ANNA UNIVERSITY, CHENNAI
UNIVERSITY DEPARTMENTS, ANNA UNIVERSITY
B.E. ROBOTICS AND AUTOMATION
REGULATIONS 2019
CHOICE BASED CREDIT SYSTEM

I. PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

I.	The program aims to produce proficient engineers in Robotics and Automation field to serve the various technological needs of Industry and Society.
II.	To impart graduates with multidisciplinary engineering knowledge in Robotics and Automation system
III.	The program shall create graduates to continuously uplift the knowledge, skill, attitude, self-learning, and teamwork, constantly able to practice the ethical values and protect the environmental eco systems.

II. PROGRAM OUTCOMES (POs)

PO	Graduate Attribute
1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2	**Problem analysis**: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3	**Design/development of solutions**: Design solutions for complex 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.
4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
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 professional engineering practice.
7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multi-disciplinary settings.
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.
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.
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.

III. PROGRAM SPECIFIC OUTCOMES (PSOs)

(1)	Multi-disciplinary Engineering in Robotics: Analyse the real world needs and design the robot and Automation solutions using the competency in multi domain engineering elements and integrated software tools.
(2)	Enhancement and upgradation of existing systems: Analyse conventional functions and process of various engineering elements and propose robots and automation solutions for enhanced performance of conventional systems.
(3)	Robotic system integration and automated Solution and connectivity: Recommend the sensing, interfacing, controlling, actuating, communicating technologies and analysing the data through various subsystems and build the robots.

PEO's – PO's& PSO's MAPPING:

PEO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
I.	3	3	3	3	3	2	1	1	2	1	2	1	3	3	3
II.	3	3	3	3	3	2	1	1	2	1	2	2	3	3	3
III.	1	1	1	1	1	2	3	3	3	2	1	1	1	1	1

Attested

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ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

B.E. ROBOTICS AND AUTOMATION

REGULATIONS - 2019

CHOICE BASED CREDIT SYSTEM

CURRICULA AND SYLLABI FOR I TO VIII SEMESTERS

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	HS5151	Technical English	HSMC	4	0	0	4	4
2.	MA5158	Engineering Mathematics-I	BSC	3	1	0	4	4
3.	PH5151	Engineering Physics	BSC	3	0	0	3	3
4.	CY5151	Engineering Chemistry	BSC	3	0	0	3	3
5.	GE5151	Engineering Graphics	ESC	1	0	4	5	3
PRACTICAL								
7	BS5161	Basic Sciences Laboratory	BSC	0	0	4	4	2
8	GE5162	Workshop Practices Laboratory	ESC	0	0	4	4	2
			TOTAL	**14**	**1**	**12**	**27**	**21**

SEMESTER II

SL. No.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	HS5251	Professional Communication	HSMC	4	0	0	4	4
2.	MA5252	Engineering Mathematics - II	BSC	3	1	0	4	4
3.	GE5153	Problem Solving and Python Programming	ESC	3	0	0	3	3
4.	EE5202	Basic Electrical, Electronics Engineering and Measurements	ESC	3	0	0	3	3
5.	GE5152	Engineering Mechanics	ESC	3	1	0	4	4
6.	PH5252	Physics for Electronic Sciences	BSC	3	0	0	3	3
PRACTICAL								
7.	GE5161	Problem Solving and Python Programming	ESC	0	0	4	4	2
8.	EE5212	Basic Electrical, Electronics Engineering and Measurements Laboratory	ESC	0	0	4	4	2
			TOTAL	**19**	**2**	**8**	**29**	**25**

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SEMESTER III

S. No.	Course Code	Course title	Cate Gory	Periods per week			Total contact periods	Credits
				L	T	P		
THEORY								
1.		Elective – Humanities I	HSMC	3	0	0	3	3
2.	MA5355	Transforms Techniques and Partial Differential Equations	BSC	3	1	0	4	4
3.	PR5451	Kinematics and Dynamics of Machines	ESC	3	1	0	4	4
4.	RO5301	Digital Electronics and Microprocessor	ESC	3	0	0	3	3
5.	RO5302	Electrical Drives and Actuators	PCC	3	0	0	3	3
6.	AU5352	Mechanics of Solids	PCC	3	0	0	3	3
PRACTICALS								
7.	RO5311	Electrical Drives and Actuators Laboratory	PCC	0	0	4	4	2
8.	RO5312	Mechanics of Solids and Machines Laboratory	PCC	0	0	4	4	2
			TOTAL	**18**	**2**	**8**	**28**	**24**

SEMESTER IV

S. No.	Course Code	Course title	Cate Gory	Periods per week			Total contact periods	Credits
				L	T	P		
THEORY								
1.		Elective – Humanities II	HSMC	3	0	0	3	3
2.	GE5251	Environmental Sciences	BSC	3	0	0	3	3
3.	PR5301	Thermodynamics and Fluid Mechanics	ESC	3	0	0	3	3
4.	RO5401	Manufacturing Technology	PCC	3	0	0	3	3
5.	RO5402	Robot Kinematics	PCC	3	0	0	3	3
6.	RO5403	Materials for Robots	PCC	3	0	0	3	3
7.		Audit Course- I*	AC	3	0	0	3	-
PRACTICALS								
8.	RO5411	Thermal and Fluid mechanics Laboratory	PCC	0	0	4	4	2
9.	ME5461	Manufacturing Technology Laboratory	PCC	0	0	4	4	2
			TOTAL	**21**	**0**	**8**	**29**	**22**

*Audit Course is optional.

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SEMESTER V

S. No.	Course Code	Course title	Cate Gory	Periods per week			Total contact periods	Credits
				L	T	P		
THEORY								
1	RO5501	Embedded Systems and Programming	PCC	3	0	0	3	3
2	RO5502	Sensors and Transducers	PCC	3	0	0	3	3
3	EE5402	Control Systems	PCC	3	0	0	3	3
4	RO5503	Design of Robot Elements	PCC	3	0	0	3	3
5		Professional Elective I	PEC	3	0	0	3	3
6		Professional Elective II	PEC	3	0	0	3	3
7		Audit Course - II*	AC	3	0	0	3	
PRACTICALS								
8	RO5511	Embedded Systems Laboratory	PCC	0	0	4	4	2
9	RO5512	Sensors and Control Systems Laboratory	PCC	0	0	4	4	2
10	RO5513	Modelling and Simulation of Robot Elements Laboratory	PCC	0	0	4	4	2
			TOTAL	**21**	**0**	**12**	**33**	**24**

*Audit Course is optional.

SEMESTER VI

S. No.	Course Code	Course title	Cate Gory	Periods per week			Total contact periods	Credits
				L	T	P		
THEORY								
1.	RO5601	Robot Dynamics and Control	PCC	3	0	0	3	3
2.	RO5602	Robot Path Planning	PCC	3	0	0	3	3
3.	RO5603	Fluid Power Systems and Industrial Automation	PCC	3	0	2	5	4
4.		Open Elective – I	OEC	3	0	0	3	3
5.		Professional Elective III	PEC	3	0	0	3	3
6.		Professional Elective IV	PEC	3	0	0	3	3
PRACTICALS								
7.	RO5611	Robot Kinematics and Dynamics Laboratory	PCC	0	0	4	4	2
8.	RO5612	Mini Project / Internship*	EEC	0	0	2	2	1
			TOTAL	**18**	**0**	**8**	**26**	**22**

* minimum of 2 weeks Internship

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SEMESTER VII

S. No.	Course Code	Course title	Category	Periods Per week			Total contact periods	Credits
				L	T	P		
THEORY								
1.	RO5701	Robotic Vision and Intelligence	PCC	3	0	0	3	3
2.	RO5702	Autonomous Mobile Robots	PCC	3	0	0	3	3
3.	RO5703	Machine Learning for Intelligent Systems	PCC	3	0	0	3	3
4.		Open Elective – II	OEC	3	0	0	3	3
5.		Professional Elective – V	PEC	3	0	0	3	3
6.		Professional Elective – VI	PEC	3	0	0	3	3
PRACTICALS								
7.	RO5711	Robotic Programming, Vision and Intelligence Laboratory	PCC	0	0	4	4	2
8.	RO5712	Project - I	EEC	0	0	6	6	3
			TOTAL	**18**	**0**	**10**	**28**	**23**

SEMESTER VIII

S. No.	Course Code	Course title	Cate Gory	Periods per week			Total contact periods	Credits
				L	T	P		
PRACTICALS								
1.	RO5811	Project - II	EEC	0	0	16	16	8
			TOTAL	**0**	**0**	**16**	**16**	**8**

TOTAL CREDITS: 169

SUMMARY

Name of the Programme										
S. No	Subject Area	Credits per Semester								Total Credits
		I	II	III	IV	V	VI	VII	VIII	
1	**HSMC**	4	4	3	3					14
2	**BSC**	12	7	4	3					26
3	**ESC**	5	14	7	3					29
4	**PCC**			10	13	18	12	11		64
5	**PEC**					6	6	6		18
6	**OEC**						3	3		6
7	**EEC**						1	3	8	12
8	**Non-Credit /(Mandatory)**				√	√				
Total		**21**	**25**	**24**	**22**	**24**	**22**	**23**	**8**	**169**

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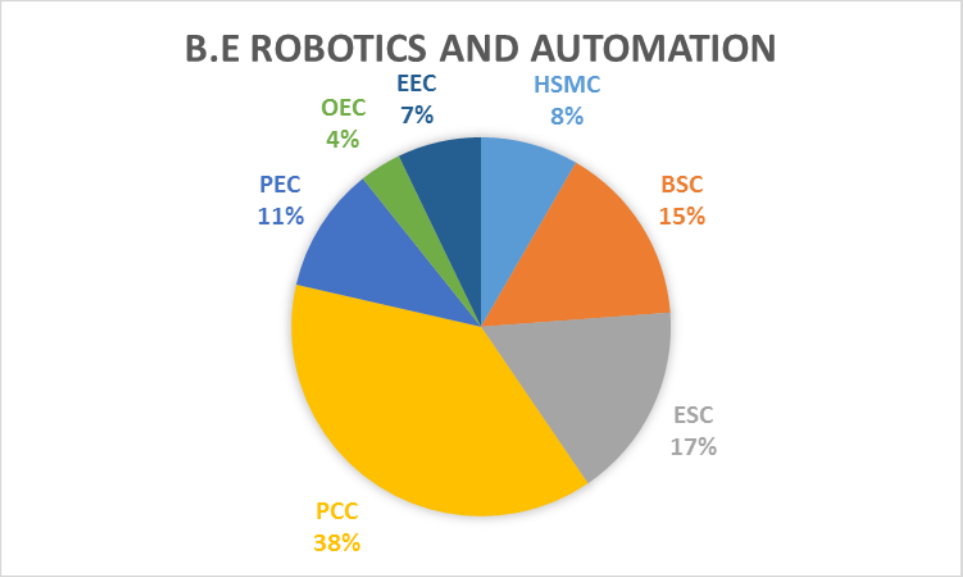

BASIC SCIENCES COURSES (BSC)

Sl. No.	Course code	Course title	Category	Periods Per week			Total contact periods	Credits
				L	T	P		
1	MA5158	Engineering Mathematics-I	BSC	3	1	0	4	4
2	PH5151	Engineering Physics	BSC	3	0	0	3	3
3	CY5151	Engineering Chemistry	BSC	3	0	0	3	3
4	BS5161	Basic Science Laboratory	BSC	0	0	4	4	2
5	MA5252	Engineering Mathematics - II	BSC	3	1	0	4	4
6	PH5252	Physics for Electronic Sciences	BSC	3	0	0	3	3
7	MA5355	Transforms Techniques and Partial Differential Equations	BSC	3	1	0	4	4
8	GE5251	Environmental Sciences	BSC	3	0	0	3	3

ENGINEERING SCIENCE (ESC)

Sl. No.	Course code	Course title	Category	Periods Per week			Total contact periods	Credits
				L	T	P		
1.	GE5151	Engineering Graphics	ESC	1	0	4	5	3
2.	GE5162	Workshop Practices Laboratory	ESC	0	0	4	4	2
3.	GE5153	Problem Solving and Python Programming	ESC	3	0	0	3	3
4.	EE5202	Basic Electrical, Electronics Engineering and Measurements	ESC	3	0	0	3	3
5.	GE5152	Engineering Mechanics	ESC	3	1	0	4	4
6.	GE5161	Problem Solving and Python Programming Laboratory	ESC	0	0	4	4	2
7.	EE5212	Basic Electrical, Electronics Engineering and Measurements Laboratory	ESC	0	0	4	4	2

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8.	PR5451	Kinematics and Dynamics of Machines	ESC	3	0	0	3	3
9.	RO5301	Digital Electronics and Microprocessor	ESC	3	0	0	3	3
10.	PR5301	Thermodynamics and Fluid Mechanics	ESC	3	0	0	3	3

PROFESSIONAL CORE COURSES (PCC)

Sl. No.	Course code	Course title	Category	Periods Per week			Total contact periods	Credits
				L	T	P		
1	RO5302	Electrical Drives and Actuators	PCC	3	0	0	3	3
2	AU5352	Mechanics of Solids	PCC	3	0	0	3	3
3	RO5311	Electrical Drives and Actuators Laboratory	PCC	0	0	4	4	2
4	RO5312	Mechanics of Solids and Machines Laboratory	PCC	0	0	4	4	2
5	RO5401	Manufacturing Technology	PCC	3	0	0	3	3
6	RO5402	Robot Kinematics	PCC	3	0	0	3	3
7	RO5403	Materials for Robots	PCC	3	0	2	3	3
8	RO5411	Thermal and Fluid mechanics Laboratory	PCC	0	0	4	4	2
9	ME5461	Manufacturing Technology Laboratory	PCC	0	0	4	4	2
10	RO5501	Embedded Systems and Programming	PCC	3	0	0	3	3
11	RO5502	Sensors and Transducers	PCC	3	0	0	3	3
12	EE5402	Control Systems	PCC	3	0	0	3	3
13	RO5503	Design of Robot Elements	PCC	3	0	0	3	3
14	RO5511	Embedded Systems Laboratory	PCC	0	0	4	4	2
15	RO5512	Sensors and Control Systems Laboratory	PCC	0	0	4	4	2
16	RO5513	Modelling and Simulation of Robot Elements Laboratory	PCC	0	0	4	4	2
17	RO5601	Robot Dynamics and Control	PCC	3	0	0	3	3
18	RO5602	Robot Path Planning	PCC	3	0	0	3	3
19	RO5603	Fluid Power and Industrial Automation	PCC	3	0	2	5	4
20	RO5611	Robot Kinematics and Dynamics Laboratory	PCC	0	0	4	4	2
21	RO5701	Robotic Vision and Intelligence	PCC	3	0	0	3	3
22	RO5702	Mobile Robotics	PCC	3	0	0	3	3
23	RO5703	Machine Learning for Intelligent Systems	PCC	3	0	0	3	3
24	RO5711	Robotic Programming, Vision and Intelligence Laboratory	PCC	0	0	4	4	2

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PROFESSIONAL ELECTIVE COURSES

PROFESSIONAL ELECTIVE I

Sl. No.	Course Code	Course title	Category	Periods Per week			Total contact periods	Credits
				L	T	P		
1	RO5001	Robots and Systems in Smart Manufacturing	PEC	3	0	0	3	3
2	RO5002	Robot and Machine Elements Design	PEC	3	0	0	3	3
3	ME5071	Automobile Engineering	PEC	3	0	0	3	3
4	RO5003	Linear Integrated Circuits	PEC	3	0	0	3	3
5	RO5004	Applied Signal Processing	PEC	3	0	0	3	3
6	ME5009	Mechanical Vibrations And Noise Control	PEC	3	0	0	3	3

PROFESSIONAL ELECTIVE II

Sl. No.	Course Code	Course title	Category	Periods Per week			Total contact periods	Credits
				L	T	P		
1.	RO5005	Drone Technologies	PEC	3	0	0	3	3
2.	AU5651	Electric and Hybrid Vehicles	PEC	3	0	0	3	3
3.	RO5006	Applied Image Processing	PEC	3	0	0	3	3
4.	RO5007	Industrial computer and Single Board Computers	PEC	3	0	0	3	3
5.	RO5008	Smart mobility and Intelligent Vehicles	PEC	3	0	0	3	3
6.	RO5009	Immersive Technologies and Haptics	PEC	3	0	0	3	3
7.	RO5010	Motion Control System	PEC	3	0	0	3	3

PROFESSIONAL ELECTIVE III

Sl. No.	Course code	Course title	Category	Periods Per week			Total contact periods	Credits
				L	T	P		
1	RO5011	Microrobotics	PEC	3	0	0	3	3
2	RO5012	CNC Machine Tools and Programming	PEC	3	0	0	3	3
3	RO5013	Automotive Mechatronics	PEC	3	0	0	3	3
4	RO5014	Robot Operating System (ROS)	PEC	3	0	0	3	3
5	ME5081	Process Planning and Cost Estimation	PEC	3	0	0	3	3
6	MF5005	Electronics Manufacturing Technology	PEC	3	0	0	3	3
7	BM5010	Brain Computer Interface and Applications	PEC	3	0	0	3	3
8	RO5015	Multi Body Dynamics	PEC	3	0	0	3	3

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PROFESSIONAL ELECTIVE IV

Sl. No.	Course Code	Course title	Category	Periods Per week			Total contact periods	Credits
				L	T	P		
1	RO5016	Computer Vision and Deep Learning	PEC	3	0	0	3	3
2	RO5017	Agricultural Automation	PEC	3	0	0	3	3
3	RO5018	Automotive System Modelling and Simulation	PEC	3	0	0	3	3
4	RO5019	Condition Monitoring and Fault Diagnostics	PEC	3	0	0	3	3
5	RO5020	Micro Electro Mechanical Systems	PEC	3	0	0	3	3
6	AE5026	UAV System Design	PEC	3	0	0	3	3
7	EI5009	Model Predictive Control	PEC	3	0	0	3	3

PROFESSIONAL ELECTIVE V

Sl. No.	Course Code	Course title	Category	Periods Per week			Total contact periods	Credits
				L	T	P		
1	RO5021	Collaborative Robotics	PEC	3	0	0	3	3
2	PR5004	Unconventional Machining Processes	PEC	3	0	0	3	3
3	RO5022	Vehicle Dynamics and Control	PEC	3	0	0	3	3
4	BM5701	Biomechanics	PEC	3	0	0	3	3
5	GE5451	Total Quality Management	PEC	3	0	0	3	3
6	MF5501	Metrology And Computer Aided Inspection	PEC	3	0	0	3	3
7	PR5022	Integrated Product Development	PEC	3	0	0	3	3

PROFESSIONAL ELECTIVE VI

Sl. No.	Course code	Course title	Cate gory	Periods Per week			Total contact periods	Credits
				L	T	P		
1	RO5023	Humanoid Robotics	PEC	3	0	0	3	3
2	RO5024	Virtual Instrumentation	PEC	3	0	0	3	3
3	MF5652	Additive Manufacturing	PEC	3	0	0	3	3
4	RO5025	Aircraft Mechatronics	PEC	3	0	0	3	3
5	RO5026	Optimization Techniques	PEC	3	0	0	3	3
6	RO5027	Total Integrated Automation	PEC	3	0	0	3	3
7	RO5028	Advanced Driver Assistance System	PEC	3	0	0	3	3

HS5151 **TECHNICAL ENGLISH** **L T P C**
4 0 0 4

COURSE OBJECTIVES:

The first semester English course entitled 'Technical English' aims to,

- Familiarise first year students of engineering and technology with the fundamental aspects of technical English.
- Develop all the four language skills by giving sufficient practice in the use of the skills in real life contexts.
- Enhance the linguistic and communicative competence of first year engineering and technology students.

UNIT I INTRODUCING ONESELF 12

Listening: Listening and filling a form, listening to speeches by specialists from various branches of engineering and completing activities such as answering questions, identifying the main ideas of the listening text, style of the speaker (tone and tenor) – **Speaking**: Introducing oneself –introducing friend/ family - **Reading:** Descriptive passages (from newspapers / magazines)- **Writing**: Writing a paragraph (native place, school life)- **Grammar:** Simple present, present continuous – **Vocabulary Development**: One word substitution

UNIT II DIALOGUE WRITING 12

Listening: Listening to conversations (asking for and giving directions) –**Speaking:** making conversation using (asking for directions, making an enquiry), Role plays-dialogues- **Reading:** Reading a print interview and answering comprehension questions-**Writing**: Writing a checklist, Dialogue writing- **Grammar**: Simple past – question formation (Wh- questions, Yes or No questions, Tag questions)- **Vocabulary Development**: Stress shift, lexical items related to the theme of the given unit.

UNIT III FORMAL LETTER WRITING 12

Listening: Listening to speeches by famous people and identifying the central message of the speech – answering multiple-choice questions)-**Speaking:** Giving short talks on a given topic-**Reading:** Reading motivational essays on famous engineers and technologists (answering open-ended and closed questions)- **Writing:** Writing formal letters/ emails (Complaint letters)-**Grammar**: Future Tense forms of verbs, subject and verb agreement-**Vocabulary Development**: Collocations – Fixed expressions

UNIT IV WRITING COMPLAINT LETTERS 12

Listening: Listening to short talks (5 minutes duration and fill a table, gap-filling exercise) note taking/note making- **Speaking:** Small group discussion, giving recommendations-**Reading:** Reading problem – solution articles/essays drawn from various sources- **Writing:** Making recommendations – Writing a letter/ sending an email to the Editor- note making- **Grammar:** Modals – Phrasal verbs – cause and effect sentences- **Vocabulary Development**: Connectives, use of cohesive devices in writing, technical vocabulary.

UNIT V WRITING DEFINITIONS AND PRODUCT DESCRIPTION 12

Listening: Listening to a product description (labeling and gap filling) exercises- **Speaking:** Describing a product and comparing and contrasting it with other products- **Reading**: Reading graphical material for comparison (advertisements)-**Writing:** Writing Definitions (short and long) – compare and contrast paragraphs- **Grammar:** Adjectives – Degrees of comparison - compound nouns- **Vocabulary Development**: Use of discourse markers – suffixes (adjectival endings).

TOTAL: 60PERIODS

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LEARNING OUTCOMES

At the end of the course the students will have gained,

- Exposure to basic aspects of technical English.
- The confidence to communicate effectively I various academic situations.
- Learnt the use of basic features of Technical English.

TEXT BOOK:

1. Revised Edition of 'English for Engineers and Technologists' Volume 1 published by Orient Black Swan Limited 2019.

ASSESSMENT PATTERN

- Assessments will assess all the four skills through both pen and paper and computer based tests.
- Assessments can be pen and paper based, quizzes.

MA5158	ENGINEERING MATHEMATICS – I (Common to all branches of B.E. / B.Tech. Programmes in I Semester)	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

- To develop the use of matrix algebra techniques that is needed by engineers for practical applications.
- To familiarize the students with differential calculus.
- To familiarize the student with functions of several variables. This is needed in many branches of engineering.
- To make the students understand various techniques of integration.
- To acquaint the student with mathematical tools needed in evaluating multiple integrals and their applications.

UNIT I MATRICES 12

Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of eigenvalues and eigenvectors – Cayley-Hamilton theorem – Diagonalization of matrices – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms.

UNIT II DIFFERENTIAL CALCULUS 12

Limit of function – One sided limit – Limit Laws – Continuity – left and right continuity – types of discontinuities – Intermediate Value Theorem – Derivatives of a function - Differentiation rules – Chain rule – Implicit differentiation – logarithmic differentiation – Maxima and minima – Mean value theorem – (Optional: Polar coordinate system – Differentiation in polar coordinates).

UNIT III FUNCTIONS OF SEVERAL VARIABLES 12

Partial derivatives – Homogeneous functions and Euler's theorem – Total derivative – Differentiation of implicit functions – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor's series for functions of two variables – Errors and approximations – Maxima and minima of functions of two variables – Lagrange's method of undetermined multipliers.

UNIT IV INTEGRAL CALCULUS 12

Definite and Indefinite integrals - Substitution rule - Techniques of Integration - Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions - Improper integrals.

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UNIT V MULTIPLE INTEGRALS **12**

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of solids – Change of variables in double and triple integrals.

TOTAL :60 PERIODS

COURSE OUTCOMES:

At the end of the course the students will be able to

- Use the matrix algebra methods for solving practical problems.
- Apply differential calculus tools in solving various application problems.
- Able to use differential calculus ideas on several variable functions.
- Apply different methods of integration in solving practical problems.
- Apply multiple integral ideas in solving areas, volumes and other practical problems.

TEXT BOOKS:

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, 44th Edition, New Delhi, 2017.
2. James Stewart, "Calculus with Early Transcendental Functions", Cengage Learning, 6th Edition, New Delhi,2013.
3. Joel Hass, Christopher Heil and Maurice D.Weir, "Thomas' Calculus", Pearson, 14th Edition, New Delhi, 2018.
4. Narayanan S. and Manicavachagom Pillai T. K., "Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2009.

REFERENCES:

1. Bali N., Goyal M. and Watkins C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), 7th Edition, New Delhi, 2009.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2015.
3. Greenberg M.D., "Advanced Engineering Mathematics", Pearson Education2nd Edition, 5th Reprint, Delhi, 2009.
4. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics",Narosa Publications, 5th Edition, New Delhi, 2017.
5. Peter V.O'Neil, "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, 7th Edition, New Delhi , 2012.
6. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Co. Ltd., 11th Reprint, New Delhi, 2010.

PH5151 **ENGINEERING PHYSICS** **L T P C**

(Common to all branches of B.E / B.Tech programmes) **3 0 0 3**

COURSE OBJECTIVES:

- To make the students in understanding the importance of mechanics.
- To equip the students on the knowledge of electromagnetic waves.
- To introduce the basics of oscillations, optics and lasers.
- To enable the students in understanding the importance of quantum physics.
- To elucidate the application of quantum mechanics towards the formation of energy bands in crystalline materials.

UNIT I MECHANICS 9

Moment of inertia (M.I) - Radius of gyration - Theorems of M .I - M.I of circular disc, solid cylinder , hollow cylinder , solid sphere and hollow sphere - K.E of a rotating body – M.I of a diatomic molecule – Rotational energy state of a rigid diatomic molecule - centre of mass – conservation of linear momentum – Relation between Torque and angular momentum - Torsional pendulum.

UNIT II ELECTROMAGNETIC WAVES 9

Gauss's law – Faraday's law - Ampere's law - The Maxwell's equations - wave equation; Plane electromagnetic waves in vacuum, Conditions on the wave field - properties of electromagnetic waves: speed, amplitude, phase, orientation and waves in matter - polarization - Producing electromagnetic waves - Energy and momentum in EM waves: Intensity, waves from localized sources, momentum and radiation pressure - Cell-phone reception. Reflection and transmission of electromagnetic waves from a non-conducting medium-vacuum interface for normal incidence.

UNIT III OSCILLATIONS, OPTICS AND LASERS 9

Simple harmonic motion - resonance - waves on a string - standing waves - traveling waves - Energy transfer of a wave - sound waves - Doppler effect - reflection and refraction of light waves - total internal reflection - interference - interferometers - air wedge experiment. Theory of laser - characteristics - Spontaneous and stimulated emission - Einstein's coefficients - population inversion - Nd-YAG laser, CO_2 laser, semiconductor laser - applications.

UNIT IV BASIC QUANTUM MECHANICS 9

Photons and light waves - Electrons and matter waves - The Schrodinger equation (Time dependent and time independent forms) - meaning of wave function - Normalization - Particle in a infinite potential well - Normalization, probabilities and the correspondence principle.

UNIT V APPLIED QUANTUM MECHANICS 9

The harmonic oscillator - Barrier penetration and quantum tunneling - Tunneling microscope - Resonant diode - Finite potential wells - particle in a three dimensional box - Bloch's theorem for particles in a periodic potential, Kronig-Penney model and origin of energy bands.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of this course, the students should able to

- Understanding the importance of mechanics.
- Express the knowledge of electromagnetic waves.
- Know the basics of oscillations, optics and lasers.
- Understanding the importance of quantum physics.
- Apply quantum mechanical principles towards the formation of energy bands in crystalline materials.

TEXT BOOKS

1. D.Kleppner and R.Kolenkow. An Introduction to Mechanics. McGraw Hill Education, 2017.
2. D.Halliday, R.Resnick and J.Walker. Principles of Physics. John Wiley & Sons, 2015.
3. N.Garcia, A.Damask and S.Schwarz. Physics for Computer Science Students. Springer-Verlag, 2012.

REFERENCES

1. R.Wolfson. Essential University Physics. Volume 1 & 2. Pearson, 2016.
2. D.J.Griffiths. Introduction to Electrodynamics. Pearson Education, 2015
3. K.Thyagarajan and A.Ghatak. Lasers: Fundamentals and Applications. Springer, 2012.

CY5151	ENGINEERING CHEMISTRY (COMMON TO ALL BRANCHES)	L T P C 3 0 0 3

COURSE OBJECTIVES:

- To introduce the basic concepts of polymers, their properties and some of the important applications.
- To impart knowledge on the basic principles and preparatory methods of nanomaterials.
- To facilitate the understanding of the laws of photochemistry, photoprocesses and instrumentation & applications of spectroscopic techniques.
- To familiarize the operating principles and applications of energy conversion, its processes and storage devices.
- To inculcate sound understanding of water quality parameters and water treatment techniques.

UNIT I POLYMER CHEMISTRY 9

Introduction: Functionality-degree of polymerization. Classification of polymers- natural and synthetic, thermoplastic and thermosetting. Types and mechanism of polymerization: addition (free radical, cationic, anionic and living); condensation and copolymerization. Properties of polymers: Tg, tacticity, molecular weight-weight average, number average and polydispersity index. Techniques of polymerization: Bulk, emulsion, solution and suspension. Structure, Properties and uses of: PE, PVC, PC, PTFE, PP, Nylon 6, Nylon 66, Bakelite, Epoxy; Conducting polymers – polyaniline and polypyrrole.

UNIT II NANOCHEMISTRY 9

Basics-distinction between molecules, nanomaterials and bulk materials; size-dependent properties. Types –nanoparticle, nanocluster, nanorod, nanowire and nanotube. Preparation of nanomaterials: sol-gel, solvothermal, laser ablation, chemical vapour deposition, electrochemical deposition and electro spinning. Characterization - Scanning Electron Microscope and Transmission Electron Microscope - Principle and instrumentation (block diagram). Properties (optical, electrical, mechanical and magnetic) and Applications of nanomaterials - medicine, agriculture, electronics and catalysis.

UNIT III PHOTOCHEMISTRY AND SPECTROSCOPY 9

Photochemistry: Laws of photochemistry - Grotthuss-Draper law, Stark-Einstein law and Lambert-Beer Law (derivation and problems). Photo physical processes – Jablonski diagram. Chemiluminescence, photo-sensitization and photoquenching – mechanism and examples. Spectroscopy: Electromagnetic spectrum - absorption of radiation - electronic, vibrational and rotational transitions. Width and intensities of spectral lines. Atomic absorption spectroscopy, UV-Vis and IR spectroscopy- principles, instrumentation (Block diagram) and applications.

UNIT IV ENERGY CONVERSIONS AND STORAGE 9

Nuclear fission - controlled nuclear fission - nuclear fusion - differences between nuclear fission and fusion - nuclear chain reactions - nuclear energy - light water nuclear power plant – fast breeder reactor. Solar energy conversion - solar cells. Wind energy. Batteries - types of batteries – primary battery (dry cell), secondary battery (lead acid, nickel-cadmium and lithium-ion-battery). Fuel cells – H_2-O_2 and microbial fuel cell. Explosives – classification, examples: TNT, RDX, Dynamite; Rocket fuels and propellants – definition and uses.

UNIT V WATER TECHNOLOGY 9

Water – sources and impurities – water quality parameters: colour, odour, pH, hardness, alkalinity, TDS, COD and BOD. Boiler feed water – requirement – troubles (scale & sludge,

caustic embrittlement, boiler corrosion and priming & foaming. Internal conditioning – phosphate, calgon and carbonate treatment. External conditioning - zeolite (permutit) and ion exchange demineralization. Municipal water treatment process – primary (screening, sedimentation and coagulation), secondary (activated sludge process and trickling filter process) and tertiary (ozonolysis, UV treatment, chlorination, reverse osmosis).

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- To recognize and apply basic knowledge on different types of polymeric materials, their general preparation methods and applications to futuristic material fabrication needs.
- To identify and apply basic concepts of nanoscience and nanotechnology in designing the synthesis of nanomaterials for engineering and technology applications.
- To identify and apply suitable spectroscopic technique for material analysis and study different forms of photochemical reactions.
- To recognize different forms of energy resources and apply them for suitable applications in energy sectors.
- To demonstrate the knowledge of water and their quality in using at different industries.

TEXT BOOKS:

1. Jain P. C. & Monica Jain., "Engineering Chemistry", 16th Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2015.
2. Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2012.
3. S.S.Dara, "A text book of Engineering Chemistry", Chand Publications, 2014.

