFACTURING TECHNOLOGY FOR MECHATRONICS	4		3 0 2 4

COURSE OBJECTIVES

The course should enable the students to:

- Concept of casting Technology
- Study the various ways of working of metals
- Concept of Machining with lathes and automats
- Various Surface finishing and Gear manufacturing processes
- Study of Milling machine, Shaper, Planer and Slotting processes

UNIT - I CASTING AND WELDING 9

Introduction to casting, Patterns, Types, Pattern materials, Allowances - Moulding - types- Moulding sand, Cores &Core making. Special Casting Process- Shell Investment, Die casting, Centrifugal Casting. Special welding- Laser, Electron Beam, Ultrasonic, Friction welding.

UNIT - II MECHANICAL WORKING OF METALS 9

Hot and Cold Working: Rolling, Forging, Wire Drawing, Extrusion- types- Forward and backward extrusion. Sheet Metal Operations: Blanking, Piercing, Punching, Trimming, Stretch forming, Bending- Embossing and coining, Types of dies: Progressive, compound and combination dies.

UNIT - III THEORY OF METAL CUTTING 9

Orthogonal and oblique cutting- Classification of cutting tools: single, multipoint - Mechanics of orthogonal cutting - Shear angle and its significance - Chip formation-Cutting tool materials- Tool wear and tool life - Machinability - Cutting Fluids- Simple problems.

UNIT - IV GEAR MANUFACTURING AND SURFACE FINISHING PROCESS 9

Gear manufacturing processes: Gear Machining: Forming. Gear generating process- Gear shaping, Gear hobbing. Grinding process, various types of grinding machine, Grinding Wheel- types - dressing and truing. Fine Finishing- Lapping, Buffing, Honing, and Super finishing.

UNIT - V MACHINE TOOLS 9

Milling Machine - specification, Types, Types of cutters, operations, Indexing methods- simple problems. Shaping, Planning and Slotting Machine- description, Operations, Work and tool holding Devices.

LIST OF EXPERIMENTS FOR LABORATORY COURSE

1.	Study of lathe – types – accessories – capabilities and process – specification
2.	Lathe operation – plain & step turning, taper turning, grooving and under cutting, knurling, thread cutting (single, multistart and internal), eccentric turning
3.	Machining of plane and inclined surfaces, grooving, dovetail cutting using shaping machine.
4.	Cutting of spur, helical, bevel gear and milling of polygon surface using milling machine.
5.	Making of helical gear using gear Hobbing machine.
6.	Cutting of keyway (internal & external) using slotting machine
7.	Exercises involving cylindrical grinder
8.	Exercises involving surface grinder

CO	COURSE OUTCOMES
At the end of the course the student should be able to	
1.	Learn the process of metal casting.
2.	Understand different sheet metal operations.
3.	Explain the concept of different metal forming operations.
4.	Discuss the mechanism of metal cutting and different forces acting on the tools.
5.	Explain the different gear manufacturing processes and gear finishing operations.
6.	Understand the different advance manufacturing processes and their applications.
TEXT BOOKS	
1.	Sharma, P.C., A textbook of Production Technology - Vol I and II, S. Chand & Company Ltd., New Delhi, 1996.
2.	Rao, P.N., Manufacturing Technology, Vol I & II, Tata McGraw Hill Publishing Co., New Delhi, 1998.
REFERENCE BOOKS	
1.	Chapman W. A. J., Workshop Technology Vol. I and II, Arnold Publisher, New Delhi, 1998
2.	HajraChoudhary, S. K. and HajraChoudhary, A. K., Elements of Manufacturing Technology, Vol II, Media Publishers, Bombay, 1988
3.	Jain. R. K., Production Technology, Khanna Publishers, New Delhi, 1988
4.	Kalpakjian, Manufacturing and Technology, Addison Wesley Longman Pvt., Singapore, 2000
5.	Kalpakjian, Manufacturing Engineering and Technology, Addison Wesley Longman Pvt., Singapore, 2000

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	✓	✓	✓	✓	✓	✓			✓		✓	✓	✓	
CO2	✓	✓	✓	✓	✓	✓			✓		✓	✓	✓	
CO3	✓	✓	✓	✓	✓	✓			✓		✓	✓	✓	
CO4	✓	✓	✓	✓	✓						✓	✓	✓	
CO5	✓	✓	✓	✓	✓						✓	✓	✓	
CO6	✓	✓	✓	✓	✓	✓					✓	✓	✓	

Course Code	Course Name	Semester	Credits	L T P C
	INDUSTRIAL INSTRUMENTATION	4		3 0 0 3

COURSE OBJECTIVES

The course will enable the students to:

- Have an idea about the temperature standards, calibration, thermocouples; signal conditioning used in RTD's and pyrometer techniques.
- Learn about Tachometer, Load cells, Torque meter and various densitometers.
- Have an adequate knowledge about pressure transducers.
- Understand about various types of flow meters and their installation.
- Have sound knowledge about various types of viscometers, level measurements, humidity and moisture measurements adopted in industrial environment

UNIT - I MEASUREMENT OF TEMPERATURE 9

Temperature scales, Bimetallic thermometer, filled- in Thermometers, Vapour pressure thermometers, Resistance thermometers, Thermistor, Thermostat, Thermocouples - types and ranges, characteristics, laws of thermocouples, cold junction compensation, IC temperature sensors AD 590, Pyrometers - radiation and optical pyrometers.

UNIT - II MEASUREMENT OF PRESSURE 9

Manometers – different types of manometers, Elastic pressure transducers, Dead weight Tester, Electrical types, Vacuum gauges - McLeod gauge, Knudsen gauge, thermocouple gauge, ionization gauge, Differential pressure transmitter - electrical & pneumatic types.

UNIT - III MEASUREMENT OF FLOW, LEVEL 9

Orifice, Venturi, Pitot tube, flow nozzle rotameter, Positive displacement meter, turbine flowmeter, electromagnetic flow meter, ultrasonic flow meter, open channel flow measurement, solid flow measurement. Sight glass, float gauge, displacer, torque tube, bubbler tube, diaphragm box, Differential Pressure methods, electrical methods- resistance type,capacitance type, ultrasonic level gauging.

UNIT - IV MEASUREMENTOFSPEED,FORCE,TORQUE, ACCELERATION 9

Measurement of speed- Revolution counter, Drag cup tachometer, AC and DC tachogenerators, photo electric pickup. Measurement of force - Load cell, pneumatic load cell, hydraulic load cell. Measurement of Torque using strain gauges and magneto elastic principle, Measurement of acceleration - Elementary accelerometers, seismic accelerometers, practical accelerometers, calibration.

UNIT - V MEASUREMENT OF DENSITY, VISCOSITY, HUMIDITY 9

Hydrometer – continuous weight measurement, liquid densitometer – float principle, air pressure balanced method, using gamma rays – gas density measurements – gas specific gravity measurements – Viscosity terms, saybolt viscometer, rotometer type viscometer, and Industrial consistency meters. Humidity terms – dry & wet bulb psychrometers – hot wire electrode type hygrometer, electrolytic hygrometer, Dew point hygrometer.

CO	COURSE OUTCOMES
At the end of the course, the students should be able to	
1.	Understand the various techniques used for the measurement of industrial parameters.
2.	Explain the design and working of various instruments.
3.	Understand the installation techniques of various systems.
4.	Understand the concept of various transducers used in industries.
5.	Work with signal conditioning circuit of various measuring equipments.

TEXT BOOKS	
1.	D. Patranabis, "Principles of Industrial Instrumentation", Tata McGraw Hill, 3rd Edition, New Delhi, Reprint 2017.
2.	S. K. Singh, "Industrial Instrumentation & Control" 3rd Edition, Tata McGraw Hill, Reprint 2009.
3.	K.Krishnaswamy&S.Vijayachitra, "Industrial Instrumentation" New age International, Reprint 2019.
REFERENCES	
1.	Ernest O. Doeblin, Dhanish. N. Manik, "Measurement Systems Application & Design", TMH, 7th Edition,2019.
2.	R.K.Jain,"Mechanical&IndustrialMeasurements",KhannaPublishers,11thEdition,2004.

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	
CO2	✓	✓	✓	✓									✓	
CO3	✓		✓		✓	✓	✓						✓	
CO4	✓			✓						✓			✓	
CO5							✓	✓	✓	✓	✓	✓	✓	

Course Code	Course Name	Semester	Credits	L T P C
	SENSORS AND ACTUATORS	4		3 0 0 3

COURSE OBJECTIVES

At the end of the course, the student will be able to:

- Acquire knowledge about the principles and analysis of sensors.
- Emphasis on characteristics and response of micro sensors.
- Acquire adequate knowledge of different transducers and Actuators.
- Learn about the Micro sensors and Micro actuators.

Selection of sensor materials for fabrication for different applications

UNIT - I SENSORS **9**

Difference between sensor, transmitter and transducer - Primary measuring elements - selection and characteristics: Range; resolution, Sensitivity, error, repeatability, linearity and accuracy,impedance, backlash, Response time, Dead band. Signal transmission - Types of signal: Pneumatic signal; Hydraulic signal; Electronic Signal. Principle of operation, construction details,characteristics and applications of potentiometer, Proving Rings, Strain Gauges, Resistance thermometer, Thermistor, Hot-wire anemometer, Resistance Hygrometer, Photo-resistive sensor.

UNIT- II INDUCTIVE & CAPACITIVE TRANSDUCER **9**

Inductive transducers: - Principle of operation, construction details, characteristics and applications of LVDT, Induction potentiometer, variable reluctance transducer, synchros, microsyn.

Capacitive transducers: - Principle of operation, construction details, characteristics of Capacitive transducers – different types & signal conditioning- Applications:- capacitormicrophone, capacitive pressure sensor, proximity sensor.

UNIT - III ACTUATORS **9**

Definition, types and selection of Actuators; linear; rotary; Logical and Continuous Actuators, Pneumatic actuator- Electro-Pneumatic actuator; cylinder, rotary actuators, Mechanical actuating system: Hydraulic actuator - Control valves; Construction, Characteristics and Types, Selection criteria.

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 motors - Piezoelectric Actuator

UNIT - IV MICRO SENSORS AND MICRO ACTUATORS **9**

Micro Sensors: Principles and examples, Force and pressure micro sensors, position and speed micro sensors, acceleration micro sensors, chemical sensors, biosensors, temperature micro sensors and flow micro sensors.

Micro Actuators: Actuation principle, shape memory effects-one way, two way and pseudo elasticity. Types of micro actuators- Electrostatic, Magnetic, Fluidic, Inverse piezo effect, other principles

UNIT - V SENSOR MATERIALS AND PROCESSING TECHNIQUES **9**

Materials for sensors: Silicon, Plastics, metals, ceramics, glasses, nano materials Processing techniques: Vacuum deposition, sputtering, chemical vapour deposition, electro plating, photolithography, silicon micro machining, Bulk silicon micro machining, Surface silicon micro machining, LIGA process

CO	COURSE OUTCOMES
The students should be able to	
1.	Analyze the basics and design the resistive sensors.
2.	Identify the materials and designing of inductive and Capacitive Sensors.
3.	Analyze various types of Actuators.
4.	Design Micro sensors and Micro Actuators for various applications.
5.	Implement fabrication process and technologies and compare various Micro machining processes.

TEXT BOOKS	
1.	Patranabis.D, ”Sensors and Transducers”, Second Edition, PHI Learning Private Limited, 2004.
2.	SergejFatikow and Ulrich Rembold, “Microsystem Technology and Microbotics”, First edition, Springer –VerlagNEwyork, Inc, 1997.
3.	Jacob Fraden, “Handbook of Modern Sensors: Physics, Designs and Application” Fifth edition, Springer, 2016.
REFERENCES	
1.	Robert H.Bishop,“The Mechatronics HandBook”, Second edition, CRC Press, 2008.
2.	Thomas.G.Bekwithand Lewis Buck.N, “Mechanical Measurements”, Oxfordand IBH publishing Co. Pvt. Ltd., 2010.
3.	Massood Tabib and Azar, “Microactuators Electrical, Magnetic, thermal, optical, mechanical, chemical and smart structures”, First edition, Kluwer academic publishers, Springer, 1997.
4.	Manfred Kohl, ”Shape Memory Actuators”, first edition, Springer, 2004.

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	✓	✓	✓										✓	
CO2	✓		✓			✓	✓	✓	✓	✓			✓	
CO3	✓		✓			✓	✓	✓	✓	✓			✓	
CO4	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	
CO5	✓	✓	✓					✓	✓		✓		✓	

Course Code	Course Name	Semester	Credits	L T P C
	PROGRAMMING USING MATLAB	4		1 0 2 2

COURSE OBJECTIVES

- Gaining a solid foundation in MATLAB programming and its applications in Solid Mechanics
- Gaining a solid foundation in MATLAB programming and its applications in Heat Transfer
- Gaining a solid foundation in MATLAB programming and its applications in Control Systems
- Gaining a solid foundation in MATLAB programming and its applications in Vehicle Dynamics
- Gaining a solid foundation in MATLAB programming and its applications in Automatic Transmission Simulation

LIST OF EXPERIMENTS

1.	To understand variables, arrays, matrices, and their operations
2.	To Learning about scripts, functions, loops, conditional statements, and control flow
3.	To solve linear and nonlinear equations using MATLAB
4.	To solving linear systems, Gaussian elimination, eigenvalues, and eigenvectors.
5.	Applying statistical methods for data analysis, including descriptive statistics, regression analysis, and hypothesis testing.
6.	Creating various types of plots (2D and 3D) to visualize data and results.
7.	Using MATLAB for simulation and modeling of mechanical systems and processes
8.	Modelling and simulating the behaviour of structures using MATLAB
9.	Analyzing heat transfer phenomena and solving heat transfer equations using MATLAB
10.	Designing and simulating control systems using MATLAB and Simulink
11.	Modelling and analyzing the dynamics of vehicles using MATLAB
12.	Coding and evaluating the performance of an automatic transmission in MATLAB

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Being able to implement various programming concepts in Solid Mechanics using MATLAB.
2.	Being able to implement various programming concepts in Heat Transfer using MATLAB.
3.	Being able to implement various programming concepts in Control Systems using MATLAB.
4.	Being able to implement various programming concepts in Vehicle Dynamics using MATLAB.
5.	Being able to implement various programming concepts in Automatic Transmission Simulation using MATLAB.

TEXT BOOKS

1.	S. J. Chapman, "MATLAB Programming for Engineers", 7 th edition, Cengage Learning, 2024.
2.	D. J. Higham and N. J. Higham, "MATLAB Guide", third edition, SIAM, 2017.
3.	A. Gilat, "MATLAB: An introduction with Applications", 6th Edition, John Wiley and Sons, 2024
4.	D. Houcque. Applications of MATLAB: Ordinary Differential Equations. Internal communication, Northwestern University, pages 1–12, 2005.

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	√	√	√		√							√	√	
CO2	√	√	√		√							√	√	
CO3	√	√	√		√							√	√	
CO4	√	√	√		√							√	√	
CO5	√	√	√		√							√	√	

SEMESTER – V

Course Code	Course Name	Semester	Credits	L T P C
	THEORY OF MACHINES	5		3 0 2 4

COURSE OBJECTIVES

- To understand the force motion relationship in components subjected to external forces and analysis of standard mechanisms.
- To understand the motion resulting from a specified set of cam mechanisms for specified output motions.
- To understand the basic concepts of toothed gearing, kinematics of gear trains and the effects of friction in motion transmission and in machine components.
- To understand the principle in mechanisms used for speed, stability control and effects of unbalances resulting from prescribed motions in mechanism.
- To understand the effect of dynamics of free vibrations and forced vibration.

UNIT- I	MECHANISMS AND FORCE ANALYSIS	9

Mechanisms – Terminology and definitions – Kinematics inversions of 4 bar and slider crank chain – kinematics analysis in simple mechanisms – Velocity and acceleration polygon – Dynamic Force Analysis – Inertia Forces and Inertia Torque – Turning moment diagrams – Reciprocating engine mechanisms – Fluctuation of energy and speed, Weight of flywheels..

UNIT-II	CAMS	9

Classification of Cam and Follower – Displacement diagrams – Cam profile construction for Uniform velocity, Uniform acceleration, SHM and Cycloidal motion of follower.

UNIT-III	GEARS AND GEAR TRAINS	9

Fundamentals of toothed gearing – Spur gear terminology and definition – Involute as a gear tooth profile – Interchangeable of gears – Interference and under cutting – Minimum number of teeth to avoid interference – Contact ratio – Internal gears – cycloidal tooth form – Gear trains – Types of gear trains – Velocity ratio and Torque calculations in Epicyclic gear – Automobile differential.

UNIT-IV	BALANCING AND GOVERNORS	9

Static and dynamic balancing of rotating masses in same and different planes – Function of governors – Porter, Proell and Spring-loaded governors, Sensitivity, Stability, Hunting and Isochronisms – Calculation of equilibrium speeds and ranges of governors.

UNIT-V	VIBRATIONS	9

Introduction – Types of Vibration – Frequency of undamped system – Viscous damping – Damped free vibration – Stiffness of spring – Series, Parallel and combined springs – Critical speed of shafts – Torsional vibration – Forced vibration – Harmonic Forcing – Vibration isolation.

LIST OF EXPERIMENTS FOR LABORATORY COURSE

DYNAMICS

1.	Study of cutting force using Lathe/Drill tool dynamometer
2.	Determination of critical speed of Whirling of shaft
3.	Static & dynamic balancing of rotors
4.	Dynamic balancing of masses using computerised M/C.
5.	Determination of M.I by suspension of Simple and compound pendulum method
6.	Study of undamped of free vibration of equivalent spring mass system
7.	Study of undamped torsional vibrations of single rotor system
8.	Porter, Proell and Hartnell Governors

9.	Characteristics of Hydrodynamics – Journal bearing.
10.	Cam and follower analysis.
CO	**COURSE OUTCOMES**
Upon completion of this course, Students should be able to	
1.	Analyze the force motion relationship of standard mechanisms.
2.	Develop CAM profiles and analyze the motion of the follower.
3.	Analyze the gears and gear trains to transmit the motion in machine components.
4.	Analyze and calculate speed, stability control in mechanisms and effects of unbalances in mechanism.
5.	Analyze the effect of dynamics of free and forced vibrations.
TEXT BOOKS	
1.	Uicker, J.J., Pennock G.R and Shigley, J.E., "Theory of Machines and Mechanisms", Oxford University Press, 2017.
2.	R.S. KHURMI & GUPTA .J.K, A TEXT BOOKS of Theory of Machines, S. Chand & Co., 2008, 14th Edition.
3.	Ramamurthi. V, "Mechanics of Machines", Narosa Publishing House, 3rd edition 2019.
REFERENCES	
1.	Amitabha Ghosh and Asok Kumar Mallik, "Theory of Mechanisms and Machines", Affiliated East-West Pvt. Ltd., 1988..
2.	Rao.J.S. and Dukkipati.R.V. "Mechanism and Machine Theory", New Age International Pvt. Ltd., 2nd edition, 2014.
3.	P.L.Ballaney, Theory of Machines, Khanna Publishers, 2005, 24th Edition.
4.	S.S.Rattan, Theory of Machines, Tata McGraw Hill. 2008, 2nd Edition.
5.	Sadhu Singh, Theory of Machines, Pearson Education Ltd, 2007.
6.	Wilson and Sadler, Kinematics and Dynamics of Machinery, Pearson, 2008.
7.	Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw-Hill, 2013.

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	✓	✓	✓	✓										✓
CO2	✓	✓	✓	✓									✓	
CO3	✓	✓	✓	✓										✓
CO4	✓	✓	✓	✓									✓	
CO5	✓	✓	✓	✓									✓	✓

Course Code	Course Name	Semester	Credits	L T P C
	SYSTEM DYNAMICS AND CONTROL	**5**		**3 0 2 4**

COURSE OBJECTIVES

- To model and represent mechanical and electrical systems using transfer functions, block diagrams, and signal flow graphs.
- To analyze time-domain response, steady-state error, and stability of control systems using classical techniques.
- To evaluate control system performance in the frequency domain using Bode, Polar, and Nyquist plots.
- To formulate and analyze state-space models and apply controllability, observability, and state feedback concepts.
- To design and tune controllers using P, PI, PD, and PID actions based on standard performance indices and tuning methods.

UNIT- I System Representation **9**

Basic Elements and types of Control System - Transfer function, Mathematical Modeling of Mechanical and Electrical systems – Reduction Techniques - Block diagram, Signal flow graph.

UNIT-II Time Response and Stability analysis **9**

Time response specifications - Analysis of first order and second order systems - Steady state errors – P, PI, PD and PID Controllers. Routh-Hurwitz Criterion, Root Locus Technique.

UNIT-III Frequency Response Analysis **9**

Frequency response specifications – Analysis: Bode Plot, Polar Plot, and Nyquist Plot

UNIT-IV State Space Analysis **9**

State variable representation-Conversion of state variable models to transfer functions-Conversion of transfer functions to state variable models-Solution of state equations-Concepts of Controllability and Observability-Stability of linear systems-Full state feedback controller design-Full order observer design-Design examples.

UNIT-V Controller Characteristics **9**

Basic control actions characteristics of On-Off, proportional, integral , derivative control modes and composite control modes: P+I, P+D and P+I+D. Optimum controller settings Evaluation criteria-IAE, ISE and ITAE decay ratio Tuning of controllers by process reaction curve method, damped oscillation method, Ziegler-Nichols tuning.

LIST OF EXPERIMENTS FOR LABORATORY COURSE

1.	Determinations of the transfer function of a DC servo motor and study of the effect of feedback on system performance.
2.	Analysis of step, ramp, impulse, and parabolic responses of first-order and second-order systems.
3.	Determination and analysis of time-domain performance specifications of a second-order system.
4.	Stability analysis of linear control systems using graphical methods in both time and frequency domains.
5.	Tuning of PID controllers using the Cohen–Coon method through MATLAB/Simulink.
6.	Tuning of PID controllers using the Ziegler–Nichols method through MATLAB/Simulink.
7.	Study of the relationship between controllability, observability, and transfer function representation.
8.	Design and simulation of lag, lead, and lag–lead compensators using MATLAB/Simulink.

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Apply mathematical modeling techniques to represent mechanical and electrical systems using transfer functions, block diagrams, and signal flow graphs
2.	Analyze time-domain response, steady-state errors, and stability of control systems using classical control techniques
3.	Evaluate control system performance and stability in the frequency domain using Bode, Polar, and Nyquist plots
4.	Develop and analyze state-space models and design controllers using controllability, observability, state feedback, and observer concepts.
5.	Design and tune control systems using P, PI, PD, and PID controllers based on standard performance indices and tuning methods.
TEXT BOOKS	
1.	I. J. Nagrath and M. Gopal, Control System Engineering, New Age International Publishers, New Delhi, 2011
2.	M. Gopal, Control Systems: Principles and Design, Tata McGraw-Hill, New Delhi, 2012
REFERENCES	
1.	K. Ogata, Modern Control Engineering, Pearson Education, New Delhi, 2015
2.	B. C. Kuo, Automatic Control Systems, Prentice-Hall of India Pvt. Ltd., New Delhi, 2014

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02
CO1	✓	✓	-	-	✓	-	-	-	-	-	-	-	✓	-
CO2	✓	✓	-	-	✓	-	-	-	-	-	-	-	✓	-
CO3	✓	✓	-	-	✓	-	-	-	-	-	-	-	✓	-
CO4	✓	✓	✓	✓	✓	-	-	-	-	-	-	-	✓	-
CO5	✓	✓	✓	✓	✓	-	-	-	-	-	-	-	✓	-

Course Code	Course Name	Semester	Credits	L T P C
	MICROPROCESSOR AND MICROCONTROLLER	**5**		**3 0 2 4**

COURSE OBJECTIVES

- To understand the architecture, instruction set, addressing modes, interrupts, and communication of 8085 microprocessor.
- To study the architecture and system organization of the 8086 microprocessors.
- To learn multiprocessor configurations including coprocessors and I/O processors.
- To develop skills in interfacing peripheral devices with microprocessors.
- To understand the architecture and programming of 8051 microcontroller and modern embedded platforms.

UNIT- I Introduction to Microprocessor 8085 — **9**

Microprocessors historical perspective, 8085-pin diagram, architecture, functional block diagram, addressing modes, overview of 8085 instruction set, microprocessor communication bus timings and interrupts.

UNIT-II 8086 (16-Bit Microprocessor) — **9**

Intel 8086 microprocessor - Architecture, signal description of 8086, physical memory organization, I/O addressing capability, minimum & maximum mode 8086 system and timings, Addressing modes and Instruction Set- Simple Examples.

UNIT-III Multiprocessor Configurations — **9**

Coprocessor Configuration, Closely Coupled Configuration, Loosely Coupled Configuration. 8087 Numeric Data Processor: Data types, architecture. 8089 I/O Processor Architecture, Communication between CPU and IOP.

UNIT-IV Interfacing of Peripherals with Microprocessor — **9**

8255-Programmable peripheral Interface along with 8085 (detailed mode operations); 8254-Programmable Interval Timer along with Intel 8086.
Need for the following ICs: 8251 - USART; 8257 - Direct Memory Access Controller; 8259- Programmable Interrupt Controller; 8279 - Keyboard / Display Interface.

UNIT-V Microcontroller 8051 — **9**

Architecture of 8051 Microcontroller - Signals – I/O ports – SFR - memory – counters and timers – serial data I/O - interrupts - Interfacing -keyboard, LCD. Programming in Arduino.

LIST OF EXPERIMENTS FOR LABORATORY COURSE

EXPERIMENTS IN MICROPROCESSOR 8085:	
1.	Write an ALP to perform basic arithmetic operation on two 8-bit numbers.
2.	Write an ALP to find the square of a given number using Lookup Table Technique.
3.	Write an ALP to sort the given array of numbers in Ascending/Descending Order.
4.	Write an ALP to search for a given number and display the number of occurrences of the given number
EXPERIMENTS IN MICRPROCESSOR 8086:	
5.	Write an ALP to perform basic arithmetic operation on two 16-bit Numbers.
6.	Write an ALP to study the addressing modes in 8086
EXPERIMENTS IN MICROCONTROLLER:	

7.	Write a microcontroller program to perform basic arithmetic operation on two 8-Bit numbers
8.	Study and analyze the interfacing of LCD Display with Microcontroller 8051
9.	Study and analyze the interfacing of various sensors with Arduino.
10.	Study and analyze the interfacing of various sensors with ESP32.
CO	**COURSE OUTCOMES**
Upon completion of this course, Students should be able to	
1.	Explain the architecture, instruction set, addressing modes, and interrupt handling of 8085 microprocessor.
2.	Analyze the architecture, memory organization, addressing modes, and instruction set of 8086 microprocessors.
3.	Examine multiprocessor configurations and the operation of coprocessors like 8087 and I/O processors like 8089.
4.	Design and implement interfacing of peripherals such as 8255, 8254, 8251, 8257, 8259, and 8279 with microprocessors.
5.	Apply the concepts of 8051 microcontroller programming, interfacing, and embedded system applications using Arduino/ESP32.
TEXT BOOKS	
1.	Kant, Krishna. Microprocessors and Microcontrollers: Architecture, Programming and System. 2nd ed., PHI Learning Pvt Ltd, 2014.
2.	Das, Lyla B. Microprocessors and Microcontrollers. Pearson, 2012.
3.	Gaonkar, Ramesh S. Microprocessors: Architecture, Programming and Applications with the 8085. 5th ed., Penram, 2011.
REFERENCES	
1.	Liu, Yn-cheng, and Glenn A. Gibson. Microcomputer Systems: The 8086 / 8088 Family Architecture, Programming and Design. 2nd ed., Prentice Hall of India, 2006.
2.	Hall, Douglas V. Microprocessors and Interfacing: Programming and Hardware. 2nd ed., TMG Hill, 2006.
3.	Ray, A. K., and K. M. Bhurchandi. Advanced Microprocessor and Peripherals – Architecture, Programming and Interfacing. Tata McGraw Hill, 2006.
4.	Ayala, Kenneth J. The 8051 Microcontroller. 3rd ed., 2004.

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02
CO1	✓	✓	-	-	✓	-	-	-	-	-	-	✓	-	✓
CO2	✓	✓	✓	✓	✓	-	-	-	-	-	-	-	-	✓
CO3	✓	✓	✓	✓	✓	-	-	-	✓	-	-	✓	-	✓
CO4	✓	✓	✓	✓	✓	-	-	-	✓	-	-	-	-	✓
CO5	✓	✓	✓	✓	✓	-	-	-	✓	-	-	✓	-	✓

Course Code	Course Name	Semester	Credits	L T P C
	ANALYTICAL INSTRUMENTATION	**5**		**3 0 0 3**

COURSE OBJECTIVES

- To understand the principles, instrumentation, sources, and detectors used in UV–Visible, IR, FTIR, atomic absorption, flame emission, and fluorescence spectrophotometry.
- To classify chromatographic techniques based on bed shape, mobile phase, and separation mechanisms and to understand the applications of GC, LC, and HPLC.
- To study the operating principles of industrial gas analyzers and analyze air pollution measurement techniques for gases, dust, and smoke.
- To understand electrochemical principles involved in pH, conductivity, and ion-selective measurements and to study dissolved component and water quality analyzers.
- To understand the principles and applications of NMR, mass spectrometry, and nuclear radiation detection techniques.

UNIT- I SPECTROPHOTOMETRY **9**

Spectral methods of analysis– Beer-Lambert law – UV-Visible spectrophotometers – Single and double beam instruments, Sources and detectors. IR Spectrophotometers – Types – Attenuated total reflectance – FTIR spectrophotometers - Atomic absorption spectrophotometers – Sources and detectors –– Flame emission photometers – Fluorescence spectrophotometer.

UNIT-II CHROMOTOGRAPHY **9**

Different techniques – Techniques by chromatographic bed shape: Column chromatography- Planer Chromatography-Paper Chromatography-Thin layer Chromatography-Applications - Techniques by physical state of mobile phase: Gas chromatography – Sources- Detectors – Liquid chromatographs – sources-detectors- Applications – High-pressure liquid chromatographs – sources- detectors- Applications- Techniques by separation mechanism: Ion exchange chromatography-size- exclusion chromatography-Applications

UNIT-III INDUSTRIAL GAS ANALYZERS AND POLLUTION MONITORING INSTRUMENTS **9**

Types of gas analyzers – Oxygen analyzers, IR analyzers, thermal conductivity analyzers, analysis based on ionization of gases. Air pollution due to carbon monoxide, hydrocarbons, nitrogen oxides, Sulphur dioxide estimation - Dust and smoke measurements.

UNIT-IV pH METERS AND DISSOLVED COMPONENT ANALYSERS **9**

Principle of pH measurement and conductivity measurements - Selective ion electrodes - dissolved oxygen analyzer – Sodium analyzer – Silicon analyzer – Water quality Analyzer

UNIT-V NUCLEAR MAGNETIC RESONANCE AND RADIATION TECHNIQUE **9**

NMR: – Basic principles, Continuous and Pulsed Fourier Transform NMR spectrometer and Applications -.Mass spectrometry and Applications, Nuclear radiation detectors, GM counter, proportional counter, solid state detectors, Scintillation counter.

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Explain the principles and working of spectrophotometric techniques including UV–Visible, IR, FTIR, atomic absorption, flame emission, and fluorescence spectrophotometry.
2.	Describe and compare various chromatographic techniques based on bed shape, mobile phase, and separation mechanism, and identify their industrial and analytical applications.
3.	Analyze the operating principles and applications of industrial gas analyzers and pollution monitoring instruments for air quality assessment.
4.	Apply the principles of electrochemical and analytical measurement techniques to pH meters, conductivity meters, selective ion electrodes, and dissolved component analyzers.
5.	Explain the fundamentals, instrumentation, and applications of NMR, mass spectrometry, and nuclear radiation detection techniques

TEXT BOOKS	
1.	Willard, Hobart H., et al. Instrumental Methods of Analysis. 7th ed., CBS Publishers, 2010
2.	2Skoog, Douglas A., et al. Principles of Instrumental Analysis. 6th ed., Cengage Learning, 2007
REFERENCES	
1.	Chatwal, G. R., and Sham K. Anand. Instrumental Methods of Chemical Analysis. Himalaya Publishing House, 2011.
2.	Fifield, F. W., and D. Kealey. Principles and Practice of Analytical Chemistry. Blackwell Science, 2000
3.	N. S. Nise, Control Systems Engineering, 4th Edition, John Wiley & Sons, New York, 2003

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02
CO1	✓	✓	-	-	✓	-	-	-	-	-	-	-	-	✓
CO2	✓	✓	-	-	✓	-	-	-	-	-	-	-	-	✓
CO3	✓	✓	-	✓	✓	-	-	-	-	-	-	-	-	✓
CO4	✓	✓	✓	-	✓	-	-	-	-	-	-	-	-	✓
CO5	✓	✓	-	-	✓	-	-	-	-	-	-	-	-	✓

Course Code	Course Name	Semester	Credits	L T P C
	INDUSTRIAL DATA COMMUNICATION	**5**		**3 0 0 3**

COURSE OBJECTIVES

- To understand the fundamentals of industrial communication networks, OSI reference model, and commonly used wired communication protocols.
- To study wireless communication technologies and IoT/IIoT protocols relevant to industrial and automation applications.
- To analyze industrial network requirements and understand the architecture, communication methods, and benefits of HART and PLC-based networks.
- To understand the concepts, architecture, installation, and troubleshooting of Foundation Fieldbus systems in industrial environments.
- To explore advanced industrial and automotive communication protocols and their role in Industry 4.0, robotics, and defense applications.

UNIT- I Introduction to Networks **9**

OSI reference model, Protocols, overview -RS 232, RS485, AS-interface, CAN, LIN, Device net- applications.

UNIT-II Wireless Technologies **9**

Satellite systems, Wireless LANs , WiFi, VPAN, IEEE 802.15.4-Zigbee, Bluetooth GPRS and – their comparison, limitations and characteristics, Introduction to IOT and IIOT, HF RFID ,– their relevance to industrial applications.

UNIT-III Industrial Networks & HART **9**

Industrial Network Requirements – Process Automation Controllers – Programmable Logic Controllers – PROFIBUS/PROFINET, HART:-Architecture, Physical, Data Link, Application, Communication Technique, Normal and burst mode of communication, Troubleshooting, Benefits of HART.

UNIT-IV Field Buses **9**

Foundation Fieldbus:- Fieldbus requirement, features, advantages, fieldbus components, types, architecture-physical, data link, application layer, system and network management, wiring, segment functionality checking, installation in safe and hazardous area and troubleshooting, function block application process.

UNIT-V Advanced Protocols in Industry **9**

Interaction Protocols for Multi-Robot Systems - Queue Telemetry Transport (MQTT), Constrained Application Protocol (CoAP) – Industry 4.0- EtherCAT - ,OPC UA , Ethernet TSN - Automotive industry- FlexRay and MOST Automotive Protocols - 6G communication protocol – Defense communication protocol.

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Explain the fundamentals of industrial networks, OSI reference model, and wired communication protocols.
2.	Compare wireless communication technologies and analyze their industrial relevance.
3.	Analyze industrial network requirements, programmable logic controllers, communication techniques, including troubleshooting methods.
4.	Understand Foundation Fieldbus architecture, components, and installation procedures and troubleshooting.
5.	Evaluate advanced industrial and automotive communication protocols and their applications in Industry 4.0, robotics, and defense communication systems.

TEXT BOOKS

1.	Buchanan, W. Industrial Networks and Protocols: Design, Configuration and Troubleshooting. McGraw-Hill Education, 2017.
2.	Raju, S., and N. Kumar. Industrial Communication Systems: Protocols and Applications. Springer, 2018.

REFERENCES	
1.	Litz, L. Industrial Communication Technology Handbook. CRC Press, 2014.
2.	Kim, H., and M. P. O'Malley. Fieldbus and Networking in Process Automation. Elsevier, 2015.
3.	Wendt, K. Embedded Networking with CAN and CAN open. Springer, 2016.

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PS01**	**PS02**
CO1	✓	✓	-	-	✓	-	-	-	-	-	-	-	✓	-
CO2	✓	✓	-	-	✓	-	-	-	-	-	-	-	✓	-
CO3	✓	✓	✓	✓	✓	-	-	-	-	-	-	-	✓	-
CO4	✓	✓	✓	✓	✓	-	-	-	-	-	-	-	✓	-
CO5	✓	✓	✓	✓	✓	-	-	-	-	-	-	-	✓	-

Course Code	Course Name	Semester	Credits	L T P C
	MACHINE DRAWING PRACTICAL	5		0 0 4 2

COURSE OBJECTIVES

- To familiarize with the standard conventions for different materials and machine parts in working drawings.
- To understand the general aspects of Limits, Fits and Tolerances in the various parts of the machine drawings.
- To make part drawings including sectional views for various machine elements.
- To get the knowledge on the surface finish and welding symbols on the various machine elements.
- To prepare assembly drawings given the details of part drawings.

UNIT- I **9**

Indian standard code of practice for engineering drawing - BIS specifications – Conventional representations of threaded parts, springs, gear and common features – Conventions for sectioning and dimensioning.

UNIT-II **9**

General aspects of Limits – Tolerance – Types – Representation of tolerances on drawing – Fits – Types – Selection and specification of fits – Allowance.

UNIT-III **9**

Geometric tolerances – Form and positional tolerances – Surface finish and welding symbols on the machine elements.

UNIT-IV **9**

Assembly and Detailed drawings of the various Machine Elements

UNIT-V **9**

Joints: Cotter joint and knuckle joint - **Couplings:** Flange coupling and Universal coupling - **Engine parts:** Connecting rod and Cross head for horizontal and vertical engines - **Machine tool parts:** Plummer block, Lathe Tail stock, Screw Jack, Machine Vices Swivel bearing, Tool head shaper

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Understand the significance of the standard codes and specifications of the machine components.
2.	Realize the importance of the conventional representations of machine parts, such as springs, gears and various threaded sections.
3.	Understand the fundamentals of the fits, tolerance and allowances of the various machine parts.
4.	Understand the working principles of an assembly of the final product from the various machine parts effectively.
5.	Apply their knowledge to produce new machine parts to meet the standards effectively.

TEXT BOOKS

1.	Gopalakrishnan K.R., "Machine Drawing", 22nd Edition, Subhas Stores Books Corner, Bangalore, 2013
2.	K.L. Narayana, P.Kannaiah & K.Venkata Reddy., "Machine Drawing", New Age Publishers, 4th Edition, 2012
3.	Dhawan., "Machine Drawing", S. Chand Publications, 1st Revised Edition,1998

REFERENCES

1.	N. D. Bhatt and V.M. Panchal, "Machine Drawing", 48th Edition, Charotar Publishers, 2013
2.	Junnarkar, N.D., "Machine Drawing", 1st Edition, Pearson Education, 2004
3.	N. Siddeshwar, P. Kanniah, V.V.S. Sastri, "Machine Drawing" , published by Tata Mc GrawHill, 2006
4.	Machine drawing – P.S. Gill S.K. Kataria & Sons Delhi
5.	P.S.G. Design Data book", Coimbatore

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	✓	✓	✓	✓	✓	✓	-	-	-	-	✓	✓	✓	✓
CO2	✓	✓	✓	✓	-	-	-	-	-	-	-	-	✓	✓
CO3	✓	✓	✓	✓	-	-	✓	-	-	-	-	-	✓	✓
CO4	✓	✓	✓	✓	-	-	-	✓		-	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓	-	-	-	-	-	✓	✓	✓	✓

SEMESTER – VI

Course Code	Course Name	Semester	Credits	L T P C
	OPERATION RESEARCH & MANAGEMENT	**6**		**3 0 2 4**

COURSE OBJECTIVES

- Formulate real-life engineering and managerial problems as Linear Programming problems using Graphical method and Simplex algorithm.
- Formulate and solve Transportation and Assignment problems.
- Analyze project scheduling problems using CPM and PERT techniques.
- Apply EOQ, quantity discount, multi-product inventory and single-server & multi-server queuing models.
- Formulate and solve replacement, search, and dynamic programming models.

UNIT- I	**LINEAR PROGRAMMING, GRAPHICAL METHOD, AND SIMPLEX METHOD**	**9**

Introduction – Structure of Linear Programming – Advantages of Using Linear Programming – Limitations of Linear Programming – Application Areas of Linear Programming – General Mathematical Model of Linear Programming – Guidelines on Linear Programming Model Formulation – Examples of LP Model Formulations.
The Graphical Method: Introduction – Important Definitions – Graphical Solution Methods of LP Problems – Special Cases in Linear Programming.
The Simplex Method: Introduction – Standard Form of LP Problem – Simplex Algorithm (Minimization Case) – Simplex Algorithm (Maximization Case): The Big-M Method.

UNIT-II	**TRANSPORTATION AND ASSIGNMENT PROBLEMS**	**9**

Transportation Problem: Introduction – Mathematical Model of Transportation Problem – The Transportation Algorithm – Method for finding Initial Solution – Test for Optimality – Variations in Transportation Problem – Maximization Transportation Problem – Tran-Shipment Problem.
Assignment Problem: Introduction – Mathematical Model of Assignment Problem – Solution Method of Assignment Problem – Variations of Assignment Problem – A Typical Assignment Problem – Travelling-Salesman Problem.

UNIT-III	**THEORY OF GAMES AND SEQUENCING PROBLEMS**	**9**

Theory of Games: Introduction – Two-Person Zero-Sum Games – Pure Strategies (Minimax and Maximin Principles):Games with Saddle Point – Mixed Strategies: Games without Saddle Point – The Rules (Principles) of Dominance – Solution Methods Games without Saddle Point.
Sequencing Problems: Introduction – Notations, Terminology and Assumptions – Processing n jobs through Two Machines – Processing n jobs through Three Machines – Processing n jobs through m machines – Processing Two jobs through m machines.

UNIT-IV	**DETERMINISTIC INVENTORY MODELS – REPLACEMENT AND MAINTENANCE MODELS**	**9**

Deterministic Inventory Control Models: Introduction – The Meaning of Inventory Control – Functional Role of Inventory – Reasons for Carrying Inventory – Factors involved in Inventory Problem Analysis – Inventory Model Building – Single Item Inventory Control Model without Shortages – Single Item Inventory Control Model with Shortages.
Replacement and Maintenance Models: Introduction – Types of Failures – Replacement of Items whose Efficiency Deteriorates with Time – Replacement of Items that Completely Fail.

UNIT-V	**PROJECT MANAGEMENT: PERT AND CPM**	**9**

Introduction – Basic differences between PERT and CPM – Phases of Project Management – PERT/CPM Network Components and Precedence Relationships – Critical Path Analysis – Project Scheduling with Uncertain Activity Times – Project Time-Cose Trade-off.