REFERENCES:

1. Schdeva M V, "Basics of Nano Chemistry", Anmol Publications Pvt Ltd
2. B.Sivasankar, "Instrumental Methods of Analysis", Oxford University Press. 2012.
3. Friedrich Emich, "Engineering Chemistry", Scientific International Ltd.
4. V RGowariker, N V Viswanathan and Jayadev Sreedhar, "Polymer Science" New AGE International Publishers, 2009.

GE5151 ENGINEERING GRAPHICS **L T P C**
1 0 4 3

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

1. Drawing free hand sketches of basic geometrical shapes and multiple views of objects.
2. Drawing orthographic projections of lines and planes.
3. Drawing orthographic projections of solids.
4. Drawing development of the surfaces of objects.
5. Drawing isometric and perspective views of simple solids.

CONCEPTS AND CONVENTIONS (NOT FOR EXAMINATION) 1

Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning.

UNIT I PLANE CURVES AND FREE HANDSKETCHING 14

Basic Geometrical constructions, Curves used in engineering practices-Conics – Construction of ellipse, parabola and hyperbola by different methods – Construction of cycloid – construction

of involutes of square and circle – Drawing of tangents and normal to the above curves. Visualization concepts and Free Hand sketching: Visualization principles – Representation of Three-Dimensional objects – Layout of views- Free hand sketching of multiple views from pictorial views of objects

UNIT II PROJECTION OF POINTS, LINES AND PLANE SURFACES 15

Orthographic projection- principles-Principle planes-First angle projection-Projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes-Determination of true lengths and true inclinations by rotating line method and trapezoidal method and traces Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

UNIT III PROJECTION OF SOLIDS 15

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to both the principal planes by rotating object method and auxiliary plane method.

UNIT IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES 15

Sectioning of solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones. Development of lateral surfaces of solids with cut-outs and holes.

UNIT V ISOMETRIC AND PERSPECTIVE PROJECTIONS 12

Principles of isometric projection – isometric scale –Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions and miscellaneous problems. Perspective projection of simple solids-Prisms pyramids and cylinders by visual ray method and vanishing point method.

COMPUTER AIDED DRAFTING (DEMONSTRATION ONLY) 3

Introduction to drafting packages and demonstration of their use

TOTAL (L: 15 + P: 60)=75 PERIODS

COURSE OUTCOMES:

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

1. Draw free hand sketching of basic geometrical shapes and multiple views of objects.
2. Draw orthographic projections of lines and planes
3. Draw orthographic projections of solids
4. Draw development of the surfaces of objects
5. Draw isometric and perspective views of simple solids.

TEXT BOOKS:

1. Bhatt, N.D.,Panchal V M and Pramod R. Ingle, “Engineering Drawing”, Charotar Publishing House, 53rd Edition, 2014.
2. Parthasarathy, N. S. and Vela Murali, “Engineering Drawing”, Oxford University Press, 2015

REFERENCES:

1. Agrawal, B. and Agrawal C.M., “Engineering Drawing”, Tata McGraw, N.Delhi, 2008.
2. Gopalakrishna, K. R., “Engineering Drawing”,Subhas Stores, Bangalore, 2007.
3. Natarajan, K. V., “A text book of Engineering Graphics”, 28thEd.,Dhanalakshmi Publishers, Chennai, 2015.
4. Shah, M. B., and Rana, B. C., “Engineering Drawing”, Pearson, 2ndEd., 2009.
5. Venugopal, K. and Prabhu Raja, V., “Engineering Graphics”, New Age,2008.

Publication of Bureau of Indian Standards:

1. IS 10711 – 2001: Technical products Documentation – Size and lay out of drawing sheets
2. IS 9609 (Parts 0 & 1) – 2001: Technical products Documentation – Lettering.
3. IS 10714 (Part 20) – 2001 & SP 46 – 2003: Lines for technical drawings.
4. IS 11669 – 1986 & SP 46 – 2003: Dimensioning of Technical Drawings.
5. IS 15021 (Parts 1 to 4) – 2001: Technical drawings – Projection Methods.

Special points applicable to University Examinations on Engineering Graphics:

1. There will be five questions, each of either or type covering all units of the syllabus.
2. All questions will carry equal marks of 20 each making a total of 100.
3. The answer paper shall consist of drawing sheets of A3 size only.
4. The students will be permitted to use appropriate scale to fit solution within A3 size.
5. The examination will be conducted in appropriate sessions on the same day.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3				3					2		2	2	3	2
2	3									2		2	2	2	
3	3				3					2		2	2	2	
4	3		2		3					2		2	2	2	
5	3		3		3					2		2	2	2	

BS5161 **BASIC SCIENCES LABORATORY** **L T P C**

(Common to all branches of B.E. / B.Tech Programmes) **0 0 4 2**

PHYSICS LABORATORY: (Any Seven Experiments)

COURSE OBJECTIVES:

- To inculcate experimental skills to test basic understanding of physics of materials including properties of matter, thermal and optical properties.
- To induce the students to familiarize with experimental determination of velocity of ultrasonic waves and band gap determination.

LIST OF EXPERIMENTS:

1. Torsional pendulum - Determination of rigidity modulus of wire and moment of inertia of disc
2. Non-uniform bending - Determination of Young's modulus
3. Uniform bending – Determination of Young's modulus
4. Lee's disc Determination of thermal conductivity of a bad conductor
5. Potentiometer-Determination of thermo e.m.f of a thermocouple
6. Laser- Determination of the wave length of the laser using grating
7. Air wedge - Determination of thickness of a thin sheet/wire
8. a) Optical fibre -Determination of Numerical Aperture and acceptance angle
   b) Compact disc- Determination of width of the groove using laser.
9. Acoustic grating- Determination of velocity of ultrasonic waves in liquids.
10. Ultrasonic interferometer – determination of the velocity of sound and compressibility of liquids
11. Post office box -Determination of Band gap of a semiconductor.
12. Spectrometer- Determination of wavelength using gating.

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13. Photoelectric effect
14. Michelson Interferometer.
15. Estimation of laser parameters.
16. Melde's string experiment

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able

- To determine various moduli of elasticity and also various thermal and optical properties of materials.
- To determine the velocity of ultrasonic waves, band gap determination and viscosity of liquids

CHEMISTRY LABORATORY: (Minimum of 8 experiments to be conducted)

COURSE OBJECTIVES:

- To inculcate experimental skills to test basic understanding of water quality parameters, such as, acidity, alkalinity, hardness, DO, chloride and copper.
- To induce the students to familiarize with electroanalytical techniques such as, pH metry, potentiometry and conductometry in the determination of impurities in aqueous solutions.
- To demonstrate the analysis of metals and polymers by spectroscopy and viscometry methods.

LIST OF EXPERIMENTS:

1. Estimation of HCl using Na_2CO_3 as primary standard and Determination of alkalinity in water sample.
2. Determination of total, temporary & permanent hardness of water by EDTA method.
3. Determination of DO content of water sample by Winkler"s method.
4. Determination of chloride content of water sample by argentometric method.
5. Estimation of copper content of the given solution by Iodometry.
6. Determination of strength of given hydrochloric acid using pH meter.
7. Determination of strength of acids in a mixture of acids using conductivity meter.
8. Estimation of iron content of the given solution using potentiometer.
9. Estimation of iron content of the water sample using spectrophotometer (1, 10-Phenanthroline / thiocyanate method).
10. Estimation of sodium and potassium present in water using flame photometer.
11. Determination of molecular weight of polyvinylalcohol using Ostwald viscometer.
12. Pseudo first order kinetics-ester hydrolysis.
13. Corrosion experiment-weight loss method.
14. Phase change in a solid.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

- To analyse the quality of water samples with respect to their acidity, alkalinity, hardness and DO.
- To determine the amount of metal ions through volumetric and spectroscopic techniques
- To determine the molecular weight of polymers by viscometric method.
- To quantitatively analyse the impurities in solution by electroanalytical techniques
- To design and analyse the kinetics of reactions and corrosion of metals

TEXT BOOKS:

1. Laboratory Manual- Department of Chemistry, CEGC, Anna University (2014).
2. Vogel's Textbook of Quantitative Chemical Analysis (8th edition, 2014).

Attested

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GE5162	WORKSHOP PRACTICES LABORATORY	L	T	P	C
	(Common to all Branches of B.E. / B.Tech. Programmes)	0	0	4	2

COURSE OBJECTIVES:

The main learning objective of this course is to provide hands on training to the students in:

1. Drawing pipe line plan; laying and connecting various pipe fittings used in common household plumbing work; Sawing; planing; making joints in wood materials used in common household wood work.
2. Wiring various electrical joints in common household electrical wire work.
3. Welding various joints in steel plates using arc welding work; Machining various simple processes like turning, drilling, tapping in parts; Assembling simple mechanical assembly of common household equipments; Making a tray out of metal sheet using sheet metal work.
4. Soldering and testing simple electronic circuits; Assembling and testing simple electronic components on PCB.

GROUP – A (CIVIL & ELECTRICAL)

PART I CIVIL ENGINEERING PRACTICES 15

PLUMBING WORK:

a) Connecting various basic pipe fittings like valves, taps, coupling, unions, reducers, elbows and other components which are commonly used in household.
b) Preparing plumbing line sketches.
c) Laying pipe connection to the suction side of a pump
d) Laying pipe connection to the delivery side of a pump.
e) Connecting pipes of different materials: Metal, plastic and flexible pipes used in household appliances.

WOOD WORK:

a) Sawing,
b) Planing and
c) Making joints like T-Joint, Mortise joint and Tenon joint and Dovetail joint.

Wood Work Study:

a) Studying joints in door panels and wooden furniture
b) Studying common industrial trusses using models.

PART II ELECTRICAL ENGINEERING PRACTICES 15

WIRING WORK:

a) Wiring Switches, Fuse, Indicator and Lamp etc. such as in basic household,
b) Wiring Stair case light.
c) Wiring tube – light.
d) Preparing wiring diagrams for a given situation.

Wiring Study:

a) Studying an Iron-Box wiring.
b) Studying a Fan Regulator wiring.
c) Studying an Emergency Lamp wiring.

GROUP – B (MECHANICAL AND ELECTRONICS)

PART III MECHANICAL ENGINEERING PRACTICES 15

WELDING WORK:

a) Welding of Butt Joints, Lap Joints, and Tee Joints using arc welding.
b) Practicing gas welding.

BASIC MACHINING WORK:

a) (simple)Turning.
b) (simple)Drilling.
c) (simple)Tapping.

ASSEMBLY WORK:

a) Assembling a centrifugal pump.
b) Assembling a household mixer.
c) Assemblingan airconditioner.

SHEET METAL WORK:

a) Making of a square tray

FOUNDRY WORK:

a) Demonstrating basic foundry operations.

PART IV ELECTRONIC ENGINEERING PRACTICES 15

SOLDERING WORK:

a) Soldering simple electronic circuits and checking continuity.

ELECTRONIC ASSEMBLY AND TESTING WORK:

a) Assembling and testing electronic components on a small PCB.

ELECTRONIC EQUIPMENT STUDY:

a) Studying a FM radio.
b) Studying an electronic telephone.

TOTAL = 60 PERIODS

COURSE OUTCOMES:

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

1. Understand the concept of plumbing work and fittings in common household applications.
2. Ability to saw, plan and join wood materials used in common household wood applications.
3. Become familiar with wiring various electrical joints in common household electrical applications.
4. Perform various weld joints in steel plates using arc welding work; Machine various simple processes like turning, drilling, tapping in parts; Assemble simple mechanical household equipments; Make a tray out of metal sheet using sheet metal work.
5. Become familiar with soldering and testing simple electronic circuits; Assemble and test simple electronic components on PCB.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2			1							3	3	3	1
2	3	2			1							3	3	3	1
3	3	2			1		1					3	2	2	1
4	3	2			1		1					3	3	3	1
5	3	2			1		1					3	2	2	1

HS5251 PROFESSIONAL COMMUNICATION L T P C
4 0 0 4

COURSE OBJECTIVES

The course entitles 'Professional Communication' aims to,

- Improve the relevant language skills necessary for professional communication.
- Develop linguistic and strategic competence in workplace context.
- Enhance language proficiency and thereby the employability of budding engineers and technologists.

UNIT I TECHNICAL COMMUNICATION 12

Listening: Listening to telephone conversations (intent of the speaker and note taking exercises)- Speaking: Role play exercises based on workplace contexts, introducing oneself- Reading: Reading the interview of an achiever and completing exercises (skimming, scanning and predicting)- Writing: Writing a short biography of an achiever based on given hints- Grammar: Asking and answering questions, punctuation in writing, prepositional phrases- Vocabulary Development: use of adjectives.

UNIT II SUMMARY WRITING 12

Listening: Listening to talks/lectures both general and technical and summarizing the main points- Speaking: Participating in debates- Reading: Reading technical essays/ articles and answering comprehension questions-Writing: Summary writing-Grammar: Participle forms, relative clauses- Vocabulary Development: Use of compound words, abbreviations and acronyms.

UNIT III PROCESS DESCRIPTION 12

Listening: Listening to a process description and drawing a flowchart-Speaking: Participating in Group Discussions, giving instructions- Reading: Reading instruction manuals- Writing: Writing process descriptions- Writing instructions- Grammar: Use of imperatives, active and passive voice, sequence words- Vocabulary Development: Technical jargon

UNIT IV REPORT WRITING 12

Listening: Listening to a presentation and completing gap-filling exercises- Speaking: Making formal presentations- Reading: Reading and interpreting charts/tables and diagrams- Writing: Interpreting charts/tables and diagrams, writing a report- Grammar: Direct into indirect speech, use of phrases- Vocabulary Development: reporting words

UNIT V WRITING JOB APPLICATIONS 12

Listening: Listening to a job interview and completing gap=filling exercises- Speaking: Mock interview, telephone interviews- Reading: Reading a job interview, SOP, company profile and completing comprehension exercises- Writing: job applications and resumes and SOPs-Grammar: Present perfect and continuous tenses- Vocabulary Development: Technical vocabulary.

TOTAL : 45 PERIODS

LEARNING OUTCOMES

At the end of the second semester the learners should be able to,

- Read and comprehend technical texts effortlessly.
- Write reports of a technical kind.
- Speak with confidence in interviews and thereby gain employability

TEXT BOOK

1. Revised Edition of 'English for Engineers and Technologists' Volume 1 published by Orient Black Swan Limited 2019.

ASSESSMENT PATTERN

- Assessments will assess all the four skills through both pen and paper and computer based tests.
- Assessments can be pen and paper based, quizzes.

MA5252	ENGINEERING MATHEMATICS – II (Common to all branches of B.E. / B.Tech. Programmes in II Semester)	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

- To acquaint the students with the concepts of vector calculus which naturally arises in many engineering problems.
- To develop an understanding of the standard techniques of complex variable theory in particular analytic function and its mapping property.
- To familiarize the students with complex integration techniques and contour integration techniques which can be used in real integrals.
- To acquaint the students with Differential Equations which are significantly used in Engineering problems.
- To make the students appreciate the purpose of using transforms to create a new domain in which it is easier to handle the problem that is being investigated.

UNIT I VECTOR CALCULUS 12

Gradient and directional derivative – Divergence and Curl – Irrotational and Solenoidal vector fields – Line integral over a plane curve – Surface integral - Area of a curved surface - Volume integral - Green's theorem, Stoke's theorem and Gauss divergence theorem – Verification and application in evaluating line, surface and volume integrals.

UNIT II ANALYTIC FUNCTION 12

Analytic functions – Necessary and sufficient conditions for analyticity - Properties – Harmonic conjugates – Construction of analytic function - Conformal mapping – Mapping by functions - Bilinear transformation $w = c + z,\ az,\ 1/z,\ z^2$.

UNIT III COMPLEX INTEGRATION 12

Line integral - Cauchy's integral theorem – Cauchy's integral formula – Taylor's and Laurent's series – Singularities – Residues – Residue theorem – Application of residue theorem for evaluation of real integrals – Use of circular contour and semicircular contour with no pole on real axis.

UNIT IV DIFFERENTIAL EQUATIONS 12

Method of variation of parameters – Method of undetermined coefficients – Homogenous equations of Euler's and Legendre's type – System of simultaneous linear differential equations with constant coefficients.

UNIT V LAPLACE TRANSFORMS 12

Existence conditions – Transforms of elementary functions – Transform of unit step function and unit impulse function – Basic properties – Shifting theorems – Transforms of derivatives and integrals – Initial and Final Value Theorems – Inverse Transforms – Convolution Theorem – Transform of periodic functions – Application to solution of linear ordinary differential equations with constant coefficients.

TOTAL : 60 PERIODS

COURSE OUTCOMES:

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

- Calculate grad, div and curl and use Gauss, Stokes and Greens theorems to simplify calculations of integrals.
- Construct analytic functions and use their conformal mapping property in application problems.
- Evaluate real and complex integrals using the Cauchy's integral formula and residue theorem.
- Apply various methods of solving differential equation which arise in many application problems.
- Apply Laplace transform methods for solving linear differential equations.

TEXT BOOKS:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2015.
2. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, 44th Edition, New Delhi, 2017.

REFERENCES:

1. Bali N., Goyal M. and Watkins C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), 7th Edition, New Delhi, 2009.
2. Glyn James, "Advanced Modern Engineering Mathematics", Pearson Education, 4th Edition, New Delhi, 2011.
3. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", Narosa Publications, 5th Edition, New Delhi, 2017.
4. Peter V.O'Neil, "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, 7th Edition, New Delhi, 2012.
5. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Co. Ltd., 11th Reprint, New Delhi, 2010.

GE5153 PROBLEM SOLVING AND PYTHON PROGRAMMING L T P C
3 0 0 3

COURSE OBJECTIVES:

- To know the basics of algorithmic problem solving.
- To develop Python programs with conditionals and loops.
- To define Python functions and use function calls.
- To use Python data structures - lists, tuples, dictionaries.
- To do input/output with files in Python.

UNIT I INTRODUCTION TO COMPUTING AND PROBLEM SOLVING 9

Fundamentals of Computing – Computing Devices – Identification of Computational Problems – Pseudocodes and Flowcharts – Instructions – Algorithms – Building Blocks of Algorithms –

Introduction to Python Programming – Python Interpreter and Interactive Mode – Variables and Identifiers – Arithmetic Operators– Values and Types – Statements.

SUGGESTED ACTIVITIES:

- Developing Pseudocodes and flowcharts for real life activities such as railway ticket booking using IRCTC, admission process to undergraduate course, academic schedules during a semester etc.
- Developing algorithms for basic mathematical expressions using arithmetic operations.
- Installing Python.
- Simple programs on print statements, arithmetic operations.

SUGGESTED EVALUATION METHODS:

- Assignments on pseudocodes and flowcharts.
- Tutorials on Python programs.

UNIT II CONDITIONALS AND FUNCTIONS 9

Operators – Boolean Values – Operator Precedence – Expression – Conditionals: If-Else Constructs – Loop Structures/Iterative Statements – While Loop – For Loop – Break Statement – Function Call and Returning Values – Parameter Passing – Local and Global Scope – Recursive Functions.

SUGGESTED ACTIVITIES:

- Simple Python program implementation using Operators, Conditionals, Iterative Constructs and Functions.
- Implementation of a simple calculator.
- Developing simple applications like calendar, phone directory, to-do lists etc.
- Flow charts for GCD, Exponent Functions, Fibonacci Series using conditionals and iterative statements.
- External learning - Recursion vs. Iteration.

SUGGESTED EVALUATION METHODS:

- Tutorials on the above activities.
- Group discussion on external learning.

UNIT III SIMPLE DATA STRUCTURES IN PYTHON 10

Introduction to Data Structures – List – Adding Items to a List – Finding and Updating an Item – Nested Lists – Cloning Lists – Looping Through a List – Sorting a List – List Concatenation – List Slices – List Methods – List Loop – Mutability – Aliasing – Tuples: Creation, Accessing, Updating, Deleting Elements in a Tuple, Tuple Assignment, Tuple as Return Value, Nested Tuples, Basic Tuple Operations – Sets.

SUGGESTED ACTIVITIES:

- Implementing python program using lists, tuples, sets for the following scenario:
  - Simple sorting techniques
  - Student Examination Report
  - Billing Scheme during shopping.
- External learning - List vs. Tuple vs. Set – Implementing any application using all the three data structures.

SUGGESTED EVALUATION METHODS:

- Tutorials on the above activities.
- Group Discussion on external learning component.

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UNIT IV STRINGS, DICTIONARIES, MODULES 10

Strings: Introduction, Indexing, Traversing, Concatenating, Appending, Multiplying, Formatting, Slicing, Comparing, Iterating – Basic Built-In String Functions – Dictionary: Creating, Accessing, Adding Items, Modifying, Deleting, Sorting, Looping, Nested Dictionaries Built-in Dictionary Function – Finding Key and Value in a Dictionary – Modules – Module Loading and Execution – Packages – Python Standard Libraries.

SUGGESTED ACTIVITIES:

- Implementing Python program by importing Time module, Math package etc.
- Creation of any package (student's choice) and importing into the application.

SUGGESTED EVALUATION METHODS:

- Tutorials on the above activities.

UNIT V FILE HANDLING AND EXCEPTION HANDLING 7

Introduction to Files – File Path – Opening and Closing Files – Reading and Writing Files – File Position – Exception: Errors and Exceptions, Exception Handling, Multiple Exceptions.

SUGGESTED ACTIVITIES:

- Developing modules using Python to handle files and apply various operations on files.
- Usage of exceptions, multiple except blocks - for applications that use delimiters like age, range of numerals etc.
- Implementing Python program to open a non-existent file using exceptions.

SUGGESTED EVALUATION METHODS:

- Tutorials on the above activities.
- Case Studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, students will be able to:

CO1: Develop algorithmic solutions to simple computational problems.
CO2: Develop and execute simple Python programs.
CO3: Write simple Python programs for solving problems.
CO4: Decompose a Python program into functions.
CO5: Represent compound data using Python lists, tuples, dictionaries etc.
CO6: Read and write data from/to files in Python programs.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓									✓
CO2	✓		✓		✓							✓
CO3	✓	✓	✓									✓
CO4	✓	✓	✓	✓	✓							✓
CO5	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓
CO6	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

TEXT BOOKS:

1. Reema Thareja, "Python Programming: Using Problem Solving Approach", Oxford University Press, 2017.
2. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", Second Edition, Shroff/O'Reilly Publishers, 2016. (http://greenteapress.com/wp/thinkpython/).

REFERENCES:

1. Guido van Rossum, Fred L. Drake Jr., “An Introduction to Python – Revised and Updated for Python 3.2”, Network Theory Ltd., 2011.
2. John V Guttag, “Introduction to Computation and Programming Using Python”, Revised and Expanded Edition, MIT Press , 2013
3. Charles Dierbach, “Introduction to Computer Science using Python”, Wiley India Edition, 2016.
4. Timothy A. Budd, “Exploring Python”, Mc-Graw Hill Education (India) Private Ltd., 2015.
5. Kenneth A. Lambert, “Fundamentals of Python: First Programs”, Cengage Learning, 2012.

EE5202	BASIC ELECTRICAL, ELECTRONICS ENGINEERING AND MEASUREMENTS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To introduce the basics of electric circuits and analysis
2. To impart knowledge in the basics of working principles and application of electrical machines
3. To introduce analog devices and their characteristics
4. To educate on the fundamental concepts of linear integrated circuits
5. To introduce the functional elements and working of measuring instruments.

UNIT – I ELECTRICAL CIRCUITS 10

DC Circuits: Circuit Components: Conductor, Resistor, Inductor, Capacitor – Ohm’s Law - Kirchhoff’s Laws –Independent and Dependent Sources – Simple problems- Nodal Analysis, Mesh analysis with Independent sources only (Steady state)- Introduction to AC Circuits and Parameters: Waveforms, Average value, RMS Value, Instantaneous power, real power, reactive power and apparent power, power factor – Steady state analysis of RLC circuits.

UNIT – II ELECTRICAL MACHINES 10

Construction and Working principle- DC Separately and Self excited Generators, EMF equation, Types and Applications. Working Principle of DC motors, Torque Equation, Types and Applications. Construction, Working principle and Applications of Transformer, Three phase Alternator, Synchronous motor and Three Phase Induction Motor.

UNIT – III ANALOG ELECTRONICS 9

Resistor, Inductor and Capacitor in Electronic Circuits- Semiconductor Materials: Silicon &Germanium – PN Junction Diodes, Zener Diode –Characteristics Applications – Bipolar Junction Transistor-Biasing, JFET, SCR, MOSFET,IGBT – Types, I-V Characteristics and Applications, Rectifier and Inverters

UNIT – IV LINEAR INTEGRATED CIRCUITS 9

Ideal OP-AMP characteristics, Basic applications of op-amp – Inverting and Non-inverting Amplifiers, summer, differentiator and integrator-S/H circuit, D/A converter (R- 2R ladder), A/D converters- Flash type ADC using OP-AMPS . Functional block, characteristics of 555 timer– Astable multi-vibrator mode.

UNIT – V MEASUREMENTS AND INSTRUMENTATION 7

Functional elements of an instrument, Standards and calibration, Operating Principle, types - Moving Coil and Moving Iron meters, Measurement of three phase power, Energy Meter, Instrument Transformers -CT and PT, multimeter- DSO- Block diagram.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO 1: Recognize the working principle and applications of electrical machines, electronic elements and measurement instruments.

CO 1: Explain the basic concepts ofanalog electronics circuits

CO 2: Compute the electric circuit parameters for simple problems.

CO 3: Construct the various electrical and electronic circuits for given applications.

CO 4: Select the appropriate electrical and electronics measurement instruments.

Mapping of COs with POs and PSOs															
COs/POs & PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	1								1			3
CO2	3	2	1	1								1			3
CO3	3	2	1	1								1			3
CO4	3	2	1	1								1			3
CO5	3	2	1	1								1			3
CO/PO & PSO Average															
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS:

1. Del Toro ‘Electrical Engineering Fundamentals’ Pearson Education, New Delhi, 2007.
2. Alan S. Moris, Principles of Measurements and Instruments, Prentice-Hall of India Pvt. Ltd., New Delhi, 1999.
3. Smarjit Ghosh ‘Fundamentals of Electrical and Electronics Engineering, 2 nd Edition 2007

REFERENCES:

1. Rajendra Prasad ‘Fundamentals of Electrical engineering’ Prentice Hall of India, 2006.
2. Sanjeev Sharma ‘Basics of Electrical Engineering’ S.K International Publishers, New Delhi 2007.
3. John Bird, Electrical Circuits theory and Technology, Elsevier, First India Edition, 2006.
4. Doebelin, E.O., Measurements Systems – Application and Design’, McGrawHill Publishing Co, 1990.

GE5152 **ENGINEERING MECHANICS** **L T P C**
3 1 0 4

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

1. Applying the various methods to determine the resultant forces and its equilibrium acting on a particle in 2D and 3D.
2. Applying the concept of reaction forces (non-concurrent coplanar and noncoplanar forces) and moment of various support systems with rigid bodies in 2D and 3D in equilibrium. Reducing the force, moment, and couple to an equivalent force - couple system acting on rigid bodies in 2D and 3D.
3. Applying the concepts of locating centroids/center of gravity of various sections / volumes and to find out area moments of inertia for the sections and mass moment of inertia of solids.
4. Applying the concepts of frictional forces at the contact surfaces of various engineering systems.
5. Applying the various methods of evaluating kinetic and kinematic parameters of the rigid bodies subjected to concurrent coplanar forces.

UNIT I STATICS OF PARTICLES (9+3)

Fundamental Concepts and Principles, Systems of Units, Method of Problem Solutions, Statics of Particles -Forces in a Plane, Resultant of Forces, Resolution of a Force into Components, Rectangular Components of a Force, Unit Vectors. Equilibrium of a Particle- Newton's First Law of Motion, Space and Free-Body Diagrams, Forces in Space, Equilibrium of a Particle in Space.

UNITII EQUILIBRIUM OF RIGID BODIES (9+3)

Principle of Transmissibility, Equivalent Forces, Vector Product of Two Vectors, Moment of a Force about a Point, Varignon's Theorem, Rectangular Components of the Moment of a Force, Scalar Product of Two Vectors, Mixed Triple Product of Three Vectors, Moment of a Force about an Axis, Couple - Moment of a Couple, Equivalent Couples, Addition of Couples, Resolution of a Given Force into a Force -Couple system, Further Reduction of a System of Forces, Equilibrium in Two and Three Dimensions - Reactions at Supports and Connections.

UNIT III DISTRIBUTED FORCES (9+3)

Centroids of lines and areas – symmetrical and unsymmetrical shapes, Determination of Centroids by Integration , Theorems of Pappus-Guldinus, Distributed Loads on Beams, Centre of Gravity of a Three-Dimensional Body, Centroid of a Volume, Composite Bodies , Determination of Centroids of Volumes by Integration.

Moments of Inertia of Areas and Mass - Determination of the Moment of Inertia of an Area by Integration , Polar Moment of Inertia , Radius of Gyration of an Area , Parallel-Axis Theorem , Moments of Inertia of Composite Areas, Moments of Inertia of a Mass - Moments of Inertia of Thin Plates, Determination of the Moment of Inertia of a Three-Dimensional Body by Integration

UNIT IV FRICTION (9+3)

The Laws of Dry Friction. Coefficients of Friction, Angles of Friction, Wedges, Wheel Friction. Rolling Resistance, Ladder friction.

UNITV DYNAMICS OF PARTICLES (9+3)

Kinematics - Rectilinear Motion and Curvilinear Motion of Particles. Kinetics- Newton's Second Law of Motion -Equations of Motions, Dynamic Equilibrium, Energy and Momentum Methods - Work of a Force , Kinetic Energy of a Particle, Principle of Work and Energy, Principle of Impulse and Momentum, Impact, Method of Virtual Work - Work of a Force, Potential Energy, Potential Energy and Equilibrium.

TOTAL (L: 45 + T: 15)=60 PERIODS

COURSE OUTCOMES:

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

1. Apply the various methods to determine the resultant forces and its equilibrium acting on a particle in 2D and 3D.
2. Apply the concept of reaction forces (non-concurrent coplanar and noncoplanar forces) and moment of various support systems with rigid bodies in 2D and 3D in equilibrium. Reducing the force, moment, and couple to an equivalent force - couple system acting on rigid bodies in 2D and 3D.
3. Apply the concepts of locating centroids / center of gravity of various sections / volumes and to find out area moments of inertia for the sections and mass moment of inertia of solids.
4. Apply the concepts of frictional forces at the contact surfaces of various engineering systems.
5. Apply the various methods of evaluating kinetic and kinematic parameters of the rigid bodies subjected to concurrent coplanar forces.

TEXT BOOKS:

1. Beer Ferdinand P, Russel Johnston Jr., David F Mazurek, Philip J Cornwell, SanjeevSanghi, Vector Mechanics for Engineers: Statics and Dynamics, McGraw Higher Education., 11thEdition, 2017.
2. Vela Murali, "Engineering Mechanics-Statics and Dynamics", Oxford University Press, 2018.

REFERENCES:

1. Boresi P and Schmidt J, Engineering Mechanics: Statics and Dynamics, 1/e, Cengage learning, 2008.
2. Hibbeller, R.C., Engineering Mechanics: Statics, and Engineering Mechanics: Dynamics, 13th edition, Prentice Hall, 2013.
3. Irving H. Shames, Krishna Mohana Rao G, Engineering Mechanics – Statics and Dynamics, 4thEdition, Pearson Education Asia Pvt. Ltd., 2005.
4. Meriam J L and Kraige L G, Engineering Mechanics: Statics and Engineering Mechanics: Dynamics, 7th edition, Wiley student edition, 2013.
5. Timoshenko S, Young D H, Rao J V and Sukumar Pati, Engineering Mechanics, 5thEdition, McGraw Hill Higher Education, 2013.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	0.9	0.6	0.6	0.3								0.6	0.9	0.3	0.3
2	0.9	0.6	0.6	0.3								0.6	0.9	0.3	0.3
3	0.9	0.6	0.9	0.3								0.6	0.9	0.3	0.6
4	0.9	0.6	0.9	0.3								0.6	0.9	0.3	0.6
5	0.9	0.6	0.9	0.3								0.6	0.9	0.3	0.6

Attested

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PH5252 **PHYSICS FOR ELECTRONIC SCIENCES** **L T P C**

(Common to EEE and EI Branches) **3 0 0 3**

OBJECTIVE

- To make the students to understand the basics of crystallography and its importance in completionmaterials properties.
- To understand the electrical properties of materials including free electron theory, applications ofquantum mechanics and magnetic materials.
- To instill knowledge on physics of semiconductors, determination of charge carriers and deviceapplications
- To establish a sound grasp of knowledge on different optical properties of materials, opticaldisplays and applications
- To inculcate an idea of significance of nano structures, quantum confinement and ensuing nanodevice applications.

UNIT I CRYSTALLOGRAPHY 9

Crystal structures - Bravais lattices – packing factor of SC, BCC, FCC, HCP and diamond structures – Close-packed crystal directions and planes — Surface crystallography — surface structure for BCCand close packed structures - surface to volume ratio: plane, cylinder, cube, sphere - Number of atoms and number of surface atoms in a structure: unit cell approach - imperfections and impurities.