LIST OF EXPERIMENTS FOR LABORATORY COURSE

Tool Used: Microsoft Excel Solver Add-in will be used to solve operations research problems

1.	**Linear Programming:** a) Simplex method, b) Integer Programming

2.	**Transportation Problem:** a) Maximization Problem, b) Minimization Problem, c) Unbalanced problem.
3.	**Assignment Problem:** a) Maximization Problem, b) Minimization Problem, c) Unbalanced problem, d) Travelling Salesman Problem
4.	**Network Scheduling:** a) Problems on PERT, b) Problems on CPM
CO	**COURSE OUTCOMES**
Upon completion of this course, Students should be able to	
1.	Formulate linear programming models for real-life problems and solve them using graphical and simplex methods.
2.	Model transportation and assignment problems and use standard algorithms to find optimal solutions, including basic variants.
3.	Analyze two-person zero-sum games with pure and mixed strategies and design suitable job sequencing schedules.
4.	Develop simple deterministic inventory and replacement models and compute suitable inventory policies and replacement plans.
5.	Draw PERT/CPM networks for projects, identify the critical path, and perform basic time–cost trade-off analysis.
TEXT BOOK	
1.	Operations Research: Theory and Applications, J.K. Sharma, Sixth Edition (Reprint: 2017), TRINITY Press, Laxmi Publications PVT. LTD.
REFERENCES	
1.	Operations Research, Hamdy A. Taha, Prentice Hall, Eighth Edition, 2007.
2.	Operations Research, Gupta P.K. and Hira , D.S., S. Chand and Co. Ltd., New Delhi, Fifth Edition, 2001.
3.	Operations Research, Manmohan P.K. and Gupta, S.C, Sultan Chand and Co. New Delhi, Seventh Edition, 2001.
4.	Introduction to Operations Research, Fredrich. S. Hillier and Gerald . J. Liberman, McGraw Hill, Seventh Edition, 2001.
5.	Operations Research – Principle and Practice, Ravindran, Philips and Soleberg, John Wiley and sons, Second Edition, 1987.

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	✓	✓	✓	✓	✓					✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓					✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓

Course Code	Course Name	Semester	Credits	L T P C
	FLUID POWER SYSTEMS	6		3 0 0 3

COURSE OBJECTIVES

- To provide student with knowledge on the application of fluid power and about various types of hydraulic pumps.
- To provide students with an understanding of the fluids and components utilized in modern industrial fluid power system.
- To develop a measurable degree of competence in the design, construction and operation of fluid power circuits.
- To provide students with knowledge on pneumatics and is applications in industries.
- To teach the students about the various trouble shooting methods and applications of hydraulic and pneumatic systems.

UNIT- I FLUID POWER PRINCIPLES AND HYDRAULIC PUMPS — **9**

Introduction to Fluid power – Advantages and Applications – Fluid power systems – Types of fluids – Pascal's Law and its application – Principles of flow & Pumping Theory – Pump Classification, Construction, Working, Design, Advantages, Disadvantages – Performance & Selection criterion of Linear, Rotary – Fixed and Variable displacement pumps.

UNIT-II HYDRAULIC ACTUATORS AND VALVES — **9**

Hydraulic Actuators – Linear and Rotary Actuators – Types and construction – Hydraulic cushioning – Hydraulic control valves – Direction control valves – Flow control valves – Pressure control valves – Types, Construction and Operation – Servo and Proportional valves – Types of actuation – Reservoirs – Cylinder mountings – Fluid Power ANSI Symbols.

UNIT-III HYDRAULIC SYSTEMS — **9**

Accumulators – Application circuits – Intensifiers – Application circuit – Hydraulic circuits – Regenerative – Counter balance – Sequencing – Automatic Reciprocation – Synchronization – Speed control – Electrical control elements – Electro-hydraulic circuits – Cylinder control by limit switch – Reciprocation – Cylinder sequencing.

UNIT-IV PNEUMATIC SYSTEMS — **9**

Properties of air – Perfect Gas Laws – Compressors – Filter, Regulator, Lubricator, Muffler, Air control Valves – Actuators – Pneumatic Circuits – Speed control – Quick exhaust – Air-Oil-reservoir circuit – Design of pneumatic circuit by cascade method.

UNIT-V TROUBLE SHOOTING AND APPLICATIONS — **9**

Maintenance & Trouble Shooting in Hydraulic and Pneumatic systems – Design of hydraulic circuits for Shaper – Milling, Grinding & Pressing – Hydraulic lift – Conveyer feed system – Low cost Automation.

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Acquire knowledge of the working principles of fluid power systems and hydraulic pumps.
2.	Acquire knowledge of the working principles of hydraulic actuators and control components.
3.	Understand different types of hydraulic circuits and systems.
4.	Explain the working of different pneumatic circuits and systems.
5.	Summarize the various troubleshooting methods and applications of hydraulic and pneumatic systems

TEXT BOOKS

1. Anthony Esposito, "Fluid Power with Applications", Prentice Hall, 2009.
2. Shanmugasundaram. K, "Hydraulic and Pneumatic Controls", S Chand & Co, 2006.

REFERENCES

1. Majumdar, S.R., "Oil Hydraulics Systems- Principles and Maintenance", Tata McGraw Hill, 2001

2.	Majumdar, S.R., "Pneumatic Systems – Principles and Maintenance", Tata McGraw Hill, 2007.
3.	Dudelyt, A Pease and John J Pippenger, "Basic Fluid Power", Prentice Hall, 1987.
4.	Srinivasan.R, "Hydraulic and Pneumatic Controls", Vijay Nicole Imprints, 2008.
5.	Joji.P, "Pneumatic Controls", John Wiley & Sons India, 2008

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	✓	-	✓	-	-	-	-	-	-	-	-	✓	✓	-
CO2	✓	-	✓	-	-	-	-	-	-	-	-	✓	✓	-
CO3	✓	✓	✓	✓	-	-	✓	-	-	-	-	✓	✓	✓
CO4	✓	✓	✓	✓	-	-	✓	-	-	-	-	✓	✓	✓
CO5	✓	✓	✓	✓	-	✓	✓	-	-	-	-	✓	✓	✓

Course Code	Course Name	Semester	Credits	L T P C
	CAD / CAM	6		3 0 2 4

COURSE OBJECTIVES

- To understand the basics of CAD/CAM.
- To gain exposure over the concepts of computer graphics.
- To learn about the geometric issues concerned to the manufacturing and its related areas.
- To understand the latest advances in the manufacturing perspectives.
- To provide an overview of how computers are being used in design, development of manufacturing plants.

UNIT- I COMPUTER AIDED DESIGN — **9**

Product Development Cycle – Introduction to CAD/CAM – Graphics I/O Devices – Bresenham's Algorithm and Digital Differential Analyzer (DDA), Graphics software – Clipping – Hidden line/surface removal – Color models – Lighting and shading – Graphics Standards – Neutral File formats – IGES & STEP.

UNIT-II PRINCIPLES OF COMPUTER GRAPHICS — **9**

Geometric Modelling – Wireframe, Surface and Solid – Parametric representation of curves & surfaces – CSG and B-Rep – World/device coordinate representations – 2D & 3D Geometric transformations – Matrix representation – Translation, scaling, shearing, rotation and reflection – Composite transformations – Concatenation.

UNIT-III MACHINE TOOLS — **9**

Introduction to NC, CNC, DNC – Manual part Programming – Computer Assisted Part Programming – Examples using NC codes – Adaptive Control – Canned cycles and subroutines – CAD / CAM approach to NC part programming – APT language – Machining from 3D models.

UNIT-IV GROUP TECHNOLOGY, CAPP & FMS — **9**

Introduction to part families – Parts classification and cooling – Group technology machine cells – Benefits of Group technology – Process Planning – CAPP & Types of CAPP – Flexible manufacturing systems (FMS) – FMS concept – Transfer systems – Head changing FMS – Rapid prototyping – Knowledge Based Engineering.

UNIT-V COMPUTER INTEGRATED MANUFACTURING — **9**

CIM wheel – CIM Database – CIM – OSI Model – Networking Standards in CIM Environment – Network structure – Network architecture – TCP/IP – MAP – Virtual Reality – Augmented Reality – Artificial Intelligence and Expert system in CIM.

LIST OF EXPERIMENTS FOR LABORATORY COURSE

3D GEOMETRIC MODELLING

Creation of 3D assembly model of following machine elements using 3D modelling software
Introduction of 3D Modelling software

1.	Flange Coupling
2.	Plummer Block
3.	Screw Jack
4.	Lathe Tailstock
5.	Universal Joint
6.	Machine Vice
7.	Connecting rod
8.	Piston
9.	Crankshaft

MANUAL PART PROGRAMMING	
I. Part Programming - CNC Machining Centre	
1.	Linear Cutting.
2.	Circular cutting.
3.	Cutter Radius Compensation.
4.	Canned Cycle Operations.
II. Part Programming - CNC Turning Centre	
1.	Straight, Taper and Radius Turning.
2.	Thread Cutting.
3.	Rough and Finish Turning Cycle.
4.	Drilling and Tapping Cycle.
III. Computer Aided Part Programming	
1.	CL Data and Post process generation using CAM packages.
2.	Application of CAPP in Machining and Turning Centre.
3.	Study of CNC EDM, CNC EDM Wire-Cut and rapid Prototyping.
CO	**COURSE OUTCOMES**
Upon completion of this course, Students should be able to	
1.	Understand the basics of CAD/CAM.
2.	Exposure over the concepts of computer graphics.
3.	Learn about the geometric issues concerned to the manufacturing and its related areas.
4.	Understand the latest advances in the manufacturing perspectives.
5.	Provide an overview of how computers are being used in design, development of manufacturing plants.
TEXT BOOKS	
1.	P.N. Rao, CAD/CAM: Principles and Applications 3rd Edition, Tata McGraw Hill, India, 2010.
2.	Ibrahim Zeid and R. Sivasubramaniam, Mastering CAD/CAM, 2nd Edition, Tata McGraw Hill, India, 2009
3.	Prof. Sham Tickoo, Pro/Engineer Wildfire 4.0: For Engineers And Designers, Dreamtech Press, 2008.
4.	K. Venugopal, Engineering Drawing & Graphics, New Age International, 2016.
REFERENCES	
1.	Mikell P. Groover, "Automation, Production Systems and Computer Integrated Manufacturing", Pearson Education, 2007
2.	James A. Rehg, Henry W. Kraebber, "Computer Integrated Manufacturing", Pearson Education. 2007
3.	Donald Hearn and M.Pauline Baker "Computer Graphics" with OpenGL Prentice Hall, International, 2010
4.	Thomas Ewing French, Charles J. Vierck, Robert Jay Foster, Engineering Drawing and Graphic Technology, McGraw-Hill, 1993.
5.	Frederick E. Giesecke, Alva E. Mitchell, Henry C. Spencer , Technical Drawing with Engineering Graphics, Mechanical Design Technology, 2016.
6.	Kuang-Hua Chang, Machining Simulation Using SOLIDWORKS CAM, SDC Publications, 2019.
7.	Hans B. Kief, Helmut A. Roschiwal, CNC Handbook, McGraw Hill Professional, 2012.

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	✓	✓	✓		✓		✓					✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓							✓	
CO3	✓	✓	✓	✓										✓
CO4	✓	✓	✓	✓									✓	✓
CO5	✓	✓	✓	✓									✓	

Course Code	Course Name	Semester	Credits	L T P C
	PLC AND DISTRIBUTED CONTROL SYSTEMS	**6**		**3 0 2 4**

COURSE OBJECTIVES

- To understand the fundamentals, architecture, and basic programming concepts of PLC systems.
- To develop PLC programs using timers, counters, and arithmetic functions for industrial applications
- To apply PLC data handling, sequencing, and analog signal processing techniques in automation systems.
- To understand the principles, architecture, and components of SCADA systems for industrial monitoring and control.
- To gain knowledge of Distributed Control Systems (DCS), their evolution, architecture, and redundancy concepts

UNIT- I Basics of PLC **9**

Definition and History of PLC-PLC advantage and disadvantages- Over all PLC systems-CPU and Programmer/Monitors-PLC input and output models – Architecture- PLC Programming language – Relay logic – Ladder logic – Programming of Gates – Flow charting as a programming method – connecting PLC to computer - PLC Troubleshooting and Maintenance.

UNIT-II PLC Programming **9**

Programming of Timers – Introduction - ON delay, OFF delay, Retentive Timers – PLC Timer functions – Examples of timer function Industrial application. Programming Counters – up/down counter – Combining counter - Examples of counter function Industrial application.PLC Arithmetic Functions – PLC number Comparison function.

UNIT-III PLC Data Handling Functions **9**

PLC Program Control Instructions: Master Control Reset - Skip – Jump and Move Instruction. Sequencer instructions - Types of PLC Analog modules and systems, PLC analog signal processing – BCD or multi bit data processing – Case study of Tank level control system, bottle filling system and Sequential switching of Motors.

UNIT-IV SCADA Basics **9**

Computer Process interface for Data Acquisition and control – Computer control loops. Supervisory Control and Data Acquisition System (SCADA) - introduction and brief history of SCADA – SCADA Hardware and software - Remote terminal units- Master station.

UNIT-V Distributed Control Systems **9**

Elements of DCS –Evolution of DCS - Building blocks- Detailed descriptions and functions of field control units- LCUs and Redundancy concepts.

LIST OF EXPERIMENTS FOR LABORATORY COURSE

1.	Programming basic Logic Gate operations.
2.	Programming Timers and Counters.
3.	Programming using Math and Compare Instructions.
4.	Programming Data Manipulation Instructions.
5.	Programming Program Control Instructions.
6.	Programming Sequencer instructions.
7.	Programming a PLC to Control Elevator system.
8.	Programming a PLC to demonstrate an operation of Traffic Light Control.
9.	Programming a PLC to control the Level of Liquid in a Tank
10.	Programming HMI with PLC

CO	COURSE OUTCOMES

Upon completion of this course, Students should be able to	
1.	Explain PLC hardware architecture, I/O modules, and basic programming methods using ladder logic.
2.	Develop PLC programs using timers, counters, and arithmetic operations for industrial control tasks.
3.	Implement PLC data handling, sequencing, and analog control for real-time automation applications.
4.	Describe SCADA system architecture, hardware, software, and data acquisition mechanisms.
5.	Analyze the structure and functioning of Distributed Control Systems and redundancy techniques used in industries.
TEXT BOOKS	
1.	Petruzella, Frank D. Programmable Logic Controllers. 4th ed., McGraw-Hill Education, 2017
2.	Bolton, W. Programmable Logic Controllers. 6th ed., Elsevier Butterworth-Heinemann, 2015
3.	Webb, John W., and Ronald A. Reis. Programmable Logic Controllers: Principles and Applications. 5th ed., Pearson Education, 2003
4.	
REFERENCES	
1.	Mackay, Stuart, Edwin Wright, and Deon Reynders. Practical Industrial Data Communications: Best Practice Techniques. Newnes, 2004
2.	Boyer, Stuart A. SCADA: Supervisory Control and Data Acquisition. 4th ed., ISA – The Instrumentation, Systems, and Automation Society, 2010
3.	Bailey, David, and Edwin Wright. Practical SCADA for Industry. Newnes, 2003

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02
CO1	✓	✓	✓	-	-	-	-	-	-	-	-	-	-	✓
CO2	✓	✓	✓	-	-	-	-	-	-	-	-	-	-	✓
CO3	✓	✓	✓	-	-	-	-	-	-	-	-	-	-	✓
CO4	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	✓
CO5	✓	✓	✓	-	-	-	-	-	✓	✓	-	✓	-	✓

Course Code	Course Name	Semester	Credits	L T P C
	AUTOTRONICS	**6**		**3 0 0 3**

COURSE OBJECTIVES

At the end of the course, the student will be able:

- To make the students understand the evolution of electronics in automobiles and basics of charging and starting system.
- To provide student with knowledge on ignition and injection systems.
- To make the students learn about various sensors and actuators for controlling engine parameters.
- To acquaint students with various engine control systems.
- To teach the students about various chassis and safety system operation and applications.

UNIT- I	INTRODUCTION	9

Evolution of electronics in automobiles – emission laws – introduction to Euro I, Euro II, Euro III, Euro IV, Euro V standards – Equivalent Bharat Standards. Charging systems: Working and design of charging circuit diagram – Alternators – Requirements of starting system - Starter motors and starter circuits.

UNIT-II	IGNITION AND INJECTION SYSTEMS	9

Ignition systems: Ignition fundamentals - Electronic ignition systems - Programmed Ignition – Distribution less ignition - Direct ignition – Spark Plugs. Electronic fuel Control: Basics of combustion – Engine fuelling and exhaust emissions – Electronic control of carburetion – Petrol fuel injection – Diesel fuel injection.

UNIT-III	SENSOR AND ACTUATORS	9

Working principle and characteristics of Airflow rate, Engine crankshaft angular position, Hall effect, Throttle angle, temperature, exhaust gas oxygen sensors – study of fuel injector, exhaust gas recirculation actuators, stepper motor actuator, vacuum operated actuator.

UNIT-IV	ENGINE CONTROL SYSTEMS	9

Control modes for fuel control-engine control subsystems – ignition control methodologies – different ECU"s used in the engine management – block diagram of the engine management system. In vehicle networks: CAN standard, format of CAN standard – diagnostics systems in modern automobiles.

UNIT-V	CHASSIS AND SAFETY SYSTEMS	9

Traction control system – Cruise control system – electronic control of automatic transmission – antilock braking system – electronic suspension system – working of airbag and role of MEMS in airbag systems – centralized door locking system – climate control of cars.

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Understand the evolution of automotive electronics and charging system
2.	Develop through basic knowledge about various ignition and injection systems
3.	Analyse required sensors and actuators for an automotive application
4.	Understand the automotive electronics for engine management system
5.	Acquire knowledge on the safety systems of the automobile

TEXT BOOKS

1. Ribbens, "Understanding Automotive Electronics", 7th Edition, Elsevier, Indian Reprint, 2013

REFERENCES

1. Tom Denton, "Automobile Electrical and Electronics Systems", Edward Arnold Publishers, 2000
2. Barry Hollembeak, "Automotive Electricity, Electronics & Computer Controls", Delmar Publishers, 2001
3. Richard K. Dupuy "Fuel System and Emission controls", Check Chart Publication, 2000
4. Ronald. K. Jurgon, "Automotive Electronics Handbook", McGraw-Hill, 1999

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	✓	✓			✓		✓					✓	✓	
CO2	✓	✓	✓		✓		✓					✓	✓	
CO3	✓	✓	✓	✓	✓		✓					✓	✓	
CO4	✓	✓	✓	✓	✓		✓					✓	✓	
CO5	✓	✓	✓		✓	✓	✓	✓				✓	✓	

SEMESTER – VII

Course Code	Course Name	Semester	Credits	L T P C
	INDUSTRIAL ELECTRONICS	**7**		**3 0 0 3**

COURSE OBJECTIVES

- Provide comprehensive knowledge of industrial electronics and its applications.
- Develop the ability to analyze and design electronic circuits for industrial use.
- Impart knowledge on the integration of electronic systems in various industrial processes.
- The principles, methods of speed control, and quadrant operation of DC drives using converter-fed and chopper-fed configurations.
- Integrate theoretical concepts with practical applications through case studies and simulations

UNIT- I Power Semiconductor Devices — **9**

Power Diodes - Power Transistor - Study of Switching Devices: SCR, TRIAC, BJT, MOSFET, IGBT; Static Characteristics: SCR, MOSFET, and IGBT; Triggering and Commutation Circuit for SCR and Thyristor Introduction to Driver and Snubber Circuits.

UNIT-II Phase Controlled Converters — **9**

Single-Phase Half and Full Converters; Three-Phase Half Converters and Three-Phase Full Converters; Use of Flywheel Diode in Controlled Rectifier Configurations; Thyristor Triggering Circuits

UNIT-III Inverters and Choppers — **9**

Classification of Inverters: Single-Phase and Three-Phase Voltage Source Inverters (both 120° mode and 180° mode); Introduction to Integrated Power Modules (IPMs), Voltage Open Loop Multi-step Constant-Current Charging (VOOC). Buck-Boost Converter; Voltage and Current Commutated Choppers; PWM Inverters; Principle of Chopper; Chopper Classification; Step-Up and Step Down Chopper.

UNIT-IV DC Drives — **9**

Advantages, types & selection of electrical drives, Methods of speed control of DC motors – Armature control & Field control – Ward Leonard drives –Converter fed & Chopper fed DC drives - Two quadrant & Four quadrant chopper drives.

UNIT-V Industrial Applications — **9**

Solid-State Switching Circuits, Relays, Electronic Timer, Saw tooth Generator; Applications in Industrial Process Control; Motor Drive Applications; Electronic Regulator; Induction Heating; Dielectric Heating.

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Analyze the characteristics and operations of power semiconductor devices.
2.	Design and implement phase-controlled converters for various applications.
3.	Utilize inverters and choppers in industrial electronics
4.	Apply AC to AC converters in industrial systems.
5.	Implement industrial applications using solid-state switching circuits and heating methods.

TEXT BOOKS

1.	Paul, Biswanath. Industrial Electronics and Control. PHI Learning, 2014.
2.	Sen, P. C. Principles of Electric Machines and Power Electronics. Wiley, 1997.
3.	Bimbhra, P. S. Power Electronics. 5th ed., Khanna Publishers, 2012.
4.	Rashid, Muhammad H. Power Electronics: Circuits, Devices and Applications. 4th ed., Pearson Education, PHI, 2013.

REFERENCES

1.	Rashid, Muhammad H. *Power Electronics: Circuits, Devices and Applications*. Pearson, 2014.

2.	Rehg, James A., and Glenn J. Sartori. *Industrial Electronics*. Prentice Hall, 2005.
3.	"Power Electronics Applications in Power Systems." SWAYAM–NPTEL, Government of India, nptel.ac.in.
4.	"Fundamentals of Power Electronics." *SWAYAM–NPTEL*, Government of India, nptel.ac.in.
5.	"Advanced Power Electronics and Control." *SWAYAM–NPTEL*, Government of India, nptel.ac.in.

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02
CO1	✓	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-
CO2	✓	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-
CO3	✓	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-
CO4	✓	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-
CO5	✓	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-

Course Code	Course Name	Semester	Credits	L T P C
	FUNDAMENTALS OF ROBOTICS	**7**		**3 0 2 4**

COURSE OBJECTIVES

- To impart knowledge on the fundamentals of robotics, robot anatomy, and machine vision systems.
- To develop the ability to model robotic manipulators using kinematic analysis.
- To understand robot end effectors, control systems, and feedback mechanisms.
- To provide insights into robot work cell design and industrial applications.
- To introduce mobile robotics, path planning, and modern robotic software frameworks.

UNIT- I Introduction to Robotics **9**

Robot anatomy-Definition, law of robotics, History and Terminology of Robotics-Accuracy and repeatability of Robots-Simple problems- Specifications of Robot-Speed of Robot-Robot joints and links- Robot classifications-Architecture of robotic systems-Robot Drive systems- Hydraulic, Pneumatic and Electric system.

UNIT-II End Effectors and Robot Controls **9**

Mechanical grippers Slider crank mechanism Screw type Rotary actuators, cam type Magnetic grippers Vacuum grippers Air operated grippers-Gripper force analysis-Gripper design-Simple problems- Robot controls-Point to point control, Continuous path control, intelligent robot-Control system for robot joint Control actions-Feedback devices-Encoder, Resolver, LVDT-Motion Interpolations-Adaptive control.

UNIT-III Robot Kinematics **9**

Robot kinematics-Types- 2D, 3D Transformation-Scaling, Rotation, Translation- Homogeneous coordinates, multiple transformation-Simple problems. Denavit- Hartenberg convention, forward and inverse kinematics solution for SCARA configured robot.

UNIT-IV Robot Cell Design and Applications **9**

Robot work cell design and control-Sequence control, Operator interface, Safety monitoring devices in Robot Mobile robot working principle, actuation using software. Introductions-Robot applications- Material handling, Machine loading and unloading, assembly, Inspection, Welding, Spray painting and underwater robot.

UNIT-V Mobile Robotics and Machine Vision **9**

Introduction - types of mobile robot - kinematics of wheeled mobile robot -Path planning techniques in field robots- Machine Vision Systems- CCD/CMOS camera-Imaging techniques Non-conventional industrial robots-Mobile Manipulators- ROS and programming.

LIST OF EXPERIMENTS FOR LABORATORY COURSE

1.	Study the anatomy, components, and degrees of freedom of the KUKA robot.
2.	Examine robot jogging and understand coordinate systems using the teach pendant.
3.	Develop a program for the robot to reach designated teaching points using the teach pendant.
4.	Simulation of forward kinematics of a robot manipulator.
5.	Simulation of reverse kinematics of a robot manipulator.
6.	Design and force analysis of mechanical grippers (mechanical, magnetic, and vacuum grippers).
7.	Calibration of LVDT to determine displacement versus output voltage characteristics.
8.	Study and implementation of Light Dependent Resistor (LDR) for automatic lighting control systems.
9.	Design and implementation of an IR sensor-based object detection system for a stop-and-go conveyor application.
10.	Measurement of rotational speed of a motor using a non-contact photoelectric tachometer.
11.	Interfacing of proximity sensors with PLC/Arduino for automated relay control and switching operations.
12.	Calibration and interfacing of ultrasonic distance sensor for obstacle detection and avoidance in mobile robots.

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Explain robot anatomy, classifications, specifications, and select suitable robotic systems based on application requirements.
2.	Analyze and design gripper mechanisms and understand robot control systems with feedback devices.
3.	Apply transformation techniques and Denavit–Hartenberg convention to solve forward and inverse kinematics problems.
4.	Design robot work cells and select appropriate robotic systems for industrial applications like material handling, welding, and assembly.
5.	Analyze mobile robot kinematics, path planning techniques, and understand machine vision systems and modern robotic frameworks.
TEXT BOOKS	
1.	Yang, Guilin, and I-Ming Chen. Modular Robots: Theory and Practice. Springer, 2022
2.	Siciliano, Bruno, and Oussama Khatib, editors. Handbook of Robotics. 2nd ed., Springer, 2016.013.
REFERENCES	
1.	Groover, Mikell P., et al. Industrial Robotics: Technology, Programming, and Applications. 2nd ed., Tata McGraw-Hill Education, 2017.
2.	Saha, S. K. Introduction to Robotics. 2nd ed., Tata McGraw-Hill Education, 2014.
3.	Deb, S. R. Robotics Technology and Flexible Automation. 2nd ed., Tata McGraw-Hill Education, 2017.
4.	Siegwart, Roland, Illah R. Nourbakhsh, and Davide Scaramuzza. Introduction to Autonomous Mobile Robots. 2nd ed., MIT Press, 2011.
5.	Klafter, Richard D., Thomas A. Chmielewski, and Michael Negin. Robotics Engineering: An Integrated Approach. PHI Learning, 2009.

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02
CO1	✓	✓			✓							✓	✓	✓
CO2	✓	✓	✓	✓	✓				✓				✓	✓
CO3	✓	✓	✓	✓	✓								✓	✓
CO4	✓	✓	✓	✓	✓				✓			✓	✓	✓
CO5	✓	✓	✓	✓	✓				✓			✓	✓	✓

Course Code	Course Name	Semester	Credits	L T P C
	VIRTUAL INSTRUMENTATION	**7**		**3 0 2 4**

COURSE OBJECTIVES

- To understand the difference between graphical programming and Textual Programming.
- To design the loops and to do simple modular Programs.
- To understand the operation of Arrays and Clusters.
- To Plot the data in graphs and charts.
- To understand the interfacing of external hardware with graphical platform.

UNIT- I Introduction to LABVIEW **9**

Introduction to Graphical System Design (GSD) model, Virtual Instrumentation and Traditional Instrumentation, Hardware and Software in Virtual Instrumentation, Design Flow, Virtual Instrumentation advantages, comparison of Graphical Programming with Textual Programming Language. Software Environment: creating and Saving a VI, Front Panel Toolbar, Block Diagram Toolbar, Palettes, front panel controls and Indicators, Block diagram- Terminals, nodes, Functions, wires, Data types and Data flow program.

UNIT-II Modular Programming and Loops **9**

Creating an Icon, building a connector Pane, Creating Sub-VIs, Express Sub-VIs as Icons or Expandable nodes, Sub-Vis from sections of a VI, Opening and Editing Sub-Vis.
Loops: For Loops, while loops, Structure Tunnels, Shift Registers, Feedback nodes, Control timing, Communicating among multiple loops, Local Variables and Global Variables.

UNIT-III Arrays and Clusters **9**

Creating one dimensional & multi-dimensional arrays, deleting elements within array, insertinfinig elements within array, replacing elements within array, Array functions and Auto Indexing. Creating Clusters controls and indicators, cluster constants, Cluster operations, Assembling and disassembling cluster, conversion between arrays and clusters.

UNIT-IV Plotting Data and Structure **9**

Types of waveforms: Waveform Graphs, Waveform Chart, Waveform Data types, XY Graphs, 3D graphs, Customizing Graphs and Charts. Case structures, sequence structure, customizing structures, timed structures and formula nodes, event Structure. Creating String control and applications, basic of File I/O Format.

UNIT-V Data Acquisition **9**

Introduction to Analog and Digital signals, DAQ hardware, Analog Inputs and Outputs, Digital Inputs and Outputs, DAQ software Architecture, DAQ Assistant, Selecting and Configuring a Data Acquisition device, case study

LIST OF EXPERIMENTS FOR LABORATORY COURSE

1	Creating virtual instrumentation for simple applications.
2	Programming exercises for loop and charts.
3	Programming exercises for clusters and graphs.
4	Programming exercises on case and sequence structure, file input/output.
5	Data acquisition through virtual instrumentation.
6	Simulating reactor control using virtual instrumentation.
7	Real time temperature control using virtual instrumentation.
8	Real time sequential control of any batch process.
9	Creating virtual instrumentation for simple applications.

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Able to understand the difference between graphical and Textual Programming
2.	Ability to design the loops and to do simple modular Programs

3.	Able to understand the operation of Arrays and Clusters
4.	Able to Plot the data in graphs and charts
5.	Ability to interface external hardware with graphical platform
TEXT BOOKS	
1.	Gray Johnson, "LabVIEW Graphical Programming", 2nd Edition, McGraw Hill, 1997
2.	Lisa. K, Wells & Jeffery Travis, "LabVIEW for everyone", Prentice Hall, 1997
REFERENCES	
1.	Jovitha Jerome, "Virtual Instrumentation Using LabVIEW", PHI Learning Private Limited, 2010
2.	Sanjay Gupta, "VI Using LabVIEW", 2nd Edition, McGraw Hill, 2010

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02
CO1	✓		✓	✓								✓	✓	✓
CO2	✓		✓	✓								✓	✓	✓
CO3	✓	✓	✓	✓								✓	✓	✓
CO4	✓	✓	✓	✓								✓	✓	✓
CO5	✓	✓	✓	✓								✓	✓	✓

SEMESTER – VIII

Course Code	Course Name	Semester	Credits	L T P C
	PRINCIPLES OF MANAGEMENT AND PROFESSIONAL ETHICS	8		3 0 0 3

COURSE OBJECTIVES

- To understand the fundamentals of management, managerial roles, skills, and classical and modern management approaches.
- To learn the elements of planning, decision-making processes, managerial information.
- To understand organizational structures, job design, delegation, authority.
- To study moral autonomy, professional responsibilities, and ethics in engineering.
- To understand safety principles, risk assessment, risk-benefit analysis

UNIT- I Introduction to Management — **9**

Definition of Management, process of Management- Planning, Organizing, leading, Controlling Classical Approach-Contribution. And Limitation, Management Science Approach, Skills, Roles and Performance: Types of managers Managerial Skills,- Technical Skill, Analytical Skill Decision Making skill, Human Relation skill, Communication skill. Managerial Roles –Interpersonal Role, Informational Role, Decisional Role.

UNIT-II Planning Function — **9**

Elements of Planning-Objectives, Action, Resource, Implementation. Managerial Decision Making: Types of Decision, Process of Decision Making, Decision Making- Certainty Condition, Uncertainty Condition, Selecting Alternative. Managing Information System; Need for Decision Support System, MIS and DSS Strategic Planning – Organizational Strategy, Business Portfolio Matrix.

UNIT-III Organizing Function — **9**

Organizational Structure- Job Design, Departmentation, Span of Control, Delegation of Authority, Decentralized authority, Chain of Command and Authority, Line and Staff concept Matrix organizational Design.

UNIT-IV Engineering Ethics — **9**

Senses of 'engineering ethics' – variety of moral issues – types of inquiry – moral dilemmas – moral autonomy – 81ohlberg's theory – Gilligan's theory – consensus and controversy – professions and professionalism – professional ideas and virtues – theories about right action – self-interest – customs and religion – uses of ethical theories.

UNIT-V Engineers Responsibility for Safety — **9**

Safety and Risk – Assessment of safety and risk – Risk benefits analysis – Reducing risk – The Three Mile Island and Chernobyl case studies.

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Explain the principles of management, managerial skills, roles, and contributions of classical and modern management approaches.
2.	Apply planning and decision-making techniques strategic planning, in organizational contexts.
3.	Analyze organizational structures, delegation, authority
4.	Evaluate engineering ethical theories, ethical principles in engineering practice.
5.	Assess safety and risk in engineering projects, perform risk-benefit analysis.

TEXT BOOKS

1.	Koontz, Harold, and Heinz Weihrich. Essentials of Management: An International Perspective. 10th ed., McGraw-Hill Education, 2015
2.	Robbins, Stephen P., and Mary Coulter. Management. 14th ed., Pearson, 2018
3.	Ghosh, P. K. Engineering Ethics and Professionalism. 2nd ed., PHI Learning, 2016

REFERENCES

1.	Stoner, James A. F., et al. Management. 6th ed., Pearson, 2014
2.	Drucker, Peter F. The Practice of Management. Harper Business, 2006
3.	Martin, Mike W., and Roland Schinzinger. Ethics in Engineering. 4th ed., McGraw-Hill, 2010
4.	Drucker, Peter F. The Practice of Management. Harper Business, 2006
5.	Stoner, James A. F., et al. Management. 6th ed., Pearson, 2014

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02
CO1	✓	✓	-	-	✓	-	-	-	-	-	-	-	✓	-
CO2	✓	✓	✓	✓	✓	-	-	-	-	-	-	-	✓	-
CO3	✓	✓	✓	✓	✓	-	-	-	-	-	-	-	✓	-
CO4	✓	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-
CO5	✓	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-

PROFESSIONAL ELECTIVE COURSES – I

(Product Design)

Course Code	Course Name	Semester	Credits	L T P C
	SUSTAINABLE MANUFACTURING	**6**		**3 0 0 3**

COURSE OBJECTIVES

- To provide students with a clear understanding of sustainability principles
- To enable students to analyze material selection and energy usage in manufacturing processes
- To develop knowledge of cleaner production methods and green manufacturing practices
- To equip students with the ability to evaluate environmental impacts of products
- To provide insights into industrial waste management for improving overall environmental performance.

UNIT- I	**Introduction to Sustainability and Manufacturing**	**9**

Concept of sustainability and sustainable development - Triple Bottom Line (economic, environmental, social aspects) - Need for sustainable manufacturing - Environmental issues in manufacturing industries - Global standards and regulations (ISO 14000).

UNIT-II	**Materials and Energy in Manufacturing**	**9**

Sustainable material selection - Renewable and non-renewable resources - Energy consumption in manufacturing processes - Energy efficiency and conservation techniques - Waste minimization and resource optimization.

UNIT-III	**Green Manufacturing Processes**	**9**

Cleaner production and green manufacturing concepts - Sustainable machining and forming processes - Eco-friendly cutting fluids and lubricants - Additive manufacturing and sustainability benefits - Process optimization to reduce emissions and waste.

UNIT-IV	**Life Cycle Assessment and Product Design**	**9**

Introduction to Life Cycle Assessment (LCA) - Phases: Goal definition, inventory analysis, impact assessment, interpretation - Environmental impact indicators (carbon footprint, water footprint) - Design for Environment (DfE) - Design for disassembly, reuse, and recycling.

UNIT-V	**Waste Management and Sustainable Systems**	**9**

Types of industrial waste and disposal methods - Recycling and reuse techniques - Concept of circular economy - green supply chain management - Case studies of sustainable manufacturing industries.

CO	**COURSE OUTCOMES**
Upon completion of this course, Students should be able to	
1.	Understand sustainability principles in manufacturing.
2.	Analyze energy and material efficiency.
3.	Apply green manufacturing techniques.
4.	Perform basic LCA studies.
5.	Implement waste reduction and recycling strategies.
TEXT BOOKS	
1.	Sustainable Manufacturing: Fundamentals and Applications Author: David A. Dornfeld.
2.	Manufacturing Engineering and Technology Authors: Serope Kalpakjian & Steven Schmid.
3.	Introduction to Life Cycle Assessment Author: Mary Ann Curran.
REFERENCES	
1.	Green Manufacturing: Fundamentals and Applications Authors: David A. Dornfeld et al.
2.	Sustainable Manufacturing Author: Günther Seliger.
3.	Product Design for the Environment Author: Joseph Fiksel.

4.	Industrial Ecology and Sustainable Engineering Authors: Thomas E. Graedel & Braden R. Allenby.
5.	Waste Management for Sustainable Development Author: John Pichtel.

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	✓		✓			✓	✓						✓	
CO2	✓	✓				✓	✓						✓	
CO3			✓	✓			✓						✓	
CO4	✓	✓				✓	✓						✓	
CO5	✓	✓				✓	✓						✓	

Course Code	Course Name	Semester	Credits	L T P C
	PRODUCT DESIGN & DEVELOPMENT	6		3 0 0 3

COURSE OBJECTIVES

- To teach the students about the basic concepts of Product Design and Process Development.
- To expose the students about concept generation, selection and its testing for product development.
- To literate various parts of product architecture and its importance in product design and development.
- To explain the needs of various tools in industrial design process.
- To teach the students about the design for manufacturing and prototyping techniques used for product development.

UNIT- I	INTRODUCTION	9

Strategic importance of Product development – Integration of customer, designer, material supplier and process planner – Competitor and customer – Behavior analysis – Understanding customer – Promoting customer understanding – Involve customer in development and managing requirements – Organization process management and improvement.

UNIT-II	CONCEPT GENERATION, SELECTIONAND TESTING	9

Plan and establish product specifications – Task – Structured approaches – Clarification – Search externally and internally – Explore systematically – Reflect on the solutions and processes – Concept selection – Methodology – Benefits – Implications – Product change – Variety – Component standardization – Product performance – Manufacturability.

UNIT-III	PRODUCT ARCHITECTURE	9

Product development management – Establishing the architecture – Creation – Clustering – Geometric layout development – Fundamental and incidental interactions – Related system level design issues – Secondary systems – Architecture of the chunks – Creating detailed interface specifications – Portfolio Architecture.

UNIT-IV	INDUSTRIAL DESIGN	9

Integrate process design – Managing costs – Robust design – Integrating CAE, CAD, CAM tools – Simulating product performance & manufacturing processes electronically – Need for industrial design – Impact – Design process – Investigation of customer needs–conceptualization – Refinement – Management of the industrial design process.

UNIT-V	DESIGN FOR MANUFACTURINGAND PRODUCT DEVELOPMENT	9

Definition – Estimation of Manufacturing cost – Reducing the component costs and assembly costs – Minimize system complexity – Prototype basics – Principles of prototyping – Planning for prototypes – Economic Analysis.

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Get familiarized about the basic concepts of Product Design and Process Development.
2.	Know about the importance of concept generation, selection and its testing.
3.	Get a clear vision on product architecture.
4.	Understand about various tools in industrial design process.
5.	Know about the prototyping techniques used for product development.

TEXT BOOKS

1.	Ulrich K.T. and Eppinger S.D., "Product Design and Development" Tata McGraw –Hill International Editions,1999.

REFERENCES

1.	BelzA., 36-Hour Course: "Product Development" Tata McGraw-Hill, 2010.
2.	Rosenthal S., "Effective Product Design and Development", Business One Orwin, Homewood, 1992, ISBN 1-55623-603-4.
3.	Pugh S.," Total Design –Integrated Methods for successful Product Engineering", Addison Wesley Publishing, 1991, ISBN 0-202-41639-5.

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	✓		✓		✓	✓					✓		✓	
CO2	✓	✓	✓				✓						✓	✓
CO3	✓				✓				✓	✓	✓		✓	
CO4	✓		✓		✓							✓	✓	
CO5	✓	✓	✓		✓								✓	✓

Course Code	Course Name	Semester	Credits	L T P C
	COMPOSITE MATERIALS	6		3 0 0 3

COURSE OBJECTIVES

- To learn about the fundamentals, classifications and need for composite materials.
- To know about the various manufacturing methods of polymer matrix composites.
- To learn about the properties and various processing techniques of metal matrix composites.
- To learn about the properties, classifications and production methods of ceramic composites.
- To know about the advances in composite materials and testing procedures.

UNIT- I	BASICS OF COMPOSITES	9

Introduction to composites – Need for composites – Enhancement of properties – Classification of composites – Matrix-Polymer matrix composites (PMC) – Metal matrix composites (MMC) – Ceramic matrix composites (CMC) – Reinforcement – Particle reinforced composites – Fiber reinforced plastics (FRP) – Applications and advantages of various types of composites.

UNIT-II	POLYMER MATRIX COMPOSITES	9

Introduction – Polymer matrix resins – Thermosetting resins – Thermoplastic resins – Reinforcement fibers – Rovings – Woven fabrics – Non woven random mats – Various types of fibers – PMC processes - Hand layup – Spray layup processes – Vacuum bagging – Compression moulding – Reinforced Reaction injection moulding – Resin transfer moulding – Pultrusion – Filament winding – Injection moulding.

UNIT-III	METAL MATRIX COMPOSITES	9

Introduction – Characteristics of MMC – Various types of Metal matrix composites – Alloy vs. MMC – Advantages of MMC – Limitations of MMC – Metal Matrix – Reinforcements – Particles – Fibers – Effect of reinforcement – Volume fraction – Rule of mixtures – Processing of MMC – Powder metallurgy process – Diffusion bonding – Stir casting – Squeeze casting.

UNIT-IV	CERAMIC MATRIX COMPOSITES	9

Introduction – Engineering ceramic materials – Properties – Advantages – Limitations – Monolithic ceramics – Need for CMC – Ceramic matrix – Various types of Ceramic Matrix composites – Oxide ceramics – Non oxide ceramics – Aluminium oxide – Silicon nitride – Reinforcements – Particles – Fibers – Whiskers – Sintering – Hot pressing – Cold Isostatic Pressing (CIP) – Hot Isostatic Pressing (HIP).

UNIT-V	ADVANCES IN COMPOSITES	9

Introduction – Carbon / Carbon composites – Advantages of carbon matrix – limitations of carbon matrix – Carbon fiber – Chemical Vapour Deposition of carbon on carbon fibre preform – Sol-gel technique – Composites for Aerospace applications – Introduction to Nano composites – Various testing procedures for composite materials – Eco-friendly composite materials.