UNIT II ELECTRICAL AND MAGNETIC PROPERTIES OF MATERIALS 9

Classical free electron theory - Expression for electrical conductivity – Thermal conductivity, expression - Quantum free electron theory :Tunneling – degenerate states – Fermi- Dirac statistics – Density of energy states – Electron in periodic potential – Energy bands in solids – tight binding approximation - Electron effective mass – concept of hole. Ferromagnetism: origin and exchange interaction- saturation magnetization and curie temperature – Domain Theory- M versus H behaviour
– Hard and soft magnetic materials.

UNIT III SEMICONDUCTORS AND TRANSPORT PHYSICS 9

Intrinsic Semiconductors – Energy band diagram – direct and indirect band gap semiconductors – Carrier concentration in intrinsic semiconductors – extrinsic semiconductors - Carrier concentration in N-type & P-type semiconductors – Variation of carrier concentration with temperature – Carrier transport in Semiconductors: Drift, mobility and diffusion – Hall effect and devices – Ohmic contacts – Schottky diode.

UNIT IV OPTICAL PROPERTIES OF MATERIALS 9

Classification of optical materials – Absorption emission and scattering of light in metals, insulators & Semiconductors - LED's – Organic LED's – Plasma light emitting devices – LCD's – Laser diodes – Optical data storage techniques (including DVD, Blue -ray disc, Holographic data storage).

UNIT V NANO DEVICES 9

Electron density in a conductor – Significance between Fermi energy and volume of the material – Quantum confinement – Quantum structures – Density of states for quantum wells, wires and dots – Band gap of nanomaterials –Tunneling – Single electron phenomena – Single electron Transistor. Conductivity of metallic nanowires – Ballistic transport – Quantum resistance and conductance – Carbon nanotubes: Properties and applications - Transport of spin – Spintronic devices and applications.

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TOTAL: 45 PERIODS

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COURSE OUTCOMES:

After completion the above subject, students will be able to understand

CO1: Know basics of crystallography and its importance for materials properties

CO2: Come to have firm knowledge on the electrical and magnetic properties of materials and theirapplications

CO3: Acquire adequate understanding of semiconductor physics and functioning of semiconductordevices

CO4: Understand the optical properties of materials and working principles of various optical devices

CO5: Appreciate the importance of nanotechnology, physics of nano devices, low-dimensionalstructures and their applications

Mapping of COs with POs and PSOs															
Cos / POs &PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	3	3	3				1		1				
CO2	3	3	3	3	3				1		1				
CO3	3	3	3	3	3				1		1				
CO4	3	3	3	3	3				1		1				
CO5	3	3	3	3	3				1		1				
CO/PO & PSO Average	3	3	3	3	3				1		1				
1 – Slight, 2 – Moderate, 3 – Substantial															

REFERENCES

1. W.D.Callitser and D.G.Rethwish. Materials Science and Engineering. John Wiley & Sons, 2014.
2. S.O. Kasap. Principles of Electronic Materials and Devices. McGraw Hill Education, 2017.
3. R.F.Pierret. Semiconductor Device Fundamentals. Pearson, 2006.
4. N.Garcia, A. Damask and S.Schwarz. Physics for Computer Science Students. Springer-Verlag,2012.
5. G.W.Hanson. Fundamentals of Nanoelectronics. Pearson Education, 2009.
6. J.Wilson and J.F.B.Hawkes. Optoelectronics. Pearson Education, 2018.
7. N.Gershenfeld. The Physics of Information Technology. Cambridge University Press, 2011.

GE5161 PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY L T P C
0 0 4 2

COURSE OBJECTIVES:

- To understand the problem solving approaches.
- To learn the basic programming constructs in Python.
- To articulate where computing strategies support in providing Python-based solutions to real world problems.
- To use Python data structures - lists, tuples, dictionaries.
- To do input/output with files in Python.

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EXPERIMENTS:

1. Identification and solving of simple real life or scientific or technical problems, and developing flow charts for the same.
2. Python programming using simple statements and expressions.
3. Scientific problems using Conditionals and Iterative loops.
4. Implementing real-time/technical applications using Lists, Tuples.
5. Implementing real-time/technical applications using Sets, Dictionaries.
6. Implementing programs using Functions.
7. Implementing programs using Strings.
8. Implementing programs using written modules and Python Standard Libraries.
9. Implementing real-time/technical applications using File handling.
10. Implementing real-time/technical applications using Exception handling.
11. Exploring Pygame tool.
12. Developing a game activity using Pygame like bouncing ball, car race etc.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

On completion of the course, students will be able to:

CO1: Develop algorithmic solutions to simple computational problems
CO2: Develop and execute simple Python programs.
CO3: Structure simple Python programs for solving problems.
CO4: Decompose a Python program into functions.
CO5: Represent compound data using Python data structures.
CO6: Apply Python features in developing software applications.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓									✓
CO2	✓		✓		✓							✓
CO3	✓	✓	✓									✓
CO4	✓	✓	✓	✓	✓							✓
CO5	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓
CO6	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

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EE5212	BASIC ELECTRICAL, ELECTRONICS ENGINEERING AND MEASUREMENTS LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

1. To train the students in conducting load tests on electrical machines
2. To gain practical experience in characterizing electronic devices
3. To train the students to use DSO/multi-meters for measurements

ELECTRICAL

1. Verification of ohms and Kirchhoff's Laws.
2. Load test on Self Excited DC Generator
3. Load test on DC Shunt Motor.
4. Load test on Single phase Transformer
5. Load Test on Induction Motor

ELECTRONICS

6. Design of Transistor/MOSFET/IGBT based switching circuits.
7. Design of Inverting and non-inverting amplifier.
8. Design of ADC and DAC.
9. Design of timer and counter

MEASUREMENTS

10. Measurement of Amplitude, Frequency, Time, Phase Measurement using DSO.
11. Measurement of electrical parameters (voltage, current, resistance, capacitance) using multi-meters.
12. Measurement of DC and AC Power using wattmeter's

TOTAL: 60 PERIODS

COURSE OUTCOMES:

After completing this course, the students will be able to

1. Use experimental methods to verify the Ohm's and Kirchhoff's Laws.
2. Analyze experimentally the load characteristics of electrical machines
3. Analyze the characteristics of basic electronic devices. Use DSO to measure the various parameters

CO-PO MAPPING:

Mapping of COs with POs and PSOs															
COs/POs &PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1		1							1	1	2	3
CO2	3	2	1		1							1	1	2	3
CO3	3	2	1		1							1	1	2	3
CO/PO & PSO Average	3	2	1		1							1	1	2	3
1 – Slight, 2 – Moderate, 3 – Substantial															

Attested

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MA5355 TRANSFORM TECHNIQUES AND PARTIAL DIFFERENTIAL EQUATIONS

L	T	P	C
3	1	0	4

COURSE OBJECTIVES:

- To introduce the effective mathematical tools for the solutions of partial differential equations that model physical processes;
- To introduce Fourier series analysis which is central to many applications in engineering :
- To develop the analytic solutions for partial differential equations used in engineering by Fourier series;
- To acquaint the student with Fourier transform techniques used in wide variety of situations in which the functions used are not periodic;
- To develop Z- transform techniques which will perform the same task for discrete time systems as Laplace Transform, a valuable aid in analysis of continuous time systems.

UNIT I PARTIAL DIFFERENTIAL EQUATIONS 12

Formation – Solutions of first order equations – Standard types and Equations reducible to standard types – Lagrange's Linear equation – Solution of linear equations of higher order with constant coefficients – Linear non-homogeneous partial differential equations.

UNIT II FOURIER SERIES 12

Dirichlet's conditions – General Fourier series – Odd and even functions – Half-range Sine and cosine series – Complex form of Fourier series – Parseval's identity – Harmonic Analysis.

UNIT III APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATION 12

Classification of partial differential equations- Method of separation of variables – Solutions of one dimensional wave equation and one-dimensional heat equation – Steady state solution of two-dimensional heat equation – Fourier series solutions in cartesian coordinates.

UNIT IV FOURIER TRANSFORM 12

Fourier integral theorem – Fourier transform pair - Sine and cosine transforms – Properties – Transform of elementary functions – Convolution theorem – Parseval's identity.

UNIT V Z – TRANSFORM AND DIFFERENCE EQUATIONS 12

Z-transform – Elementary properties – Inverse Z-transform – Convolution theorem – Initial and final value theorems – Formation of difference equation – Solution of difference equation using Z - transform.

TOTAL : 60 PERIODS

COURSE OUTCOMES :

At the end of the course, students will be able to

- Solve partial differential equations which arise in application problems.
- Analyze the functions as an infinite series involving sine and cosine functions.
- Obtain the solutions of the partial differential equations using Fourier series.
- Obtain Fourier transforms for the functions which are needed for solving application problems.
- Manipulate discrete data sequences using Z transform techniques.

TEXT BOOKS:

1. Erwin kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons, 10th Edition, New Delhi, 2015.
2. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, 44th Edition, New Delhi, 2017.

REFERENCES:

1. Bali N., Goyal M. and Watkins C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), 7th Edition, New Delhi, 2009.
2. Glyn James, "Advanced Modern Engineering Mathematics", Pearson Education, 4th Edition, New Delhi, 2011.
3. Peter V.O'Neil, "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, 7th Edition, New Delhi, 2012.
4. Ramana, B.V. "Higher Engineering Mathematics", Tata McGraw Hill, 11th Reprint, New Delhi, 2010.

PR5451 KINEMATICS AND DYNAMICS OF MACHINES L T P C
3 1 0 4

COURSE OBJECTIVES:

- To impart knowledge on various types of mechanisms and synthesis.
- To impart skills and analyze the position, velocity and acceleration of mechanisms.
- To understand the effects of friction in motion in transmission and machine components.
- To familiarize higher pairs like cams and gears.
- To study the undesirable effects of unbalances resulting from prescribed motions in mechanisms.

UNIT I MECHANISMS 9+3

Definition – Machine and Structure – Kinematic link, pair and chain – classification of Kinematic pairs – Constraint and motion – Degrees of freedom - Slider crank – single and double – Crank rocker mechanisms – Inversions, applications – Introduction to Kinematic analysis and synthesis of simple mechanisms – Determination of velocity and acceleration of simple mechanisms.

UNIT II FRICTION 9+3

Types of friction – friction in screw and nut – screw jack – pivot, collar and thrust bearings – plate and cone clutch – belt (Flat and V) and rope drives – creep in belts – open and crossed belt drives – Ratio of tensions – Effect of centrifugal and initial tensions – condition for maximum power transmission.

UNIT III GEARS AND CAMS 9+3

Gear – Types and profile – nomenclature of spur and helical gears – laws of gearing – interference – requirement of minimum number of teeth in gears – gear trains – simple, compound and reverted gear trains – determination of speed and torque in epicyclic gear trains – cams different types of followers – Cam – Types of cams and followers – Cam design for different follower motions.

UNIT IV VIBRATION 9+3

Free, forced and damped vibrations of single degree of freedom systems – force transmitted to supports – vibration Isolation – vibration absorption – torsional vibration of shafts – single and multi-rotor systems – geared shafts – critical speed of shafts.

UNIT V BALANCING 9+3

Static and dynamic balancing – single and several masses in different planes – primary and secondary balancing of reciprocating masses – Balancing of single and multi-cylinder engines – Governors and Gyroscopic effects.

TOTAL:60 PERIODS

COURSE OUTCOMES:

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

CO1: Apply the kinematics and dynamics of machinery in design and analysis of engineering problems.
CO2: Demonstrate the ability to synthesize and analysis mechanisms
CO3: Design and analyze cam and their motion.
CO4: Select the gears and gear trains for their applications.
CO5: Examine the concept of free, forced and damped vibrations.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√				√			
CO2	√	√	√	√	√				√			
CO3	√	√	√	√	√				√			
CO4	√	√	√	√	√				√			
CO5	√	√	√	√	√				√			

TEXT BOOKS:

1. Bansal R.K., "Theory of Machines", Laxmi Publications Pvt Ltd., New Delhi, 20th edition 2009.
2. Rattan S.S., "Theory of machines", Tata McGraw Hill publishing Co., New Delhi, 2nd edition 2011.

REFERENCES:

1. Gosh A and Mallick A.K., "Theory of Machines and Mechanisms", Affiliated East West press, 2009.
2. Malhotra D.R. and Gupta H.C ,"The Theory of machines", Satya Prakasam, Tech. India Publications, 2008.
3. Rao J.S. and Dukkipati R.V., "Mechanism and Machine Theory", Second Edition, Wiley Eastern Limited, 2006.
4. Shigley J.E. and Uicker J.J., "Theory of Machines and Mechanisms", McGraw Hill, 2006.
5. Ambekar A.G., "Mechanism and Machine Theory", PHI India Pvt Ltd, 2007

RO5301 DIGITAL ELECTRONICS AND MICROPROCESSOR

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To present the Digital fundamentals, Boolean algebra and its applications in digital systems
2. To familiarize with the design of various combinational digital circuits using logic gates
3. To introduce the analysis and design procedures for synchronous and asynchronous sequential circuits
4. To explain the various semiconductor memories and related technology
5. To introduce the electronic circuits involved in the making of logic gate

UNIT – I DIGITAL FUNDAMENTALS **9**

Number Systems – Decimal, Binary, Octal, Hexadecimal, 1's and 2's complements, Codes – Binary, BCD, Excess 3, Gray, Alphanumeric codes, Boolean theorems, Logic gates, Universal gates, Sum of products and product of sums, Minterms and Maxterms, Karnaugh map Minimization and Quine-McCluskey method of minimization.

UNIT – II COMBINATIONAL & SYNCHRONOUS SEQUENTIAL CIRCUITS 9

Design of Half and Full Adders, Half and Full Subtractors, Binary Parallel Adder -Multiplexer, Demultiplexer, Decoder, Priority Encoder. Flip flops – SR, JK, T, D, design of clocked sequential circuits – Design of Counters- Shift registers, Universal Shift Register

UNIT – III ASYNCHRONOUS SEQUENTIAL CIRCUITS AND MEMORY DEVICES 9

Stable and Unstable states, output specifications, cycles and races, state reduction, race free assignments, Hazards, Essential Hazards, Pulse mode sequential circuits, Design of Hazard free circuits. Basic memory structure – ROM -PROM – EPROM – EEPROM –EAPROM, RAM – Static and dynamic RAM - Programmable Logic Devices – Programmable Logic Array (PLA) - Programmable Array Logic (PAL) – Field Programmable Gate Arrays (FPGA).

UNIT – IV 8085 PROCESSOR 9

Hardware Architecture, pin diagram – Functional Building Blocks of Processor – Memory organization – I/O ports and data transfer concepts– Timing Diagram – Interrupts.

UNIT – V PROGRAMMING PROCESSOR 9

Instruction - format and addressing modes – Assembly language format – Data transfer, data manipulation& control instructions – Programming: Loop structure with counting & Indexing – Look up table - Subroutine instructions – stack -8255 architecture and operating modes

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon the completion of this course, the students will be able to

CO1: Recognize fundamental operating concepts behind digital logic circuits and microprocessors.

CO2: Know the procedures for Combinational, synchronous and asynchronous sequential circuits

CO3: Apply the use of electronic circuits involved in the design of logic gates and semiconductor memories

CO 4: Design the DLC and Microprocessor 8085.

CO 5: Recommend the correct circuits using DLC and Microprocessor.

Mapping of COs with POs and PSOs															
Cos / POs &PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	1								3	1	3	3
CO2	3	3	2	2	1							3	1	3	3
CO3	3	2	1	1								3	1	3	3
CO4	3	2	1	1								3	1	3	3
CO5	3	3	2	2	1							3	1	3	3
CO/PO & PSO Average															
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS:

1. Gopal K.Dubey, Fundamentals of Electrical Drives, Narosa Publishing House, 2020.
2. BimalK.Bose. Modern Power Electronics and AC Drives, Pearson Education, 2015.
3. R. Krishnan, Electric Motor & Drives: Modeling, Analysis and Control, Pearson, 2001.

REFERENCES

1. VedamSubramanyam, " Electric Drives Concepts and Applications ", 2e, McGraw Hill, 2017
2. ShaahinFelizadeh, "Electric Machines and Drives", CRC Press (Taylor and Francis Group), 2017.

3. John Hindmarsh and Alasdain Renfrew, “Electrical Machines and Drives System,” Elsevier 2012.
4. N.K. De., P.K. SEN” Electric drives” PHI, 2012.

RO5302 ELECTRICAL DRIVES AND ACTUATORS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To familiarize a relay and power semiconductor devices
2. To get a knowledge on drive characteristics
3. To obtain the knowledge on DC motors and drives.
4. To obtain the knowledge on AC motors and drives.
5. To obtain the knowledge on Stepper and Servo motor.

UNIT – I RELAY AND POWER ELECRONIC DEVICES 9

Study of Switching Devices – Relay and Types, Switching characteristics -BJT, SCR, TRIAC, GTO, MOSFET, IGBT and IGCT-: SCR, MOSFET and IGBT - Triggering and commutation circuit - Introduction to Driver and snubber circuits.

UNIT – II DRIVE CHARACTERISTICS 9

Electric Drive – Equations Governing Motor Load Dynamics – Steady State Stability – Multi Quadrant Dynamics: Acceleration, Deceleration, Torque, and Direction Starting & Stopping – Selection of Motor.

UNIT – III DC MOTORS AND DRIVES 9

DC Motors, PMDC, BLDC motors and Servomotors – Types, Principle of Operation - EMF Equations and Speed Torque Relationship and DC and BLDC Driver Circuits. H Bridge Circuits – 4 Quadrant Operation – Robotics Applications.

UNIT – IV STEPPER MOTORS 9

Constructional Features – Principle of Operation – Types Stepper Motors – Position and Director Control - Drive Circuits – Closed Loop Control - Modern Stepper Motors and Drives– Robotic Applications.

UNIT – V INDUCTION AND SERVO MOTORS AND DRIVES 9

AC Permanent Magnet Synchronous Servo Motors – Linear Electrical Motors – VFD Drives – AC Servo Drives - Modern Servo Drives – Overview of Motion Control - Applications

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon the completion of this course, the students will be able

CO 1: Recognize the working principle of switching device, motors and drives.
CO 2: Relate the working of drives and motors together.
CO 3: Apply the switching device and circuits for motors control.
CO 4: Use the appropriate motors for based on the specific requirements
CO 5: Select the appropriate motor for given applications

Mapping of COs with POs and PSOs															
COs/Pos & PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	1	1	2	1							1	1		3
CO2	3	1	2	2	1							1	1		3
CO3	3	1	2	2	1							1	1		3
CO4	3	1	1	2	2							1	1		3
CO5	3	1	1	2	2							1	1		3
CO/PO & PSO Average	3	1	1.4	2	1.4							1	1		3
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Bimbhra B.S., "Power Electronics", 6th Edition, Kanna Publishers, New Delhi, 2018.
2. Mehta V.K. & Rohit Mehta, "Principles of Electrical Machines", 2nd Edition, S. Chand& Co. Ltd., New Delhi, 2016.

REFERENCES

1. Gobal K. Dubey, "Fundamentals of Electrical Drives", 2nd Edition, Narosal Publishing House, New Delhi, 2005.
2. Theraja B.L. & Theraja A.K., "A Text Book of Electrical Technology", 2nd Edition, S.Chand & Co. Ltd., New Delhi, 2012.
3. Singh M.D. & Kanchandhani K.B., "Power Electronics", McGraw Hill, New Delhi, 2011.

AU5352 MECHANICS OF SOLIDS L T P C
3 0 0 3

COURSE OBJECTIVES:

The objective of this course is

1. To know about how a solid (materials, structures) behaves when it is exposed to forces and deformations.
2. To apply the fundamental concepts of principle of superposition, equilibrium, compatibility, force deformation, and stress-strain relationships to the solid and structural mechanics problems
3. To analyze determinate and indeterminate bars, beams, to determine axial forces, torques, shear forces, and bending moments
4. To have physical insight into distribution of stresses and strains in structural members
5. To identify the biaxial stresses in acting in a body or an element.

UNIT I STRESS - STRAIN, AXIAL LOADING 9

Stress and strain, elastic limit, Hooke's law, factor of safety, shear stress, shear strain, relationship between elastic constants. Stresses in stepped bars, uniformly varying sections, composite bars due to axial force. Lateral strain, Poisson's ratio, volumetric strain, changes in dimensions and volume. Thermal stresses and impact loading.

UNIT II STRESSES IN BEAMS 9

Beam – Definition, types of end supports, types of beam, types of loading. Shear force diagram and bending moment diagram for cantilever, simply supported and overhanging beams under point load, UDL, UVL and moments. Euler beam theory - Bending equation, section modulus, Bending stress in beams – Shear stress in beams.

UNIT III DEFLECTION OF BEAMS AND COLUMNS 9

Governing differential equation - Problems on Double integration method - Macaulay's Method – Moment area method. Concepts of Conjugate Beam method and Method of superposition. Columns – different end conditions – buckling load – Euler's theory – Rankine's formula.

UNIT IV TORSION AND SPRINGS 9

Theory of torsion and assumptions - torsion equation, polar modulus, stresses in solid and hollow circular shafts, power transmitted by a shaft, shafts in series and parallel, deflection in shafts fixed at the both ends. Springs – types, Deflection expression for closed coiled helical spring – Stress in springs - design of springs.

UNIT V BIAXIAL STRESS 9

Principal stresses, normal and tangential stresses, maximum shear stress - analytical and graphical method. Stresses in combined loading. Thin walled cylinder under internal pressure – changes in dimensions – volume. spherical shells subjected to internal pressure – deformation in spherical shells – Lame's theory.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the students are expected to

i. Know about how a solid (materials, structures) behaves when it is exposed to forces and deformations.
ii. Apply the fundamental concepts of principle of superposition, equilibrium, compatibility, force-deformation, and stress-strain relationships to the solid and structural mechanics problems
iii. Analyze determinate and indeterminate bars, beams, to determine axial forces, torques, shear forces, and bending moments
iv. Have physical insight into distribution of stresses and strains in structural members
v. Identify the biaxial stresses in acting in a body or an element.

TEXT BOOKS:

1. James M Gere, Barry J Goodno, "Mechanics of Materials, SI Edition", Ninth Edition, Cengage Learning, 2018
2. Russell C. Hibbeler, "Mechanics of Materials", Tenth Edition, Pearson education, 2017
3. Stephen Timoshenko, 'Strength of Materials', Vol I & II, CBS Publishers and Distributors, 3rd edition, 2004.

REFERENCES:

1. Clive L. Dym , Irving H. Shames, "Solid Mechanics : A Variational Approach, Augmented Edition", Springer publishers, 2013
2. Roy R Craig, "Mechanics of Materials", Third Edition, John Wiley & Sons, 2011
3. R.K.Rajput, 'Strength of Materials', S Chand; 4th Rev. Edition 2007.
4. Timothy A. Philpot, "Mechanics of Materials: An Integrated Learning System," 3rd Edition, Wiley, 2012.
5. William A. Nash, Merle C. Potter, "Schaum's Outline of Strength of Materials", 6th Edition, McGraw Hill Education, 2014

RO5311	ELECTRICAL DRIVES AND ACTUATORS LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

1. To impart knowledge on Performance of the fundamental control practices associated with AC and DC machines (starting, reversing, braking, plugging, etc.) using power electronics
2. To impart industry oriented learning
3. To evaluate the use of computer-based analysis tools to review the major classes of machines and their physical basis for operation

LIST OF EXPERIMENTS

1. Load test on DC Motor
2. Load test on 3 Phase Induction Motor
3. Load test on 3 Phase Synchronous Motor.
4. Rheostat based Speed control of motors (AC and DC)
5. Switching circuits of MOSFET, IGBT, SCR and TRAIC.
6. Gate pulsation generation using PWM signals.
7. Speed control of DC motor using Power Electronic Drive.
8. Position and direction control DC servomotor using Power Electronic Drive.
9. Position, direction and speed control of BLDC and PMDC motors using Power Electronic Drive.
10. Four quadrant operation of three-phase Induction Motor using Power Electronic Drive.
11. VFD control of single phase and three-phase induction motor using Power Electronic Drive.
12. AC servomotor position, direction and speed control using Power Electronic Drive.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon the completion of this course, the students will be able to;

CO 1: To learn about the load test on DC motor, Induction motor and synchronous motor

CO 2: To understand the control of DC motor using power electric drive

CO 3: To develop the ability to works on AC, DC motor using power electric drive

CO-PO MAPPING:

Mapping of COs with POs and PSOs															
COs/POs & PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1		1							1	1		3
CO2	3	2	1		1							1	1		3
CO3	3	2	1		1							1	1		3
CO/PO & PSO Average	3	2	1		1							1	1		3
1 – Slight, 2 – Moderate, 3 – Substantial															

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RO5312	MECHANICS OF SOLIDS AND MACHINES LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

1. To study the mechanical properties of materials when subjected to different types of loading.
2. Applying the principles of kinematics involved in various mechanisms
3. Applying the principles of Dynamics involved in various Experiments

PART I MECHANICS OF SOLIDS LABORATORY

List of Experiments:

1. Tension test on mild steel rod
2. Torsion test on mild steel rod
3. Hardness test on metal beam (Rockwell, Vicker's and Brinell Hardness Tests)
4. Compression test on helical spring
5. Deflection test on carriage spring
6. Impact Test (Izod and Charpy)

PART II MECHANICS OF MACHINES LABORATORY

List of Experiments:

1. Study of gears, gear trains and harmonic gears.
2. To determine mass moment of inertia and radius of gyration using compound pendulum.
3. To determine the torsional frequency of a single and double rotor system.
4. To perform experiment on Watt Governors to prepare performance characteristic Curves, and to find effect and sensitivity.
5. To perform experiment on Porter Governors to prepare performance characteristic Curves, and to find effect and sensitivity.
6. To find transverse vibration of free-beam with & without concentrated Masses.
7. To study the Profile and Jump Phenomenon of Cam.
8. Experiment of motorized gyroscope.
9. Determination of critical speed of shaft.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon the completion of this course, the students will be able

CO1: Perform Tension, Torsion, Hardness, Compression, and Deformation test on Solid materials.

CO2: Apply the measurement of various kinematic parameters.

CO3: Apply the vibration parameters in various experiments.

CO-PO MAPPING:

Mapping of COs with POs and PSOs															
COs/POs & PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	1								1			3
CO2	3	2	1	1								1			3
CO3	3	2	1	1								1			3
CO/PO & PSO Average															
1 – Slight, 2 – Moderate, 3 – Substantial															

GE5251 ENVIRONMENTAL SCIENCES L T P C
3 0 0 3

COURSE OBJECTIVES:

- To introduce the basic concepts of environment, ecosystems and biodiversity and emphasize on the biodiversity of India and its conservation.
- To impart knowledge on the causes, effects and control or prevention measures of environmental pollution and natural disasters.
- To facilitate the understanding of global and Indian scenario of renewable and non-renewable resources, causes of their degradation and measures to preserve them.
- To familiarize the influence of societal use of resources on the environment and introduce the legal provisions, National and International laws and conventions for environmental protection.
- To inculcate the effect of population dynamics on human and environmental health and inform about human right, value education and role of technology in monitoring human and environmental issues.

UNIT I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY 14

Definition, scope and importance of environment – need for public awareness - concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers – energy flow in the ecosystem – ecological succession – food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity definition: genetic, species and ecosystem diversity – bio geographical classification of India – value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, national and local levels – India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity. Field study of common plants, insects, birds Field study of simple ecosystems – pond, river, hill slopes, etc.

UNIT II ENVIRONMENTAL POLLUTION 8

Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards – soil waste management: causes, effects and control measures of municipal solid wastes – role of an individual in prevention of pollution – pollution case studies – disaster management: floods, earthquake, cyclone and landslides. Field study of local polluted site – Urban / Rural / Industrial / Agricultural.

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UNIT III NATURAL RESOURCES 10

Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. case studies – Land resources: Land as a resource, land 47 degradation, man induced landslides, soil erosion and desertification – role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles. Field study of local area to document environmental assets – river / forest / grassland / hill / mountain.

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT 7

From unsustainable to sustainable development – urban problems related to energy – water conservation, rain water harvesting, watershed management – resettlement and rehabilitation of people; its problems and concerns, case studies – role of non-governmental organization-environmental ethics: Issues and possible solutions – climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. – wasteland reclamation – consumerism and waste products – environment protection act – Air (Prevention and Control of Pollution) act – Water (Prevention and control of Pollution) act – Wildlife protection act – Forest conservation act – enforcement machinery involved in environmental legislation- central and state pollution control boards- Public awareness.

UNIT V HUMAN POPULATION AND THE ENVIRONMENT 6

Population growth, variation among nations – population explosion – family welfare programme – environment and human health – human rights – value education – HIV / AIDS – women and child welfare – role of information technology in environment and human health – Case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- To recognize and understand the functions of environment, ecosystems and biodiversity and their conservation.
- To identify the causes, effects and environmental pollution and natural disasters and contribute to the preventive measures in the immediate society.
- To identify and apply the understanding of renewable and non-renewable resources and contribute to the sustainable measures to preserve them for future generations.
- To recognize different forms of energy and apply them for suitable applications in for technological advancement and societal development.
- To demonstrate the knowledge of societal activity on the long and short term environmental issues and abide by the legal provisions, National and International laws and conventions in professional and personal activities and to identify and analyse effect of population dynamics on human value education, consumerism and role of technology in environmental issues.

TEXT BOOKS:

1. Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition, New Age International Publishers (2018).
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, (2016).
3. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education (2004).

REFERENCES:

1. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media.
2. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001.
3. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT. LTD, New Delhi, 2007.
4. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press (2005).
5. Erach Bharucha "Textbook of Environmental Studies for Undergraduate Courses" Orient Blackswan Pvt. Ltd. (2013).

PR5301 THERMODYNAMICS AND FLUID MECHANICS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

1. To make students understand the basic laws of thermodynamics.
2. To make the students to familiarize with the concepts, laws and methodologies for the analysis of gas turbines and compressors.
3. To introduce the basic concepts of fluid mechanics.
4. To make students understand the working principle of different types of pumps and Hydraulic turbines.

UNIT – I BASIC CONCEPTS AND LAWS OF THERMODYNAMICS 9

Thermodynamic system and surroundings – properties of system – STATE AND EQUILIBRIUM – Forms of energy – Quasi static process – Zeroth law of thermodynamics – Work and heat transfer – Path and point functions – First law of thermodynamics applied to open systems – SFEE equation and its applications. Second law of thermodynamics applied to Heat engines, Refrigerators& Heat pumps. Carnot's theorem and clausius inequality – Concept of entropy applied to reversible and irreversible processes – Third law of thermodynamics.

UNIT – II INTRODUCTION TO APPLICATIONS OF THERMODYNAMICS 9

Air standard cycles – Thermodynamics assumption – Otto cycle, diesel cycle and Brayton cycle (air standard efficiency, mean effective pressure and power. Air compressors: classification, single and multistage compressors, inter-cooler in compression process. Refrigerators: classification, vapour compression and absorptions systems, Eco-friendly refrigerants. Heat Transfer: introduction to modes of heat transfer with examples.

UNIT – III BASIC CONCEPT OF FLUID MECHANICS & FLOW OF FLUIDS 9

Fluid: Properties and types. Pressure: laws of pressure, types of pressure, pressure measurement using manometers and mechanical gauges. Viscosity: Kinematic and dynamic viscosity. Fluid kinematics and dynamics – Types of fluid flow – velocity – rate equation of continuity – energy of a liquid in motion – head of a liquid – Bernoulli's theorem

UNIT – IV DIMENSIONAL AND MODEL ANALYSIS 9

Dimension – need for dimensional analysis, Rayleigh's and Buckingham's method applied to flow problems, limitation of dimensional analysis. Model analysis – similitude, dimensionless numbers and their significance, similarity laws, model studies, limitation of scale models.

UNIT – V HYDRAULIC MACHINES 9

Introduction and classification of hydraulic machines. Reciprocating pump: constructional

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details, working principle, co-efficient of discharge, slip, power required. Centrifugal pump: classification and working principle, specific speed. Turbines: classification, working principle of a Pelton wheel turbine.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon the completion of this course, the students will be able

CO1: Understand and apply the basic laws of thermodynamics and fluid mechanics for different applications.

CO2: Use the basic concepts and methodologies for the analysis of gas turbine and compressors.

CO3: Recognize the concepts in fluid mechanics and also know about the flow of fluids

CO4: Understand the need of dimensional and model analysis.

CO5: Understand the working principle of different types of pumps and hydraulic turbines.

Mapping of COs with POs and PSOs															
COs/Pos & PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	1	1	2	1							1	1		3
CO2	3	1	2	2	1							1	1		3
CO3	3	1	2	2	1							1	1		3
CO4	3	1	1	2	2							1	1		3
CO5	3	1	1	2	2							1	1		3
CO/PO & PSO Average	3	1	1.4	2	1.4							1	1		3
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS:

1. Nag, P.K., “Engineering Thermodynamics”, Tata McGraw-Hill Co. Ltd., 2007.
2. Chattopadhyay, P.,” Engineering Thermodynamics”, Oxford University Press, New Delhi, 2010.
3. Rathakrishnan, E., “Fundamentals of Engineering Thermodynamics” Prentice-Hall India, 2005.
4. Bansal. R.K., “Fluid Mechanics and Hydraulics Machines”, Lakshmi Publications Pvt. Ltd., New Delhi, 9th Edition, 2015.