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Learn about the fundamentals of composite materials.
2.	Know the manufacturing methods of polymer matrix composites.
3.	Understand about the processing techniques of metal matrix composites.
4.	Know production methods of ceramic composites.
5.	Understand about the advances in composite materials.

TEXT BOOKS

1.	Mathews F.L. and Rawlings R.D., "Composite materials: Engineering and Science", Chapman and Hall, London, England, 1st edition, 1994.
2.	Chawla K.K., "Composite materials", Springer – Verlag, 1987

REFERENCES

1.	Clyne T.W. and Withers P.J., "Introduction to Metal Matrix Composites", Cambridge University Press, 1993.

2.	Strong A.B., "Fundamentals of Composite Manufacturing", SME, 1989.
3.	Sharma S.C., "Composite materials", Narosa Publications, 2000.
4.	"Short Term Course on Advances in Composite Materials, Composite Technology Centre, Department of Metallurgy", IIT- Madras, December 2001.
5.	Madhu Jit Mukho Padhyay, Mechanics of Composite Materials and Structures, University Press, 2004.

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	✓	✓	✓		✓	✓					✓		✓	✓
CO2	✓		✓	✓	✓	✓						✓	✓	✓
CO3	✓	✓	✓	✓							✓	✓	✓	✓
CO4	✓	✓		✓	✓	✓							✓	✓
CO5	✓		✓		✓	✓					✓		✓	✓

Course Code	Course Name	Semester	Credits	L T P C
	TRIBOLOGY IN DESIGN	6		3 0 0 3

COURSE OBJECTIVES

- To understand the concept and different types of friction
- To understand the concept and different types of wear
- To understand the mechanism of hydro static lubrication
- To understand the mechanism of hydro static lubrication
- To understand the concept and testing of lubricants

UNIT- I	FRICTION	9

Dry friction – Topography of surfaces – Contact between surfaces – Sliding friction – Energy dissipation – Theory of molecular attraction – Fretting corrosion and prevention – Variables in dry friction – Present concept of friction – Boundary friction – Oiliness – Variables of boundary friction – Friction characteristics of metals and non-metals– Rolling friction – Sources of measurement of friction.

UNIT-II	Wear	9

Wear – Types – Mechanism – Factors affecting wear – Adhesive wear – Abrasive Wear – Fatigue wear – Corrosive wear – Brittle fracture wear – Delamination – Wear measurement.

UNIT-III	VISCOSITY AND FLOW	9

Fundamentals of viscosity and flow – Petroff's equation – Friction torque – Viscosity measurement – Factors affecting viscosity – Principle of hydrostatic lubrication – Hydrostatic step bearing – Multi recess bearing – Design problems – Different types of compensation and their effect on bearing, parameters – Hydrostatic lift – Simple problems – Hydrostatic journal bearing – Simple problems – Hydrostatic squeeze films.

UNIT-IV	HYDRODYNAMIC LUBRICATION	9

Hydrodynamic lubrication – Solution of Reynold's equation – Application to tilting pad thrust bearing – Design of hydrodynamic journal bearings – Force feed of oil flow with various types of grooves – Dynamic bearings and rotor systems – Brief discussion – Lubrication systems – Bearing materials – Gas bearings – Elasto hydrodynamic lubrication.

UNIT-V	LUBRICANTS AND MAINTENANCE	9

Lubricants and maintenance – Lubricants – Types – Solids and liquid-properties – Additives – Testing – Reclamation of lubricants – Surface treatment – Phosphating of metal surface – Teflon coating – Predictive maintenance – Signature analysis and condition monitoring – Basic principles – Instrumentation.

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	The mechanism and types of friction
2.	The mechanism and types of wear
3.	The mechanism of hydrostatic lubrication
4.	The mechanism of hydrodynamic lubrication
5.	The concept and testing of lubricants

TEXT BOOKS

1. Hutchings. M, Tribology, Friction and Wear of Engg. Materials, Edward Arnold, London, 1992.
2. Majumdar, Introduction of Tribology of Bearings, A.H.Wheeler & Co., 1986.

REFERENCES

1. Ncalc, Newncs, Tribology Handbook, Butterworths, 1975.
2. Dudley D.Fuller, Theory and Practice of Lubrication for Engineers, John Wiley & Sons, 1984.
3. Cameron.A, Basic Lubrication Theory, Wiley Eastern Ltd., 1987.
4. Bharat Bhusan & B.K.Gupta, Handbook of Tribology, Tata McGraw Hill Inc., 1991.

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	✓	✓	✓	✓	✓							✓	✓	✓
CO2	✓	✓	✓	✓	✓							✓	✓	✓
CO3	✓	✓	✓	✓	✓							✓	✓	✓
CO4	✓	✓	✓	✓	✓							✓	✓	✓
CO5	✓	✓	✓	✓	✓							✓	✓	✓

Course Code	Course Name	Semester	Credits	L T P C
	GEOMETRIC DIMENSIONING AND TOLERANCING	6		3 0 0 3

COURSE OBJECTIVES

- Recognize the key GD&T terminology and comprehend the applied meaning of each
- Identify the engineering drawing symbols most closely associated with GD&T
- Differentiate between datums, datum features, and the parts of datum systems
- Understand various forms and orientation
- Understand various tolerances and its application

UNIT- I	INTRODUCTION	9

Dimensioning and Tolerancing – Dimensioning Units – Fundamental Dimensioning Rules Tolerancing Fundamentals – Maximum Material Condition (MMC) – Least Material Condition (LMC) – Basics of Fits – Dimensioning – Rules and Concepts of GD&T.

UNIT-II	DATUM CONTROL	9

Datums – Datum Feature Symbol – Datum Feature – The Datum Reference Frame Concept – Datum Target Symbols – Partial Datum Surface – Coplanar Surface Datums – Datum Axis – Movable Datum Target Symbols and Datum Target Points – Movable Datum Target Symbols and Datum Target Spheres – Datum Center Plane – The Center of a Pattern of Features as the Datum Axis.

UNIT-III	FORM AND ORIENTATION CONTROL	9

Introduction – Straightness, Flatness, Circularity, Free State Variation, Cylindricity Tolerance – Applying Form Control to a Datum Feature – Orientation Tolerances – Parallelism Tolerance – Perpendicularity Tolerance – Angularity Tolerance.

UNIT-IV	LOCATION TOLERANCE	9

Positional Tolerance – Locating Multiple Features – Positional Tolerancing of Coaxial Features – Positional Tolerancing of Nonparallel Holes – Locating Slotted Features – Positional Tolerancing of Spherical Features – Fasteners – Projected Tolerance Zone – Virtual Condition – Concentricity Tolerance – Positional Tolerancing for Coaxially – Symmetry – Composite – Mini Project – GD&T analysis of real-time product.

UNIT-V	PROFILE AND RUNOUT TOLERANCE	9

Non-Uniform Profile Tolerance Zone – Specifying Basic Dimensions in a Note – Combination of Geometric Tolerances – Runout Tolerances – Combination of Geometric Tolerances Specifying Independency – Development of gauge design using GD&T – Applying GD&T with CADD software Mini Project – GD&T analysis of real-time product.

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Read and understand basic GDT symbols on a print.
2.	Explain basic GDT concepts.
3.	Identify minimum and maximum material conditions
4.	Measure and verify position tolerances with applied material conditions
5.	Set up and use basic rectangular datum reference frames

TEXT BOOKS

1.	Dimensioning and Tolerancing, Engineering Product Definition and Related Documentation Practices, ASMEY14.5-2018,2019.
2.	James D Meadows, Geometric Dimensioning and Tolerancing applications and techniques for use in design, manufacturing and inspection, Marcel Dekker Inc. 2009
3.	N D Bhatt and VM Panchal, Machine Drawing, Charotar Publishing, 2014.
4.	P.S. Gill, Geometric Dimensioning & Tolerancing, S.K. Kataria & Sons, 2013

REFERENCES

1.	David A. Madsen and David P. Madsen. Geometric Dimensioning and Tolerancing, 9th Edition, The Goodheart-Wilcox Company Inc, USA,2013.

2.	Hoda A. ElMaraghy. Geometric Design Tolerancing: Theories, Standards and Applications. 2nd edition Springer US. 2012
3.	Henzold. G. Geometrical Dimensioning and Tolerancing for Design, Manufacturing and Inspection. 2ndedition, Elsevier Science, 2006
4.	P.S. Gill Geometric Dimensioning and Tolerancing, S K Kataria and Sons, 2009

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	✓	✓		✓								✓	✓	✓
CO2	✓	✓		✓								✓	✓	✓
CO3	✓	✓		✓								✓	✓	✓
CO4	✓	✓		✓								✓	✓	✓
CO5	✓	✓		✓								✓	✓	✓

PROFESSIONAL ELECTIVE COURSES - II

(Robotics)

Course Code	Course Name	Semester	Credits	L T P C
	MEDICAL ROBOTICS	**7**		**3 0 0 3**

COURSE OBJECTIVES

- Identify and describe different types of medical robots and their potential applications.
- Know basic concepts in kinematics, Dynamics, and control relevant to Medical Robotics.
- Develop the Analytical and Experimental skills necessary to Design and Implement robotic assistance for both minimally invasive surgery and Image guided interventions
- Be familiar with the state of the art in applied medical robotics and medical robotics research
- Understand the various roles that robotics can play in healthcare.

UNIT- I INTRODUCTION **9**

Types of medical robots - Navigation - Motion Replication - Imaging - Rehabilitation and Prosthetics – State of art of robotics in the field of healthcare-DICOM

UNIT-II LOCALIZATION AND TRACKING **9**

Position sensors requirements - Tracking - Mechanical linkages - Optical – Sound based - Electromagnetic - Impedance-based - In-bore MRI tracking-Video matching - Fiber optic tracking systems - Hybrid systems.

UNIT-III DESIGN OF MEDICAL ROBOTS **9**

Characterization of gestures to the design of robots - Design methodologies - Technological choices - Security

UNIT-IV SURGICAL ROBOTICS **9**

Minimally invasive surgery and robotic integration -surgical robotic sub systems - synergistic control - Control Modes - Radiosurgery - Orthopedic Surgery - Urologic Surgery and Robotic Imaging -Cardiac Surgery – Neurosurgery - case studies.

UNIT-V ROBOTS IN REHABILITATION AND MEDICAL CARE **9**

Rehabilitation for Limbs - Brain-Machine Interfaces - Steerable Needles - Assistive robots – Robots in Physiotherapy - case studies.

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Identify various medical robots and their potential applications.
2.	Recognize the position tracking and hybrid systems
3.	Apply Robotics and its concepts in medical field
4.	Simulate a MIS procedure and be aware of the state of art in surgical and oncology robotics
5.	Design a medical robotic system given the specific requirements for Rehabilitation and Medical care.

TEXT BOOKS

1. Achim Ernst Floris Schweikard, Medical Robotics, Springer, 2016.
2. Paula Gomes, Medical robotics Minimally invasive surgery, Woodhead, 2013.

REFERENCES

1. Jaydev P Desai, Rajni V Patel, Antoine Ferreira; Sunil Kumar Agrawal, The Encyclopedia of Medical Robotics, World Scientific Publishing Co. Pvt. Ltd, 2019.
2. Jocelyne Troccaz , Medical Robotics, John Wiley & Sons Incorporated, 2013.

3.	Vanja Bonzovic , Medical Robotics, I-tech Education publishing, Austria, 2008.
4.	Farid Gharagozloo Robotic Surgery, Springer, 2022

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	✓	✓	✓	✓	✓				✓	✓		✓	✓	✓
CO2	✓	✓	✓	✓	✓				✓	✓		✓	✓	✓
CO3	✓	✓	✓	✓	✓	✓			✓	✓		✓	✓	✓
CO4	✓	✓	✓	✓	✓	✓			✓	✓		✓	✓	✓
CO5	✓	✓	✓	✓	✓	✓			✓	✓		✓	✓	✓

Course Code	Course Name	Semester	Credits	L T P C
	MOBILE ROBOTICS	**7**		**3 0 0 3**

COURSE OBJECTIVES

- To formulate the challenges in developing autonomous mobile robots.
- To abstract kinematic control of wheeled mobile robots.
- To understand the challenges involved in sensory perception for mobile robots.
- To understand the localization and path planning algorithms.
- To comprehend the challenges in implementing controllers

UNIT- I INTRODUCTION **9**

Mobile Robots vs. Manipulators - Introduction to autonomous mobile robots - Locomotion aspects of mobile robots - Introduction to wheeled mobile robots- wheel types - Wheeled Configurations - Maneuverability, controllability, Stability of mobile robots - Wheeled Locomotion - Case studies - Degrees of freedom, differential degrees of freedom - Holonomic and non-holonomic systems- Kinematic constraints of a fixed standard wheel- Kinematic constraints of a omni-directional wheels.

UNIT-II KINEMATICS AND DYNAMICS OF MOBILE ROBOTS **9**

Forward kinematic models of three wheeled differential drive robot - Forward kinematics of a three wheeled omni-directional robot - Degree of Maneuverability- Mobility analysis of various wheeled configurations - Workspace and trajectory considerations - Comparison of maneuverability and controllability- State space modelling of three wheeled differential drive robot- Multi-rotor aerial robot, Types and applications- Modelling of Control of Quadrotor Aerial Vehicle-Introduction to Underwater vehicles- Modelling of dynamics of underwater vehicle.

UNIT-III SENSORS FOR MOBILE ROBOTS **9**

Sensors for mobile robots - Characteristics applicable to mobile robots - Relating the characteristics to performance attributes of mobile robot - Physical and computational attributes of sensors applicable to mobile robots - sensor noise and sensor aliasing - GPS and heading sensors - Principles, challenges and interpretation Light and sound based ranging - Principles, challenges and interpretation -Wheel Odometry- Implementation algorithm for wheel odometry- Wheel Odometry Critical Analysis- Wheel Odometry error reduction- Vision for mobile robots- Introduction to Visual Odometry and V-SLAM- Multi-sensor combinations- Need and types

UNIT-IV MOBILE ROBOT CONTROL **9**

Robot Motion - Smoothing Algorithm, Path Smoothing - Zero Data Weight- PID - Implementation aspects of proportional control, integral control, derivative control: Systematic Bias - PID Tuning for autonomous mobile systems - Parameter Optimization: Go-goal Controller - Cruise Controller

UNIT-V LOCALIZATION AND PATH PLANNING **9**

Introduction to localization, Localization challenges - Belief representations, Considerations in Belief representations & Map representations - Types, trade-offs -Introduction to Kalman filtering & Derivation of Kalman gain - Kalman filter and Extended Kalman Filter for localization - Sensor fusion using Kalman filter - Particle Filter Based Localization - Object Detection and Sensor Data Fusion Introduction to path planning, D* Lite - Bug algorithms - Vector field histogram Collision avoidance algorithms

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Explain the fundamentals of mobile robots, locomotion mechanisms, and kinematic constraints.
2.	Analyze and model kinematics and dynamics of wheeled, aerial, and underwater mobile robots.
3.	Evaluate different sensors and perception techniques used in mobile robotics, including odometry and vision systems.
4.	Design and implement control strategies such as PID and motion planning controllers for mobile robots.
5.	Apply localization and path planning algorithms like Kalman Filter, Particle Filter, and collision avoidance techniques.

TEXT BOOKS	
1.	Siegwart, Nourbakhsh & Scaramuzza – Introduction to Autonomous Mobile Robots
2.	Roland Siegwart & Illah Reza Nourbakhsh – Autonomous Mobile Robots
REFERENCES	
1.	Howie Choset et al. – Principles of Robot Motion
2.	Mark W. Spong, Seth Hutchinson, M. Vidyasagar – Robot Modeling and Control
3.	Sebastian Thrun, Wolfram Burgard, Dieter Fox – Probabilistic Robotics
4.	Kevin M. Lynch & Frank C. Park – Modern Robotics: Mechanics, Planning, and Control

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	✓	✓	✓						✓			✓	✓	✓
CO2	✓	✓	✓	✓					✓	✓		✓	✓	✓
CO3	✓	✓	✓	✓	✓	✓			✓	✓		✓	✓	✓
CO4	✓	✓	✓	✓	✓	✓			✓	✓		✓	✓	✓
CO5	✓	✓	✓	✓	✓	✓			✓	✓		✓	✓	✓

Course Code	Course Name	Semester	Credits	L T P C
	HUMANOID ROBOTICS	**7**		**3 0 0 3**

COURSE OBJECTIVES

- To know the basic knowledge about Humanoid robots.
- To impart knowledge in kinematics of humanoids.
- To learn about the dynamics in humanoid robots.
- To understand the basic in biped walking.
- To know about the different walking patterns.

UNIT- I Introduction **9**

Historical development of Humanoids, Human Likeness of a Humanoid Robot, Trade-Offs in Humanoid Robot Design, Human-Friendly Humanoid Robot Design, characteristics of humanoid robots

UNIT-II Kinematics **9**

Kinematic structure, forward and inverse kinematic problems, differential kinematics, Twist, Spatial Velocity, and Spatial Transform, Inverse Differential Kinematic Relations. Differential kinematics at singular configurations- Gait Analysis

UNIT-III ZMP and Dynamics **9**

ZMP Overview,2D Analysis,3D Analysis, Measurement of ZMP, General Discussion- ZMP of Each Foot, ZMP for Both Feet Contact, Dynamics of Humanoid Robots, Humanoid Robot Motion and Ground Reaction Force , Momentum, Angular Momentum, Angular Momentum and Inertia Tensor of Rigid Body, Calculation of Robot's Center of Mass, Link Speed and Angular Velocity, Calculation of Robot's Momentum and Angular Momentum

UNIT-IV Biped Walking **9**

Two Dimensional Walking Pattern Generation, Two Dimensional Inverted Pendulum, Behavior of Linear Inverted Pendulum, Orbital Energy, Support Leg Exchange, Planning a Simple Biped Gait, Extension to a Walk on Uneven Terrain

UNIT-V Walking Pattern Generation **9**

ZMP Based Walking Pattern Generation, Cart-Table Model, Off-Line Walking Pattern Generation,Stabilizer, Principles of Stabilizing Control, Stabilizing Control of Honda Humanoid Robot, Advanced Stabilizers.

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Describe about the evolution of Humanoid robots
2.	Expose the basic knowledge in kinematics of humanoids.
3.	Calculate the Humanoid Robot Motion and Ground Reaction Force.
4.	Identify Two-Dimensional Walking pattern on different terrain.
5.	Create the Walking Pattern models

TEXT BOOKS

1.	Dragomir N. Nenchev, Atsushi Konno, "Humanoid Robots Modeling and Control", Butterworth Heinemann, 2019
2.	2. Shuuji K, Hirohisa H, Kensuke H, Kazuhito, Springer-Verlag GmbH "Introduction to Humanoid Robotics", Springer, London, 2014.
3.	Goswami Ambarish, Vadakkepat Prahlad, "Humanoid Robotics: A Reference", Springer, 2019.
4.	J. Craig, "Introduction to Robotics: Mechanics and Control", Fourth Edition, Pearson, 2022

REFERENCES

1.	J K. Harada, E. Yoshida, K. Yokoi (Eds.), "Motion Planning for Humanoid Robots", Springer, London, 2010.
2.	Lorenzo Sciavicco and Bruno Siciliano, "Modelling and Control of Robot Manipulators", Second Edition, Springer, 2000.
3.	Jean-Claude Latombe, "Robot Motion Planning", Kluwer Academy Publishers, 2004.

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PS01**	**PS02**
CO1	✓	✓	✓	✓								✓	✓	✓
CO2	✓	✓	✓	✓								✓	✓	✓
CO3	✓	✓	✓									✓	✓	✓
CO4	✓		✓	✓								✓	✓	✓
CO5	✓	✓	✓	✓								✓	✓	✓

Course Code	Course Name	Semester	Credits	L T P C
	ROBOT OPERATING SYSTEMS	**7**		**3 0 0 3**

COURSE OBJECTIVES

- To introduce ROS and programming
- To develop the Robot environment
- To obtain the simulation robots in ROS with GAZEBO
- To simulate robots with V-Rep
- To understand mapping, navigation and motion planning ROS with Move-it

UNIT- I ROS Essentials — **9**

Introduction to ROS- Advantages and Disadvantages of ROS - ROS Framework- ROS package C++, Python – ROS computation Graph – nodes, Messages, topics, services, bags, ROS Master- ROS Community- Basic programming and Syntax overview in C++ and Python – start with ROS programming - Creating Environment - Services-Actions and Nodes- Simple Interaction with the Simulation environment

UNIT-II Build Your Own Robot Environment — **9**

CAD Tools for Robot Modelling – ROS Packages for robot modelling – Unified Robot Description Format and Tags- Kinematics and Dynamics Library – Create URDF Model – Robot Modelling using Unified Robot Description Format (URDF),-ROS parameter server and adding real-world object representations to the simulation environment _ Create Robot description using 7 DOF: joint number, name, type and angle limits – Xacro – Rviz – viewing of 7 DOF arm – creation of wheeled robot.