REFERENCES:

1. Reynold, “Thermodynamics”, Int. Student Edition, McGraw-Hill Co. Ltd., 1990.
2. Ramalingam, K.K., “Thermodynamics”, Sci-Tech Publications, 2006
3. Holman, J.P,” Heat Transfer”, 3rd Edition, McGraw-Hill, 2007.
4. Shames, I.H., “Mechanics of Fluids”, Kogakusha, Tokyo, 1998 5. Kumar, K.L., “Fluid Mechanics”, Eurasia Publishers, 1990.

RO5401 MANUFACTURING TECHNOLOGY

L	**T**	**P**	**C**
3	**0**	**0**	**3**

COURSE OBJECTIVES:

1. To learn about casting process and its classifications
2. To learn about welding process.
3. To learn about various Machining process
4. To learn about forming and shaping of plastics.
5. To learn about metal forming and powder metallurgy

UNIT – I CASTING **8**

Casting types, procedure to make sand mould, types of core making, moulding tools, machine moulding, special moulding processes – CO2 moulding; shell moulding, investment mounding, permanent mould casting, pressure die casting, centrifugal casting, continuous casting, casting defects.

UNIT – II WELDING **8**

Classification of welding processes. Principles of Oxy-acetylene gas welding. A.C metal arc welding, resistance welding, submerged arc welding, tungsten inert gas welding, metal inert gas welding, plasma arc welding, thermit welding, electron beam welding, laser beam welding, defects in welding, soldering and brazing.

UNIT – III MACHINING **12**

General principles (with schematic diagrams only) of working and commonly performed operations in the following machines: Lathe, Shaper, Planer, Horizontal milling machine, Universal drilling machine, Cylindrical grinding machine, Capstan and Turret lathe. Basics of CNC machines. General principles and applications of the following processes: Abrasive jet machining, Ultrasonic machining, Electric discharge machining, Electro chemical machining, Plasma arc machining, Tand Electron beam machining and Laser beam machining.

UNIT – IV FORMING AND SHAPING OF PLASTICS **8**

Types of plastics - Characteristics of the forming and shaping processes – Moulding of Thermoplastics – Working principles and typical applications of - Injection moulding – Plunger and screw machines – Blow moulding – Rotational moulding – Film blowing – Extrusion - Typical industrial applications – Thermoforming – Processing of Thermosets – Working principles and typical applications - Compression moulding – Transfer moulding – Bonding of Thermoplastics – Fusion and solvent methods – Induction and Ultrasonic methods

UNIT – V METAL FORMING AND POWDER METALLURGY **9**

Principles and applications of the following processes: Forging, Rolling, Extrusion, Wire drawing and Spinning, Powder metallurgy – Principal steps involved advantages, disadvantages and limitations of powder metallurgy

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO1. Recognize casting process and its classifications
CO2. Recognize about welding process.
CO3. Recognize about various Machining process
CO4. Recognize about forming and shaping of plastics.
CO5. Recognize about metal forming and powder metallurgy

Mapping of COs with POs and PSOs

COs/POs& PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1	1								1			3
CO2	3	2	1	1								1			3
CO3	3	2	1	1								1			3
CO4	3	3	1	2								1			3
CO5	3	1	1	2								1			3
CO/PO & PSO Average															
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Hajra Choudhury, “Elements of Workshop Technology”, Vol. I and II, Media Promoters and Publishers Pvt., Ltd., Mumbai, 2010.
2. Nagendra Parashar B.S. and Mittal R.K., “Elements of Manufacturing Processes”, Prentice-Hall of India Private Limited, 2012.

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REFERENCES
1. Adithan. M and Gupta. A.B., "Manufacturing Technology", New Age, 2007.
2. "H.M.T. Production Technology – Handbook", Tata McGraw-Hill, 2017.
3. Jain. R.K. and S.C. Gupta, "Production Technology", Khanna Publishers. 16th Edition, 2012.
4. Roy. A. Linberg, "Process and Materials of Manufacture", PHI, 2015.
5. SeropeKalpajian, Steven R.Schmid, "Manufacturing Processes for Engineering Materials", Fourth Edition, Pearson Education, Inc. 2018.

RO5402	ROBOT KINEMATICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES
1. To introduce Robots history, terminologies, classification and configurations.
2. To get knowledge about basic Geometrical and Algebraic approach to solve forward kinematics of serial manipulator.
3. To get knowledge about advanced forward kinematics of serial manipulator.
4. To get knowledge about inverse kinematics of various serial manipulator.
5. 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- Singularities – Manipulability of manipulators.

UNIT – II FORWARD KINEMATICS - 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 – DENAVIT-HARTEBERG (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 Convention and Procedures and Solutions: 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 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 JACOBIAN AND DIFFERENTIAL MOTION **9**

Forward and Inverse Jacobian-introduction - Singularity - Linear and angular velocity of end effector using Jacobian - Differential operator - Finding new location of end effector based on differential motion.

TOTAL : 45 PERIODS

COURSE OUTCOMES

At the end of the course students able to

CO 1: Explain the history, classifications and basic terminologies of robotics and various configuration of robots.
CO 2: Evaluate forward kinematic model for planar and spatial robot manipulator.
CO 3: Evaluate forward kinematic model for multi-DOF robot manipulators.
CO 4: Evaluate inverse kinematic model for multi-DOF robot manipulators.
CO 5: Evaluate differential motion of robot.

Mapping of COs with POs and PSOs															
COs/POs& PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	1								1			3
CO2	3	2	1	1								1			3
CO3	3	2	1	1								1			3
CO4	3	3	1	2								1			3
CO5	3	1	1	2								1			3
CO/PO & PSO Average															
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOK

1. Mikell P. Groover, "Industrial Robotics", McGraw Hill, 2nd edition, 2012.
2. John J. Craig, “Introduction to Robotics”, 3rd Edition, Addison Wesley, ISE 2020.

REFERENCE

1. S K Saha, Introduction to Robotics, Tata McGraw-Hill, ISBN: 9789332902800, Second Edition, 9789332902800, 2019.
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. 2010.
5. J. Srinivas, R. V. Dukkipati, K., “Robotics: Control and Programming”, Narosa Publishing House, 2009.
6. Tsuneo Yohikwa, Foundations of Robotics Analysis and Control, Prentice Hall of India Pvt. Ltd., 2016.
7. Bijay K. Ghosh, Ning Xi, T.J. Tarn, Control in Robotics and Automation Sensor - Based integration, Academic Press, 1999.

RO5403 MATERIALS FOR ROBOTS

L	**T**	**P**	**C**
3	**0**	**0**	**3**

COURSE OBJECTIVES:

1. To impart knowledge on the various structural features of metallic materials.
2. To desire the various ferrous and nonferrous alloys and their applications.
3. To illustrate the role of heat treatment and surface modification of materials.
4. To review nonmetallic materials and composites with their applications
5. To enable student to select material for applications including the modern materials.

UNIT – I ALLOYS AND PHASE DIAGRAM **9**

Atomic structure and interatomic bonding the structure of crystalline and non-crystalline materials. Constitution of alloys- Solid solution, substitutional and interstitial- phase diagrams,

Isomorphous, eutectic, eutectoid, peritectic and peritectoid reactions, iron –carbon equilibrium diagram.

UNIT – II FERROUS AND NON FERROUS METALS 9

Classifications of the steels – effect of alloying addition of steel-stainless and tool steel-HSLA. Cast iron- Gray, White, Malleable and Spheroidal – alloy cast iron, Copper and Copper alloys, Brass, Bronze and Cupronickel – Aluminium alloys and AI-Cu –precipitation strengthening treatment – Alloys of Aluminium, Titanium and Magnesium.

UNIT – III HEAT TREATMENT AND SURFACE MODIFICATION 7

Isothermal transformation diagrams – cooling curves superimposed on I.T. diagram CCR - Types and stages of annealing, stress relief, recrystallization and spheroidizing – normalizing, hardening and tempering of steel – Introduction to case hardening, Thermal spraying, CVD, PVD and nonmetallic coatings.

UNIT – IV NON METALLIC MATERIALS AND COMPOSITES 11

Polymers- Thermo, Thermoset Polymers, PE, PS, PVS PMMA, PC, PET, ABS- Engineering Polymers, PA, PPS, PI, PFE- Natural and Synthetic rubbers, Elastomers - Adhesives – Ceramics - Natural and Synthetic Ceramic - Composites – classification - structural composites and applications of composites

UNIT – V FUNCTIONAL MATERIALS 9

Introduction to smart materials, principles of piezoelectricity, piezoelectric polymers. Magnetostrictive materials - Magneto resistance effect, Introduction to Electro active polymers, Ionic polymer matrix composite. Shape memory alloys - Bulk Metallic glasses and nano crystalline materials.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO1: Identify the various structural features of metallic materials.
CO2: Recognize the various ferrous and nonferrous alloys with their applications.
CO3: Relate the heat treatment, Coating, microstructure and properties.
CO4: Explain the various nonmetallic materials and composites with their applications.
CO5: Suggest suitable materials for a given application.

Mapping of COs with POs and PSOs

COs/POs & PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1	1								1			3
CO2	3	2	1	1								1			3
CO3	3	2	1	1								1			3
CO4	3	2	1	1								1			3
CO5	3	2	1	1								1			3
CO/PO & PSO Average															

1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOKS:

1. David G Rethwisch, Callister's 'Materials Science and Engineering', Wiley India Pvt. Limited, 2021.
2. Kenneth G.Budinski and Michael K.Budinski ,"Engineering Materials", 9th Indian Reprint, Prentice-Hall of India Private Limited, 2016.

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REFERENCES:

1. Callisers's Jr. W.D, Rethuish, D.G, Materials Science and Engineering, 9th Edition, Wiley, 2014.
2. Donald R. Askeland, Pradeep P. Fulay and Wendelin J. Wright, "The Science and Engineering of Materials", 7 th Edition, Cengage Learning, Inc. 2017.
3. Sidney H. Avner, "Introduction to Physical Metallurgy", McGraw Hill Book Company, 2017.
4. Ashby M.F., Material Selection in Mechanical Design, 5thEdition, Butter Worth 2017.

RO5411	THERMAL AND FLUID MECHANICS LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

1. To learn to conduct performance test on various pumps
2. To determine the loses in compressors, and various pipes
3. To learn to conduct the performance test on various thermal systems

A. FLUID MECHANICS

1. Determine the coefficient of discharge using Flow through Venturimeter/ Orifice/ rotameter
2. Conduct the performance test and plot the Characteristics curves for Centrifugal pumps
3. Conduct the performance test and plot the Characteristics curves for Gear pump
4. Conduct the performance test and plot the Characteristics curves for Reciprocating pump
5. Conduct the performance test and plot the Characteristics curves for Francis turbine
6. Determination the major and minor losses in flow through pipes
7. Pressure distribution around a circular cylinder in high Reynolds number flow

B. THERMAL

1. Determine the viscosity of the oil using Redwood /Saybolt viscometer
2. Determination of Flash and Fire point of the oil
3. Draw the valve timing and port timing diagram for the 4S and 2S engines
4. Conduct the performance test and plot the Characteristics curves for Reciprocating air compressor
5. Conduct the performance test on Vapor compression Refrigeration system
6. Conduct the performance test on Air-conditioning system
7. Composite plane wall apparatus
8. Convective heat transfer coefficient by natural convection

TOTAL: 60 PERIODS

Course Outcomes:
CO1: Conduct performance test on various pumps
CO2: Determine the loses in compressors, and various pipes
CO3: Conduct the performance test on various thermal systems

CO-PO MAPPING:

Mapping of COs with POs and PSOs															
COs/POs& PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	1								1			3
CO2	3	2	1	1								1			3
CO3	3	2	1	1								1			3
CO/PO & PSO Average	3	2	1	1								1			3
1 – Slight, 2 – Moderate, 3 – Substantial															

ME5461 MANUFACTURING TECHNOLOGY LABORATORY L T P C
0 0 4 2

COURSE OBJECTIVES:
The main learning objective of this course is to provide hands on training to the students in:

1. Select appropriate tools, equipments and machines to complete a given job.
2. Develop component using casting processes.
3. Perform various joints by Gas Metal Arc Welding (GMAW) processes.
4. Perform various manufacturing processes such as rolling, drawing, turning, shaping, drilling, milling.
5. Fabricate gears using gear making machines.

.

LIST OF EXPERIMENTS

1. Fabricating simple structural shapes using Gas Metal Arc Welding machine.
2. Preparing green sand moulds with cast patterns.
3. Casting aluminum parts using stir casting machine.
4. Reducing thethickness of the plates using rolling machine.
5. Reducing the diameter of on circular parts using wire drawing process machine.
6. Taper Turning and Eccentric Turning on circular parts using lathe machine.
7. Knurling, external and internal thread cutting on circular parts using lathe machine.
8. Shaping – Square and Hexagonal Heads on circular parts using shaper machine.
9. Drilling and Reaming using vertical drilling machine.
10. Milling contours on plates using vertical milling machine.
11. Cutting spur and helical gear using milling machine.
12. Generating gearsusing gear hobbingmachine.
13. Generatinggears using gear shapingmachine.
14. Grinding components using cylindrical, surface and centerless grindingmachine.
15. Broaching components using broaching machine.

Total (P: 60) = 60 Periods

COURSE OUTCOMES: Upon completion of this course, the students will be able to:

1. Select appropriate tools, equipments and machines to complete a given job.

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2. Create components using casting processes.
3. Perform various welding process using GMAW.
4. Perform various machining process such as rolling, drawing, turning, shaping, drilling, milling.
5. Fabricate the gears using various gear generation and forming processes.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	3			2	2	1	3	3		1	3	3	2
2	3	2	3			2	2	1	3	3		1	3	3	2
3	3	2	3			2	2	1	3	3		1	3	3	2
4	3	3	3			2	2	1	3	3		1	3	3	2
5	3	3	3			2	2	1	3	3		1	3	3	2

RO5501 EMBEDDED SYSTEMS AND PROGRAMMING

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To familiarize the architecture and fundamental units of microcontroller.
2. To know the microcontroller programming methodology and to acquire the interfacing skills and data exchange methods using various communication protocols.
3. To design the interface circuit and programming of I/O devices, sensors and actuators.
4. To understand ARM processor architecture and its functions to meet out the computational and interface needs of growing mechatronic systems.
5. To acquaint the knowledge of real time embedded operating system for advanced system developments.

UNIT – I MICROCONTROLLER **9**

Fundamentals Functions of ALU - Microprocessor - Microcontrollers – CISC and RISC – Types Microcontroller - 8051 Family - Architecture - Features and Specifications - Memory Organization - Instruction Sets – Addressing Modes.

UNIT – II PROGRAMMING AND COMMUNICATION **9**

Fundamentals of Assembly Language Programming – Instruction to Assembler – Compiler and IDE - C Programming for 8051 Microcontroller – Basic Arithmetic and Logical Programming - Timer and Counter - Interrupts – Interfacing and Programming of Serial Communication, I^2C, SPI and CAN of 8051 Microcontroller – Bluetooth and WI-FI interfacing of 8051 Microcontroller.

UNIT – III PERIPHERAL INTERFACING **9**

I/O Programming – Interfacing of Memory, Key Board and Displays – Alphanumeric and Graphic, RTC, interfacing of ADC and DAC, Sensors - Relays - Solenoid Valve and Heater - Stepper Motors, DC Motors - PWM Programming – Closed Loop Control Programming of Servomotor – Traffic Light

UNIT – IV ARM PROCESSOR **9**

Introduction ARM 7 Processor - Internal Architecture – Modes of Operations – Register Set – Instruction Sets – ARM Thumb - Thumb State Registers – Pipelining – basic programming of ARM 7 - Applications.

UNIT – V SINGLE BOARD COMPUTERS(SBC) AND PROGRAMMING 9

System on Chip - Broadcom BCM2711 SoC – SBC architecture - Models and Languages – Embedded Design – Real Time Embedded Operating Systems - Real Time Programming Languages -– Python for Embedded Systems- GPIO Programming – Interfacing –IOT Concepts

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO 1: Select the microcontroller based on the features and specifications.

CO 2: Setup the programming platform and establish the various communications.

CO 3: Design the microcontroller based interfacing of sensors, actuators and other I/O's for controller development.

CO 4: Use and program the ARM processor growing needs of mechatronic systems.

CO 5: Establish and use the real time embedded operating systems and programming languages for peripheral interfacing and control.

Mapping of COs with POs and PSOs															
COs/Pos&PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	1	2	2						1	3	1	3
CO2	3	2	1	1	2	2						1	3	1	3
CO3	3	2	1	1	2	2						1	3	1	3
CO4	3	2	1	1	2	2						1	3	1	3
CO5	3	2	1	1	2	2						1	3	1	3
CO/PO & PSO Average	3	2	1	1	2	2						1	3	1	3
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Frank Vahid and Tony Givagis, "Embedded System Design", 2011, Wiley.
2. James W. Stewart, "The 8051 Microcontroller Hardware, Software and Interfacing", Regents Prentice Hall, 2003.
3. John B. Peatman, "Design with Microcontrollers", McGraw Hill International, USA, 2005.
4. Kenneth J. Aylala, "The 8051 Microcontroller, the Architecture and Programming Applications", 2005.

REFERENCES

1. Muhammad Ali Mazidi and Janice Gillispic Mazidi, "The 8051 Microcontroller and Embedded Systems", Pearson Education, 2014.
2. Simon Monk, Programming the Raspberry Pi, Second Edition: Getting Started with Python McGraw Hill TAB; 2nd edition,2015

RO5502 SENSORS AND TRANSDUCERS

L	**T**	**P**	**C**
3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To understand the concepts of measurement technology.
- To learn the various motion, proximity and ranging sensors
- To learn the various Force, Magnetic and Heading Sensors
- To learn the various Optical, Pressure and Temperature Sensors.
- To learn the fundamentals of signal conditioning, data acquisition and communication systems used in mechatronics system development**.**

UNIT – I INTRODUCTION 9

Basics of Measurement – Classification of Errors – Error Analysis – Static and Dynamic Characteristics of Transducers – Performance Measures of Sensors – Classification of Sensors – Sensor Calibration Techniques – Sensor Output Signal Types.

UNIT – II MOTION, PROXIMITY AND RANGING SENSORS 9

Motion Sensors – Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer – GPS, Bluetooth, Range Sensors – RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR).

UNIT – III FORCE, MAGNETIC AND HEADING SENSORS 7

Strain Gage, Load Cell, Magnetic Sensors –Types, Principle, Requirement and Advantages: Magneto Resistive – Hall Effect – Current Sensor Heading Sensors – Compass, Gyroscope, Inclinometers.

UNIT – IV OPTICAL, PRESSURE AND TEMPERATURE SENSORS 11

Photo Conductive Cell, Photo Voltaic, Photo Resistive, LDR – Fiber Optic Sensors – Pressure – Diaphragm, Bellows, Piezoelectric – Tactile Sensors, Temperature – IC, Thermistor, RTD, Thermocouple. Acoustic Sensors – Flow and Level Measurement, Radiation Sensors - Smart Sensors - Film Sensor, MEMS & Nano Sensors, LASER Sensors.

UNIT – V SIGNAL CONDITIONING AND DAQ SYSTEMS 9

Bridge circuits - Amplification – Filtering – Sample and Hold Circuits – Data Acquisition: Single Channel and Multi-Channel Data Acquisition – Signals Characteristics – Data Logging - Applications – Robotics, Automobile, Aerospace, Home Appliances, Manufacturing, and Environmental Monitoring.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO1: Recognize with various calibration techniques and signal types for sensors.

CO2: Describe the working principle and characteristics of force, magnetic, heading, pressure and temperature, smart and other sensors and transducers.

CO3: Apply the various sensors in the Automotive and Mechatronics applications

CO4: Select the appropriate sensor for different applications

CO5: Acquire the signals from different sensors using Data acquisition systems.

Mapping of COs with POs and PSOs

COs/POs & PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1	1								1			3
CO2	3	2	1	1								1			3
CO3	3	2	1	1								1			3
CO4	3	2	1	1								1			3
CO5	3	2	1	1								1			3
CO/PO & PSO Average															
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS:

1. Ernest O Doebelin, “Measurement Systems – Applications and Design”, Tata McGraw-Hill, 2019
2. Sawney A K and PuneetSawney, “A Course in Mechanical Measurements and Instrumentation and Control”, 12th edition, DhanpatRai& Co, New Delhi, 2013.

REFERENCES:

1. C. Sujatha ... Dyer, S.A., Survey of Instrumentation and Measurement, John Wiley & Sons, Canada, 2001
2. Hans Kurt Tönshoff (Editor), Ichiro, "Sensors in Manufacturing" Volume 1, Wiley-VCH April 2010.
3. John Turner and Martyn Hill, "Instrumentation for Engineers and Scientists", Oxford Science Publications, 2000.
4. Patranabis D, "Sensors and Transducers", 2nd Edition, PHI, New Delhi, 2013.
5. Richard Zurawski, "Industrial Communication Technology Handbook" 2nd edition, CRC Press, 2015

EE5402	CONTROL SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To make the students familiarize various representations of systems.
- To make the students analyze the stability of linear systems in time domain and frequency domain.
- To make the students analyze the stability of linear systems in frequency domain.
- To make the students design compensator based on the time and frequency domain Specifications.
- To develop linear models mainly state variable model and Transfer function model

UNIT – I MODELING OF LINEAR TIME INVARIANT SYSTEM (LTIV) 9

Control system: Open loop and Closed loop – Feedback control system characteristics – First principle modelling: Mechanical, Electrical and Electromechanical systems – Transfer function representations: Block diagram and Signal flow graph.

UNIT – II TIME DOMAIN ANALYSIS 9

Standard test inputs – Time responses – Time domain specifications – Stability analysis: Concept of stability – Routh Hurwitz stability criterion – Root locus: Construction and Interpretation. Effect of adding poles and zeros

UNIT – III FREQUENCY DOMAIN ANALYSIS 7

Bode plot, Polar plot and Nyquist plot: – Frequency domain specifications Introduction to closed loop Frequency Response. Effect of adding lag and lead compensators.

UNIT – IV STATE VARIABLE ANALYSIS 11

State variable formulation – Non uniqueness of state space model – State transition matrix – Eigen values – Eigen vectors-Free and forced responses for Time Invariant and Time Varying Systems – Controllability – Observability

UNIT – V DESIGN OF FEED BACK CONTROL SYSTEM 9

Design specifications – Lead, Lag and Lag-lead compensators using Root locus and Bode plot techniques –PID controller-Design using reaction curve and Ziegler-Nichols technique- PID control in State Feedback form.

TOTAL: 45 PERIODS

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COURSE OUTCOMES

After completion the above subject, students will be able to understand

CO1: Represent simple systems in transfer function and state variable forms.
CO2: Analyse simple systems in time domain.
CO3: Analyse simple systems in frequency domain.
CO4: Infer the stability of systems in time and frequency domain.
CO5: Interpret characteristics of the system and find out solution for simple control problems.

Mapping of COs with POs and PSOs															
COs/ Pos & PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1		1							3	2	3	1
CO2	3	2	1		1							2	2	3	1
CO3	3	2	1		1							2	2	3	1
CO4	3	2	1		1							2	2	3	1
CO5	3	2	1		1							2	3	3	1
CO/PO & PSO Average	3	2	1		1							2.2	2.2	3	1
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS:

1. Benjamin C. Kuo, “Automatic Control Systems”, 7th edition PHI Learning Private Ltd, 2010.
2. Nagarath, I.J. and Gopal, M., “Control Systems Engineering”, New Age International Publishers 2010.

REFERENCES:

1. Richard C.Dorf and Bishop, R.H., “Modern Control Systems”, Education Pearson, 3 Impression 2009.
2. John J.D., Azzo Constantine, H. and Houpis Sttuart, N Sheldon, “Linear Control System Analysis and Design with MATLAB”, CRC Taylor& Francis Reprint 2009.
3. Katsuhiko Ogata, “Modern Control Engineering”, PHI Learning Private Ltd, 5thEdition, 2010
NPTEL Video Lecture Notes on “Control Engineering” by Prof.S.D.Agashe, IIT Bombay

RO5503 DESIGN OF ROBOT ELEMENTS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

1. To introduce the students to the fundamentals of machine design, material selection and to solve the basic design problems.
2. To learn to derive various parameters for modelling links and joints in a robot.
3. To learn about Fundamentals of Computer Graphics
4. To learn and understand curves and surfaces in robot modelling.
5. To learn to derive various parameters for modelling end-effectors of a robot

UNIT – I FUNDAMENTALS OF MECHANICAL DESIGN 8

Fundamentals of Machine Design-Engineering Design, Phases of Design, Design Consideration - Standards and Codes - Design against Static and Dynamic Load –Modes of Failure, Factor of Safety, Principal Stresses, Theories of Failure-Stress Concentration, Stress Concentration Factors, Variable Stress, Fatigue Failure, Endurance Limit, Design for Finite and Infinite Life, Soderberg and Goodman Criteria.

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UNIT – IV DESIGN OF LINKS AND JOINTS 9

Loads and Forces on Links and Joints - Design of solid and hollow shafts - Rigid and flexible couplings -Threaded fasteners - rolling contact bearings-– Links Design: Path and Motion Synthesis – Cognate Linkages – Design of Spherical Joints.

UNIT – III FUNDAMENTALS OF COMPUTER GRAPHICS 9

Product cycle- Design process - Computer Aided Design – Computer graphics – co-ordinate systems- 2D and 3D transformations- homogeneous coordinates - graphic primitives (point, line, circle drawing algorithms) - Clipping- viewing transformation.

UNIT – IV CURVES AND MODELLING 9

Representation of curves - Hermite cubic spline curve, Bezier curve, B-spline curves, Fundamentals of solid modeling, Different solid representation schemes, Half -spaces, Boundary representation (B-rep), Constructive solid geometry (CSG), Sweep representation, Analytic solid modeling, Perspective, Parallel projection, Hidden line removal algorithms.

UNIT – V DESIGN OF GRIPPERS 9

Grippers – Types of Grippers Mechanisms – Gripping Methods – Gripping Force analysis – Gripper Design – Two Finger gripper – Three Finger Gripper – Magnetic Gripper Design – Vacuum Gripper Design – Hooks – Scoops – Spools – Miscellaneous Grippers

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Derive various parameters for modelling links and joints in a robot.

CO2: Recognize various end-effectors and derive various parameters for modelling end-effectors of a robot.

CO3: Know about various fundamentals of Computer Graphics

CO4: Recognize curves and surfaces in robot modelling.

CO5: Derive various parameters for modelling end-effectors of a robot.

Mapping of COs with POs and PSOs															
COs/POs & PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	1								1			3
CO2	3	2	1	1								1			3
CO3	3	2	1	1								1			3
CO4	3	2	1	1								1			3
CO5	3	2	1	1								1			3
CO/PO & PSO Average															
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS:

1. Joseph Edward Shigley, Charles R. Mischke “Mechanical Engineering Design”, McGraw Hill, International Edition, 2021
2. Sharma. C.S. and Kamlesh Purohit, “Design of Machine Elements”, Prentice Hall of India Private Limited, 2003
3. Ibrahim Zeid, “CAD/CAM theory and Practice”, Tata McGraw Hill, 2010
4. Ashby. M.F., “Materials Selection in Mechanical Design”, Third edition, Butterworth-Heineman, New York, 16th edition, 2017.

REFERENCES:

1. Bhandari. V.B., “Design of Machine Elements”, Tata McGraw-Hill Publishing Company Limited, 2017.

2. Robert L. Norton, “Machine Design – An Integrated Approach”, Prentice Hall International Edition, 2020.
3. Charles. J. A. and Crane. F. A. A, “Selection and Use of Engineering Materials”, second edition, Butterworth-Heinemann Ltd., 3rd edition 2013.
4. Kevin Otto, Kristin Wood, “Product Design”, Pearson Education, 7th Reprint, 2011.
5. Mikell P. Groover, "Industrial Robotics", McGraw Hill, 2nd edition, 2012.
6. Dragomir N. Nenchev, Atsushi Konno, Teppei Tsujita, “Humanoid Robots: Modelling and Control”, Butterworth-Heinemann, 2018
7. Zeid, I., CAD/CAM, McGraw Hill (2010).

RO5511	EMBEDDED SYSTEMS LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

- To give the hands on experience on designing a microcontroller based I/O interface circuits.
- To acquire the practice on programming the interfaces of keyboards, sensors, actuators, timers and counters, display devices and communication protocols using 8051 microcontroller and ARM processor.

LIST OF EXPERIMENTS

1. Assembly Language Programming and Simulation of 8051.
2. Alphanumeric and Graphic LCD Interfacing using 8051 Microcontroller.
3. Input switches and keyboard interfacing of 8051.
4. Sensor Interfacing with ADC to 8051 and DAC & RTC Interfacing with 8051. .
5. Timer, Counter and Interrupt Program Application for 8051.
6. Step Motor (Unipolar & Bipolar Motor) and PWM Servo Motor Control to Interfacing with 8051.
7. UART Serial and Parallel Port Programming of 8051.
8. I^2C, SPI and CAN Programming of 8051.
9. Interfacing and Programming of Bluetooth and Wi-Fi with 8051
10. Programming of ARM Processor for Sensor Interface.
11. Stepper Motor and Servo Motor Control Using ARM Processor.
12. Serial Communication of ARM Processor with Computation Platform.
13. Wireless Communication of ARM Processor with Computation Platform.
14. GPIO Programming of Real Time Embedded Operating Systems.
15. IOT application using SBC.

TOTAL = 60 PERIODS

COURSE OUTCOMES

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

CO1: Design and use a microcontroller based system control with I/O interface circuit.

CO2: Program the interfaces of keyboards, sensors, actuators, timers and counters, display devices and communication protocols using 8051 microcontroller and ARM processor.

CO3: Use the single board computers for real time applications.

RO5512	SENSORS AND CONTROL SYSTEMS LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

1. To learn about various force, pressure and vibration measuring sensors.
2. To learn about various Temperature, light and magnetic field measuring sensors
3. To learn about various displacement and speed measuring sensors.

LIST OF EXPERIMENTS

SENSORS

1. Determination of Load, Torque and Force using Strain Gauge.
2. Determination of the characteristics of Pressure Sensor and Piezoelectric Force Sensor
3. Determination of Displacement using LVDT.
4. Determine the Characteristics of Various Temperature Sensors.
5. Determine the Characteristics of Various Light Detectors (Optical Sensors).
6. Distance Measurement using Ultrasonic and Laser Sensor.
7. Determine angular velocity of gyroscope,
8. Vibration measurement using Accelerometer.
9. Direction measurement using Magnetometer.
10. Speed, Position and Direction Measurement Using Encoders.
11. Force measurement using 3 axis force sensor.
12. Force Measurement using tactile sensors.
13. Data acquisition, visualization and analysis of signals.

(Any 8 experiments)

CONTROL SYSTEMS LABORATORY

Experiments

1. Mathematical Modelling and Simulation of a Physical Systems and Simulation and Reduction of Cascade and Parallel, and Closed Loop Sub-System.
2. Simulation and Analysis of First and Second Order System Equations in Time and Frequency Domain.
3. Simulation and Analysis of System using Root-Locus and Bode Plot.
4. Simulation and Implementation of PID Combination for First Order Systems.
5. Simulation and Implementation of PID Combination Second Order Systems.
6. Auto tuning of PID parameters and analysis of PID Control.
7. Test of controllability and observability in continuous and discrete domain in simulation platform

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon the completion of this course, the students will be able to;

CO1: Demonstrate the various contact and non-contact sensors.

CO2: Analyze and Identify appropriate sensors for given applications.

CO3: Create a sensor system for given requirements.

Mapping of COs with POs and PSOs															
COs/POs & PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	1	2	1						1	2	1	3
CO2	3	2	1	1	2	1						1	2	1	3
CO3	3	2	1	1	2	1						1	2	1	3
CO/PO & PSO Average	3	2	1	1	2	1						1	2	1	3
1 – Slight, 2 – Moderate, 3 – Substantial															

RO5513	MODELLING AND SIMULATION OF ROBOT ELEMENTS LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

1. Make the students knowledgeable in modeling the basic components of a robot
2. Make the students knowledgeable in modeling some common joints, links and transmission assembly for a robot.
3. Make the students knowledgeable in modeling a robot and its end effector.

LIST OF EXPERIMENTS

1. 2D Sketch of a Gear.
2. 2D Sketch and 3D modelling of Sheet Metal Components
3. 3D Modelling Mounting clamp for motor.
4. 3D Modeling of GT2 pulley and belt drive system
5. 3D Modelling Ball Screw and Nut assembly.
6. 3D Modelling and motion simulation of Rotational Joint assembly.
7. 3D Modelling and motion simulation of Prismatic Joint assembly.
8. 3D modelling and simulation of Cartesian Robot
9. 3D modelling and simulation of Articulated / Spherical / Cylindrical Robot.
10. 3D modelling and motion simulation of 2 fingered gripper assembly.
11. Study on Harmonic Gear drive.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon the completion of this course, the students will be able to;

CO1: Create basic components of a robot in CAD software

CO2: Create some common joints, links and transmission assembly for a robot in CAD software.

CO3: Create a robot and its end effector in CAD software.

CO-PO MAPPING:

Mapping of COs with POs and PSOs															
COs/POs & PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	1								1			3
CO2	3	2	1	1								1			3
CO3	3	2	1	1								1			3
CO/PO & PSO Average															
1 – Slight, 2 – Moderate, 3 – Substantial															

RO5601	ROBOT DYNAMICS AND CONTROL	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To learn and understand generalized co-ordinates, Jacobian matrix Mass Distribution and other fundamental equations.
2. To understand Lagrangean and Hamiltonian mechanics
3. To understand nonlinearities in control system
4. To Understand various force control strategies
5. To understand various concepts in linearizing a no linear signal

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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 –Non-rigid 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 - Lagrangean Multiplier - Langrage's Equation - Hamilton Equation - Hamilton vector Field- Euler - Langrage Equation – State Vector and Equation Formulation

UNIT - III ROBOT CONTROL SYSTEM 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.

TOAL: 45 PERIODS

COURSE OUTCOME

Upon the completion of this course, the students will be able to;

CO1: Describe generalized co-ordinates, Jacobian matrix Mass Distribution and equation of motion.

CO2: Develop the static force model and inverse dynamic model of multi-degree of freedom (DOF) manipulator. Evaluate dynamics of robot using Lagrangean and Hamiltonian mechanics.

CO3: Describe the control architecture of robot manipulator.

CO4: Evaluate linear and nonlinearities in control system.

CO5: Explain various force control strategies.

Mapping of COs with POs and PSOs															
COs/POs& PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	1								1			3
CO2	3	2	1	1								1			3
CO3	3	2	1	1								1			3
CO4	3	2	1	1								1			3
CO5	3	2	1	1								1			3
CO/PO & PSO Average															
1 – Slight, 2 – Moderate, 3 – Substantial															

Attested

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TEXT BOOKS:

1. Mark W. Spong, Seth Hutchinson, M. Vidyasagar.," Robot modeling and control" 2nd Edition , 2020
2. John J. Craig, "Introduction to Robotics – Mechanics and control", 3rd edition, Prentice hall, 2022.
3. Groover. M.P., Weis. M., Nagel. R.N. and Odrey.N.G. "Industrial Robotics Technology, Programming and Applications", Mc Graw-Hill, Int., 2012.

REFERENCES:

1. K.S.Fu, Gonzalez, R.C. and Lee, C.S.G. "Robotics Control, Sensing, Vision and Intelligence", McGraw Hill, 1987.
2. Saeed B. Niku, "Introduction to Robotics: Analysis, Control, Applications", 2nd edition, John Wiley & sons, Inc., 2020
3. Klafter. R.D., Chmielewski, T.A. and Negin. M. "Robotics Engineering – An Integrated Approach", Prentice-Hall of India Pvt. Ltd., 2006.

RO5602	ROBOT PATH PLANNING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. Introduce basic trajectory planning problems.
2. Provide a basic review of various path planning theory of manipulator.
3. Provide a basic review of various path planning theory of mobile robot.
4. Introduction to the most widely used classical motion planning algorithms.
5. Introduce sufficient terminology and concepts in ROS for robot programming.

UNIT - I TRAJECTORY PLANNING APPROACHES 9

Definitions – Task planning and Trajectory planning – Representation of end-effector**:** Cartesian and joint space schemes. Workspace Analysis: work envelope of a multi DOF manipulator. Applications: Point to point motion and continuous path motion.

UNIT - II TRAJECTORY PLANNING OF MANIPULATOR 9

Joint space techniques – Motion profiles – Cubic polynomial, Linear Segmented Parabolic Blends and cycloidal motion - Cartesian space technique – Straight line and circular trajectories.

UNIT - III PATH PLANNING OF MOBILE ROBOT 9

Introduction - Representation of the Robot's Environment - Review of configuration spaces - Visibility Graphs - Voronoi diagrams - Potential Fields – Attractive and Repulsive – Cell Decomposition - Planning with moving obstacles - Probabilistic Roadmaps - Random trees - Execution of the Quadtree- Based Path Planner Program.

UNIT - IV PATH PLANNING ALGORITHMS 9

Planning - A* Algorithm - the D∗ algorithm - Path control. Graph search and discrete planning algorithms. - Sensor-Based Motion Planning Algorithms – the "Bug" algorithms – the Tangent Bug algorithm.

UNIT - V ROS PROGRAMMING 9

Robot language classification - Programming methods:Lead through method, teach pendent method - Syntax features and applications of various programming languages – Examples -

Inter locking commands - Safety features - Introduction to Robot Operating System (ROS) - ROS examples - Introduction to programming using ROS - Industrial ROS - ROS examples - Programming for point to point /continuous – operations - Case Study

TOAL: 45 PERIODS

COURSE OUTCOME

Evaluate basic trajectory planning problems.
Know about the various path planning theory of manipulator.
Recognize various path planning theory of mobile robot.
Demonstrate the most widely used classical motion planning algorithms.
Apply sufficient terminology and concepts in ROS for robot programming.

Mapping of COs with POs and PSOs															
COs/POs & PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	1								1			3
CO2	3	2	1	1								1			3
CO3	3	2	1	1								1			3
CO4	3	2	1	1								1			3
CO5	3	2	1	1								1			3
CO/PO & PSO Average															
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXTBOOKS

1. Niku S B, "Introduction to Robotics, Analysis, Control, Applications", John-Wiley & Sons Inc, 2020.
2. Howie Choset, Kevin Lynch Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki, Sebastian Thrun , "Principles of Robot Motion-Theory, Algorithms, and Implementation", MIT Press, Cambridge, 2016

REFERENCES:

1. Planning Algorithms by Steve LaValle, Cambridge Univ. Press, New York, 2014.
2. Robot Motion Planning by J.C. Latombe. 2010
3. Patnaik, Srikanta, "Robot Cognition and Navigation an Experiment with Mobile Robots", Springer-Verlag Berlin and Heidelberg, 2011.
4. Reza N Jazar, "Theory of Applied Robotics", Springer, 2022.
5. Morgan Quigley, Brian Gerkey, William D. Smart, Programming Robots with Ros: A Practical Introduction to the Robot Operating System, First Edition, 2016
6. “Principles of Robot Motion: Theory, Algorithms, and Implementations” by Howie Choset, Kevin Lynch, Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki, and Sebastian Thrun, 2016

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RO5603	FLUID POWER SYSTEMS AND INDUSTRIAL AUTOMATION	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

1. To recognize the standard symbols and to understand the functions of basic fluid power generation and actuation elements.
2. To realize the functions of fluid regulation and control elements and its typical uses in fluid power circuit and to acquire the practice on assembling the various types of pneumatic circuits.
3. To familiar and exercise the design procedure of various types of pneumatic and hydraulic fluid power circuits and to provide a training to create the various types of hydraulic circuits.
4. To learn about the fundamentals of Programmable Logic Controller.
5. To familiarize the Data Communication and Supervisory Control Systems.

UNIT – I FLUID POWER SYSTEM GENERATION AND ACTUATORS 9

Need For Automation, Classification of Drives - Hydraulic, Pneumatic and Electric – Comparison – ISO Symbols for their Elements, Selection Criteria. Generating Elements- Hydraulic Pumps and Motor Gears, Vane, Piston Pumps – Motors - Selection and Specification - Drive Characteristics – Utilizing Elements - Linear Actuator – Types, Mounting Details, Cushioning – Power Packs – Accumulators.

UNIT – II CONTROL AND REGULATIING ELEMENTS 9

Control and Regulating Elements — Direction, Flow and Pressure Control Valves -Methods of Actuation, Types, Sizing of Ports. Spool Valves - Operating Characteristics -Electro Hydraulic Servo Valves - Types - Characteristics and Performance.

UNIT – III CIRCUIT DESIGN FOR HYDRAULIC AND PNEUMATICS 9

Typical Design Methods – Sequencing Circuits Design - Combinational Logic Circuit Design - Cascade Method – KV Mapping - Electrical Control of Pneumatic and Hydraulic Circuits - Use of Relays, Timers, Counters and PLC in pneumatics and hydraulics

UNIT – IV PROGRAMMABLE LOGIC CONTROLLER 9

Industrial Automation - Programmable Logic Controller - Functions of PLCs - Features of PLC - Selection of PLC - Architecture – IEC61131-3 programming standard and types - Basics of PLC Programming – Ladder Logic Diagrams – Communication in PLC – Programming Timers and Counters – Data Handling - PLC modules – Advanced motion controlled Multi Axis PLC

UNIT – V DATA COMMUNICATION AND SUPERVISORY CONTROL SYSTEMS 9

Industrial Data Communications -– Modbus – HART – DeviceNet – Profibus – Fieldbus – RS232- RS485- Modbus/ Modbus TCP/IP - mechatrolink – CAN – EtherCAT - Introduction to Supervisory Control Systems – SCADA - Distributed Control System (DCS) – Safety Systems – human machine interfaces - Total Integrated Automation (TIA) – Industry 4.0.

TOTAL: 45 PERIODS

Laboratory

FLUID POWER DRIVES

1. Experimental Verification of Speed Control Circuits in Pneumatic and Hydraulic Trainer.
2. Experimental Verification of Single and Double Acting Cylinder Circuits Using Different Directional Control Values.
3. Experimental Verification of Electro-Pneumatic Circuits.
4. Experimental Verification of Pneumatic Sequencing Circuits.
5. Experimental Verification of Logic, Metre-in and Metre-out Pneumatic Circuits.
6. Experimental Verification of Electro Pneumatic Sequencing Circuits.

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7. Control of PLC Based Electro Pneumatic Sequencing Circuits.
8. Control of PLC Based Electro Hydraulic Sequencing Circuits.

(any 5 experiments)

INDUSTRIAL AUTOMATION

1. Design a Ladder Logic Program for various Logic Gates AND, OR, NOT, NOR, NAND, EX-OR and EX-NOR.
2. Develop Ladder Diagram Programming to set Timer and Counter in PLC.
3. Develop PLC Program to Control Traffic Light.
4. Develop PLC Program to Maintain the Pressure and Level in a Bottle Filling System.
5. Develop Ladder Diagram Program in PLC For Material Filling, Object Shorting, Orientation Check and Material Property Check.
6. Develop the Ladder Diagram Program in PLC for Material Handling, Delaying Conveyor, Feeding, Pick and Place Operation.
7. Sensor and Actuator Interfacing in PLC and PLC to PLC Communication.

(any 5 experiments)

TOTAL: 30 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO 1: Recognize the various concepts of fluid power and PLC systems.

CO 2: Comprehend functions of fluid power and PLC systems.

CO 3: Explain the various standard fluid power circuits, functions, communication and IO details of PLC.

CO 4: Demonstrate the standard fluid power circuits and PLC based interfaces.

CO 5: Construct the fluid power circuits and PLC based automation system.

Mapping of COs with POs and PSOs

COs/POs & PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1	1	2							1	3	2	3
CO2	3	2	1	1	2							1	3	2	3
CO3	3	2	1	1	2							1	3	2	3
CO4	3	2	1	1	2							1	3	2	3
CO5	3	2	1	1	2							1	3	2	3
CO/PO & PSO Average	3	2	1	1	2							1	3	2	3
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOK

1. Antony Esposito, “Fluid Power Systems and Control”, Pearson New International Edition,2014
2. Frank D, Petruzella, “Programmable Logic Controller” McGraw – Hill Publications, Fourth Edition, 2016.

REFERENCES

1. Peter Rohner, “Fluid Power Logic Circuit Design”, the Macmillan Press Ltd., London, 1979.
2. Lucas, M.P., “Distributed Control System”, Van Nastrand Reinhold Company, New York, 2016.
3. Mackay S., Wrijut E., Reynders D. and Park J., “Practical Industrial Data Networks Design, Installation and Troubleshooting”, Newnes Publication, Elsevier, First Edition, 2004.
4. Patranabis. D, “Principles of Industrial Instrumentation”, Tata McGraw-Hill Publishing Ltd., New Delhi, 2017.

RO5611 ROBOT KINEMATICS AND DYNAMICS LABORATORY

L	T	P	C
0	0	4	2

COURSE OBJECTIVES

1. To model and simulate a robot and verify its kinematics
2. To model and simulate a robot and generate a trajectory plan.
3. To model and simulate a robot and verify its dynamics

LIST OF EXPERIMENTS

1. Verification of Forward Kinematics for 2R, 2P and RP Robot.
2. Verification of D-H transformation for 6DOF Serial manipulator
3. Verification of Inverse Kinematics for 2R, 2P and RP Robot.
4. Verification of Forward Kinematics for 3R spatial Robot.
5. Kinematic Analysis of 2R planar robot for varying trajectories using Robo analyzer
6. Workspace Analysis of 2R planar robot manipulator for a specified trajectory
7. Kinematic Analysis of 6 DOF robot for varying trajectories using Robo analyzer
8. Inverse Dynamic Analysis of 6 DOF robot robot for varying trajectories using Robo analyzer
9. Forward and Inverse Dynamics of 2R planar robot using Robo analyzer
10. Creation of Robot in ROS using Gazebo/V-REP
11. Motion Simulation of Robot in ROS using Gazebo/V-REP/Moveit/Industrial.
12. Simulation of Trajectory Analysis of 2R and 3R manipulators using MATLAB-SIMULINK

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1. PC workstation - 30 No's
2. Robot analyzer (open source) installed on computer - 30 No's
3. ROS with Gazebo/moveit/v-rep installed on computer - 30 No's

COURSE OUTCOMES:

CO1. Analyse the kinematics and dynamics for various robots.
CO2. Simulate and evaluate the kinematics and dynamics for various robots.
CO3. Create a robot and program a trajectory plan for the robot.

RO5701 ROBOT VISION AND INTELLIGENCE

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To understand the basics concepts of optics and vision systems.
2. To learn and understand the fundamentals of image processing
3. To impart knowledge on object recognition and feature extraction.
4. To understand algorithms in image processing.
5. To demonstrate the various applications of machine vision system.

UNIT I IMAGE ACQUISITION **9**

The Nature of Vision- Robot vision – Need, Applications - image acquisition – Physics of Light – Interactions of light – Refraction at a spherical surface – Thin Lens Equation - Illumination techniques - linear scan sensor, planar sensor, camera transfer characteristic, Raster scan, Image capture time, volume sensors, Image representation, picture coding techniques.

UNIT II IMAGE PROCESSING FUNDAMENTALS **9**

Introduction to Digital Image Processing - Image sampling and quantization - Image enhancement: Gray Value Transformations, Radiometric Calibration, Image Smoothing– Geometric transformation– Image segmentation– Object Recognition and Image Understanding - Feature extraction: Region Features, Gray Value Features, Contour Features–Morphology– Edge extraction– Fitting and Template matching.

UNIT III OBJECT RECOGNITION AND FEATURE EXTRACTION 9

Image segmentation- Edge Linking-Boundary detection-Region growing-Region splitting and merging- Boundary Descriptors-Freeman chain code-Regional Descriptors- recognition-structural methods- Recognition procedure, mahalanobic procedure

UNIT IV COLLISON FRONTS ALGORITHM 9

Introduction, skeleton of objects. Gradients, propagation, Definitions, propagation algorithm, Thinning Algorithm, Skeleton lengths of Top most objects.

UNIT V ROBOT VISION APPLICATION 9

Case study-Automated Navigation guidance by vision system – vision based depalletizing- line tracking-. Automatic part Recognition. Image processing techniques implementation through Image Processing software

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon Completion of the course, the students will be able to

CO 1: Know the various types of sensors, lightings, hardware and concept of machine vision.
CO 2: Acquire the image by the appropriate use of sensors, lightings and hardware.
CO 3: Apply the various techniques of image processing in real time applications.
CO 4: Select the suitable sensors, lightings and hardware.
CO 5: Apply the vision techniques in Robot vision system.

Mapping of COs with POs and PSOs															
COs/POs & PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	3		2						2	3	2	3
CO2	3	2	1	3		2						2	3	2	3
CO3	3	2	1	3		2						2	3	2	3
CO4	3	2	1	3		2						2	3	2	3
CO5	3	2	1	3		2						2	3	2	3
CO/PO & PSO Average	3	2	1	3		2						2	3	2	3
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOK:

1. Rafael C. Gonzales, Richard. E. Woods, “Digital Image Processing Publishers”, Fourth Edition
2. Emanuele Trucco, Alessandro Verri, “Introductory Techniques For 3D Computer Vision”, First Edition

REFERENCES

1. Yi Ma, Jana Kosecka, Stefano Soatto, Shankar Sastry, “An Invitation to 3-D Vision From Images to Models”, First Edition, 2004
2. Fu .K.S, Gonzalez .R.S, Lee .C.S.G, “Robotics – Control Sensing, Vision and Intelligence”, Tata McGraw-Hill Education, 2008.
3. Rafel C.Gonzalez, Richard E.Woods,Steven L. Eddins, “Digital Image Processing using MATLAB”, 2nd edition, Tata McGraw Hill, 2010.

RO5702	AUTONOMOUS MOBILE ROBOTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To introduce mobile robotic technology and its types in detail.
2. To learn the kinematics of wheeled and legged robot.
3. To familiarize the intelligence into the mobile robots using various sensors.
4. To acquaint the localization strategies and mapping technique for mobile robot.
5. To aware the collaborative mobile robotics in task planning, navigation and intelligence.

UNIT – I INTRODUCTION TO MOBILE ROBOTICS 6

Introduction – Locomotion of the Robots – Key Issues on Locomotion – Legged Mobile Roots – Configurations and Stability – Wheeled Mobile Robots – Design Space and Mobility Issues – Unmanned Aerial and Underwater Vehicles – Teleportation and Control – Autonomous Mobile robot – UAV.

UNIT – II KINEMATICS 9

Kinematic Models – Representation of Robot – Forward Kinematics – Wheel and Robot Constraints – Degree of Mobility and Steerability – Manoeuvrability – Workspace – Degrees of Freedom – Path and Trajectory Considerations – Motion Controls - Holonomic Robots – Open Loop and Feedback Motion Control – Humanoid Robot - Kinematics Overview.

UNIT – III PERCEPTION 9

Sensor for Mobile Robots – Classification and Performance Characterization – Wheel/Motor Sensors – Heading Sensors - Ground-Based Beacons - Active Ranging - Motion/Speed Sensors – Vision Based Sensors – Uncertainty - Statistical Representation - Error Propagation - Feature Extraction Based on Range Data (Laser, Ultrasonic, Vision-Based Ranging) - Visual Appearance based Feature Extraction.

UNIT – IV LOCALIZATION 12

The Challenge of Localization - Sensor Noise and Aliasing - Effector Noise – Localization Based Navigation Versus Programmed Solutions - Belief Representation – Single - Hypothesis Belief And Multiple-Hypothesis Belief - Map Representation - Continuous Representations - Decomposition Strategies - Current Challenges In Map Representation - Probabilistic Map-Based Localization - Markov Localization - Kalman Filter Localization - Landmark-Based Navigation - Globally Unique Localization - Positioning Beacon Systems - Route-Based Localization - Autonomous Map Building - Stochastic Map Technique - Other Mapping Techniques. Simultaneous Localization and Mapping (SLAM).

UNIT – V PLANNING, NAVIGATION AND COLLABORATIVE ROBOTS 9

Introduction - Competences for Navigation: Planning and Reacting - Path Planning - Obstacle Avoidance - Navigation Architectures - Modularity for Code Reuse and Sharing - Control Localization - Techniques for Decomposition - Case Studies – Collaborative Robots – Swarm Robots.

TOTAL: 45 PERIODS

Mapping of COs with POs and PSOs															
COs/POs & PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	3		2						2	3	2	3
CO2	3	2	1	3		2						2	3	2	3
CO3	3	2	1	3		2						2	3	2	3
CO4	3	2	1	3		2						2	3	2	3
CO5	3	2	1	3		2						2	3	2	3
CO/PO & PSO Average	3	2	1	3		2						2	3	2	3
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOK

1. Roland Siegwart and Illah R.Nourbakish, “Introduction to Autonomous Mobile Robots” MIT Press, Cambridge, 2011.

REFERENCES:

1. Dragomir N. Nenchev, Atsushi Konno, Teppei Tsujita, “Humanoid Robots: Modelling and Control”, Butterworth-Heinemann, 2018
2. Mohanta Jagadish Chandra, “Introduction to Mobile Robots Navigation”, LAP Lambert Academic Publishing, 2015.
3. Peter Corke, “Robotics, Vision and Control”, Springer, 2017.
4. Ulrich Nehmzow, “Mobile Robotics: A Practical Introduction”, Springer, 2003.
5. Xiao Qi Chen, Y.Q. Chen and J.G. Chase, “Mobile Robots - State of the Art in Land, Sea, Air, and Collaborative Missions”, Intec Press, 2009.
6. Alonzo Kelly, Mobile Robotics: Mathematics, Models, and Methods, Cambridge University Press, 2013, ISBN: 978-1107031159.

RO5703 MACHINE LEARNING FOR INTELLIGENT SYSTEMS

L	**T**	**P**	**C**
3	**0**	**0**	**3**

COURSE OBJECTIVES:

1. To introduce basic machine learning techniques such as regression, classification
2. To learn about clustering and segmentation
3. To learn about fuzzy logic, fuzzification and defuzzification
4. To learn about basics of neural networks and neuro fuzzy networks.
5. To learn about Reinforcement learning.

UNIT – I INTRODUCTION TO MACHINE LEARNING **9**

Philosophy of learning in computers, Overview of different forms of learning, Classifications vs. Regression, Evaluation metrics and loss functions in Classification, Evaluation metrics and loss functions in Regression, Applications of AI in Robotics.

UNIT – II CLUSTERING AND SEGMENTATION METHODS **9**

Introduction to clustering, Types of Clustering, Agglomerative clustering, K-means clustering, Mean Shift clustering, K-means clustering application study, Introduction to recognition, K-nearest neighbor algorithm, KNN Application case study, Principal component analysis (PCA), PCA Application case study in Feature Selection for Robot Guidance.

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UNIT – III FUZZY LOGIC 9

Introduction to Fuzzy Sets, Classical and Fuzzy Sets, Overview of Classical Sets, Membership Function, Fuzzy rule generation, Fuzzy rule generation, Operations on Fuzzy Sets, Numerical examples, Fuzzy Arithmetic, Numerical examples, Fuzzy Logic, Fuzzification, Fuzzy Sets, Defuzzification, Application Case Study of Fuzzy Logic for Robotics Application

UNIT – IV NEURAL NETWORKS 9

Mathematical Models of Neurons, ANN architecture, Learning rules, Multi-layer Perceptrons, Back propagation, Introduction of Neuro-Fuzzy Systems, Architecture of Neuro Fuzzy Networks, Application Case Study of Neural Networks in Robotics

UNIT – V RNN AND REINFORCEMENT LEARNING 9

Unfolding Computational Graphs, Recurrent neural networks, Application Case Study of recurrent networks in Robotics, Reinforcement learning, Examples for reinforcement learning, Markov decision process, Major components of RL, Q-learning. Application Case Study of reinforcement learning in Robotics

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO1: Know about the concepts in basic machine learning techniques such as regression, classification

CO2: Recognize the methods in clustering and segmentation

CO3: Model a fuzzy logic system with fuzzification and defuzzification

CO4: Recognize the concepts of neural networks and neuro fuzzy networks.

CO5: Gain knowledge on Reinforcement learning.

Mapping of COs with POs and PSOs

COs/POs & PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	3	2	1						1	3	3	2	3
CO2	3	2	3	2	1						1	3	3	2	3
CO3	3	2	3	2	1						1	3	3	2	3
CO4	3	2	3	2	1						1	3	3	2	3
CO5	3	2	3	2	1						1	3	3	2	3
CO/PO & PSO Average	3	2	3	2	1						1	3	3	2	3
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. MichealNegnevitsky, Artificial Intelligence: A Guide to Intelligent Systems, 3rd Edition, Addision Wesley, England, 2011

REFERENCES

1. Bruno Siciliano, Oussama Khatib, “Handbook of Robotics”, 2016 2nd Edition, Springer
2. Simon Haykin, “Neural Networks and Learning Machines: A Comprehensive Foundation”, Third Edition, Pearson, 2016.
3. Timothy J Ross, “Fuzzy Logic with Engineering Applications”, 4th Edition, Chichester, 2011, Sussex Wiley.

RO5711	ROBOTIC PROGRAMMING, VISION AND INTELLIGENCE LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

1. To understand various lighting techniques, design and image acquisition of machine vision system.
2. To practice Feature Extraction, Image pre-processing and pattern recognition.
3. To apply machine learning technique to classification and object detection.

LIST OF EXPERIMENTS

1. Study on different kinds of vision sensors and lighting techniques for machine vision
2. Study on Design of Machine Vision System.
3. Experimentation on image acquisition towards the computation platform.
4. Pre-processing techniques in image processing
5. Edge detection and region of interest extraction.
6. Experimentation with image processing algorithm for feature extraction.
7. Experimentation with pattern recognition.
8. Vision based image classification using Machine Learning Techniques.
9. Vision based Object detection using Machine Learning Techniques.
10. Experimentation for Stereo vision.
11. Robot assisted image acquisition.
12. Vision based defect identification

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1. Camera with lenses and camera mounting interfaced with PC/any system - 5 No
2. Camera with any single board computers (system on chip models) – 5 No's.
3. Open CV / python with supported library/ licensed image processing software- 10 No'

Mapping of COs with POs and PSOs															
COs/POs & PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	3		2						2	3	2	3
CO2	3	2	1	3		2						2	3	2	3
CO3	3	2	1	3		2						2	3	2	3
CO/PO & PSO Average	3	2	1	3		2						2	3	2	3
1 – Slight, 2 – Moderate, 3 – Substantial															

COURSE OUTCOMES:

Upon completing this course Students able to

CO1: Select appropriate lighting techniques and image acquisition device for robot vision system.

CO2: Apply Feature Extraction, Image pre-processing and pattern recognition algorithm in real time robot.

CO3: Create a machine learning technique to classification and object detection.

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RO5001	ROBOTS AND SYSTEMS IN SMART MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To get a knowledge of working on Industrial robots and their load handling capacity
2. To enlist with an application of robots in various operation
3. To familiar with a material handling system
4. To impart the knowledge on robotic welding
5. To obtain the knowledge on various type of robot welding operation

UNIT – I INTRODUCTION **7**

Types of industrial robots - Load handling capacity - general considerations in Robotic material handling-material transfer - machine loading and unloading - CNC machine tool loading - Robot centered cell

UNIT – II SELECTION OF ROBOTS AND OTHER APPLICATIONS **9**

Factors influencing the choice of a robot - robot performance testing - economics of robotisation - Impact of robot on industry and society. Application of Robots in continuous arc welding - Spot welding - Spray painting -assembly operation - cleaning - robot for underwater applications.

UNIT – III MATERIAL HANDLING **13**

concepts of material handling - principles and considerations in material handling systems design - conventional material handling systems - industrial trucks - monorails - rail guided vehicles - conveyor systems -cranes and hoists - advanced material handling systems - automated guided vehicle systems - automated storage and retrieval systems(ASRS) - bar code technology - radio frequency identification technology -Introduction to Automation Plant design softwares.

UNIT – IV ROBOTIC WELDING **8**

Robotic welding system, Programmable and flexible control facility –Introduction-Types- Flex Pendant-Lead through programming, Operating mode of robot, Jogging-Types, programming for robotic welding, Welding simulation, Welding sequences, Profile welding

UNIT – V APPLICATIONS OF ROBOTS IN WELDING AND ALLIED PROCESSES **8**

Application of robot in manufacturing: Exploration of practical application of robots in welding: Robots for car body's welding, robots for box fabrication, robots for microelectronic welding and soldering – Applications in nuclear, aerospace and ship building, case studies for simple and complex applications

TOTAL: 45 PERIODS

COURSE OUTCOMES:

The Student must be able to

CO 1: Learn about the basic concepts of Industrial Robot.
CO 2: Ability in selecting the required robots
CO 3: Apply their knowledge in handling the materials.
CO 4: Learn about the Welding operation and also related to Programming
CO 5: Know the various applications of robots.

Mapping of COs with POs and PSOs															
COs/POs & PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2		3		2						2	3	2	3
CO2	3	2		3		2						2	3	2	3
CO3	3	2		3		2						2	3	2	3

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CO4	3	2		3		2						2	3	2	3
CO5	3	2		3		2						2	3	2	3
CO/PO & PSO Average	3	2		3		2						2	3	2	3
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXTBOOKS:

1. Richard D Klafter, Thomas Achmielewski, MickaelNegin , "Robotic Engineering – An integrated Approach", Prentice Hall India, New Delhi, 2006.
2. Mikell P Groover, "Automation, Production Systems, and Computer-Integrated Manufacturing", Pearson Education, New York, 2021.
3. Pires J N, Loureiro A, Bolmsjo G, "Welding Robots: Technology, System Issues and Application", Springer, London, 2010.

REFERENCE:

1. Parmar R S, "Welding Processes and Technology", Khanna Publishers, New Delhi, 2nd Edition, 2013.
2. John A. piotrowski, William T. Randolph, "Robotic welding: A Guide to Selection and Application, Welding Division, Robotics International of SME", Publications Development Dept., Marketing Division, 1987.
3. Mikell P Groover, Mitchel Weiss, Roger N Nagel, N.G.Odrey, Ashish Dutta, "Industrial Robotics (SIE): Technology, Programming and Applications", 2nd Edition, McGraw Hill Education India Pvt Ltd, 2017.
4. Yoram Koren , "Robotics for Engineers", McGraw-Hill, 1987.

RO5002 ROBOT AND MACHINE ELEMENTS DESIGN

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

1. Designing machine members subjected to static and variable loads.
2. Designing flexible elements like belts, ropes, and chain drives for engineering applications.
3. Designing shafts and threaded fasteners for various applications.
4. Designing and selecting bearings and robot grippers.
5. Designing gears and gearbox for machine tools and applications.

UNIT I FUNDAMENTAL CONCEPTS IN DESIGN 7

Introduction to Robots - factors influencing robot design, selection of materials based on mechanical properties - Modes of failure -Factor of safety – stresses due to bending and torsion moment - Eccentric loading, Design against fluctuating loads - theories of failures.

UNIT II DESIGN OF FLEXIBLE ELEMENTS AND BEARINGS 9

Introduction to flexible elements, Design of belt drives – Flat, Vee, and Timing Belts, Design of chain drives - Sliding contact and rolling contact bearings - Hydrodynamic journal bearings, Sommerfield Number, Raimondi & Boyd graphs - Selection of Rolling Contact bearings.

UNIT III DESIGN OF SHAFTS AND THREADED FASTENERS 9

Shafts and Axles - Design of solid and hollow shafts based on strength, rigidity, and critical speed - Keys and splines, Threaded fasteners - Bolted joints – Simple and eccentrically loaded bolted joints.

UNIT IV DESIGN OF GEARS AND GEAR BOXES 8

Design of Gears (Spur, Helical and Bevel) - Geometric progression - Standard step ratio - Ray diagram, kinematic layout - Design of sliding mesh gear box - Design of multi speed gear box for machine tool applications.

UNIT V DESIGN OF ROBOT GRIPPERS AND END EFFECTORS 12

Types of End Effectors and Gripper Mechanisms, Force analysis, Miniature Grippers and Micro Grippers, Compliance, Selected case studies - Sheet metal handling, pretension of cuboid/ cylindrical / objects, coils, irregular surfaces and flexible objects, handling castings, and medical applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES :

Upon successful completion of the course, students should be able to:

CO1: Design machine members subjected to static and variable loads.
CO2: Design flexible elements like belt, ropes and chain drives for engineering applications.
CO3: Design shafts and threaded fasteners for various applications.
CO4: Design gear and gear box for machine tool applications.
CO5: Design and bearings and robot grippers.

Mapping of COs with POs and PSOs															
COs/POs & PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	1	3													
CO2	1	3													
CO3	1	3													
CO4	1	3													
CO5	1	3													
CO/PO & PSO Average	1	3													
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXTBOOKS:

1. Bhandari. V.B, “Design of Machine Elements”, Tata McGraw-Hill Education, 5th Edition, 2020.
2. Joseph Edward Shigley, Charles R. Mischke, “Mechanical Engineering Design”, McGraw Hill, 11th Edition, 2020.
3. Gareth J.Monkman, Stefan Hesse, Ralf Steinmann, Henrik Schunk, “Robot Grippers”, Wiley, 2007.

REFERENCES:

1. Sundararajamoorthy T. V, Shanmugam .N, "Machine Design", Anuradha Publications, 2018.
2. Robert L.Norton, “Machine Design – An Integrated Approach”, Prentice Hall International Edition, 5th Edition, 2019.
3. Sharma. C.S, Purohit. K.,”Design of Machine Elements”, Prentice-Hall of India, 2003.
4. Adam Morecki, Joze Knapczyk, “Basics of Robotics: Theory and Components of Manipulators and Robots”, Springer, 2014.
5. Shimon Y. Nof, “Handbook of Industrial Robotics”, John Wiley & Sons, 2013.
6. “P.S.G.Design Data Hand Book”, PSG College of Tech Coimbatore.
7. Mikell P. Groover, "Industrial Robotics", McGraw Hill, 2nd Edition, 2017.