UNIT-III Simulation Robots in ROS with GAZEBO — **9**

Robot simulation - Gazebo –create simulation model at Gazebo- Adding colors, textures, transmission tags, 3D vision sensor to Gazebo- Moving robot joints using ROS controllers- ROS controller interacts with Gazebo, interfacing state controller, simulation of moving the robot joints – simulation of differential wheeled robot in Gazebo

UNIT-IV ROS with VREP — **9**

V-REP is a multi-platform robotic simulator - Simulating the robotic arm using V-REP – Adding the ROS interface to V-REP joint - Simulating a differential wheeled robot, Adding a laser sensor , 3D vision sensor

UNIT-V Mapping, Navigation and Motion Planning ROS with MOVEIT — **9**

Move it Instattion - Generating the Self-Collision matrix .virtual joints, planning groups, robot poses, robot end effector - MoveIt Architecture Diagram - Trajectory from RViz GUI executing in Gazebo - Planning scene overview diagram- Collision Checking - Motion Planning, Pick and Place Behaviors using Industrial Robots with ROS Moveit – ROS with MATLAB

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Recognize the concept of ROS and programming.
2.	Evaluate various robot algorithms in ROS programming
3.	Deploy mapping, navigation and motion planning ROS with Move-it.
4.	Simulate robots in ROS with GAZEBO and V-REP
5.	Program a Robot using ROS and its tool boxes

TEXT BOOKS

1. Lentin Joseph, Jonathan Cacace, "Mastering ROS for Robotics Programming", Second Edition, Packt Publishing, 2018.

REFERENCES

1. Lentin Joseph, Aleena Johny, "Robot Operating System (ROS) for Absolute Beginners
2. Robotics Programming Made Easy", Second Edition, Apress, 2022.

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PS01**	**PS02**
CO1	✓		✓	✓								✓	✓	✓
CO2	✓		✓	✓								✓	✓	✓
CO3	✓	✓	✓	✓								✓	✓	✓
CO4	✓	✓	✓	✓								✓	✓	✓
CO5	✓	✓	✓	✓								✓	✓	✓

Course Code	Course Name	Semester	Credits	L T P C
	AGRICULTURAL ROBOTICS	**7**		**3 0 0 3**

COURSE OBJECTIVES

- To learn about Farming related Machines.
- To understand the global position and information system in machines.
- To know about traction and testing
- To familiarize the concept on weed management
- To learn about machinery selection

UNIT- I Introduction **9**

History of Mechanized Agriculture - Farming Operations and Related Machines - Tillage, Planting Cultivation, and Harvesting, Agricultural Automation - Agricultural Vehicle Robot.

UNIT-II Precision Agriculture **9**

Sensors – types and agricultural applications, Global Positioning System (GPS) - GPS for civilian use, Differential GPS, Carrier-phase GPS, Real-time kinematic GPS, Military GPS, Geographic Information System, Variable Rate Applications and Controller Area Networks

UNIT-III Traction and Testing **9**

Hitching- Principles of hitching, Types of hitches, Hitching and weight transfer, Control of hitches, Tires and Traction models, Traction predictor spread sheet, Soil Compaction, Traction Aids, Tractor Testing.

UNIT-IV Soil Tillage and Weed Management **9**

Tillage Methods and Equipment, Mechanics of Tillage Tools, Performance of Tillage Implements, Hitching of Tillage Implements, Weed Management - Conventional Cropping Systems, Tools, Crop Rotation, Mechanical Cultivation

UNIT-V Machinery Selection **9**

Screw Conveyors, Pneumatic Conveyors, Bucket Elevators, Forage Blowers and Miscellaneous Conveyors, Machinery Selection - Field Capacity and Efficiency, Draft and Power Requirements, Machinery Costs

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Recognize the areas in agricultural process where robotics can be applied.
2.	Integrate sensor and system for a required specific process in agricultural applications.
3.	Apply Mechanics to the design various robot parameters
4.	Convert various mechanisms into robot by providing actuation at specific links and joints of the mechanism
5.	Develop suitable robotic system for specific agricultural tasks

TEXT BOOKS

1.	Ajit K. Srivastava, Carroll E. Goering, Roger P. Rohrbach, Dennis R. Buckmaster, "Engineering Principles of Agricultural Machines", ASABE Publication, 2012.
2.	Myer Kutz , "Handbook of Farm, Dairy and Food Machinery Engineering", Academic Press, 2019

REFERENCES

1.	Qin Zhang, Francis J. Pierce, "Agricultural Automation Fundamentals and Practices", CRC Press, 2016.
2.	Stephen L Young, Francis J. Pierce, "Automation: The Future of Weed Control in Cropping Systems", Springer, Dordrecht Heidelberg New York London, 2014.
3.	R.A. Kepner, Roy Bainer, E.L. Barger, "Principles of Farm Machinery", 3rd Edition, CBS Publishers, New Delhi, 2005.
4.	Guangnan Chen, "Advances in Agricultural Machinery and Technologies", 1st Edition, CRC Press, 2021.

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PS01**	**PS02**
CO1	✓	✓	✓	✓								✓	✓	✓
CO2	✓	✓	✓	✓								✓	✓	✓
CO3	✓	✓	✓									✓	✓	✓
CO4	✓		✓	✓								✓	✓	✓
CO5	✓	✓	✓	✓								✓	✓	✓

Course Code	Course Name	Semester	Credits	L T P C
	ROBOT KINEMATICS	**7**		**3 0 0 3**

COURSE OBJECTIVES

- To introduce Robots history, terminologies, classification and configurations.
- To get knowledge about basic Geometrical and Algebraic approach to solve forward kinematics of serial manipulator
- To get knowledge about advanced forward kinematics of serial manipulator.
- To get knowledge about inverse kinematics of various serial manipulator
- To get knowledge about Jacobian aspects and infinitesimal motion of robot mechanisms

UNIT- I Overview of Robotics **9**

Introduction to Robotics - History - Definitions - Law of Robotics – Terminologies – Classifications Overview – Links & Joints - Degrees of Freedoms - Coordinate Systems - Work Volume - Precision, Repeatability & Accuracy - Position and Orientation of Objects - Roll, Pitch and Yaw Angles - Joint Configuration of Five Types of Serial Manipulators - Wrist Configuration- Overview of end effector - Selection and Application of Serial Manipulators.

UNIT-II Forward Kinematic Modeling – Geometrical and Algebraic Approach **9**

Need for forward and Inverse Kinematics Equation – Parameters in Design and Control – Methods of forward and inverse kinematics- Geometrical and Algebraic Approach in Forward Kinematics Solution, 1 DOF - 2 DOF Planar Robot (2P and 2R); 3DOF 2RP Spatial Robot.

UNIT-III Forward Kinematic Modeling – DH Approach **9**

Unit Circle Trigonometry - Translation Matrix - Rotation matrix, Euler Angles – Quaternion Fundamental - Dot and Cross Products - Frames and Joint Coordinates – Homogeneous Transformation - D-H and Modified D-H Convention and Procedures – Forward kinematics Solution using D-H Convention: 3 DOF wrist , RR Planar, 3 DOF RRP, Cartesian, Cylindrical, Spherical , SCARA and Articulated 3 DOF robots - 3 DOF robot with wrist

UNIT-IV Inverse Kinematics Modeling **9**

Introduction to inverse kinematics -Issues in inverse kinematics - Inverse kinematics of 2 DOF Planar robot - 2 and 3DOF planar and Spatial robot - Tool configuration - Inverse kinematics of 3 axis robot and 6 axis Robot - Inverse kinematics Computation- Closed loop solution.

UNIT-V Kinematic Modeling of Differential Drive Robot **9**

Degree of Mobility, Steerability and Maneuverability- Mobile Robot kinematics - Kinematic model and constraints, Mobile robot workspace – Representation of robot position – Kinematic models of differential wheel drive - Fixed wheel and steered wheel - Mobile manipulators and its applications – swarm robots.

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Explain the history, classifications, and basic terminologies of robotics and various configuration of robots
2.	Evaluate forward kinematic model for planar and spatial robot manipulator.
3.	Evaluate forward kinematic model for multi-DOF robot manipulators.
4.	Evaluate inverse kinematic model for multi-DOF robot manipulators.
5.	Evaluate forward kinematic model for differential drive mobile robot.

TEXT BOOKS

1.	Mikell P. Groover, "Industrial Robotics", McGraw Hill, 2nd edition, 2012
2.	John J. Craig, "Introduction to Robotics", 3rd Edition, Addison Wesley, ISE 2008
3.	Lynch, Kevin M., and Frank C. Park. Modern Robotics: Mechanics, Planning, and Control 1st ed. Cambridge University Press, 2017

REFERENCES

1.	S K Saha, Introduction to Robotics, Tata McGraw-Hill, Second Edition, 2017

2.	Arthor Critchlow, "Introduction to Robotics", 1st edition, Macmillan, 2009.
3.	Mohsen Shahinpoor, "A Robot Engineering Text Book", 1st edition, Harper and Row, 2004
4.	Deb S.R., "Robotics Technology and Flexible Automation", 2nd edition, Tata McGraw - Hill Publis Robotics: Control and Programming.
5.	J. Srinivas, R. V. Dukkipati, K., "Robotics: Control and Programming", Narosa Publishing House, 2009

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02
CO1	✓	✓	✓	✓								✓	✓	✓
CO2	✓	✓	✓	✓								✓	✓	✓
CO3	✓	✓	✓	✓								✓	✓	✓
CO4	✓	✓	✓	✓								✓	✓	✓
CO5	✓	✓	✓	✓								✓	✓	✓

Course Code	Course Name	Semester	Credits	L T P C
	ROBOT DYNAMICS AND CONTROL	7		3 0 0 3

COURSE OBJECTIVES

- To learn and understand generalized co-ordinates, Jacobian matrix Mass Distribution and other fundamental equations motion of robot mechanisms
- To understand Lagrangean and Hamiltonian mechanics
- To understand nonlinearities in control system
- To understand various force control strategies
- To understand various concepts in linearizing a no linear signal

UNIT- I Robot Force Models — **9**

Generalized co-ordinates - Generalized Forces - Equation of Motions – Static Forces in Manipulators - Jacobian matrix - Jacobians in The Force Domain - Cartesian Transformation of Velocities and Static Forces - Acceleration of A Rigid Body - Mass Distribution – Nonrigid Body Effects - Newton's Equation - Euler's Equation – Langrage Equation

UNIT-II Robot Dynamics — **9**

General Expressions for Kinetic and Potential Energy - Kinetic Energy for an n-Link Robot - Potential Energy for an n-Link Robot - Equations of Motion -Lagrangian Multiplier - Langrage's Equation - Hamilton Equation - Hamilton vector Field- Euler - Langrage Equation – State Vector and Equation Formulation.

UNIT-III Robot Control Systems — **9**

The manipulator control problem, Linear second-order model of manipulator. Functions of controller and power amplifier. Joint actuators- stepper motor, servo motor. Control Schemes: PID control scheme – Position and force control schemes. Robotic sensors and its classification, Internal sensors – Position, velocity, acceleration and force information, External Sensors – Contact sensors-Limit switches, piezoelectric, pressure pads, Non-contact sensors – Range sensors, Vision sensor- robotic vision system, Description of components of vision system.

UNIT-IV Control of Manipulators — **9**

Linear Time Varying and Linearization – Input and Output Stability - Background: The Frobenius Theorem - Single-Input Systems. Introduction to nonlinear system – time varying systems – multi-input, multi-output control systems - the control problem for manipulators - practical considerations - current industrial-robot control systems - Lyapunov stability analysis – Cartesian - based control systems - adaptive control - Limit Cycle - Describing Function.

UNIT-V Force Control — **9**

Constrained Dynamics - Static Force/Torque Relationships - Constraint Surfaces - Natural and Artificial Constraints - Network Models and Impedance - Impedance Operators - Classification of Impedance Operators - Force Control Strategies - Impedance Control - Hybrid Impedance Control.

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Describe generalized co-ordinates, Jacobian matrix Mass Distribution and equation of motion
2.	Develop the static force model and inverse dynamic model of multi-degree of freedom (DOF) manipulator. Evaluate dynamics of robot using Lagrangian and Hamiltonian mechanics.
3.	Describe the control architecture of robot manipulator.
4.	Evaluate linear and nonlinearities in dynamics of robots.
5.	Develop the control strategies for robot system.

TEXT BOOKS

1. Mark W. Spong, Seth Hutchinson, M. Vidyasagar, "Robot Modeling and Control", Wiley India Edition, 2006
2. John J. Craig, "Introduction to Robotics – Mechanics and control", 3rd edition, Prentice Hall, 2005

REFERENCES

1.	Groover,M.P., Weis,M., Nagel,R.N. and Odrey,N.G., "Industrial Robotics Technology, Programming and Applications", McGraw-Hill, Int., 1986
2.	K.S.Fu, Gonzalez, R.C. and Lee, C.S.G., "Robotics Control, Sensing, Vision and Intelligence", McGraw Hill, 1987.
3.	Saeed B. Niku, "Introduction to Robotics: Analysis, Control, Applications", 2nd edition, John Wiley & Sons, Inc., 2011
4.	Klafter,R.D., Chmielewski, T.A. and Negin,M., "Robotics Engineering – An Integrated Approach", Prentice-Hall of India Pvt. Ltd., 1984

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02
CO1	✓	✓	✓		✓							✓	✓	✓
CO2	✓	✓	✓		✓							✓	✓	✓
CO3	✓	✓	✓		✓							✓	✓	✓
CO4	✓	✓	✓		✓							✓	✓	✓
CO5	✓	✓	✓		✓							✓	✓	✓

PROFESSIONAL ELECTIVE COURSES - III

(Sensor and Control Technologies)

Course Code	Course Name	Semester	Credits	L T P C
	MACHINE VISION	**7**		**3 0 0 3**

COURSE OBJECTIVES

- To understand the fundamentals of human vision vs machine vision systems.
- To learn the principles of image acquisition, including lighting, sensors, and camera models.
- To study digital image processing techniques in spatial and frequency domains.
- To gain knowledge in image analysis, feature extraction, and pattern recognition.
- To explore real-world applications of machine vision in industries and robotics

UNIT- I Introduction **9**

Human visual system – Active vision system – Machine vision and Computer vision –Benefits of machine vision – Machine vision components – Block diagram and function of machine vision system – Frame Grabber – Sensing and Digitizing Image Data – Signal Conversion – Image Storage – Lighting Techniques – Implementation of industrial machine vision system – Refraction at a spherical surface – Thin Lens Equation – image function and characteristics – image formation – image sensing frequency space analysis

UNIT-II Image Acquistion **9**

Physics of Light – Interactions of light – Lighting parameters – Lighting sources –Lighting Techniques – Scene constraints – Types and Setups – Machine Vision Lenses –Optical Filters – Imaging Sensors – General problem in capturing the image – selection of camera – optics in camera – CCD and CMOS Specifications – Inter face Architectures –Analog and Digital Cameras – Digital Camera Interfaces – Camera Computer Interfaces – Geometrical Image formation models – Camera Calibration.

UNIT-III Image Processing **9**

Machine Vision Software – Fundamentals of Digital Image – Image formation –Filtering technique - Image Acquisition - Image Processing in Spatial and Frequency Domain– Sampling and quantization – Segmentation- Thresholding - Grayscale Stretching – Image Smoothing and Sharpening – Edge Detection – Binary Morphology – Color image processing.

UNIT-IV Image Analysis **9**

Feature extraction –Decision Making – Geometry of curves – Shape identification –Edge detection techniques – Normalization – Gray scale correction – Template techniques –Texture and texture Analysis – Image resolution – Depth and volume – Color image processing – Pattern recognition – Image data compression – Template Matching and Classification – 3D Machine Vision Techniques

UNIT-V Machine Vision Applications **9**

Machine vision applications in Manufacturing, Electronics, Printing, Pharmaceutical, Textile –Applications in Non-visible spectrum – Metrology and Gauging – OCR and OCV–Inspection part identification – Vision guided robotics: Industrial robot control – Mobile robots – Field and Service Applications – Agricultural and Bio medical field - Vision system calibration – Case studies.

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Explain the working principles of machine vision systems and compare with human vision.
2.	Analyze and design image acquisition systems using appropriate lighting, sensors, and cameras.
3.	Apply image processing techniques such as filtering, segmentation, and edge detection.
4.	Perform image analysis and feature extraction for decision-making and classification tasks.
5.	Implement machine vision solutions in industrial, biomedical, and robotic applications.

TEXT BOOKS

1.	Digital Image Processing, "Digital Image Processing", 4th Edition, Pearson Education, 2018.
2.	Machine Vision, "Machine Vision", McGraw-Hill International Edition, 1995.

REFERENCES	
1.	Computer Vision: Algorithms and Applications, "Computer Vision: Algorithms and Applications", Springer, 2011.
2.	Handbook of Machine Vision, "Handbook of Machine Vision", Wiley-VCH, 2006.
3.	Image Processing Analysis and Machine Vision, "Image Processing, Analysis, and Machine Vision", 4th Edition, Cengage Learning, 2014.
4.	Learning OpenCV, "Learning OpenCV: Computer Vision with the OpenCV Library", O'Reilly Media, 2008.

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PS01**	**PS02**
CO1	✓	✓	✓	✓								✓	✓	✓
CO2	✓	✓	✓	✓								✓	✓	✓
CO3	✓	✓	✓	✓								✓	✓	✓
CO4	✓	✓	✓	✓								✓	✓	✓
CO5	✓	✓	✓	✓								✓	✓	✓

Course Code	Course Name	Semester	Credits	L T P C
	POWER PLANT INSTRUMENTATION	**7**		**3 0 0 3**

COURSE OBJECTIVES

- To provide an overview of different methods of power generation with a particular stress on thermal power generation.
- To bring out the various measurements involved in power generation plants.
- To provide knowledge about the different types of devices used for analysis.
- To impart knowledge about the different types of controls and control loops.
- To familiarize the student with the methods of monitoring different parameters like speed, vibrationof turbines and their control.

UNIT- I Overview of Power Generation **9**

Brief survey of methods of power generation – hydro, thermal, nuclear, solar and wind power – importance of instrumentation in power generation – thermal power plants – building blocks – details of boiler processes UP&I diagram of boiler – cogeneration.

UNIT-II Measurements in Power Plants **9**

Electrical measurements – current, voltage, power, frequency, power – factor etc. – non electrical parameters – flow of feed water, fuel, air and steam with correction factor for temperature – steam pressure and steam temperature – drum level measurement – radiation detector – smoke density measurement – dust monitor.

UNIT-III Analyzers in Power Plants **9**

Flue gas oxygen analyzer – analysis of impurities in feed water and steam – dissolved oxygen analyzer, Zirconia oxygen analyzer – chromatography – PH meter – fuel analyzer – pollution monitoring instruments. Nuclear power plant instrumentation - radiations detection instruments - process sensors - Spectrum Analyzer – nuclear reactor control systems and allied instrumentation.

UNIT-IV Control Loops in Boiler **9**

Combustion control – air/fuel ratio control – furnace draft control – induced draught, power requirements for draught systems - Combustion control: Fuel/Air ratio, combustion efficiency, excess air, parallel and cross limited combustion control- soot-blowing operation. - drum level control – main stem and reheat steam temperature control – super heater control – at temperature – deaerator control – distributed control system in power plants – interlocks in boiler operation.

UNIT-V Turbine Monitoring and Control **9**

Speed, Vibration, Shell Temperature monitoring and control – Steam pressure control – lubricant oil temperature control – cooling system.

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Understand the basic principles of power generation.
2.	Understand about measurement of various parameters in power plant.
3.	Know the various analyzers in power plant.
4.	Understand about the turbine boiler control.
5.	Understand about the turbine monitoring.

TEXT BOOKS

1.	Elonka,S.M.and Kohal A.L.Standard Boiler Operations, McGraw Hill, New Delhi, 1994.
2.	R.K.Jain, Mechanical and industrial Measurements, Khanna Publishers, New Delhi, 1995.
3.	Everett Woodruff, Herbert Lammers, Thomas Lammers, Steam Plant Operation,9th Edition McGraw Hill, 2012.
4.	Rajput R.K., A Text books of Power plant Engineering. 5th Edition, Lakshmi Publications, 2013.
5.	E.Al. Wakil, 'Power Plant Engineering', Tata McGraw Hill, 1984.

6.	John G Webster-The Measurement, Instrumentation, and Sensors Handbook- CRC and IEEE Press, 1999
7.	Chakrabarti, A., Soni, M.L., Gupta, P.V. and Bhatnagar, U.S., A TEXT BOOKS on Power System Engineering, Dhanpat Rai and Co. (P) Ltd. (2008).
REFERENCES	
1.	Sam G. Dukelow, "The control of Boilers", Instrument Society of America, 1991.
2.	"Modern Power Station Practice", Vol.6, Instrumentation, Controls and Testing, Pergamon Press, Oxford, 1971.
3.	Liptak B.G., "Instrumentation in Process Industries", Chilton, 1973
4.	P.Tamilmani, "Power Plant Instrumentation", SAMS Publishers, Chennai.
5.	P.K.Nag, "Power plant Engineering", Tata McGraw-Hill Education, 3rd edition, 2007.
6.	Krishnaswamy.K, Ponnibala.M., "Power Plant Instrumentation", PHI Learning Pvt. Ltd., New Delhi, 2011.

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02
CO1	✓	-	✓	-	-	✓	-	-	-	✓	-	-	✓	✓
CO2	✓	✓	✓	✓	✓	-	✓	-	-	✓	-	✓	✓	✓
CO3	-	-	-	-	✓	-	✓	-	-	✓	-	✓	✓	✓
CO4	✓	-	✓	-	✓	✓	✓	-	-	✓	-	-	✓	✓
CO5	✓	-	✓	-	-	✓	-	-	-	✓	-	-	✓	✓

Course Code	Course Name	Semester	Credits	L T P C
	MEDICAL SENSORS	**7**		**3 0 0 3**

COURSE OBJECTIVES

- To understand bio-potential generation, electrodes, and bio-amplifier fundamentals.
- To study measurement and interpretation of electro-physiological signals.
- To learn biomedical physical sensors for temperature, blood flow, and pressure.
- To understand detectors and sensors used in medical imaging systems.
- To gain knowledge of biomedical assisting and therapeutic devices

UNIT- I Bio-potential Electrodes and Bio Amplifiers **9**

Origin of bio potential and its propagation. Electrode-electrolyte interface, electrode–skin interface, half-cell potential, impedance, polarization effects of electrode – non-polarizable electrodes. Types of electrodes - surface, needle and micro electrodes. Necessity for low noise preamplifiers – difference amplifiers – chopper amplifiers – electrical safety – grounding and isolation.