ME5071 **AUTOMOBILE ENGINEERING** **L T P C**
3 0 0 3

COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students for:
1. Classifying the types of chassis and identify different class of automobiles
2. Outline the engine systems and their emission control.
3. Illustrating the functions of various transmission systems.
4. Imparting the working of different braking and steering systems.
5. Understanding the working of electrical and electronic components.

UNIT I INTRODUCTON TO AUTOMOBILE AND TYPES 9
An overview of different types of automobiles and their power sources. Specifications, Performance Parameters, Types of power delivery, Safety standards, Trends in automobile design. Two and Types, Regulations, Car body construction. Bus Body Details, General consideration relating to chassis layout. Introduction to MV Act, Pollution Norms,

UNIT II POWERTRAIN AND FUEL MANAGEMENT SYSTEMS 9
Reciprocating Engine systems, Hybrid systems. Pollutant emissions and their control; Catalytic converter systems, Electronic Engine Management systems for SI and CI engines. Liquid and gaseous alternate fuels - Alcohol, LPG, CNG, and Hydrogen

UNIT III CLUTCH AND TRANSMISSION SYSTEMS 9
Clutch system and types, Gear box and types - manual, automatic, and AMT, propeller shafting, Differential, Axles - function, and types, Wheels, Tyres - types, construction and specification, suspension system - types and functioning,

UNIT IV BRAKING AND SUSPENSION SYSTEMS 9
Braking system - requirements and types, Steering system - working, types and steering geometry parameters. Wheel balancing & Alignment Wind Tunnel testing, Servicing of Vehicles,

UNIT V ELECTRICAL AND ELECTRONIC SYSTEMS 9
Introduction to Battery, Alternator, and Starter Motor systems, working principle, and circuitry, Safety systems - seat belts, air-bag, ABS, Modern electronic features in vehicles like tyre pressure monitoring, ESP, EBD, Automatic headlamp ON, Rain sensing wipers, speed sensing auto locking, OBD. HVAC system

TOTAL = 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1. Distinguish the different types of automobiles and chassis.
2. Interpret the various types of engines and their emission control.
3. Select the appropriate transmission systems.
4. Compare the braking and steering systems.
5. Infer the functions of different electrical and electronic components.

TEXTBOOKS:

1. Jack Erjavek, “Automotive Technology – A Systems Approach”, Thomson Learning, 3rdEdition, 1999.
2. William H. Crouse and Donald L. Anglin, “Automotive Mechanics”, Tata McGraw Hill, 10thEdition, 2004.

REFERENCES:

1. Gill P.S., “A Textbook of Automobile Engineering – Vol. I , II and III”, S.K.Kataria and Sons, 2ndEdition, 2012.
2. Giri, N.K., “Automotive Technology”, Khanna Publishers, 2ndEdition, 2002.

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3. Kirpal Singh, Automobile Engineering Volume I and II, Standard Publishers &Distributors, 14th Edition, 2017.
4. Kumar D.S., "Automobile Engineering", S.K.Kataria and Sons, 2nd Edition, 2017.
5. Robert Bosch GmbH, "Automotive Handbook", Robert Bosch, 2004.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2					2	2					1	1	1	
2	2				1	2	2					1	1	2	
3	2					2	1					1	1	1	
4	2					1	1					1	1	1	
5	2				1	2	1					1	1	1	

RO5003 LINEAR INTEGRATED CIRCUITS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To introduce the basic building blocks of linear integrated circuits
2. To learn the linear and non-linear applications of operational amplifiers
3. To introduce the theory and applications of analog multipliers and PLL
4. To learn the theory of ADC and DAC
5. To introduce the concepts of waveform generation and introduce some special function ICs

UNIT – I BASICS OF OPERATIONAL AMPLIFIERS 9

Current mirror and current sources, Current sources as active loads, Voltage sources, Voltage References, BJT Differential amplifier with active loads, Basic information about op-amps – Ideal Operational Amplifier – General operational amplifier stages -and internal circuit diagrams of IC 741, DC and AC performance characteristics, slew rate, Open and closed loop configurations –JFET Operational Amplifiers – LF155 and TL082.

UNIT – II APPLICATIONS OF OPERATIONAL AMPLIFIERS 9

Sign Changer, Scale Changer, Phase Shift Circuits, Voltage Follower, V-to-I and I-to-V converters, adder, subtractor, Instrumentation amplifier, Integrator, Differentiator, Logarithmic amplifier, Antilogarithmic amplifier, Comparators, Schmitt trigger, Precision rectifier, peak detector, clipper and clamper, Low-pass, high-pass and band-pass Butterworth filters.

UNIT – III ANALOG MULTIPLIER AND PLL 9

Analog Multiplier using Emitter Coupled Transistor Pair – Gilbert Multiplier cell – Variable transconductance technique, analog multiplier ICs and their applications, Operation of the basic PLL, Closed loop analysis, Voltage controlled oscillator, Monolithic PLL IC 565, application of PL for AM detection, FM detection, FSK modulation and demodulation and Frequency synthesizingand clock synchronization

UNIT – IV ANALOG TO DIGITAL AND DIGITAL TO ANALOG CONVERTERS 9

Analog and Digital Data Conversions, D/A converter – specifications – weighted resistor type, R-2 Ladder type, Voltage Mode and Current-Mode R – 2R Ladder types – switches for D/A converters high speed sample-and-hold circuits, A/D Converters – specifications – Flash type – Successive Approximation type – Single Slope type – Dual Slope type – A/D Converter using Voltage-to-Time Conversion – Over-sampling A/D Converters, Sigma – Delta converters.

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UNIT – V WAVEFORM GENERATORS AND SPECIAL FUNCTION ICS 9

Sine-wave generators, Multivibrators and Triangular wave generator, Saw-tooth wave generator,ICL8038 function generator, Timer IC 555, IC Voltage regulators – Three terminal fixed and adjustable voltage regulators – IC 723 general purpose regulator – Monolithic switching regulator, Low Drop – Out(LDO) Regulators – Switched capacitor filter IC MF10, Frequency to Voltage and Voltage to Frequency converters, Audio Power amplifier, Video Amplifier, Isolation Amplifier, Optocouplers and fibre optic IC.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO 1: Design linear and nonlinear applications of OP – AMPS
CO 2: Design applications using analog multiplier and PLL
CO 3: Design ADC and DAC using OP – AMPS
CO 4: Generate waveforms using OP – AMP Circuits
CO 5: Analyze special function ICs

Mapping of COs with POs and PSOs															
COs/POs & PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	1			1					1	1	2	3
CO2	3	2	1	1			1					1	1	2	3
CO3	3	2	1	1			1					1	1	2	3
CO4	3	2	1	1			1					1	1	2	3
CO5	3	2	1	1			1					1	1	2	3
CO/PO & PSO Average	3	2	1	1			1					1	1	2	3
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS:

1. D. Roy Choudhry, Shail Jain, —Linear Integrated Circuits, New Age International Pvt. Ltd., Sixth Edition, 2021. (Unit I – V)
2. Sergio Franco, —Design with Operational Amplifiers and Analog Integrated Circuits‖, 4th Edition, Tata Mc Graw-Hill, 2016 (Unit I – V)

REFERENCES:

1. Ramakant A. Gayakwad, —OP-AMP and Linear ICs‖, 4th Edition, Prentice Hall Pearson Education, 2015.
2. Robert F. Coughlin, Frederick F. Driscoll, —Operational Amplifiers and Linear Integrated Circuits‖, Sixth Edition, PHI, 2014.
3. B. S. Sonde, —System design using Integrated Circuits‖, 2nd Edition, New Age Pub, 2001.
4. Gray and Meyer, —Analysis and Design of Analog Integrated Circuits‖, Wiley International, 5th Edition, 2011.

RO5004 **APPLIED SIGNAL PROCESSING** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

1. To understand the characteristics of various types of signals.
2. To carry out the pre-processing of continuous time signals and systems.
3. To learn DTFT, FFT and Z-Transform methods in signals processing.
4. To design digital IIR, FIR filters for signal processing.
5. To learn about various signal processors and its applications of signals.

UNIT – I INTRODUCTION TO SIGNALS AND SYSTEMS 9

Elementary signals in continuous and discrete time - graphical and mathematical representation - Elementary operations and classification of continuous and discrete time signals – CT systems and DT systems - Properties of CT systems and DT systems Classification of systems

UNIT – II ANALYSIS OF CONTINUOUS TIME SIGNALS AND SYSTEMS 9

The continuous time Fourier series - Fourier Transform properties - Laplace transform and properties - Impulse response - convolution integrals - Fourier and Laplace transforms in Analysis of CT systems - Frequency response of systems characterized by differential Equations

UNIT – III ANALYSIS OF DISCRETE TIME SIGNALS AND SYSTEMS 9

Fourier Transform of discrete time signals (DTFT) Properties of DTFT - Discrete Fourier Transform - Fast Fourier Transform (FFT) - Z Transform and Properties – Impulse response - Convolution sum - System analysis from difference equation model - Stability of systems

UNIT – IV DESIGN OF DIGITAL FILTERS 9

Review of design techniques for analog low pass filters - Frequency transformation - IIR filters - Properties - Design of IIR digital filters using bilinear transformation - FIR filters - Characteristics of FIR filters with linear phase - Design of FIR filters using Window functions

UNIT – V DIGITAL SIGNAL PROCESSORS AND APPLCATIONS 9

Architecture of TMS320C54xx DSP - Addressing Modes - Instructions and Programming - Applications: Signal Compression - Sine wave generators - Noise generators – DTMF Tone Detection - Echo cancellation - Speech enhancement and recognition

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

1. Understand the characteristics of various types of signals.
2. Analyze continuous time signals and systems
3. Understand DTFT, FFT and Z-Transform methods in signals processing.
4. Design digital IIR, FIR filters for signal processing
5. Analyze and Apply various signal processors and its applications of signals.

Mapping of COs with POs and PSOs

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1	1								1	1	1	3
CO2	3	2	1	1								1	1	1	3
CO3	3	2	1	1								1	1	1	3
CO4	3	2	1	1								1	1	1	3
CO5	3	2	1	1								1	1	1	3
CO/PO & PSO Average	3	2	1	1								1	1	1	3
1 – Slight, 2 – Moderate, 3 – Substantial															

Attested

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TEXT BOOKS:

1. Alan V Oppenheim, Alan S Willsky, Hamid Nawab S, "Signals and Systems", PHI Learning, New Delhi, 2nd Edition, 2015.
2. John G. Proakis, Dimitris K Manolakis, "Digital Signal Processing, Hoboken, NJ: Pearson Education, New Delhi, 5th Edition, 2021.

REFERENCES:

1. Lonnie C Ludeman, "Fundamentals of Digital Signal Processing", Wiley & Sons, New Delhi, 2014.
2. Emmanuel C Ifeachor, Barrie W Jervis, "Digital Signal Processing", Pearson Education, New Delhi, 2013.
3. Haykin S, Barry Van Veen, "Signals and Systems", John Wiley and sons, New Delhi, 2016.
4. Vinay K Ingle, John G Proakis , "Digital Signal Processing using MATLAB", Cengage Learning, New Delhi, 2012.

ME5009 MECHANICAL VIBRATIONS AND NOISE CONTROL L T P C
3 0 0 3

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

1. Apply the fundamental concepts of vibration.
2. Apply the fundamentals of noise.
3. Describe the various sources of noise for automotive applications.
4. Determine the natural frequencies and mode shapes of the two degree freedom systems.
5. Apply the various control techniques to reduce the vibration and noise to improve the life of the components .

UNIT I BASICS OF VIBRATION 9

Introduction, classification of vibration: free and forced vibration, undamped and damped vibration, linear vibration, response of damped and undamped systems under harmonic force, analysis of single degree systems, torsional vibration - determination of natural frequencies and critical speed of shafts.

UNIT II BASICS OF NOISE 9

Introduction, amplitude, frequency, wavelength and sound pressure level, addition, subtraction and averaging decibel levels, noise dose level, legislation, measurement and analysis of noise, measurement environment, equipment, frequency analysis, tracking analysis, sound quality analysis.

UNIT III AUTOMOTIVE NOISE SOURCES 9

Noise - Characteristics of engines, engine overall noise levels, assessment of combustion noise, assessment of mechanical noise, engine radiated noise, intake and exhaust noise, engine necessary contributed noise, transmission noise, aerodynamic noise, tyre noise, brake noise.

UNIT IV TWO DEGREE FREEDOM SYSTEM 9

Introduction-Free Vibration Of Undamped And Damped - Forced Vibration With Harmonic Excitation System –Coordinate Couplings And Principal Coordinates – Vibration absorbers

UNIT V CONTROL OF VIBRATION AND NOISE 9

Major sources of noise – Noise survey techniques – Measurement technique for vehicular noise – Road vehicle noise standards – Industrial noise sources – Control Strategies – Noise control at the source and along the path – use of acoustic barriers – Noise control at the receiver – vibration isolation methods

TOTAL = 45 PERIODS

COURSE OUTCOMES:

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

1. Apply the fundamental concepts of vibration.
2. Apply the fundamentals of noise.
3. Describe the various sources of noise for automotive applications.
4. Determine the natural frequencies and mode shapes of the two degree freedom systems.
5. Apply the various control techniques to reduce the vibration and noise to improve the life of the components

TEXT BOOKS:

1. Ambekar. A. G., Mechanical Vibrations and Noise Engineering", Prentice Hall of India Pvt. Ltd., 2006
2. Singiresu S. Rao, "Mechanical Vibrations", Pearson Education Incorporated, 2017

REFERENCES:

1. Benson H. Tongue, "Principles of Vibrations", Oxford University, 2007.
2. David A. Bies and Colin H. Hansen, "Engineering Noise Control – Theory and Practice", Spon Press, 2009.
3. Grover. G.K., edited by Nigam. S. P., "Mechanical Vibrations", Nem Chand and Bros., 2014.
4. Julian Happian-Smith - "An Introduction to Modern Vehicle Design", Butterworth-Heinemann, 2001.
5. William T. Thomson, "Theory of Vibration with Applications", Taylor & Francis, 2003.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	2			1	1				1	2	2	1
2	3	2	2	2			1	1				1	2	2	1
3	3	2	2	2			1	1				1	2	2	1
4	3	2	2	2			1	1				1	2	2	1
5	3	2	2	2			1	1				1	2	2	1

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RO5005	DRONE TECHNOLOGIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To understand the basics of drone concepts
2. To learn and understand the fundaments of design, fabrication and programming of drone
3. To impart the knowledge of an flying and operation of drone
4. To know about the various applications of drone
5. To understand the safety risks and guidelines of fly safely

UNIT – I INTRODUCTION TO DRONE TECHNOLOGY 9

Drone Concept - Vocabulary Terminology- History of drone - Types of current generation of drones based on their method of propulsion- Drone technology impact on the businesses- Drone business through entrepreneurship- Opportunities/applications for entrepreneurship and employability

UNIT – II DRONE DESIGN, FABRICATION AND PROGRAMMING 9

Classifications of the UAV -Overview of the main drone parts- Technical characteristics of the parts -Function of the component parts -Assembling a drone- The energy sources- Level of autonomy- Drones configurations -The methods of programming drone- Download program - Install program on computer- Running Programs- Multi rotor stabilization- Flight modes -Wi-Fi connection.

UNIT – III DRONE FLYING AND OPERATION 9

Concept of operation for drone -Flight modes- Operate a small drone in a controlled environment- Drone controls F-light operations –management tool –Sensors- Onboard storage capacity -Removable storage devices- Linked mobile devices and applications

UNIT – IV DRONE COMMERCIAL APPLICATIONS 9

Choosing a drone based on the application -Drones in the insurance sector- Drones in delivering mail, parcels and other cargo- Drones in agriculture- Drones in inspection of transmission lines and power distribution -Drones in filming and panoramic picturing

UNIT – V FUTURE DRONES AND SAFETY 9

The safety risks- Guidelines to fly safely -Specific aviation regulation and standardization- Drone license- Miniaturization of drones- Increasing autonomy of drones -The use of drones in swarms

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO 1: Known about a various type of drone technology
CO 2: Obtain a knowledge about design, fabrication and programming in drone
CO 3: Learn about the flying and operation of drone
CO 4: Knowledge about the various commercial application of drone
CO 5: Understand the safety risks and guidelines to fly safely

Mapping of COs with POs and PSOs

COs/POs & PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	2	3	1	3	2						1	2	1	3
CO2	1	2	3	1	3	2						1	2	1	3
CO3	1	2	3	1	3	2						1	2	1	3
CO4	1	2	3	1	3	2						1	2	1	3
CO5	1	2	3	1	3	2						1	2	1	3

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CO/PO & PSO Average	1	2	3	1	3	2						1	2	1	3
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Daniel Tal and John Altschuld, “Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation”, 2021 John Wiley & Sons, Inc.
2. Terry Kilby and Belinda Kilby, “Make:Getting Started with Drones “,Maker Media, Inc, 2016

REFERENCES

1. John Baichtal, “Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs”, Que Publishing, 2016
2. Zavrsnik, “Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance”, Springer, 2018.

AU5651 ELECTRIC AND HYBRID VEHICLES L T P C
3 0 0 3

COURSE OBJECTIVES:

The course should enable the students to:

i. General aspects of Electric and Hybrid Vehicles (EHV), including architectures, modeling, sizing, sub system design and hybrid vehicle control.
ii. Understand about vehicle dynamics,
iii. Design the required energy storage devices,
iv. Select the suitable electric propulsion systems and
v. Understand of hybrid electric vehicles.

UNIT I NEED FOR ALTERNATIVE SYSTEM 10

Need for hybrid and electric vehicles – main components and working principles of a hybrid and electric vehicles, Different configurations of hybrid and electric vehicles. Comparative study of diesel, petrol, hybrid and electric Vehicles. Advantages and Limitations of hybrid and electric Vehicles. Case study on specification of electric and hybrid vehicles.

UNIT II DESIGN CONSIDERATIONS FOR ELECTRIC VEHICLES 9

Design requirement for electric vehicles- Range, maximum velocity, acceleration, power requirement, mass of the vehicle. Various Resistance- Transmission efficiency- Electric vehicle chassis and Body Design, Electric Vehicle Recharging and Refueling Systems.

UNIT III ENERGY SOURCES 9

Battery Parameters- - Different types of batteries – Lead Acid- Nickel Metal Hydride - Lithium ion- Sodium based- Metal Air. Battery Modeling- Equivalent circuits, Battery charging- Quick Charging devices. Fuel Cell- Fuel cell Characteristics- Fuel cell types-Half reactions of fuel cell. Ultra capacitors. Battery Management System.

UNIT IV MOTORS AND CONTROLLERS 9

Types of Motors, Characteristic of DC motors, AC single phase and 3-phase motor, PM motors, Switched reluctance motors, Motor Drives and speed controllers, Torque Vectoring, Regenerative Braking. Rectifiers, Inverters, DC/DC converters.

UNIT V SUBSYSTEMS OF HYBRID AND ELECTRIC VEHICLES 8

Power Split devices for Hybrid Vehicles - Operation modes - Control Strategies for Hybrid Vehicle- Economy of hybrid Vehicles. Steering and Suspension system. Choice of Tires.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

The students able to understand

i. Electric and hybrid vehicle operation and architectures
ii. Design of hybrid and electric vehicles.
iii. Energy requirement for vehicles.
iv. Vehicle characteristics, operating modes, and performance parameters of the vehicle
v. Different subsystems of hybrid and electric vehicles

TEXT BOOKS:

1. Iqbal Husain, " Electric and Hybrid Vehicles-Design Fundamentals", CRC Press,2003
2. Mehrdad Ehsani, " Modern Electric, Hybrid Electric and Fuel Cell Vehicles", CRC Press,2005.

REFERENCES:

1. James Larminie and John Lowry, "Electric Vehicle Technology Explained " John Wiley & Sons,2003
2. Lino Guzzella, " Vehicle Propulsion System" Springer Publications,2005
3. Ron HodKinson, "Light Weight Electric/ Hybrid Vehicle Design", Butterworth Heinemann Publication,2005

RO5006	APPLIED IMAGE PROCESSING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To introduce various image processing and preprocessing techniques.
2. To learn about feature detection and matching using Image processing
3. To learn about segmentation using Image processing techniques.
4. To learn about computational photography.
5. To learn about image recognition using Image processing techniques.

UNIT – I IMAGE FORMATION AND PROCESSING 9

Introduction - Geometric primitives and Transformations - Photometric Image formation - The digital camera. Introduction to image processing - point - spatial - Fourier Transform - Pyramids and wavelets - Geometric transformations - global optimization

UNIT – II FEATURE DETECTION AND MATCHING 9

Introduction - Points and patches - Feature detectors - Feature Descriptors - SIFT - PCA SIFT - Gradient location orientation histogram

UNIT – III SEGMENTATION 9

Introduction - Active contours - Snakes - Scissors - Level sets - Split and merge - Watershed – Region splitting - region merging - and graph based segmentation - mean shift and mode finding - Normalized cuts – graph cuts and energy based methods – application

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UNIT – IV COMPUTATIONAL PHOTOGRAPHY 9

Photometric calibration - Radiometric response function - Noise level estimation - Vignetting - Optical blur - High dynamic range imaging - Super resolution and blur removal - Color image demos icing – application

UNIT – V IMAGE RECOGNITION 9

Object detection - Face recognition - Instance recognition - category recognition - Bag of words - Part based models - context and scene understanding- Application: Image search.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:
Understand various image processing and preprocessing techniques.
Design a feature detection algorithm for given application
Design a segmentation algorithm for given application.
Understand and recognize various computational photography techniques.
Design an image recognition for given application.

Mapping of COs with POs and PSOs															
COs/POs & PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	1	1	2			1					1	1	3	2
CO2	2	1	1	2			1					1	1	3	2
CO3	2	1	1	2			1					1	1	3	2
CO4	2	1	1	2			1					1	1	3	2
CO5	2	1	1	2			1					1	1	3	2
CO/PO & PSO Average	2	1	1	2			1					1	1	3	2
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS:

1. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer, 2010.
2. Hartley R, Zisserman A, "Multiple View Geometry in Computer Vision", Cambridge University Press, 2019.

REFERENCES:

1. Forsyth D A, Ponce J, "Computer Vision: A Modern Approach", 2nd Edition Boston Pearson, 2015.
2. Duda R O, Hart P E, Stork D G, "Pattern Classification", Wiley, 2001.
3. Richard Sc "Computer Vision: Algorithms and Applications", Springer, 2010.
4. Simon J. D. Prince "Computer Vision: Models, Learning and Inference", Cambridge University Press, New York, 2014.

RO5007 INDUSTRIAL COMPUTER AND SINGLE BOARD COMPUTERS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To know the architecture Single board computers
2. To understand the function and uses of Real time operating system
3. To familiar the python programming
4. To develop the embedded based python programming
5. To experiment the application development in SBC using python programming.

UNIT – I INTRODUCTION TO SINGLE BOARD COMPUTERS 9

On-Board System Architecture - Processor- Architecture – Features - SPI-I2C- UART- USB - Ethernet- CAN Protocol - Wi-Fi – Bluetooth - HDMI- GPIO- Memory- Input Devices – Camera Interfacing.

UNIT – II REAL TIME OPERATING SYSTEM 8

Operating System Architecture – File Systems- Resource Management – Process Scheduling – Applications.

UNIT – III PYTHON PROGRAMMING 10

Python Language – Using the Interpreter – Python Data Types And Functions – Working With Data – List, Dictionary And Set – Processing Primitives – List Comprehensions – File Handling – Object Model Including Variables, Reference Counting, Copying, and Type Checking – Error Handling Iterative Statement- Conditional Statement – Operators – Arrays Libraries- Library - GUI Development.

UNIT – IV EMBEDDED PYTHON PROGRAMMING 9

GPIO Programming – Numerical Library- Communication Library- Image Processing – Machine Learning.

UNIT – V APPLICATIONS 9

Automotive – Mobile Robotics - IOT- Factory Automation - Home Automation.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO1: Select the Single board computers for mechatronics system development
CO2: Access the library and functions for Real time operating system
CO3: Write the python programming for various applications
CO4: Use the GPIO and peripherals using embedded based python programming
CO5: Develop the application in SBC using python programming.

Mapping of COs with POs and PSOs

COs/POs &PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1	1								1	1	2	3
CO2	3	2	1	1								1	1	2	3
CO3	3	2	1	1								1	1	2	3
CO4	3	2	1	1								1	1	2	3
CO5	3	2	1	1								1	1	2	3
CO/PO & PSO Average	3	2	1	1								1	1	2	3

1 – Slight, 2 – Moderate, 3 – Substantial

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REFERENCES:
1. David Beazley and Brian K. Jones, “Python Cookbook”, O'Reilly Media, 2014
2. Gabriele Manduchi and Ivan CibrarioBertolotti, “Real-Time Embedded Systems: Open-Source Operating Systems”, CRC Press, 2017.
3. Guttag, John. “Introduction to Computation and Programming Using Python”, MIT Press, 2021.
4. NinadSathaye, “Learning Python Application Development”, Packt Publishing, 2016
5. Sai Yamanoor, Srihari Yamanoor, “Raspberry-Pi Mechatronics Projects”, Packt Publishing, 2016.
6. Warren Gay, “Mastering the Raspberry Pi”, A press, 2017.

RO5008	**SMART MOBILITY AND INTELLIGENT VEHICLES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

The objectives of the course are:

1. To introduce students to the various technologies and systems used to implement smart mobility and intelligent vehicles.
2. To learn Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, LIDAR Sensor Technology and Systems and other sensors for automobile vision system.
3. To learn Basic Control System Theory applied to Autonomous Automobiles.
4. To produce overall impact of automating like various driving functions, connecting the automobile to sources of information that assist with a task
5. To allow the automobile to make autonomous intelligent decisions concerning future actions of the vehicle that potentially impact the safety of the occupants through connected car & autonomous vehicle technology

UNIT – I INTRODUCTION TO AUTOMATED, CONNECTED, AND INTELLIGENT VEHICLES **9**

Concept of Automotive Electronics, Electronics Overview, History & Evolution, Infotainment, Body, Chassis, and Powertrain Electronics, Introduction to Automated, Connected, and Intelligent Vehicles. Case studies: Automated, Connected, and Intelligent Vehicles

UNIT – II SENSOR TECHNOLOGY FOR SMART MOBILITY **9**

Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, Lidar Sensor Technology and Systems, Camera Technology, Night Vision Technology, Other Sensors, Use of Sensor Data Fusion, Integration of Sensor Data to On-Board Control Systems

UNIT – III CONNECTED AUTONOMOUS VEHICLE **9**

Basic Control System Theory applied to Automobiles, Overview of the Operation of ECUs, Basic Cyber-Physical System Theory and Autonomous Vehicles, Role of Surroundings Sensing Systems and Autonomy, Role of Wireless Data Networks and Autonomy

UNIT – IV VEHICLE WIRELESS TECHNOLOGY & NETWORKING **9**

Wireless System Block Diagram and Overview of Components, Transmission Systems – Modulation/Encoding, Receiver System Concepts– Demodulation/Decoding, Wireless Networking and Applications to Vehicle Autonomy, Basics of Computer Networking – the Internet of Things, Wireless Networking Fundamentals, Integration of Wireless Networking and On-Board Vehicle Networks

UNIT – V CONNECTED CAR & AUTONOMOUS VEHICLE TECHNOLOGY 9

Connectivity Fundamentals, Navigation and Other Applications, Vehicle-to-Vehicle Technology and Applications, Vehicle-to-Roadside and Vehicle-to-Infrastructure Applications, Autonomous Vehicles - Driverless Car Technology, Moral, Legal, Roadblock Issues, Technical Issues, Security Issues

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO1: Understand the concept of cyber-physical control systems and their application to collision avoidance and autonomous vehicles

CO2: Understand the concept of remote sensing and the types of sensor technology needed to implement remote sensing

CO3: Become familiar with the concept of fully autonomous vehicles

CO4: Understand the basic concepts of wireless communications and wireless data networks

CO 5: Understand the concept of the connected vehicle and its role in automated vehicles

Mapping of COs with POs and PSOs

COs/POs & PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1	1		1						1	2	1	1
CO2	3	2	1	1		1						1	2	1	1
CO3	3	2	1	1		1						1	2	1	1
CO4	3	2	1	1		1						1	2	1	1
CO5	3	2	1	1		1						1	2	1	1
CO/PO & PSO Average	3	2	1	1		1						1	2	1	1
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. "Intelligent Transportation Systems and Connected and Automated Vehicles", 2016, Transportation Research Board
2. Radovan Miucic, "Connected Vehicles: Intelligent Transportation Systems", 2019, Springer

REFERENCES

1. Tom Denton, "Automobile Electrical and Electronic systems, Roultedge", Taylor & Francis Group, 5th Edition, 2018.

RO5009 IMMERSIVE TECHNOLOGIES AND HAPTICS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To identify the terminologies of haptic devices.
2. To understand the structure of haptic system and to aware the tele-operation for various applications.
3. To acquire the knowledge on modelling for haptic system development relevant to the human.
4. To emphasize the significance of knowledge in virtual and augmented reality.
5. To know the concepts and hardware of mixed reality.

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UNIT – I INTRODUCTION TO HAPTICS 8

Definition - Importance of Touch - Tactile Proprioception - Tactual Stereo Genesis - Kinesthetic Interfaces - Tactile Interfaces - Human Haptics - Overview of Existing applications - Basics of Force Feedback Devices - Kinesthetic Vs. Tactile Haptic Devices - Configurations of Kinesthetic Devices -Types of Kinesthetic Devices

UNIT – II KINESTHETIC HAPTIC DEVICES AND TELEOPERATION 10

Mechatronics in Haptics System - Haptic Kinematics - Haptic Dynamics - Existing Kinesthetic Devices - Haptic Device Static Rendering - Haptic Device Dynamic Rendering - Control of Haptic Devices - Stability Analysis of Haptic Devices - Stability Analysis of the Rendered Model -Passivity of the Rendered Model. Types of Sensors - Measurement of Haptic Parameters - Types of Actuators - Types of Transmission - Admittance Type Kinesthetic Device - Admittance Control - Comparison of Impedance and Admittance Type Devices - Genesis of Tele-Operation - Tele-Operation Controllers -Tele-Operator Transparency - Stability Analysis of Tele-operator - Tracking and Transparency - Surface Haptic - Exogenous Force Inputs.

UNIT – III HUMAN HAPTICS ITS PLATFORM 9

Introduction - Types of Haptic Sensing - Active vs. Passive Touch - Mechanoreception- Mechanoreceptive Afferents - Kinesthetic Sensing - Force Sensing and Proprioception- Introduction to Psychophysics - Measurement Thresholds - Laws of Psychophysics - Weber's Law - Fechner's Law - Fitt's Law - Psychophysical Methods of Limit, Constant Stimuli and Adjustment - Introduction to Virtual Reality Modelling Language (VRML) – Open Haptic Platform - OpenGL- Virtual Environment Manager - Modelling of Simple Haptic System.

UNIT – IV VIRTUAL AND AUGMENTED REALITY 9

The Reality – Virtuality Continuum - Virtual Reality Definitions - Software, Hardware, Sensation and Perception - Multi-Modal Interaction Challenges - System Architecture of Virtual Reality. Aspects of Geometrical Modelling and Environmental Modelling General Solution for Calculating Geometric & Illumination Consistency in the Augmented Environment. Usability Guidelines - Design and Implementation of an Immersive User Experience - Case Study for VR and AR.

UNIT – V MIXED REALITY 9

System Architecture of a Mixed Reality System - Common Interaction Techniques for Mixed Reality Environments - Common Navigation Techniques - Common Interface for MR - Menu Design Directions - Haptic Control Panel - Performance of an Interaction Techniques, Advanced Interaction Techniques, Design and Implementation of an Immersive User Experience - Case Study for MR.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO1: Recognize the haptic technology and its concepts in various haptic systems.
CO2: Classify the elements of haptics system and tele-operation in detail.
CO3: Design and use the devices in human haptic applications.
CO4: Combine and build the virtual and augmented reality based models.
CO5: Develop the design and model the hardware of mixed reality.

Mapping of COs with POs and PSOs

COs/POs & PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	1	2		1							2	2	3	1
CO2	2	1	2		1							2	2	3	1
CO3	2	1	2		1							2	2	3	1

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CO4	2	1	2		1							2	2	3	1
CO5	2	1	2		1							2	2	3	1
CO/PO & PSO Average	2	1	2		1							2	2	3	1
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Burdea, G. C. and P. Coffet. "Virtual Reality Technology", 3rd edition, Wiley-Interscience, Hoboken New Jersey, 2012.
2. Eckehard Steinbach et al, "Haptic Communications", Vol. 100, 4:937-956, 2012
3. Hannaford B and Okamura A. M "Haptics: Handbook of Robotics", Springer, pp. 718735, 2008.

REFERENCES

1. Kenneth Salisbury, Francois Conti and Federico Barbagli, "Haptic Rendering: IEEE Computer Graphics and Applications, v24 n2 (200403): 24-32, 2004.
2. Jean-Pierre Bresciani, Knut Drewing and Marc O. Ernst. "Human Haptic Perception and the Design of Haptic-Enhanced Virtual Environments: The Sense of Touch and Its Rendering",STAR 45, pp. 61–106, 2008.
3. MacLean K. E, "Haptic Interaction Design for Everyday Interfaces: Reviews of Human Factors and Ergonomics", 4:149194, 2008.
4. Weir D. W and Colgate J. E "Stability of Haptic Display: Haptic Rendering: Foundations, Algorithms, and Applications". AK Peters, 2008.
5. Sherman, William R. and Alan B. Craig. "Understanding Virtual Reality – Interface, Application, and Design" 2nd edition, Morgan Kaufmann, Cambridge U.S 2019.
6. Yuichi Ohta, Hideyuki Tamura, "Mixed Reality: Merging Real and Virtual Worlds", Springer Verlag, Berlin, 2014.

RO5010 MOTION CONTROL SYSTEM

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To introduce the basics in motion control system
2. To knowledge about on architecture of motion control system
3. To understand the features and specifications in motion control drives
4. To learn about intelligent motors.
5. To inculcate the use motion control technologies including controller, driver and motors.

UNIT – I INTRODUCTION MOTION CONTROL SYSTEMS 9

Introduction to Motion Control System - Dynamic System Modeling - Control System Design Fundamentals – Parameters in Control – Actuators and Measurement in Motion Control Systems -Multi-Body Dynamics – Need for Motion Controller – Specification of Motion Control

UNIT – II ARCHITECTURE OF MOTION CONTROL SYSTEM 9

Introduction to Motion Controller – Programmable Automation Controllers – Features & Specification of Motion Controllers – Digital I/O – Analog I/O – Standards in I/O – I/O Specific to Sensors – Modular and Expansion Concepts - Drives

UNIT – III MOTION CONTROL DRIVES 9

Programmable Automation Controllers – Features & Specification of Motion Controllers – Digital I/O – Analog I/O – Standards in I/O – I/O Specific to Sensors – Modular and Expansion Concepts - Drives

UNIT – IV INTELLIGENT MOTORS WITH INTEGRATED DRIVE 9

Intelligent motors – intelligent drives – features of drives – programmable I/Os- communication

protocols – features – Software - Programming – current, position and speed loops – Application in robots and portable systems

UNIT – V PROGRAMMING OF MOTION CONTROLLER 9

IEC 61131 standards and Its Programming Languages overview- CoDeSys Platform - status Diagram – PLC Open - Motion Planer - PID - Servo Tuning – Position- velocity, Acceleration and Torque Profiling – CAM Profiling – Multi- Axis Motion Controllers – CNC Machines – Robot case study

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO 1: Appreciate the architecture of motion controllers and its features.
CO 2: Realize the hardware and software features of the motion controller.
CO 3: Select the controllers, drivers and motors according to the requirement
CO 4: Build the programmes for various applications
CO 5: Use the motion controller for various applications

Mapping of COs with POs and PSOs

COs/POs& PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1	1								1			3
CO2	3	2	1	1								1			3
CO3	3	2	1	1								1			3
CO4	3	2	1	1								1			3
CO5	3	2	1	1								1			3
CO/PO & PSO Average															

1 – Slight, 2 – Moderate, 3 – Substantial

REFERENCES

1. M. Nakamura .S. Gata & N. Kyura, Mechatronic Servo System Control, Springer, 2004.
2. Sabanovic Asif, Motion Control Systems, John Wiley & Sons Inc, 2011,
3. Model 4000 indexer user Guide, Parker Hannifin Corporation, 1994.
4. 2-Axis Motion Controller User Guide, Parker Hannifin Corporation, 1995.
5. Operating instructions Compax3 T30 Programmable motion control according to IEC61131-3, Parker Hannifin Corporation, 2008.
6. Programming with Easy Motion Studio – User's Manual, online, technosoftmotion.com.
7. Technical Reference, IPOS4808 BX-CAT-STO Intelligent Servo Drive for Step, DC, Brushless DC and AC Motors, Technosoft, 2022.

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RO5011 **MICROROBOTICS** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

1. To expose students to the fundamental aspects of the emerging field of micro robotics.
2. To expose students to micro scale, technologies for fabricating small devices, bio-inspired design, and applications of the field.
3. To expose students to various Mathematical formalism for flexures, Electrostatic actuators, Piezo-electric actuators, Magneto-strictive actuator and other sensors.
4. To apply micro robotics to various applications
5. To engage students in implementation of microrobotics

UNIT – I INTRODUCTION TO MICROROBOTICS 9

Introduction to Micro robotics **-**MST (Micro System Technology) - Micromachining - Working principles of Microsystems Applications of Microsystems - Micro-fabrication principles-Design selection criteria for micromachining - Packaging and Integration aspects - Micro-assembly platforms and manipulators

UNIT – II SCALING LAWS AND MATERIALS FOR MEMS 9

Introduction - Scaling laws - Scaling effect on physical properties scaling effects on Electrical properties - scaling effect on physical forces - Physics of Adhesion - Silicon - compatible material system - Shape memory alloys - Material properties - Piezoresistivity, Piezoelectricity and Thermoelectricity

UNIT – III FLEXURES, ACTUATORS AND SENSORS 9

Elemental flexures - Flexure systems - Mathematical formalism for flexures - Electrostatic actuators - Piezo-electric actuators - Magneto-strictive actuators - Electromagnetic sensors - Optical-based displacement sensors - Motion tracking with microscopes

UNIT – IV MICROROBOTICS 9

Introduction - Task specific definition of micro-robots - Size and Fabrication Technology based definition of micro- robots - Mobility and Functional-based definition of micro-robots - Applications for MEMS based micro-robots.

UNIT – V IMPLEMENTATION OF MICROROBOTS 9

Arrayed actuator principles for micro-robotic applications - Micro-robotic actuators
- Design of locomotive micro-robot devices based on arrayed actuators - Micro-robotics devices - Micro- grippers and other micro-tools - Micro-conveyors - Walking MEMS Micro-robots - Multi-robot system: Micro-robot powering, Micro-robot communication.

TOTAL: 45 PERIODS

The Student will be able to

CO 1: Formulate the specifications and design of mechatronic systems (choice of sensors, actuators, embedded systems)
CO 2: Explain and apply the concepts of mass, energy, and momentum balance.
CO 3: Model design, and optimize energy conversion systems and Industrial processes and experimentally the steady-state or dynamic response of solids and fluids.
CO 4: Apply adapt, and synthesize learned engineering skills to create novel solutions.
CO 5: Expound and Iterate multiple design concepts based on the models and simulations in scientific terms and apply the principles of tribology and contact mechanics.

Mapping of COs with POs and PSOs

COs/POs & PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1	1	2							1	2	1	3
CO2	3	2	1	1	2							1	2	1	3
CO3	3	2	1	1	2							1	2	1	3

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CO4	3	2	1	1	2							1	2	1	3
CO5	3	2	1	1	2							1	2	1	3
CO/PO & PSO Average	3	2	1	1	2							1	2	1	3
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS:

1. Mohamed Gad-el-Hak , "The MEMS Handbook", 2nd Edition, CRC Press, New York, 2019.
2. Yves Bellouard, "Microrobotics Methods and Applications", CRC Press, Massachusetts, 2019.

REFERENCES:

1. NadimMaluf and KirtWilliams, "An Introduction to Microelectromechanical systems Engineering", 2nd edition, Artech House, 2004.
2. Julian W Gardner, "Microsensors: Principles and Applications", 2nd edition, Wiley, 2007.
3. MetinSitti, "Mobile Microrobotics", MIT Press, 2017.
4. Nicolas Chaillet, Stephane Rangier, "Microrobotics for Micromanipulation", John Wiley & Sons, 2013.

RO5012 CNC MACHINE TOOLS AND PROGRAMMING

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. Explain the mechanics of metal cutting and the factors affecting machinability
2. Explain the working of basic and advanced turning machines.
3. Teach the basics of machine tools with reciprocating and rotating motions and abrasive finishing processes.
4. Explain the constructional features of CNC machine tools.
5. Explain the basics of CNC programming and the machine tools through planning, writing codes and ,setting up CNC machine tools

UNIT I MECHANICS OF METAL CUTTING 9

Mechanics of chip formation, forces in machining, types of chip, cutting tools – Single point cutting tool nomenclature, orthogonal and oblique metal cutting, thermal aspects, cutting tool materials, tool wear, tool life, surface finish, cutting fluids and Machinability.

UNIT II TURNING MACHINES 9

Centre lathe, constructional features, specification, operations – taper turning methods, thread cutting methods, special attachments, surface roughness in turning, machining time and power estimation. Special lathes - Capstan and turret lathes - tool layout – automatic lathes: semi-automatic – single spindle: Swiss type, automatic screw type – multi spindle

UNIT III RECIPROCATING MACHINE TOOLS 9

Reciprocating machine tools: shaper, planer, slotter: Types and operations- Hole making: Drilling, reaming, boring, tapping, type of milling operations-attachments- types of milling cutters– machining time calculation - Gear cutting, gear hobbing and gear shaping – gear finishing methods Abrasive processes: grinding wheel – specifications and selection, types of grinding process – cylindrical grinding, surface grinding, centreless grinding, internal grinding - micro finishing methods

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UNIT IV CNC MACHINES 9

Computer Numerical Control (CNC) machine tools, constructional details, special features – Drives, Recirculating ball screws, tool changers; CNC Control systems – Open/closed, point-to-point/continuous - Turning and machining centers - Work holding methods in Turning and machining centers, Coolant systems, Safety features.

UNIT V PROGRAMMING OF CNC MACHINE TOOLS 9

Coordinates, axis and motion, Absolute vs Incremental, Interpolators, Polar coordinates, Program planning, G and M codes, Manual part programming for CNC machining centers and Turning centers – Fixed cycles, Loops and subroutines, Setting up a CNC machine for machining.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO1 Analyse the mechanics of metal cutting process and to identify the factors involved in improving machinability.

CO2 Understand the constructional features and working principles of basic and advanced turning machines.

CO3 Evaluate and select suitable machining operation to manufacture a given component.

CO4 Understand the constructional features and working principles of CNC machine tools.

CO5 Program CNC machine tools through planning, writing codes and setting up CNC machine tools to manufacture a given component.

Mapping of COs with POs and PSOs															
COs/POs & PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	2	1	1							1	1	1	3	1
CO2	2	2	1	1							1	1	1	3	1
CO3	2	2	1	1							1	1	1	3	1
CO4	2	2	1	1							1	1	1	3	1
CO5	2	2	1	1							1	1	1	3	1
CO/PO & PSO Average	2	2	1	1							1	1	1	3	1
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXTBOOKS:

1. Kalpakjian. S, “Manufacturing Engineering and Technology”, Pearson Education 8th Edition, 2022.
2. Michael Fitzpatrick, “Machining and CNC Technology”, McGraw-Hill Education;4th edition, 2019.

REFERENCES:

1. Roy. A. Lindberg, “Processes and materials of manufacture”, Pearson India Education Services Pvt. Ltd, 4th edition, 2015.
2. GeofreyBoothroyd, “Fundamentals of Metal Machining and Machine Tools”, McGraw Hill, 2005.
3. Rao. P.N, “Manufacturing Technology Volume 2, Metal Cutting and Machine Tools”, McGraw- Hill, New Delhi, 3rd edition, 2018.
4. Peter Smid, “CNC Programming Handbook”, Industrial Press Inc., 3rd edition, 2007.
5. A. B. Chattopadhyay, “Machining and Machine Tools”, Wiley, 2nd edition, 2017.

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RO5013	AUTOMOTIVE MECHATRONICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. The intention and purpose of this course is to study the basics of electronics, emission controls and its Importance in automobiles.
2. To study the Ignition and Injection system in Automobiles
3. To study the various sensors and actuators used in automobiles for improving fuel economy and emission control.
4. To study the various blocks of mechatronic control units used for control of fuel, ignition and exhaust systems.
5. To learn about different types of chassis and mechatronics safety systems in automobile

UNIT – I INTRODUCTION 8

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 10

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 IN AUTOMOTIVES 7

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, and vacuum operated actuator.

UNIT – IV ENGINE CONTROL SYSTEMS 10

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 10

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.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO1: Know the importance of emission standards in automobiles.

CO2: Understand the electronic fuel injection/ignition components and their function.

CO3: Choose and use sensors and equipment for measuring mechanical quantities, temperature and appropriate actuators.

CO4: Diagnose electronic engine control systems problems with appropriate diagnostic tools.

CO5: Analyze the chassis and vehicle safety system.

Mapping of COs with POs and PSOs

CO/POs & PSO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1	1	1							1	1	2	1
CO2	3	2	1	1	1							1	1	2	1
CO3	3	2	1	1	1							1	1	2	1

CO4	3	2	1	1	1							1	1	2	1
CO5	3	2	1	1	1							1	1	2	1
CO/PO & PSO Average	3	2	1	1	1							1	1	2	1
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Ribbens, "Understanding Automotive Electronics", 8th Edition, Elsevier, Indian Reprint, 2017.

REFERENCES

1. Barry Hollembeak, “Automotive Electricity, Electronics & Computer Controls”, Delmar Publishers, 7th edition, 2019.
2. Richard K. Dupuy “Fuel System and Emission controls”, Check Chart Publication,4th edition, 2000.
3. Ronald. K. Jurgon, “Automotive Electronics Handbook”, McGraw-Hill, 1999.
4. Tom Denton, “Automobile Electrical and Electronics Systems”, Edward Arnold Publishers, 2000.

RO5014 ROBOT OPERATING SYSTEM

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To introduce Robot Operating System (ROS) and programming
2. To develop the Robot environment
3. To obtain the simulation robots in ROS with GAZEBO
4. To simulate robots with V-Rep
5. 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

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UNIT – V MAPPING, NAVIGATION AND MOTION PLANNINGROS 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 - ROS with Industrial

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

1. Understand the concept of ROS and programming.
2. Develop the Robot environment for simulation.
3. Simulate robots in ROS with GAZEBO
4. Simulate robots with V-Rep
5. Understand mapping, navigation and motion planning ROS with Move-it.

Mapping of COs with POs and PSOs															
COs/POs & PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	1	1	2							1	1	2	1	2
CO2	2	1	1	2							1	1	2	1	2
CO3	2	1	1	2							1	1	2	1	2
CO4	2	1	1	2							1	1	2	1	2
CO5	2	1	1	2							1	1	2	1	2
CO/PO & PSO Average	2	1	1	2							1	1	2	1	2
1 – Slight, 2 – Moderate, 3 – Substantial															

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 Robotics Programming Made Easy”, Second Edition, Apress, 2022.
2. Lentin Joseph, “ROS Robotics Projects”, Packt publishing, 2017

ME5081 PROCESS PLANNING AND COST ESTIMATION L T P C
3 0 0 3

COURSE OBJECTIVES:

The main learning objectives of this course are to:

1. Elucidate the steps involved in preparing a process plan for a given Product.
2. Provide an overview for costestimation of a given product.
3. Explain the allocation of overhead costs in manufacturing.
4. Elucidate the procedure to estimate the cost ofcastings and forging products.
5. Explain the costs involved in machining and estimate the machining cost.

UNIT I PROCESS PLANNING 9

Defining process planning –Drawing interpretation –Material selection process and methods – Selection of Production Processes from Tables – Selection of Process Parameters from Tables–

Factors to be considered in selecting: Processes; Process Sequencing; Operation Sequencing; Equipment & Tool Selection; Tool Holding Devices; Measuring Instruments –Computer Aided Process Planning – Retrieval / Variance CAPP and Generative CAPP - Case Study in Process Planning.

UNIT II FUNDAMENTAL OF ESTIMATING AND ELEMENTS OF COST 9

Concept and Purpose of Estimating, Functions of Estimating Department, Concept of Costing, Costing versus Estimating, Types of Estimates, Importance of Estimates, Estimating Procedure, Cost Estimators and their Qualifications, Principal Constituents in a Cost Estimate – Elements of Cost – Introduction, Material Cost, Labour Cost, Expenses and Cost of Product (Ladder Cost).

UNIT III OVERHEADS AND DEPRECIATION 9

Overheads , Allocation or Distribution of Overhead Cost , Depreciation and Methods to Calculate it, Interest on Capital, Idleness Costs, Repair and Maintenance Cost

UNIT IV ESTIMATION OF CASTING, FORGING & WELDING COSTS 9

Estimation of cost for Casting processes, Welding processes and Forging processes.

UNIT V ESTIMATION OF MACHINING TIME AND COST 9

Estimation of Machining Time and Cost – Lathe operations, Drilling, Milling, Shaping Planing, and Grinding operations.

TOTAL = 45 PERIODS

COURSE OUTCOMES:

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

1. Create a Process Plan for a given Product.
2. Identify Cost elements for a given Product.
3. Allocate Overhead to different departments in manufacturing a product.
4. Estimate cost for Casting and Forging products.
5. Analyze the costs for machining a product

TEXT BOOKS:

1. Adithan, M, Process Planning and Cost Estimation, New Age International Publishers, 2007.
2. Peter Scallan, Process planning, The Design/Manufacture Interface, Butterworth-Heinemann, 2003.

REFERENCES:

1. Chitale A. K., and Gupta R. C., “Product Design and manufacturing”, Prentice Hall of India, New Delhi, 1997.
2. Gideon Halevi, “Process and operation planning”, Kluwer academic publishers (Printed ebook), 2003.
3. Narang G.B.S. & Kumar .V, “Production and Costing”, Khanna Publishers, 2000.
4. Phillip F. Ostwald & Jairo Munoz, “Manufacturing Processes And Systems”, 9th Edition, Wiley student edition, 2002.
5. Robert Creese, Adithan M. &Pabla B. S., “Estimating and Costing for the Metal Manufacturing Industries”, Marcel Dekker, 1992.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	2	2	1	1	1	1		1	1	2	2	2
2	3	3	2	1		1	1	1	1		1	1	2	2	2
3	3	3	2	2		1	1	1			1	1	2	2	1
4	3	3	2	2		1	1	1			1	1	2	2	1
5	3	3	2	2		1	1	1			1	1	2	2	1

MF5005 ELECTRONICS MANUFACTURING TECHNOLOGY L T P C
3 0 0 3

COURSE OBJECTIVES:

- To impart knowledge on wafer preparation and PCB fabrication
- To introduce Through Hole Technology (THT) and Surface Mount Technology (SMT) with various types of electronic components
- To elaborate various steps in Surface Mount Technology (SMT)
- To be acquainted with various testing and inspection methods of populated PCBS
- To outline repair, rework and quality aspects of Electronic assemblies.

UNIT I INTRODUCTION TO ELECTRONICS MANUFACTURING 9

History, definition, wafer preparation by growing, machining, and polishing, diffusion, microlithography, etching and cleaning, Printed circuit board –fabrication, types, single sided, double sided, multi-layer and flexible printed circuit board

UNIT II COMPONENTS AND PACKAGING 9

Introduction to packaging, types-Through hole technology(THT) and Surface mount technology (SMT), Through hole components – axial, radial, multi leaded, odd form
Surface-mount components- active, passive. Interconnections - chip to lead interconnection, die bonding, wire bonding, TAB, flip chip, chip on board, multi chip module, direct chip array module, leaded, leadless, area array and embedded packaging, miniaturization and trends.

UNIT III SURFACE MOUNT TECHNOLOGY 9

SMT Process, SMT equipment and material handling systems, handling of components and assemblies - moisture sensitivity and ESD, safety and precautions needed, IPC and other standards, stencil printing process - solder paste material, storage and handling, stencils and squeegees, process parameters, quality control. Component placement- equipment type, flexibility, accuracy of placement, throughput, packaging of components for automated assembly, soldering- wave soldering, reflow process, process parameters, profile generation and control, adhesive, underfill and encapsulation process

UNIT IV INSPECTION AND TESTING 9

Inspection techniques, equipment and principle- AOI, X-ray. Defects and Corrective action - stencil printing process, component placement process, reflow soldering process, electrical testing of PCB assemblies- In circuit test, functional testing, fixtures and jigs.

UNIT V REPAIR, REWORK, QUALITY AND RELIABILITY OF ELECTRONICS ASSEMBLIES 9

Repair and rework of PCB- Coating removal, base board repair, conductor repair, thermo-mechanical effects and thermal management, Reliability fundamentals, reliability testing, failure analysis, design for manufacturability, assembly, reworkability, testing, reliability, and environment.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students should be able to:

- CO1: Perceive wafer preparation and PCB fabrication
- CO2: Recognize the importance of Through Hole Technology (THT) and Surface Mount Technology (SMT)
- CO3: Demonstrate various steps in Surface Mount Technology (SMT)
- CO4: Identify various testing and inspection methods of populated PCBS
- CO5: Discuss various techniques in repair, rework, quality and reliability of electronics Assemblies

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	0.9											0.6	0.3	0.3	0.6
2	0.9											0.6	0.3	0.3	0.3
3	0.9		0.3									0.6	0.6	0.6	0.6
4	0.9		0.3			0.3						0.6	0.6	0.6	0.6
5	0.9		0.3			0.6	0.3					0.6	0.6	0.9	0.9

TEXT BOOKS:

1. Prasad R., "Surface Mount Technology – Principles and practice",2nd Edition, Chapman and Hall., New York, 1997, ISBN 0-41-12921-3.
2. Tummala R.R., "Fundamentals of microsystem packaging", Tata *McGraw Hill* Co. Ltd., New Delhi, 2001, ISBN 00-71-37169-9.

REFERENCES:

1. Harper C.A., "Electronic Packaging and Interconnection Handbook" 2nd Edition, McGraw Hill Inc., New York, N.Y., 1997, ISBN 0-07-026694-8.
2. Lee N.C., "Reflow Soldering Process and Trouble Shooting SMT, BGA, CSP and Flip Chip Technologies", Elsevier Science. United Kingdom, 2001.
3. Puligandla Viswanadham and Pratap Singh., "Failure Modes and Mechanisms in Electronic Packages", Chapman and Hall., New York, 1997, N.Y. ISBN 0-412-105591-8. Science and Technology, United Kingdom, 1997, ISBN 0750698756.
4. Totta P., Puttlitz K. and Stalter K., "Area Array Interconnection Handbook", Kluwer Academic Publishers, Norwell, MA, United States, 2001, ISBN 0-7923-7919-5.
5. Zarrow P. and Kopp D., "Surface Mount Technology Terms and Concepts", Elsevier, 1997.

BM5010 BRAIN COMPUTER INTERFACE AND APPLICATIONS L T P C

3 0 0 3

OBJECTIVES:

- To understand the basic concepts of brain computer interface
- To study the various signal acquisition methods
- To study the signal processing methods used in BCI

UNIT I INTRODUCTION TO BCI 9

Fundamentals of BCI – Structure of BCI system – Classification of BCI – Invasive, Non-invasive and Partially invasive BCI – EEG signal acquisition - Signal Preprocessing – Artifacts removal.

UNIT II ELECTROPHYSIOLOGICAL SOURCES 9

Sensorimotor activity – Mu rhythm, Movement Related Potentials – Slow Cortical Potentials- P300 - Visual Evoked Potential - Activity of Neural Cells - Multiple Neuromechanisms.

UNIT III FEATURE EXTRACTION METHODS 9

Time/Space Methods – Fourier Transform, PSD – Wavelets – Parametric Methods – AR,MA,ARMA models – PCA – Linear and Non-Linear Features.

UNIT IV FEATURE TRANSLATION METHODS 9

Linear Discriminant Analysis – Support Vector Machines - Regression – Vector Quantization– Gaussian Mixture Modeling – Hidden Markov Modeling – Neural Networks.

UNIT V APPLICATIONS OF BCI **9**

Functional restoration using Neuroprosthesis - Functional Electrical Stimulation, Visual Feedback and control - External device control, Case study: Brain actuated control of mobile Robot.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Describe BCI system and its potential applications.
CO2: Analyze event related potentials and sensory motor rhythms.
CO3: Compute features suitable for BCI.
CO4: Design classifier for a BCI system.
CO5: Implement BCI for various applications.

TEXT BOOKS:

1. R. Spehlmann, "EEG Primer", Elsevier Biomedical Press, 1981.
2. Bernhard Graimann, Brendan Allison, Gert Pfurtscheller, "Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction", Springer, 2010.

REFERENCES:

1. Arnon Kohen, "Biomedical Signal Processing", Vol I and II, CRC Press Inc, Boca Rato, Florida, 1986.
2. Bishop C.M., "Neural Networks for Pattern Recognition", Oxford, Clarendon Press, 1995.

COURSE OUTCOMES	PROGRAMME OUTCOMES											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			√	√	√	√	√	√	√			√
CO2			√	√	√	√	√	√	√			√
CO3			√	√	√	√	√	√	√	√	√	√
CO4			√	√	√	√	√	√	√	√	√	√
CO5			√	√	√	√	√	√	√	√	√	√

RO5015 MULTI-BODY DYNAMICS **L T P C**
3 0 0 3

COURSE OBJECTIVES:

1. To understand the important concepts of multi-body dynamics
2. To familiar the various computational methods multi-body dynamics.
3. To characterize the nonlinear concepts of multi-body dynamics.
4. To recognize the need of control in nonlinear dynamics multi body interactions.
5. To interpret the nonlinear dynamics of multi body systems and its realization of control.

UNIT – I INTRODUCTION TO DYNAMICS **9**

Importance of Multibody Dynamics - Particle Mechanics - Rigid Body Mechanics - Deformable Bodies - Constrained Motion- -Kinematics - Rotation - Translation - Velocity- Acceleration Equations – Mechanics of Deformable Bodies - Floating Frame Reference Formulation – Inertia - Generalized Forces - Equation of Motions - Multi Body Systems - Sub Systems - Friction and Spring Nonlinear Model - Nonlinear Dynamic Equations Formulation

UNIT – II COMPUTATIONAL METHODS FOR DYNAMIC ANALYSIS 9

Jacobian Matrix - Newton-Rasphon Method - Nonlinear Kinematic Constrain Equation – System Mass Matrix - External and Elastic Forces - Acceleration Vector – Lagrangian Multiplier - Langrage's Equation – Kinetic Energy – Hamilton Equation - Hamilton vector Field- Euler - Langrage Equation- Generalized Reaction Forces – State Vector and Equation Formulation.

UNIT – III NONLINEAR SYSTEMS AND CONCEPTS 8

Linear Time Varying and Linearization – Input and Output Stability - Lyapunov Stability Analysis – Asymptotic Stability - Popov's and Circle Criterion - Perturbed System – Chaos – Periodic Orbits- Index theory and Limit Cycle – Center Manifold Theory- Normal Forms- Nonlinear analysis- Poincare Maps - Bifurcations – Maps - Vector Fields - Methods – Control System Design using Lyapunov's Direct Method

UNIT – IV SYSTEM CHARACTERIZATION 8

Stability, Controllability, Observability - Phase Plane Analysis - Phase Portrait - Limit Cycle - Describing Function - Assumption – Limit Cycles

UNIT – V CONTROL OF NONLINEAR MECHANICAL SYSTEMS 10

Double Inverted Pendulum – Nonlinear Machineries – Robots - Suspension System - Aircraft.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO1: Use the important concepts in multi-body dynamics.

CO2: Formulate mathematical model for capturing the dynamics of multi-body interactions.

CO3: Describe the nonlinear behavior of multi-body dynamics

CO4: Practice the control in nonlinear dynamics of multi body interactions.

CO5: Demonstrate control for the nonlinear behavior of multi body systems.

Mapping of COs with POs and PSOs

COs/POs & PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	3	2	2							2	2	2	3	1
CO2		3	2	2							2	2	2	3	1
CO3		3	2	2							2	2	2	3	1
CO4		3	2	2							2	2	2	3	1
CO5	2	3	2	2							2	2	2	3	1
CO/PO & PSO Average	2	3	2	2							2	2	2	3	1
1 – Slig2ht, 2 – Moderate, 3 – Substantial															

REFERENCES

1. Ahmed A. Shabana, "Dynamics of Multibody Systems", Cambridge University Press, 2013.
2. Brian L. Stevens, Frank L. Lewis, "Aircraft Control and Simulation", Wiley India Pvt Ltd, 2010.
3. Hasan Khalil, "Nonlinear Systems and Control", Prentice Hall, 2002.
4. Mahmut Reyhanoglu, "Dynamics and Control of a Class of Under Actuated Mechanical Systems", IEEE Transactions on Automatic Control, 44(9), 1999.
5. Stephen Wiggins, "Introduction to Applied Nonlinear Dynamics System and Chaos", SpringerVerlag, 2000.
6. Wei Zhong and Helmut Rock, "Energy and Passivity Based Control of the Double Inverted Pendulum on a Cart", IEEE, 2001

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RO5016	COMPUTER VISION AND DEEP LEARNING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To familiar the fundamentals of image processing and functioning of camera.
2. To appreciate 3 dimensional structure and motions.
3. To learn the visual servicing for robotic applications
4. To understand the fundamentals of Neural network
5. To appreciate and develop the deep learning networks for image processing

UNIT – I IMAGE FORMATION AND CAMERA CALIBRATION 9

Basics: Sampling Theorem – Numerical Differentiation – Singular Value Decomposition Introduction to Vision, Terminologies of Fields, Comparison of Biological and Computer Vision, Projective Geometry Basics, Modelling of Geometric Image Formation, Modelling of Camera Distortion, Camera Calibration, Methods of Camera Calibration, Estimation of Projection Matrix, Experimental Performance Assessment in Computer Vision.

UNIT – II 3-D STRUCTURE AND MOTION 9

Computational Stereopsis – Geometry, Parameters – Correspondence Problem, Epipolar Geometry, Essential Matrix And Fundamental Matrix, Eight Point Algorithm – Reconstruction by Triangulation, Visual Motion – Motion Field of Rigid Objects – Optical Flow – Estimation of Motion Field – 3D Structure and Motion from Sparse and Dense Motion Fields – Motion Based Segmentation – Image Processing.

UNIT – III ACTIVE AND ROBOT VISION 8

LIDAR - Construction, Working Principle, Specifications and Selection Criteria. Point Cloud Data Processing. Visual Tracking – Kalman Filtering – Visual SLAM, Solutions, Visual Servoing, Types and Architecture.

UNIT – IV INTRODUCTION TO NEURAL NETWORKS 8

Introduction to Neural Networks, Philosophy and Types of Networks, Back propagation, Numerical Problems for Back Propagation, Multi-Layer Perceptrons, Numerical Problems Based on Perceptron, Conventional Neural Networks vs. Deep Learning in the Context of Computer Vision, Loss Function, Optimization, Higher-Level Representations, Image Features, Stochastic Gradient Descent

UNIT – V DEEP LEARNING 10

Convolutional Neural Networks - Convolution, Pooling, Activation Functions, Initialization, Dropout, Batch Normalization, Deep Learning Hardware - CPU, GPU and TPU -Tuning Neural Networks, Best Practices, Training Neural Networks, Update Rules, Ensembles, Data Augmentation, Transfer Learning, Popular CNN Architectures for Image Classification – Alexnet, VGG, Resnet, , Inception, CNN Architectures for Object Detection – RCNN and Types – Yolo - Semantic Segmentation - FCN, Instance Segmentation - Mask RCNN – Deep Learning frameworks.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO1: Process and practice the basic images.
CO2: Develop the 3-Dimensional structures and motions.
CO3: Model the visual serving for robotic applications
CO4: Acquire and practice the basic neural networks.
CO5: Develop and train the deep learning networks for image processing.

Mapping of COs with POs and PSOs															
COs/POs & PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	1	2		1							2	2	3	1
CO2	2	1	2		1							2	2	3	1
CO3	2	1	2		1							2	2	3	1
CO4	2	1	2		1							2	2	3	1
CO5	2	1	2		1							2	2	3	1
CO/PO & PSO Average	2	1	2		1							2	2	3	1
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOK

1. Boguslaw Cyganek, J. Paul Siebert, “An Introduction to 3D Computer Vision Techniques and Algorithms”, 2nd edition, John Willey, 2017.
2. Davies E.R, “Computer and Machine Vision: Theory, Algorithm, Practicalities”, 4th edition Academic Press, Elsevier, Waltham 2012.
3. Emanuele Trucco, Alessandro Verri, “Introductory Techniques for 3D Computer Vision”, Prentice Hall, South Asia, 2006.

REFERENCES

1. Rafael C. Gonzales, Richard.E.Woods, “Digital Image Processing”, 3rd edition, Gatesmark Publishing, Tenessee 2020.
2. Emanuele Trucco, Alessandro Verri, “Introductory Techniques for 3D Computer Vision”, Prentice Hall, 1998.
3. Ian Goodfellow and YoshuaBengio and Aaron Courville, “Deep Learning”, First Edition, MIT Press, 2018.
4. Forsyth and Ponce, “Computer Vision: A Modern Approach”, 2nd edition Pearson, Harlow Uk 2015.

RO5017 AGRICULTURAL AUTOMATION

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To learn about Farming related Machines.
2. To understand the global position and information system in machines.
3. To know about traction and testing
4. To familiarize the concept on weed management
5. 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

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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.