UNIT-II Electro-Physiological Measurement **9**

Bio signal characteristics – frequency and amplitude ranges, ECG – EEG – EMG – ERG – lead system and recording methods – typical waveforms.

UNIT-III Physical Sensors in Biomedicine **9**

Temperature measurement: core temperature, -surface temperature- invasive. Blood flow measurement: skin blood- hot film anemometer- Doppler sonography- electromagnetic sensor. Blood pressure measurement: noninvasive- hemodynamic invasive.

UNIT-IV Detectors in Radiology **9**

X ray imaging with sensors, detectors in nuclear radiology, magnetic field sensors for imaging, magnetic resonance imaging. computer tomography, ultra-sonography, endoscopy.

UNIT-V Assisting and Therapeutic Devices **9**

Blood gas and pH sensor, electrochemical sensor, optical fiber sensor, mass spectrometer, optical oximetry, pulse oximetry, ear oximetry. Cardiac pacemakers, defibrillators, ventilators, diathermy, heart lung machine.

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Analyze bio-potential electrodes and bio-amplifier systems.
2.	Interpret electro-physiological signals using standard measurements.
3.	Apply biomedical sensors for physiological parameter measurement.
4.	Explain medical imaging detectors and diagnostic systems.
5.	Describe biomedical assisting and therapeutic devices

TEXT BOOKS

1.	Webster, John G. Medical Instrumentation: Application and Design. 3rd ed., John Wiley & Sons, 1999.
2.	Khandpur, Raghbir Singh. Handbook of Biomedical Instrumentation and Measurements. Tata McGraw-Hill, 1987.
3.	Arumugam, M. Biomedical Instrumentation. Anuradha Publications, Chennai.

REFERENCES

1.	Geddes, Leslie A., and L. E. Baker. Principles of Applied Biomedical Instrumentation. John Wiley & Sons, 1975.
2.	Wise, Donald L. Applied Biosensors. Butterworth Publishers, 1989.
3.	Koryta, J. Medical and Biological Applications of Electrochemical Devices. John Wiley & Sons, 1980.

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PS01**	**PS02**
CO1	✓	✓	-	-	✓	-	-	✓	-	-	-	✓	✓	✓
CO2	✓	✓	-	✓	✓	-	-	-	-	-	-	✓	✓	✓
CO3	✓	✓	✓	✓	✓	-	-	-	-	-	-	✓	✓	✓
CO4	✓	✓	-	✓	✓	✓	-	-	-	-	-	✓	✓	✓
CO5	✓	✓	✓	-	✓	✓	-	✓	-	-	-	✓	✓	✓

Course Code	Course Name	Semester	Credits	L T P C
	AIRCRAFT INSTRUMENTATION	**7**		**3 0 0 3**

COURSE OBJECTIVES

- To provide a strong concept on the classification of aircrafts and displays panels.
- To provide knowledge on various pressure measuring instruments
- To provide knowledge on gyroscopic and magnetic instruments
- To provide information on Aircraft Instruments and Instrument systems.
- To study on Aircraft Fuel systems.

UNIT- I Flight Instrumentation **9**

Instrument elements and mechanisms-Classification of aircrafts – Instrument displays, panels, cock-pit layout – Cockpit Voice Recorder – Flight Data Recorder– Air Data Instruments – Types- Flight Management Systems.

UNIT-II Pressure Instruments **9**

Layers of Atmosphere – Pitot and Static Sources – Pressure Altimeter –Servo Altimeter –Vertical Speed Indicator – Airspeed Indicator –Mach Meter – Critical Mach Number –Direct Reading Mach Meter.

UNIT-III Gyroscopic and Magnetic Instruments **9**

Basic Properties of Mechanical Gyroscopes – Types of Gyroscope – Direction Indicator –Attitude Indicator – Turn and Slip Indicator and Turn Coordinator – Magnetic Compass –Terrestrial Magnetism – Direct Indicating Magnetic Compass – Flux Gate Sensor

UNIT-IV Aircraft Instruments and Instrument Systems **9**

Principles of Instrument Operations – Flight Instruments – Flight Instrument Systems –Engine Instruments – Fuel Quantity Indicators – Fuel System Monitoring Instruments –Electronic Instruments – Position and Warning Systems – Cabin-Cooling Systems Installation and Maintenance of Instruments.

UNIT-V Aircraft Fuel Systems **9**

Requirements-Fuel Tanks – Fuel system components – Types of Fuel sy stems – Fuel Subsystems-Aircraft Fuel Systems – Inspection, Maintenance and Troubleshooting.

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Develop basic knowledge in the behavior and characteristics of various display devices in aircraft.
2.	Acquire knowledge on various pressure measuring instruments.
3.	Acquire knowledge on gyroscopic instruments and Magnetic instruments.
4.	Acquire knowledge on Flight instruments and Waring systems
5.	Acquire knowledge on Fuel Systems, maintenance and servicing

TEXT BOOKS

1.	Binns, Chris. Aircraft Systems: Instruments, Communications, Navigation, and Control. , 2019
2.	Wyatt, David. Aircraft Flight Instruments and Guidance Systems: Principles, Operations and Maintenance. Routledge, 2014

REFERENCES

1.	Pallett, Aircraft Instruments, Prentice-Hall International, 2002
2.	Nagabhushana, S., and L. K. Sudha. Aircraft instrumentation and systems. IK International Pvt Ltd, 2010.
3.	Michael J. Kroes, Aircraft Maintenance and Repair

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PS01**	**PS02**
CO1	✓	-	-	-	-	-	-	-	✓	-	✓	✓	✓	✓
CO2	✓	-	-	-	-	✓	-	✓	-	-	✓	✓	✓	✓
CO3	-	✓	✓	-	-	✓	-	-	-	-	-	-	✓	✓
CO4	-	✓	✓	-	-	✓	-	-	-	-	-	-	✓	✓
CO5	-	✓	✓	-	-	-	-	-	-	-	-	-	✓	✓

Course Code	Course Name	Semester	Credits	L T P C
	PROCESS CONTROL	**7**		**3 0 0 3**

COURSE OBJECTIVES

- To introduce the dynamics of various processes and modelling of physical process using first principles.
- To educate the effect of various control actions and the methods of tuning the controller.
- To study about the construction, and characteristics of control valves.
- To introduce the concept of various complex control schemes.

UNIT- I Mathematical Modeling of a Process **9**

Process variables – degrees of freedom – mathematical model of first order and second order level processes- interacting and non-interacting systems, mathematical model of thermal process, mixing process – batch process and continuous process – Servo and self- regulatory response – Inverse response.

UNIT-II Control Action **9**

Characteristics of On-Off, proportional, single speed floating, integral and derivative control modes – composite control modes – P+I, P+D and P+I+D control modes – response of controller for different types of test inputs – integral windup – auto/manual transfer – Electronics controllers - Nonlinear PID Controller.

UNIT-III Controllers Tuning and Final Control Element **9**

Tuning of controllers by process reaction curve method – continuous cycling method – damped oscillation method – Ziegler-Nichol's tuning – 1/4 decay ratio. Performance Criteria – I/P and P/I Converter – Pneumatic Actuators - Control valve characteristics – Selection of Control Valve –Control Valve Sizing – Classification of Control Valves - Cavitation and Flashing.

UNIT-IV Advanced Control System **9**

Feedback Control, Feed forward, Cascade Control, Ratio Control, Split Range Control, multivariable control, Case Study: Distillation column – control of top and bottom product compositions – reflux ratio – control of chemical reactor - Boiler drum level control

UNIT-V Piping and Instrumentation Diagram **9**

Piping and Instrumentation Diagram of control loops. Complete air–supply system for pneumatic control equipment – major components and their functions. Instrument line symbols- General Instrument Symbols-General function symbols-SAMA diagramming system-ISA instrumentation diagramming symbols- Examples of SAMA instrumentation diagramming symbols - Example of P&ID of temperature, level, flow control systems.

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Understand basic principles and importance of process control in industrial process plant.
2.	Acquire knowledge basic control action and its form.
3.	Specify the required instrumentation and final control elements to ensure well-tuned control.
4.	Apply the control system in various complex processes.
5.	Gain the knowledge of Piping and Instrumentation Diagram.

TEXT BOOKS

1.	George Stephanopoulos, "Chemical Process Control: An Introduction to Theory and Practice", First edition, Prentice Hall of India, 2008.
2.	D.R. Coughanowr and Steven LeBlanc, "Process Systems Analysis and Control", Third Edition, McGraw Hill, 2009.

REFERENCES

1.	B.C. Kuo, Donald P Eckman, "Principles of Industrial Process Control", Second Edition, J. Wiley & Sons, 1965.
2.	Peter Harriott, "Process Control", First Edition, Tata McGraw-Hill Education, 2001.
3.	Surekha Bhanot, "Process Control Principles and Applications", Oxford University Press, 2007.

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PS01**	**PS02**
CO1	✓	✓	-	✓	-	-	-	-	-	-	-	-	✓	✓
CO2	✓	✓	-	✓		-	-	✓	-	-	✓	-	✓	✓
CO3	✓	✓	✓	-	✓	-	✓		✓	✓	-	-	✓	✓
CO4	✓	✓	✓	-	✓	-	-	-	-	-	-	✓	✓	✓
CO5	✓	-	✓	-		-	-	-	-	-	-	-	✓	✓

Course Code	Course Name	Semester	Credits	L T P C
	DIGITAL CONTROL SYSTEM	**7**		**3 0 0 3**

COURSE OBJECTIVES

- To introduce the components of digital control system.
- To provide knowledge on pulse transfer function and their analysis
- To introduce stability concepts in discrete domain.
- To introduce state variable analysis in discrete domain

UNIT- I Introduction to Digital Control **9**

Introduction to Digital Control Systems – Advantages and Practical aspects of the choice of sampling rate and multirate sampling- Basic discrete time signals – Quantization – Sampling Theorem – Data Conversion – Sampling Process-Mathematical Modeling – Data reconstruction and filtering of sampled signals.

UNIT-II Z Transform and Inverse Z Transform **9**

Relationship between s-plane and z-plane – Difference equation – Solution by recursion and Z- transform – Pulse Transfer functions of the zero-order hold and relationship between G(s) and G(z) – Bilinear transformation.

UNIT-III Digital Control Systems **9**

Pulse transfer function – Z transform analysis of open loop, closed loop systems – Modified z transform. Root Loci – Frequency domain analysis – Bode plots – Gain marginand phase margin- Design of Digital control systems based on Root Locus Technique. State equations of discrete data systems, solution of discrete state equations, State transition Matrix: Z- Transform method. Relation between state equations and transfer functions.

UNIT-IV Controllability and Observability **9**

Concepts on Controllability and Observability – Digital state observer: Design of the full order and reduced order state observer – Pole placement de sign by state feedback.

UNIT-V Stability Analysis **9**

Stability analysis of linear digital control systems – Stability tests, Stability analysis of discrete time systems based on Lyapunov approach.

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Analyze digital systems in time domain.
2.	Analyze digital systems in frequency domain.
3.	Model and analysis digital systems in state space representation.
4.	Design state observer and state feedback by pole placement design
5.	Understand the concept of stability in discrete domain.

TEXT BOOKS

1.	C.M. Houpis, G.B. Lamount, "Digital Control Systems-Theory, Hardware, Software International" Student Edition, McGraw Hill Book Co., 1985
2.	V.I. George and C.P. Kurien, "Digital Control Systems", Cengage Learning, 2012
3.	Richard C. Dorf, Robert H. Bishop, "Modern Control Systems", Pearsons Education Inc., New Delhi 2008
4.	Isermann R, "Digital Control Systems", Vol. 1 and Vol. 2, Narosa Publishing 2014

REFERENCES

1.	M. Gopal, Digital Control and State Variable Methods, Tata McGraw Hill, 3rd Edition, 2009
2.	B.C. Kuo, Digital Control System, 2nd Edition, Oxford University Press, 2010
3.	M. Sami Fadali, Antonio Visioli, Digital Control Engineering Analysis and Design, Academic Press, 2013

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PS01**	**PS02**
CO1	✓	-	-	-	-	-	-	-	✓	-	✓	✓	✓	✓
CO2	✓	-	-	-	-	✓	-	✓	-	-	✓	✓	✓	✓
CO3	-	✓	✓	✓	-	✓	-	-	-	-	-	-	✓	✓
CO4	-	✓	✓	✓	-	✓	-	-	-	-	-	-	✓	✓
CO5	-	✓	-	-	-	-	-	-	-	-	-	-	✓	✓

Course Code	Course Name	Semester	Credits	L T P C
	SMART SENSORS	**7**		**3 0 0 3**

COURSE OBJECTIVES

- To understand the role of MCUs and DSPs in sensor control, interfacing, and integration.
- To study sensor communication technologies, MEMS devices, and smart sensor networking protocols.
- To analyze smart sensor standards, plug-and-play concepts, and recent trends in intelligent sensing.
- To understand presence, absence, and identification techniques using motion sensors, barcodes, and RFID.
- To gain knowledge of vision-based sensors and dust measurement systems used in industrial applications.

UNIT- I MCUs and DSPs for Sensor — **9**

Introduction, MCU control, MCUs for sensor interface, DSP control, Software, tools and support, sensor integration.

UNIT-II Sensor Communication and MEMS — **9**

Wireless zone sensing, surface acoustical wave devices, intelligent transportation system, RF-ID, Micro optics, micro-grippers, micro-probes, micro- mirrors, FEDs, communications for smart sensors – sources and standards, automotive protocols, industrial networks, office and building automation, home automation, protocols in silicon, other aspects of network communications.

UNIT-III Implications of Smart Sensors Standards an Recent Trends — **9**

Introduction, sensor plug-and-play, communicating sensor data via existing wiring, automated/remote sensing and web, process control over the internet, alternative standards, HVAC sensor chip, MCU with integrated pressure sensors, alternative views of smart sensing, smart loop.

UNIT-IV Detection and Identifications — **9**

Motion control sensors – Encoders Rotary/Absolute/Programmable-1D/2D Barcodes, RFID Tags Identification-Area Guarding using DeTec4 Safety Light Curtains- Safety Functionality using smart sensor.

UNIT-V Vision and Dust Measurement — **9**

2D Vision Smart Camera sensor - OCR Reading and Quality Inspection- 3D Vision camera sensor – Long Distance Measurement Sensor- LiDAR Scanner- Dust Measurement Device for Continuous Emission Measurement.

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Explain the architecture and functioning of MCUs and DSPs used in sensor interfacing and control systems
2.	Describe wireless sensing, MEMS devices, and communication protocols used in smart sensor networks
3.	Interpret smart sensor standards, plug-and-play concepts, and emerging trends in intelligent sensing
4.	Apply presence, absence, and identification techniques using encoders, barcodes, RFID, and safety sensors
5.	Analyze vision sensors, LiDAR systems, and dust measurement devices for industrial monitoring applications

TEXT BOOKS

1.	Frank, Randy. Understanding Smart Sensors. 2nd ed., Artech House, 2013.
2.	Bosch, Thomas, et al. Industrial Sensors and Controls in Communication Networks. Wiley, 2006.
3.	Bentley, John P. Principles of Measurement Systems. 4th ed., Pearson Education, 2005.

REFERENCES

1.	Fraden, Jacob. Handbook of Modern Sensors: Physics, Designs, and Applications. 5th ed., Springer, 2016.

2.	Mackay, Stuart, Edwin Wright, and Deon Reynders. Practical Industrial Data Communications. Newnes, 2004.
3.	Sze, Simon M., and Kwok K. Ng. MEMS: Fundamentals and Applications. McGraw-Hill, 2010.

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PS01**	**PS02**
CO1	✓	✓	-	-	✓	-	-	-	-	-	-	-	✓	✓
CO2	✓	✓	✓	-	✓	-	-	-	-	-	-	-	✓	✓
CO3	✓	✓	-	✓	✓	-	-	-	-	-	-	✓	✓	✓
CO4	✓	✓	✓	-	✓	✓	-	-	-	-	-	-	✓	✓
CO5	✓	✓	✓	✓	✓	-	✓	-	-	-	-	✓	✓	✓

PROFESSIONAL ELECTIVE COURSES - IV

(Intelligent Automation)

Course Code	Course Name	Semester	Credits	L T P C
	IoT IN AUTOMATION	**8**		**3 0 0 3**

COURSE OBJECTIVES

- Introduction to IoT
- IoT and Machine to Machine.
- Network and Communication aspects
- Challenges and Applications of IoT.
- Developing IoT using Python Programming.

UNIT- I Introduction to IoT	**9**

Defining IoT – Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models and APIs.

UNIT-II IoT & M2M	**9**

Machine to Machine, Difference between IoT and M2M, Software define Network IoT Design Methodology.

UNIT-III Network and Communication	**9**

Wireless medium access issues, MAC protocol survey, Survey routing protocols, Sensor deployment and Node discovery, Data aggregation and dissemination.

UNIT-IV Challenges and Applications	**9**

Design challenges, Development challenges, Security challenges, Other Challenges, Home Automation, Cities and Environment and Health Monitoring.

UNIT-V Developing IoTs	**9**

Introduction to Python, Introduction to different IoT tools, developing applications through IoT tools, developing sensor-based application through embedded system platform, Implementing IoT concepts with Python.

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Understand the concepts of Internet of Things
2.	Analyze basic protocols in wireless sensor network
3.	Design IoT applications in different domain and be able to analyze their performance
4.	Implement basic IoT applications on embedded platform
5.	

TEXT BOOKS

1. Vijay Madisetti, ArshdeeoBahga, "Internet of Things: A Hands -On Approach"
2. Waltenegus Dargie, Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice"

REFERENCES

1. Francis da Costa, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, A press Publications, 2013

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PS01**	**PS02**
CO1	✓	-	-	-	-	-	-	-	✓	-	✓	✓	✓	✓
CO2	✓	-	-	-	-	✓	-	✓	-	-	✓	✓	✓	✓
CO3	-	✓	✓	✓	-	✓	-	-	-	-	-	-	✓	✓
CO4	-	✓	✓	✓	-	✓	-	-	-	-	-	-	✓	✓
CO5	-	✓	-	-	-	-	-	-	-	-	-	-	✓	✓

Course Code	Course Name	Semester	Credits	L T P C
	ADVANCED INDUSTRIAL AUTOMATION	**8**		**3 0 0 3**

COURSE OBJECTIVES

- To understand the various automation hardware for the given application.
- To review various control aspects of automation
- To obtain knowledge about capability of Industrial Automation

UNIT- I INTRODUCTION **9**

Automation in Production System - Principles and Strategies of Automation - Basic Elements of an Automated System - Advanced Automation Functions - Levels of Automations - Flow lines & Transfer Mechanisms - Fundamentals of Transfer Lines.

UNIT-II MATERIAL HANDLING AND IDENTIFICATION TECHNOLOGIES **9**

Overview of Material Handling Systems - Principles and Design Consideration - Material Transport Systems - Storage Systems Overview of Automatic Identification Methods.

UNIT-III AUTOMATED MANUFACTURING SYSTEMS **9**

Components - Classification and Overview of Manufacturing Systems - Manufacturing Cells - GT and Cellular Manufacturing FMS - FMS and its Planning and Implementation. Quality Control Systems: Traditional and Modern Quality Control Methods - SPC Tools - Inspection Principles and Practices - Inspection Technologies.

UNIT-IV CONTROL TECHNOLOGIES IN AUTOMATION **9**

Industrial Control Systems - Process Industries Versus Discrete-Manufacturing Industries – Continuous Versus Discrete Control - Computer Process and its Forms.

UNIT-V MODELING AND SIMULATION FOR PLANT AUTOMATION **9**

Introduction - need for system Modeling - Building Mathematical Model of a Plant, Modern Tools & Future Perspective. Industrial Control Applications: Cement Thermal Water Treatment & Steel Plants. SLE: Cases Studies minimum one for Cement - Thermal - Water Treatment & Steel Plants applications.

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Analyze automation principles, strategies, and transfer mechanisms to determine suitable automation solutions for industrial applications.
2.	Evaluate material handling and identification technologies to optimize efficiency in manufacturing and logistics.
3.	Assess automated manufacturing systems, including GT, FMS, and cellular manufacturing, for improved production planning and implementation.
4.	Apply industrial control technologies to develop automation strategies for discrete and process industries.
5.	Construct mathematical models and simulations for plant automation using modern tools, with applications in cement, thermal, water treatment, and steel industries.

TEXT BOOKS

1.	Krishna Kant, Computer Based Industrial Control, PHI, 2nd edition, 2011
2.	M.P.Groover, Automation, Production Systems and Computer Integrated Manufacturing, Pearson Education.5th edition, 2009
3.	Tiess Chiu Chang Richard A. Wysk, An Introduction to Automated Process Planning Systems, Longman Higher Education, 2015
4.	Viswanandham, Performance Modeling of Automated Manufacturing Systems, PHI, 1st edition, 2009

REFERENCES

1.	Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, John Wiley & Sons, 4th Edition, 2010.

2.	Hugh Jack, Automating Manufacturing Systems with PLCs, Version 5.0, 2010.
3.	Bela G. Liptak, Instrument Engineers' Handbook: Process Control and Optimization, CRC Press, 4th Edition, 2006.
4.	Katsuhiko Ogata, Modern Control Engineering, Prentice Hall, 5th Edition, 2010.
5.	W. Bolton, Programmable Logic Controllers, Newnes (Elsevier), 6th Edition, 2015.

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PS01**	**PS02**
CO1	✓	✓	✓	-	-	✓	-	-	-	✓	✓	-	✓	✓
CO2	✓	✓	✓	-	-	-	-	✓	✓	-	-	-	✓	✓
CO3	-	✓	✓	✓	-	-	-	✓	✓	-	-	-	✓	✓
CO4	✓	-	✓	-	✓	-	-	✓	✓	-	-	✓	✓	✓
CO5	-	✓	✓	-	-	-	-	-	-	-	✓	-	✓	

Course Code	Course Name	Semester	Credits	L T P C
	DATA ANALYTICS FOR IOT	8		3 0 0 3

COURSE OBJECTIVES

- Understand the challenges of IOT analytics systems development and deployment
- To learn about data analytics and use cloud offerings related to IOT
- Ability to understand the Searching and security requirements of IOT
- Acquire the knowledge of Tools, Platform and Services for IOT Analytics
- To Develop IOT infrastructure for real time scenario

UNIT- I INTRODUCTION TO IOT ANALYTICS — **9**

Introduction IOT Data and Big Data Challenges of IOT Analytics Applications IOT Analytics Lifecycle and Techniques IOT Devices and Networking Protocols.

UNIT-II IOT CLOUD, WEB SERVICES AND DATA ANALYTICS — **9**

Cloud based IOT Platform Iaas,Paas and Saas paradigms Requirements of IOT in Big Data Analytics Platform Functional Architecture Web server. Web server for IOT Amazon Web services for IOT Data Analytics for IOT.

UNIT-III SEARCHING THE INTERNET THINGS AND IOT SECURITY — **9**

Introduction A search architecture for social and physical sensors Local Event Retrieval Sensor Metadata Venue Recommendation Security Requirements in IOT Security Concerns in IOT Applications Security Architecture in the Internet of Things Insufficient Authentication/Authorization Insecure Access Control Threats to Access Control, Privacy, and Availability Attacks Specific to IOT.

UNIT-IV TOOLS AND SERVICE FOR IOT ANALYTICS — **9**

Architecture for IOT Analytics Applications Nodes Development Examples Open source framework for IOT Analytics as a service Introduction Architecture Sensing as a service Infrastructure Anatomy Scheduling, Metering and service delivery Sensing as a Service Example Semantic Analytics Tools and Platforms.

UNIT-V IOT ANALYTICS APPLICATIONS AND CASE STUDIES — **9**

Data Analytics and smart Building-Smart Cities-Data collection to deployment and operationalization using the vital platform Ethical IOT

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Assess the networking protocols for connecting devices and challenges of IOT Analytics
2.	Predict the cloud based IOT and IOT in Data Analytics.
3.	Use the concepts of Security requirements and Searching the IOT
4.	Outline the different tools and services for IOT Analytics platform.
5.	Compare applications of IOT Analytics in real time scenario.

TEXT BOOKS

1.	Wireless John Soldatos, Building Blocks for IOT Analytics, River Publisher 2017
2.	Andrew Minteer, Analytics for the Internet of Things, Packet Publishing Pvt. Ltd., Birmingham, 2017
3.	Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, StamatisKarnouskos, David Boyle, From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence, 1st Edition, Academic Press, 2014. Christopher M.Bishop, Pattern Recognition and Machine Learning, Springer, 2006
4.	Olivier Hersent, David Boswarthick, Omar Elloumi , The Internet of Things Key applications and Protocols, Wiley, 2012
5.	Practical Internet of Things Security (Kindle Edition) by Brian Russell, Drew Van, 2018

REFERENCES	
1.	Rajkumar Buyya, Amir Vahid Dastjerdi, Internet of Things: Principles and Paradigms, Morgan Kaufmann, 2016.
2.	Vijay Madisetti and Arshdeep Bahga, Internet of Things: A Hands-On-Approach, VPT Publications, 2014.
3.	Kai Hwang, Geoffrey C. Fox**,** and Jack G. Dongarra, Distributed and Cloud Computing: From Parallel Processing to the Internet of Things, Morgan Kaufmann, 2012.
4.	Bart Baesens, Analytics in a Big Data World, Wiley, 2014.
5.	William Stallings, Cryptography and Network Security: Principles and Practice, Pearson, 7th Edition, 2017.

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PS01**	**PS02**
CO1	✓	-	✓	-	-	-	-	-	✓	-	✓	-	✓	✓
CO2	✓	✓	✓	✓	-	-	-	✓	✓	✓	-	-	✓	✓
CO3	✓	-	✓	-	✓	-	-	-	-	✓	✓	✓	✓	✓
CO4	-	✓	✓	-	-	-	-	-	✓	✓	✓	-	✓	✓
CO5	✓	✓	-	-	-	-	-	-	-	-	✓	-	✓	✓

Course Code	Course Name	Semester	Credits	L T P C
	COMPUTER INTEGRATED MANUFACTURING	**8**		**3 0 0 3**

COURSE OBJECTIVES

- To develop an understanding of classical and state-of-the-art production systems, control systems, management technology, cost systems, and evaluation techniques.
- To understand the fundamentals of CAD& CAM and its network systems.
- To develop an understanding of concepts of group technology and process planning methods of computer-integrated manufacturing (CIM).
- To introduce different numerical controls and its tooling systems in CIM.
- To understand the advanced manufacturing systems and its developments

UNIT- I **9**

Introduction to Automation -Production system Facilities, Manufacturing Support Systems, Automation in Production Systems, Automated Manufacturing Systems, Types of Automation, Computerized manufacturing Support System, Reasons for Automating, Manufacturing Industries and Products, Manufacturing operations, Product / Production Relationships, Production Concepts and Mathematical Models. Basic elements of an Automated System, Advanced Automation Functions, Levels of Automation. Industrial Control Systems-Process Industries versus Discrete Manufacturing Industries, Continuous versus Discrete Control, Computer Process Control, Forms of Computer Process Control.

UNIT-II **9**

Fundamentals of CAD, CAM and CAE, CIM Definition, CIM Wheel, CIM components, Evolution of CIM - Development of computers - Needs of CIM, Benefits of CIM. CIM Hardware & Software, CIM Models. DBMS and Network system - Data base and DBMS- requirement, features and architecture of DBMS. CIM Communications (Network) System, Communication Matrix, Network Architectures, Tools and Techniques.

UNIT-III **9**

Group Technology – Introduction - coding and classification system, Production Flow Analysis, Coding System - OPTIZ, MICLASS, Benefits of Group Technology , Machine cell design. Process Planning- Structure of a Process Planning, Process Planning function, CAPP - Types of CAPP, Retrieval and Generative type CAPP, Concurrent engineering, Design for Manufacturing and Assembly, Advanced Manufacturing Planning.

UNIT-IV **9**

Fundamentals of NC Technology – Basic components of an NC System, NC Coordinate and Motion Control systems, Computer Numerical Control, Features of CNC, Machine Control Unit for CNC, CNC Software, DNC Machines, Application of NC machine tools Applications, Structure of CNC Machines, , CNC Controllers, NC Part Programming, Computer-Assisted Part Programming. Features and Applications of CNC Turning Centre, CNC Milling Machine, CNC Turn-Mill Centre, CNC machining Centre, CNC Tooling system and Automatic Tool Changing System, Computer Aided Quality Control - contact, non-contact inspection methods, Coordinate Measuring Machine CMM - Integration of CAQC with CAD / CAM.

UNIT-V **9**

FMS -Components of FMS, Computer control and function, FMS planning, scheduling and control, Knowledge Based Scheduling, FMS operation control, Hierarchy of computer control, supervisory control, types of software used in FMS, Applications and Benefits.

Production Support Machines and Systems -Industrial Robots, Automated Material Handling, Automatic Guided Vehicles, Automated Storage and Retrieval system. Developments in Manufacturing Technologies- AI and Expert System, Agile manufacturing, Lean Manufacturing, Virtual Manufacturing, Simulation in Manufacturing – Factories of Future.

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	To explain the classical and state-of-the-art production systems, control systems, management technology, cost systems, and evaluation techniques.

2.	To summarize the fundamentals of CAD & CAM and its network systems.
3.	To apply the concepts of group technology and process planning methods in manufacturing.
4.	To summarize different numerical controls and its tooling systems in CIM.
5.	To explain the advanced manufacturing systems and its developments.
TEXT BOOKS	
1.	KANT VAJPAYEE.S, "Principles of Computer- Integrated Manufacturing"; 1st ed. PHI 2006.
2.	MIKELL P. GROOVER, "Automation, Production Systems & CIM", 2nd ed. PHI 2001
3.	James A.Rehg, Henry W.Kraebber, "Computer- Integrated Manufacturing", second Edition, Pearson Education
4.	P.N. Rao, "CAD/CAM Principles and Applications", Second Edition, TMH 2006
REFERENCES	
1.	Radhakrishnan.P, Subramanyan. S, Raju.V, "CAD/CAM/CIM", Second Edition, New Age International publishers, 2000
2.	Daniel Hunt.V., "Computer Integrated Manufacturing Hand Book", Chapman & Hall, 1989
3.	Groover M.P, "Computer Aided Design and Manufacturing", Prentice Hall of India, 1987
4.	Yorem Koren, "Computer Control of Manufacturing System", McGraw Hill, 1986
5.	Ranky Paul. G., "Computer Integrated Manufacturing", Prentice Hall International, 1986.
6.	ROGER MANNAM, "Computer Integrated Manufacturing from Concepts of Realization" 1st ed. Addison Wiley, 1997.
7.	P. N. Rao, "Computer Aided Manufacturing", TMH, 2007, 12th Edition.

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02
CO1	✓	✓	✓	-	-	-	-	-	-	-	-	-	✓	✓
CO2	✓	-	✓	-	-	✓	✓	✓	-	-	-	-	✓	✓
CO3	✓	-	✓	-	-	✓	✓	✓	-	-	-	-	✓	✓
CO4	✓	✓	✓	✓	✓	✓	✓	-	-	-	✓	✓	✓	
CO5	✓	✓	✓	-	-	-	-	✓	-	-	✓		✓	✓

Course Code	Course Name	Semester	Credits	L T P C
	EMBEDDED SYSTEMS	**8**		**3 0 0 3**

COURSE OBJECTIVES

- To identify various characteristics, feature design, applications of embedded systems.
- To understand hardware, processor architecture for embedded systems implementation.
- To learn the techniques of interfacing between processors and peripheral devices related to embedded processing
- To study the OS features, functions used for embedded systems.
- To study various software issues involved in embedded systems for a real time requirement.

UNIT- I Introduction to Embedded Computing **9**

Introduction, characteristics of embedding computing applications, concept of real time systems, challenges in embedded system design, design process, requirements, specifications, architecture design, designing of components, system integration.

UNIT-II Embedded System Architecture **9**

CISC and RISC instruction set architectures, basic embedded processor architecture (CISC, RISC, DSP processor examples), Harvard architecture, memory system architecture: Caches, virtual memory, memory management unit and address translation, I/O sub-system, busy-wait I/O, DMA, interrupt driven I/O, coprocessors and hardware accelerators, processor performance enhancement, pipelining.

UNIT-III Communication Buses and Networking **9**

Serial communication devices, parallel device ports, wireless devices, Timers and counters, watchdog timers, interrupt controllers. Networked Embedded Systems: CPU bus, serial &parallel bus protocols, bus organization, wireless & mobile protocols.

UNIT-IV Real Time Operating Systems **9**

Basic features of an operating system, tasks and threads, context switching, OS services. Process management, timer functions, Memory management, Scheduling Models. Inter process communication, concept of semaphores, Mailbox, pipes, priority inversion, priority inheritance. Example to real-time OS: Basic functions of VxWorks, µCOS.

UNIT-V Embedded Software Development **9**

Software tools- compiler, assembler, cross compilers. Programming Elements- Macros, functions, Data types, Data structures, Optimization of execution time, energy & power. Design issues and techniques. Case studies – Intruder Alarm Systems – Washing Machine- Automotive application- Smart card.

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
6.	Understand the various applications, challenges involved in Embedded system design
7.	Recognize the suitable processor, understanding the memory operations of the embedded system.
8.	Understand the communication types in the embedded systems and complete understanding about the communication protocols.
9.	Understand various functions, services of RTOS and different scheduling models to design an embedded system.
10.	Implement the concepts of programming & optimization techniques. Case studies to analyze the complete development of the embedded system.

TEXT BOOKS

4.	Edward Ashford Lee, Sanjit A. Seshla, "Introduction to Embedded Systems: A Cyber-Physical Systems Approach", MIT Press, Cambridge, London, 2017
5.	Raj Kamal, "Embedded Systems – Architecture Programming and Design", Second Edition, Tata McGraw-Hill Publishing, 2008

6.	Wayne Wolf, "Computers as Components: Principles of Embedded Computing System Design", 2nd Elsevier, 2008
REFERENCES	
6.	Tim Wilmshurst, "Designing Embedded Systems with PIC Microcontrollers", 1st Edition, Newness 2007
7.	Richard H. Barnett, O. Cull Cux, "Embedded C Programming and the Microchip", PIC, Cengage Learning Inc., 2009
8.	Krzysztof Iniewski, "Embedded Systems: Hardware, Design and Implementation", Wiley Publication, 2012
9.	Peter Marwedel, "Embedded System Design", 1st Edition, Springer, 2010

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02
CO1	✓	✓	✓	✓	-	-	-	✓	✓	-	-	-	✓	✓
CO2	✓	✓	-	-	✓	-	-	✓	✓	-	-	-	✓	✓
CO3	✓	✓	-	-	✓	-	-	✓	✓	-	-	✓	✓	✓
CO4	✓	✓	-	-	✓	-	-	✓	✓	-	-	✓	✓	✓
CO5	✓	✓	-	-	✓	-	-	✓	✓	-	-	✓	✓	✓

Course Code	Course Name	Semester	Credits	L T P C
	MACHINE LEARNING	**8**		**3 0 0 3**

COURSE OBJECTIVES

- To understand the fundamentals of supervised learning algorithms
- To acquire knowledge on unsupervised learning algorithms
- To gain the knowledge on reinforcement algorithm
- To develop the neural networks and convolutional neural networks for object classifications.
- To perform object detection using CNN, RCNN, SSD and Yolo.

UNIT- I SUPERVISED LEARNING METHODS **9**

Introduction to learning & classifiers, classification and regression. bayes linear regression logistic regression support vector mechanism Random forest Non Linear Regression Polynomial Regression.

UNIT-II UNSUPERVISED LEARNING METHODS **9**

Clustering and association K means clustering K nearest neighbor Hierarchical clustering probabilistic clustering Autoencoders Apriori algorithm Principle component analysis independent component analysis Singular value decomposition.

UNIT-III REINFORCEMENT LEARNING METHODS **9**

Terms in Reinforcement Learning Key features and Elements Bellman Equation Types of Reinforcement Learning Reinforcement Learning Algorithm Markov Decision Process Monte Carlo Methods Q Learning Applications of Reinforcement Learning.

UNIT-IV DEEP LEARNING **9**

Introduction Image Fundamentals Layers Neuron Hyper parameter activation functions learning rate forward and back propagation gradient descent Neural network CNN Image classification.

UNIT-V OBJECT DETECTION METHODS **9**

ImageNet VGG Net ResNet MobileNet R-CNN Faster R-CNN Single shot detector (SSD) You only look once (YOLO) Face recognition gesture recognition object recognition.

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Explain the basic concepts of supervised learning and types of regression models.
2.	Describe the characteristics and techniques of unsupervised learning.
3.	Apply clustering and dimensionality reduction techniques to real-world data.
4.	Analyze the effectiveness of RL algorithms for dynamic environments.
5.	Assess the effect of hyper parameters and network depth on classification accuracy.

TEXT BOOKS

1.	Ethem Alpaydin, Introduction to Machine Learning, The MIT Press, Cambridge, London, 2014
2.	Vaibhav Verdhan, Computer Vision Using Deep Learning: Neural Network Architectures with Python and Keras, 1st ed. Edition, Apress, 2021
3.	Richard S. Sutton and Andrew G. Barto, Reinforcement Learning: An Introduction, Second edition, The MIT Press, 2015
4.	S. Rajasekaran, GA Vijayalakshmi Pai, Neural Networks, Fuzzy Logic and Genetic Algorithms, Prentice Hall of India Private Limited, 2003
5.	Simon Haykin, Neural Networks, A comprehensive foundation, Prentice Hall, 3rd Edition, 2004
6.	https://onlinecourses.nptel.ac.in/noc18_cs26/course.

REFERENCES	
1.	Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.
2.	Kevin P. Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.
3.	Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press, 2016.
4.	Trevor Hastie, Robert Tibshirani and Jerome Friedman, The Elements of Statistical Learning, Springer, 2nd Edition, 2009.
5.	Francois Chollet, Deep Learning with Python, Manning Publications, 2017.

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02
CO1	✓	-	✓	✓	✓	✓	-	✓	-	-	-	-	✓	✓
CO2	-	✓	✓	-	✓	-	-	✓	-	-	-	-	✓	✓
CO3	✓	-	-	✓	-	-	-	-	-	-	-	✓	✓	✓
CO4	✓	✓	✓	✓	-	-	-	-	✓	-	-	-	✓	✓
CO5	✓	✓	-	✓	✓	-	-	-	-	✓	-	-	✓	✓

Course Code	Course Name	Semester	Credits	L T P C
	ROBOT CONTROL USING ROS	**8**		**3 0 0 3**

COURSE OBJECTIVES

- To understand the concepts of ROS data types and ROS communication.
- To implement the robot model in simulation and visualization of motion and data in ROS.
- To develop the mobile robot navigation algorithm and trajectory control for the industrial robot arm.

UNIT- I ROS FOUNDATIONS — **9**

ROS concepts ROS data types and variables ROS packages Nodes ROS tools ROS message ROS communication: ROS topic, Service and action ROS custom messages Parameter server.

UNIT-II ROBOT VISUALIZATION IN ROS — **9**

2D Robot simulator Modeling Unified Robot Description format URDF Gazebo Joint controller Building and simulating mobile robot model Coordinate transforms RVIZ Displaying sensor value in RVIZ.

UNIT-III ROBOT PERCEPTION — **9**

Transformation of camera coordinates Camera Calibration OpenCV in ROS Depth Camera Simple point cloud node Loading, Saving and Interpreting point cloud images Object finder.

UNIT-IV MOBILE ROBOT NAVIGATION IN ROS — **9**

Path Trajectories State publishing Robot state estimation Odometry Fusion of Odom, GPS and Inertial sensing unit Fusion of Odometry and LIDAR Differential drive steering algorithms Map and path Making Move base Navigation stack.

UNIT-V ROBOT ARM IN ROS — **9**

One-DOF Robot model Two-DOF Robot Model Position controller Velocity controller Force controller Trajectory message for Robot arms Trajectory Interpolation Forward kinematics Inverse kinematics Motion planning: Cartesian and Join space.

CO	COURSE OUTCOMES
Upon completion of this course, Students should be able to	
1.	Implement basic ROS nodes, topics, and services in a robotic system to facilitate communication between different modules.
2.	Demonstrate the simulation and visualization of sensor data (e.g., LIDAR or camera data) in the ROS platform.
3.	Use image processing concepts and integrate OpenCV with ROS for robot perception
4.	Implement a motion control algorithm to implement localization and navigation in autonomous mobile robots.
5.	Develop controllers (position, velocity, force) for robot arms in ROS, ensuring accurate movement and task execution.

TEXT BOOKS

1.	Wyatt S. Newman, A Systematic Approach to Learning Robot Programming with ROS, CRC Press, 2018.
2.	Lentin Joseph, Robot Operating System (ROS) for Absolute Beginners: Robotics
3.	Programming Made Easy, Apress; 1st ed. edition, 2018.
4.	Anis Koubaa, Robot Operating System (ROS) The Complete Reference, Studies in Computational Intelligence, Springer, Volume 778, 2019.
5.	Morgan Quigley, Brian Gerkey, and William D. Smart, Programming Robots with ROS: A Practical Introduction to the Robot Operating System, O Reilly Media, Inc, 2018

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1.	Lentin Joseph and Aaron Martinez, Mastering ROS for Robotics Programming, Packt Publishing, Birmingham, 2016.
2.	Aaron Martinez and Enrique Fernández, Learning ROS for Robotics Programming, Packt Publishing, Birmingham, 2015.
3.	Carol Fairchild and Thomas L. Harman, ROS Robotics By Example, Packt Publishing, Birmingham, 2016.
4.	Sebastian Thrun, Wolfram Burgard and Dieter Fox, Probabilistic Robotics, MIT Press, Cambridge, 2005.
5.	Steven M. LaValle, Planning Algorithms, Cambridge University Press, Cambridge, 2006.

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PS01**	**PS02**
CO1	-	-	-	-	✓	-	-	-	-	-	-	-	✓	✓
CO2	-	-	✓	-	✓	-	-	-	-	-	-	-	✓	✓
CO3	✓	✓	✓	✓	✓	-	-	-	-	-	-	-	✓	✓
CO4	✓	✓	✓	-	✓	-	-	-	-	-	-	-	✓	✓
CO5	✓	✓	✓	✓	✓	-	-	-	-	-	-	-	✓	✓