TOTAL: 45 PERIODS

COURSE OUTCOMES

The Student will be able to

CO 1: Design robot for agriculture purposes.
CO 2: Integrate sensor and system for required agricultural applications.
CO 3: Develop suitable testing and tracking devices.
CO 4: Implement suitable Weed Management system.
CO 5: Develop and select suitable machinery for specific tasks.

Mapping of COs with POs and PSOs

COs/POs & PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	2	3		2	1						2	2	1	3
CO2	1	2	3		3	1						2	2	1	3
CO3	1	2	3		2	1						2	2	1	3
CO4	1	2	3		2	3						2	2	1	3
CO5	1	2	3		2	1						2	2	1	3
CO/PO & PSO Average	1	2	3		2.2	1.4						2	2	1	3
1 – Slight, 2 – Moderate, 3 – Substantial															

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.

REFERNCE BOOKS:

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.

RO5018	AUTOMOTIVE SYSTEM MODELLING AND SIMULATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To understand the various steps involved in the design of automotive components
2. To show their knowledge in designing engine components.
3. To complete design exercise and arrive at important dimensions of chassis components.
4. To learn the use of standard practices in design.
5. To determine the dimensions of front and rear axles

UNIT – I DESIGN OF CYLINDER, PISTON AND CONNECTING ROD 10

Choice of material for cylinder and piston, design of cylinder, design of piston, piston pin, piston rings and piston assembly. Material for connecting rod, design of connecting rod assembly. Case study on piston for car with Modelling and simulation.

UNIT – II DESIGN OF CRANK SHAFT AND VALVES 9

Material for crankshaft, design of crankshaft under bending and twisting. Design aspects of intake & exhaust manifolds, inlet & exhaust valves, valve springs, tappets and valve train. Design of cam& camshaft. Design of rocker arm. Cam profile generation. 3D Engine simulation: Introduction to thermal and flow analysis in engine cylinder, modeling of cylinder and piston for combustion analysis

UNIT – III DESIGN OF CLUTCHES AND GEARS 10

Design of single plate clutch, multi plate clutch and cone clutch assembly. Torque capacity of clutch. Design of clutch components. Gear train calculations, layout of gearboxes. Calculation of bearing loads and selection of bearings. Design of three speed and four speed gearboxes. Modelling and simulation: braking system

UNIT – IV DESIGN OF VEHICLE FRAME AND SUSPENSION 6

Study of loads-moments and stresses on frame members. Design Of frame for passenger and commercial vehicle - Design of leaf Springs-Coil springs and torsion bar springs. Case study on development of frame for ATV. Modelling and simulation of suspension system

UNIT – V DESIGN OF FRONT AND REAR AXLE 10

Design of propeller shaft. Design details of final drive gearing. Design details of full floating, semi-floating and three quarter floating rear shafts and rear axle housings. Analysis of loads-moments and stresses at different sections of front axle. Determination of optimum dimensions and proportions for steering linkages, Design of front axle beam.. Modelling and simulation of steering system, transmission system

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO1: Analyse the stress and strain imparted on automotive components.

CO2: Compute the design and find the dimension of the vehicle components.

CO3: Identify optimal design solutions to real-world problems in compliance with industry standards.

CO4: Demonstrate the design skill by creating new design strategy with the application of the knowledge

CO5: Interpret the modern system in vehicle and would help in developing the system with less impact to the environment.

Mapping of COs with POs and PSOs															
COs/POs & PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	1		1						1	1	2	3
CO2	3	2	1	1		1						1	1	2	3
CO3	3	2	1	1		1						1	1	2	3
CO4	3	2	1	1		1						1	1	2	3
CO5	3	2	1	1		1						1	1	2	3
CO/PO & PSO Average	3	2	1	1		1						1	1	2	3
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS:

1. Giancarlo Genta, Lorenzo Morello, “The Automotive Chassis Volume 1, Components Design”, Springer International Edition, 2nd edition,2020
2. Khurmi. R.S. & Gupta. J.K., "A text book of Machine Design", Eurasia Publishing House (Pvt) Ltd, 25th edition, 2022.
3. Alec Stokes, “Manual gearbox design”, Butterworth-Heinemann 1992.

REFERENCES:

1. “Design Data Hand Book”, PSG College of Technology, Coimbatore, 2020.
2. Dean Averns, "Automobile Chassis Design", Il life Book Co., 2009.
3. Kolchin-Demidov , “Design of Automotive Engines”-Mir Publishers, 1984.
4. Lukin P G G and Rodionov V, “Automobile Chassis Design and Calculations”, Mir Publishers, Moscow, 1989.
5. Robert C. Juvinall and Kurt M. Marshek, “Fundamentals of Machine component Design”, 6th Edition, Wiley, 2017.

RO5019	**CONDITION MONITORING AND FAULT DIAGNOSTICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

1. To Understand the basics of various condition monitoring methods.
2. To Identify the selection of condition monitoring sensors for various applications.
3. To study various signal processing for condition monitoring applications.
4. To Know about various failure analysis, maintenance and machine learning.
5. To provide a basic understanding with case studies on different fault diagnosis method.

UNIT – I CONDITION MONITORING TECHNIQUES AND MACHINE CONDITION MONITORING **9**

Condition Monitoring in manufacturing industries; Noise monitoring, Wear and debris Analysis, Thermography, Cracks monitoring, Ultrasonic techniques - Case studies. Vibration, Acoustic emission and vibro-acoustics signal analysis; intelligent fault detection system, Case studies.

UNIT – II SENSORS FOR FAULT DIAGNOSTICS **9**

Introduction - Contaminant monitoring sensors- Corrosion monitoring sensors - Force monitoring sensors - Gas leakage monitoring - sensors Air pollution monitoring sensors - Liquid contamination monitoring sensors - Non-destructive testing techniques - Optical examination - Temperature sensing

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UNIT – III SIGNAL PROCESSING AND ANALYSIS 9

Study of periodic and random signals, probability distribution, statistical properties, auto and cross correlation and power spectral density functions. Time domain and Frequency domain and Time-frequency domain analysis.

UNIT – IV FAILURE ANALYSIS, MAINTENANCE AND MACHINE LEARNING 9

Maintenance Principles, Failure mode analysis - Equipment down time analysis – Breakdown analysis - condition based maintenance, Vibration, Acoustic emission and vibrio-acoustics signal analysis; intelligent fault detection system, Case studies.

UNIT – V MONITORING SYSTEMS CASE STUDEIS 9

Introduction - Marine monitoring systems - Marine turbine monitoring systems - Shipboard vibration monitoring - Monitoring integrity verification - Aircraft condition monitoring - Condition monitoring - generating plant - Automotive diagnostic equipment - Systematic fault monitor selection

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

1. Understand the basics of various condition monitoring methods.
2. Select suitable condition monitoring sensors for various applications.
3. Recall various signals processing for condition monitoring applications.
4. Know about various failure analysis, maintenance and machine learning.
5. Apply different fault diagnosis method for various applications.

Mapping of COs with POs and PSOs

COs/POs & PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1	2	1						1	3	3	2	3
CO2	3	2	1	2	1						1	3	3	2	3
CO3	3	2	1	2	1						1	3	3	2	3
CO4	3	2	1	2	1						1	3	3	2	3
CO5	3	2	1	2	1						1	3	3	2	3
CO/PO & PSO Average	3	2	1	2	1						1	3	3	2	3

1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOKS

1. R. A. Collacott, “Mechanical Fault Diagnosis and condition monitoring”, Springer, 2011.Chapman and Hall London A Halstead Press Book John Wiley & Sons, New York

REFERENCES

1. W.H. Tang, Q.H. Wu ,“Condition Monitoring and Assessment of Power Transformers Using Computational Intelligence”, Springer, 2011.

RO5020	MICRO ELECTRO MECHANICAL SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To provide knowledge of semiconductors and solid mechanics to fabricate MEMS devices.
2. To educate on the rudiments of Micro fabrication techniques.
3. To introduce various sensors and actuators
4. To introduce different materials used for MEMS
5. To educate on the applications of MEMS to disciplines beyond Electrical and Mechanical engineering.

UNIT – I INTRODUCTION 9

Intrinsic Characteristics of MEMS – Energy Domains and Transducers- Sensors and Actuators –Introduction to Micro fabrication - Silicon based MEMS processes – New Materials – Review of Electrical and Mechanical concepts in MEMS – Semiconductor devices –Polymers in MEMS– Polyamide - SU-8 - Liquid Crystal Polymer (LCP) – PDMS – PMMA – Parylene – Fluorocarbon.

UNIT – II SENSORS 9

Characteristics of sensors - Electrostatic sensors – Parallel plate capacitors – Piezoresistive sensors – Piezoresistive sensor materials - Stress and strain analysis – Flexural beam bending - Torsional deflection– Applications to Inertia, Pressure, Tactile and Flow sensors – Piezoelectric sensors and actuators – piezoelectric effects – piezoelectric materials

UNIT – III ACTUATORS 9

Applications – Interdigitated Finger capacitor – Comb drive devices – Micro Grippers – Micro Motors - Thermal Sensing and Actuation – Thermal expansion – Thermal couples – Thermal resistors – Thermal Bimorph - Applications –Magnetic Actuators – Micro magnetic components – Case studies of MEMS in magnetic actuators -Actuation using Shape Memory Alloys

UNIT – IV MICROMACHINING 9

Silicon Anisotropic Etching – Anisotropic Wet Etching – Dry Etching of Silicon – Plasma Etching– Deep Reaction Ion Etching (DRIE) – Isotropic Wet Etching – Gas Phase Etchants – Case studies - Basic surface micro machining processes – Structural and Sacrificial Materials – Acceleration of sacrificial Etch – Striction and Anti restriction methods – LIGA Process - Assembly of 3D MEMS – Foundry process

UNIT – V APPLICATIONS OF MEMS INERTIAL SENSORS 9

Application to Acceleration, Inertia, Acoustic, Tactile, Pressure, Flow and Tactile sensors- Optical MEMS –Lenses and Mirrors -Actuators for Active Optical MEMS.– RF MEMS and Microfluidics.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO 1: Understand MEMS Energy Domains and Transducers, Sensors and Actuators.
CO 2: Analyse Various MEMS sensors and its Stress and strain
CO 3: Apply various MEMS actuators in Real time system.
CO4: Understand various micro machining processes, Structural and Sacrificial Materials
CO5: Apply various mems inertial, tactile, pressure and flow sensors in real time system

Mapping of COs with POs and PSOs															
COs/POs & PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	1	1		1						1	1	2	1	1
CO2	2	1	1		1						1	1	2	1	1
CO3	2	1	1		1						1	1	2	1	1
CO4	2	1	1		1						1	1	2	1	1
CO5	2	1	1		1						1	1	2	1	1
CO/PO & PSO Average	2	1	1		1						1	1	2	1	1
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS:

1. Chang Liu, "Foundations of MEMS", Pearson Education Inc., 2014, 2nd Edition .
2. Stephen D Senturia, "Microsystem Design", Springer Publication, 2001.
3. Tai Ran Hsu, “MEMS & Micro systems Design and Manufacture” Tata McGraw Hill, New Delhi, 2008.

REFERENCES:

1. James J. Allen, "Micro Electro Mechanical System Design", CRC Press Publisher, 2010
2. Julian w. Gardner, Vijay K. Varadan, Osama O. Awadelkarim, "Micro Sensors MEMS and Smart Devices", John Wiley & Son LTD, 2013.
3. Mohamed Gad-el-Hak, “The MEMS Handbook”, CRC press Baco Raton, 2005.
4. Nadim Maluf,“ An Introduction to Micro Electro Mechanical System Design”, Artech House, 2004.
5. Thomas M. Adams and Richard A. Layton, “Introduction MEMS, Fabrication and Application,” Springer, 2014.

AE5026 **UAV SYSTEM DESIGN**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES: Of this course are

01. To introduce the basic concepts of unmanned aerial vehicles.

02. To make students familiarise with the design aspects of UAV.

03. To impart knowledge on the hardware components and their application in the UAV systems.

04. To infer about the communication and control detail of UAV.

05. To introduce the basic operational futures of UAV systems.

UNIT I INTRODUCTION TO UAV **9**

History of UAV –classification – Introduction to Unmanned Aircraft Systems--models and prototypes – System Composition-applications.

UNIT II THE DESIGN OF UAV SYSTEM 9

Introduction to Design and Selection of the System- Aerodynamics and Airframe Configurations-Characteristics of Aircraft Types- Design Standards and Regulatory Aspects-UK,USA and Europe-Design for Stealth--control surfaces-specifications.

UNIT III AVIONICS HARDWARE 9

Autopilot –AGL-pressure sensors-servos-accelerometer –gyros-actuators- power supply-processor, integration, installation, configuration, and testing.

UNIT IV COMMUNICATION PAYLOADS AND CONTROLS 9

Payloads-Telemetry-tracking-Aerial photography-controls-PID feedback-radio control frequency range –modems-memory system-simulation-ground test-analysis-trouble shooting.

UNIT V DEVELOPMENT OF UAV SYSTEMS 9

Waypoints navigation-ground control software- System Ground Testing- System In-flight Testing-Future Prospects and Challenges-Case Studies – Mini and Micro UAVs.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, Students will be able to

- **CO1:** Acquire knowledge on the importance of UAVs with respect to their applications.
- **CO2:** Identify and distinguish between various subsystems and configurations of UAV.
- **CO3:** Perform ground test and troubleshooting with respect to UAV operation.
- **CO4:** Distinguish between needs of mini and micro UAVs.
- **CO5:** Gain insights with design standards and regulatory aspects of UAVs.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓	✓	✓	✓		✓					
CO2		✓	✓	✓	✓		✓					✓
CO3		✓	✓	✓	✓		✓					✓
CO4		✓	✓	✓	✓		✓					✓
CO5		✓	✓	✓	✓		✓					✓

REFERENCES:

01. Armand J. Chaput, “Design of Unmanned Air Vehicle Systems”,Lockheed Martin Aeronautics Company, 2001.
02. Kimon P. Valavanis, “Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy”, Springer, 2007.
03. Paul G Fahlstrom, Thomas J Gleason, “Introduction to UAV Systems”, UAV Systems, Inc,1998.
04. Reg Austin “unmanned aircraft systems UAV design, development and deployment”, Wiley,2010.
05. Robert C. Nelson, Flight Stability and Automatic Control, McGraw-Hill, Inc, 1998.

EI5009 **MODEL PREDICTIVE CONTROL** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

1. To teach the students the general principles of model predictive control scheme.
2. To provide a comprehensive description of model predictive control schemes namely as dynamic matrix control, generalized predictive control scheme and State space based model predictive control scheme.
3. To highlight the key features of MPC for its Industrial Success.
4. To introduce the skills required to formulate both unconstrained and constrained optimal control schemes.
5. To develop the skills needed to design Model Predictive Control schemes to achieve the desired performance.

UNIT – I MODEL PREDICTIVE CONTROL SCHEMES 9

Introduction to Model Predictive Control - Model Predictive Control Elements - Model Predictive Control Schemes: Dynamic Matrix Control and Model Algorithmic Control – Case Studies

UNIT – II GENERALIZED PREDICTIVE CONTROL SCHEME 9

Generalized Predictive Control Scheme – Simple Implementation of Generalized Predictive Control Scheme for Industrial Processes – Multivariable Generalized Predictive Control Scheme – Case Studies

UNIT – III STATE SPACE BASED MODEL PREDICTIVE CONTROL SCHEME 9

State Space Model Based Predictive Control Scheme - Review of Kalman Update based filters – State Observer Based Model Predictive Control Schemes – Case Studies

UNIT – IV CONSTRAINED MODEL PREDICTIVE CONTROL SCHEME 9

Constraints Handling: Amplitude Constraints and Rate Constraints – Constraints and Optimization – Constrained Model Predictive Control Scheme – Case Studies.

UNIT – V ADVANCED TOPICS IN MPC 9

Robust Model Predictive Control Scheme – Adaptive Model Predictive Control Scheme – Multiple Model based Model Predictive Control Scheme - Fast Methods for Implementing Nonlinear Model Predictive Control Scheme – Case Studies

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO1: Ability to describe the advantages and disadvantages of various MPC schemes.
CO2: Ability to formulate and solve unconstrained/constrained model predictive control schemes for a given process.
CO3: Ability to implement Model Predictive Control algorithms in MATLAB/SCILAB and validate through simulations.
CO4: Ability to design and implement robust, adaptive MPC schemes on the simulated model of benchmark processes
CO5: Ability to Identify, formulate and solve problems in the field of Process Control domain using MPC.

Mapping of COs with POs and PSOs

COs/POs & PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	1	2		2							2		3	
CO2	3	1	2		2							2		3	
CO3	3	1	2		2							2		3	
CO4	3	1	2		2							2		3	

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CO5	3	1	2		2							2		3	
CO/PO & PSO Average	3	1	2		2							2		3	
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Camacho, E.F., and Bordons, C., "Model Predictive Control", 2nd Edition, Advanced in Industrial Control Springer Verlag, 2013.
2. Liuping Wang, "Model Predictive Control System Design and Implementation Using MATLAB", Advanced in Industrial Control, Springer Verlag, 2009.

REFERENCES

1. Wayne Bequette, B., "Process Control: Modeling, Design, and Simulation", Prentice Hall of India, 2004.
2. Seborg,D.E., Duncan, A. Mellichamp , Edgar,T.F., and Doyle,F.J., III, "Process Dynamics and Control", John Wiley and Sons, 3rd Edition, 2010.

RO5021 COLLABORATIVE ROBOTICS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To know the fundamentals of Collaborative Robotics
2. To introduce Swarm robot and trajectory planning for Swarm
3. To introduce Modular Robotics and its Mechanics
4. To learn about various Natural models of robot collaboration
5. To introduce the concept of Reconfigurable robot

UNIT – I INTRODUCTION TO COBOTICS **9**

Collaborative Robotics- Properties - Introduction to Modern Mobile Robots: Swarm Robots, Cooperative and Collaborative Robots, Mobile Robot Manipulators-Current Challenges.

UNIT – II SWARM ROBOTICS **9**

Introduction, mapping, kinematics and trajectory error compensation, state transitions, collective decision making and methodologies, swarm robot scenarios-aggregation, clustering dispersion, pattern formation, sorting, flocking and collective motion, shepherding, heterogeneous swarms, Error Detection and Security.

UNIT – III MODULAR ROBOTICS **9**

Module Designs - Modular Robot Representation -Modular Serial Robot Kinematics - Kinematic Calibration for Modular Serial Robots- Modular Serial Robot Dynamics - Modular Parallel Robot Kinematics

UNIT – IV NATURALLY INSPIRED COLLABORATION **9**

Collective Decision-Making. Group Decision Making in Animals, Collective Motion as Decision Process, Models for Collective Decision-Making Processes, Urn Models, Voter Model ,Majority Rule , Hegselmann and Krause , Kuramoto Model , Axelrod Model, Ising Model, Fiber Bundle Model, Sznajd Model, Bass Diffusion Model, Sociophysics and Contrarians **.**

UNIT – V RECONFIGURABLE ROBOTS **9**

V-Shaped Formation Control for Robotic Swarms Constrained by Field of View – formation of

reconfigurable virtual linkage - Reconfigurable Formation Control of Multi-Agents - Self-Assembly Modular Robot Platform Based on Sambot - Swarm Dynamics Emerging from Asymmetry.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO1: Understand the fundamentals of Collaborative Robotics
CO2: Understand Swarm robot and trajectory planning for Swarm
CO3: Understand the concept Modular Robotics and its Mechanics
CO4: Analyse various Natural models for robot collaboration
CO5: Understand concept of Reconfigurable robot

Mapping of COs with POs and PSOs															
COs/POs& PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	1	2	1	1							2	2	1	1	1
CO2	1	2	1	1							2	2	1	1	1
CO3	1	2	1	1							2	2	1	1	1
CO4	1	2	1	1							2	2	1	1	2
CO5	1	2	1	1							2	2	1	1	1
CO/PO & PSO Average	1	2	1	1							2	2	1	1	1.2
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Guilin Yang, I-Ming Chen, “Modular Robots: Theory and Practice”, Springer, 2022.
2. Giandomenico Spezzano, “Swarm Robotics”, Applied Sciences, MDPI, 2019.

REFERENCES

1. Heiko Hamann, “Collective Decision-Making in Swarm Robotics: A Formal Approach”, Springer, 2019.

PR5004 UNCONVENTIONAL MACHINING PROCESSES L T P C
3 0 0 3

COURSE OBJECTIVES:

- To make acquainted the various unconventional machining processes and its applications
- To encourage the students for developing the models (experimental/theoretical) of unconventional machining Processes
- To inculcate specialized knowledge and skill in unconventional machining processes using the principles and methods of engineering analysis and design.
- To cultivate the ability to develop and implement new improved manufacturing processes resulting in creation and distribution of value in engineering applications.
- To impart knowledge about the significance of controlling process parameters for the optimal performance for newly developed engineering materials used in industries and research organizations.

UNIT I MECHANICAL ENERGY BASED PROCESSES 9

Abrasive Jet Machining (AJM) – Water Jet machining (WJM) - Abrasive Water Jet Machining (AWJM) –Working Principle – equipments used – Process parameters – MRR – Applications - Ultrasonic machining (USM) – Grain throwing and Grain hammering mechanisms**.**

UNIT II CHEMICAL AND ELECTRO CHEMICAL ENERGY BASED PROCESSES 9

Chemical machining - Etchants – maskants - techniques of applying maskants – Process Parameters – MRR – Applications – Chemical blanking – Chemical milling - Electro-Chemical machining (ECM) –Principles of ECM – Equipments – MRR – Electrochemical Grinding (ECG) and Electrochemical Honing (ECH) – Applications- Micro ECM.

UNIT III ELECTRICAL ENERGY BASED PROCESSES 9

Electric Discharge Machining (EDM) – working principle – equipments –Process Parameters – MRR – Electrode- Power circuits – Tool Wear – Dielectric – Flushing – Wire cut – EDM – Applications – Micro EDM.

UNIT IV THERMAL ENERGY BASED PROCESSES 9

Laser Beam machining (LBM) - Plasma Arc machining (PAM) - Electron Beam Machining (EBM) – Ion Beam Machining (IBM) - Principle – Parameters – Equipment – Types– MRR - Applications.

UNIT V HYBRID MACHINING 9

Abrasive based hybrid machining processes - Thermal based hybrid machining processes - Electro based hybrid machining processes – Vibration assisted EDM - Vibration assisted ECM.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will be able to

CO1: The students will be in a position to select and employ an appropriate unconventional machining process for a specific application in industries.

CO2: To categorized the various unconventional manufacturing process based on energy sources and mechanism employed

CO3: To select the best suitable advanced manufacturing process for processing of unconventional materials employed in modern manufacturing industries

CO4: To study the parametric influences during processing of materials using developed models

CO5: Analyze the processes and evaluate the role of each process parameter during machining of various advanced materials.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√		√		√	√	√	√				√
CO2	√		√		√	√	√	√				√
CO3	√		√		√	√	√	√				√
CO4	√		√		√	√	√	√				√
CO5	√		√		√	√	√	√				√

TEXT BOOKS:

1. Jain.V.K, “Advanced Machining Processes”, Allied Publishers Pvt.Ltd., New Delhi, 2002.
2. Hassan Abdel,Gawad El, Hofy ,”Advanced Machining Processes”, Tata McGraw Hill, 2005.

REFERENCES :

1. Pandey, P.C. and Shan H.S., Modern Machining Processes, Tata McGraw Hill (2004).
2. Mishra, P.K., Non Conventional Machining, Narosa Publications (2006).
3. Hofy, H.E., Advanced Manufacturing Process, B and H Publication (1998).
4. Jain, V.K., Advanced Machining processes, Allied Publishers Private Limited (2004).
5. Ghosh, A. and Mullik, A., Manufacturing Science, East –West private Limited (2010)

RO5022	VEHICLE DYNAMICS AND CONTROL	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To Develop physical and mathematical models to predict the dynamic response of vehicles
2. To Apply vehicle design performance criteria and how to use the criteria to evaluate vehicle dynamic response
3. To Use dynamic analyses in the design of vehicles.
4. To understand the principle behind the lateral dynamics.
5. To Evaluate the longitudinal dynamics and control in an automobile

UNIT – I INTRODUCTION 9

History of road and off road vehicle system dynamics - dynamics of the motor vehicle, coordinate systems- vehicle fixed coordinates system, , details of vehicle systems, wheel angles, typical data of vehicles. Fundamental approaches to vehicle dynamics modeling lumped mass, vehicle fixed coordinate system, motion variables, earth fixed coordinate system, Definitions- modeling and simulation of dynamic behavior of vehicle., motion analysis, force analysis, and energy analysis.

UNIT – II LONGITUDINAL DYNAMICS 9

Introduction to longitudinal dynamics - Performance of road vehicles: forces and moments on vehicle, equation of motion, tire forces, rolling resistance, weight distribution, tractive effort/tractive resistance and power available from the engine/ power required for propulsion, road performance curves- acceleration, grade ability, drawbar pull and the problems related to these terms. Calculation of maximum acceleration braking torque, braking force, brake proportioning, braking efficiency, stopping distance, load distribution (three wheeled and four wheeled vehicles), calculation of acceleration, tractive effort and reactions for different drives, Stability of a vehicle on slope, (Problems related to these). Steer-By-Wire Systems

UNIT – III LATERAL DYNAMICS 9

Introduction to lateral dynamics - Steering geometry, types of steering systems, fundamental condition for true rolling, development of lateral forces. slip angle, cornering force, cornering stiffness, pneumatic trail, self-aligning torque, power consumed by tire, tire stiffness, hysteresis effect in tires, steady state handling characteristics. yaw velocity, lateral acceleration, curvature response & directional stability. Stability of a vehicle on a curved track and a banked road. Gyroscopic effects, weight transfer during acceleration, cornering and braking, stability of a rigid vehicle and equations of motion of a rigid vehicle, cross wind handling, the problems related to these terms.

UNIT – IV VERTICAL DYNAMICS 9

Introduction to vertical dynamics - Human response to vibrations, classification of vibration, specification and vibration , sources of vibration, suspension systems, Modal Analysis, One

DOF, two DOF, free and forced vibration, damped vibration, magnification and transmissibility, vibration absorber, functions of suspension system. Body vibrations: bouncing and pitching. Doubly conjugate points (only basic idea). Body rolling. Roll center and roll axis, roll axis and the vehicle under the action of side forces, stability against body rolling. Vehicle dynamics and suspension design for stability, choice of suspension spring rate, chassis springs and theory of chassis springs, gas & hydraulic dampers and choice of damper, damper characteristics, mechanics of an independent suspension system. Design and analysis of passive, semi-active and active suspension using quarter car, half car and full car mode- Hydraulic Actuators for Active Suspensions

UNIT – V VEHICLE AERODYNAMIC AND DYNAMIC CONTROL SYSTEM 9

Road Loads: Air resistance-Mechanics of air flow around a vehicle, pressure distribution on a vehicle, factors affecting rolling resistance, aerodynamic forces – aerodynamic drag, drag components, dynamic Control, modelling of actuators, sensors for automobile control, sensors for detecting vehicle environment, central tyre inflation system. Prediction of vehicle performance. ABS, stability control, traction control. Dynamic Model for Simulation of a Parallel Gas-Electric Hybrid Vehicle Dynamic Model for Simulation of a Power-Split Hybrid Vehicle Background on Control Design Techniques for Energy Management – steer by wire controller Design

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO 1: To understand the vehicle system dynamics
CO 2: Evaluate the driving/ braking resistances and their influences on vehicle dynamics
CO 3: Identify and analyze the dynamics systems such as suspension systems, body vibrations, steering mechanisms.
CO 4: To analyze and solve engineering problems related to vehicle dynamics.
CO 5: Comparing and identifying the different types of control systems in automobiles

Mapping of COs with POs and PSOs															
COs/POs & PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	1								1	2	2	3
CO2	3	2	1	1								1	2	2	3
CO3	3	2	1	1								1	2	2	3
CO4	3	2	1	1								1	2	2	3
CO5	3	2	1	1								1	2	2	3
CO/PO & PSO Average	3	2	1	1								1	2	2	3
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Rajesh Rajamani, “Vehicle Dynamics and Control”, 2nd edition, Springer, 2021.
2. Singiresu S. Rao, “Mechanical Vibrations”, 8th Edition, Prentice Hall, 2018.
3. Thomas D. Gillespie, “Fundamentals of Vehicle Dynamics”, Society of Automotive Engineers Inc., 2021.
4. Wong. J. Y., “Theory of Ground Vehicles”, 5th Edition, Wiley-Interscience, 2022 .
5. N.K. Giri, “Automotive Mechanics”, Kanna Publishers, 2008.

Attested

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Centre for Academic Courses
Anna University, Chennai-600 025

REFERENCES

1. J. Y. Woung - John Willey & Sons "Theory of Ground Vehicles ", NY ,5th Edition,2022.
2. J. G. Giles," Steering, Suspension &Tyres", Ilete Books Ltd., London,1968.
3. W. Steed "Mechanics of Road Vehicles ", Ilete Books Ltd. London,1960.
4. P. M. Heldt, "Automotive Chassis", Chilton Co. NK
5. Gillespie.T.D., "Fundamental of vehicle dynamic society of Automotive Engineers ", USA, 2021 Revised Edition.
6. Rajesh Rajamani, "Vehicle dynamics and control", Springer publication,2014.
7. Reza N Jazar, "Vehicle Dynamics: Theory and Application", Springer publication,3rd Edition,2018.

BM5701 BIOMECHANICS L T P C
3 0 0 3

OBJECTIVES:

- To study about the mechanics involved with various physiological systems.
- To gain knowledge in deriving the mathematical models related to blood vessels.

UNIT I INTRODUCTION 9

Scope of mechanics in medicine, mechanics of bone structure, determination of in-vivo elastic modulus. Bio fluid mechanics, flow properties of blood. Anthropometry.

UNIT II MECHANICS OF PHYSIOLOGICAL SYSTEMS 9

Heart valves, power developed by the heart, prosthetic valves. Constitutive equations for soft tissues, dynamics of fluid flow in cardiovascular system and effect of vibration - shear stresses in extra-corporeal circuits.

UNIT III ORTHOPAEDIC MECHANICS 9

Mechanical properties of cartilage, diffusion properties of articular cartilage, mechanical properties of bone, kinetics and kinematics of joints, Lubrication of joints.

UNIT IV MATHEMATICAL MODELS 9

Introduction to Finite Element Analysis, Mathematical models - pulse wave velocities in arteries, determination of in-vivo elasticity of blood vessel, dynamics of fluid filled catheters.

UNIT V ORTHOPAEDIC APPLICATIONS 9

Dynamics and analysis of human locomotion - Gait analysis (determination of instantaneous joint reaction analysis), occupant response to vehicular vibration. Mechanics of knee joint during standing and walking.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the use of mechanics in medicine.
CO2: Understand the mechanics of physiological systems.
CO3: Distinguish the reason for abnormal patterns.
CO4: Analyze the biomechanical systems using mathematical models.
CO5: Design and develop the models specific to orthopedic applications.

TEXT BOOKS:

1. Y.C.Fung,-Bio-Mechanics, "Mechanical Properties ofTissues",Springer-Verilog,1998.
2. C. Ross Ether and Craig A.Simmons, "Introductory Biomechanics from cells to organisms", Cambridge University Press, New Delhi, 2009.

REFERENCES:

1. Susan J Hall, "Basics of Biomechanics'', Mc Graw Hill Publishing.co. New York, 5th Edition, 2007.
2. Dhanjoo N.Ghista, "Orthopaedic Mechanics", Academic Press, 1990.
3. Joseph D.Bronzino, "Biomedical Engineering Fundamentals", Taylor& Francis, 2006.
4. John Enderle, Susanblanchard, Joseph Bronzino, "Introduction to Biomedical Engineering'', Elsevier, 2005.
5. B.H.Brown, PV Lawford, RH Small wood, DR Hose, Dc Barber, "Medical Physics and Biomedical Engineering'', CRC Press, 1999.
6. Dhanjoo N.Ghista, "Bio-mechanics of Medical Devices", Marcel Dekker, 1980.
7. Haufred Clynes, "Bio-medical Engineering Systems'', McGrawHill,1998.

GE5451 TOTAL QUALITY MANAGEMENT L T P C
3 0 0 3

OBJECTIVES:

- Teach the need for quality, its evolution, basic concepts, contribution of quality gurus, TQM framework, Barriers and Benefits of TQM.
- Explain the TQM Principles for application.
- Define the basics of Six Sigma and apply Traditional tools, New tools, Benchmarking and FMEA.
- Describe Taguchi's Quality Loss Function, Performance Measures and apply Techniques like QFD, TPM, COQ and BPR.
- Illustrate and apply QMS and EMS in any organization.

UNIT I INTRODUCTION 9

Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of product and service quality –Definition of TQM-- Basic concepts of TQM –-Gurus of TQM (Brief introduction) -- TQM Framework- Barriers to TQM –Benefits of TQM.

UNIT II TQM PRINCIPLES 9

Leadership - Deming Philosophy, Quality Council, Quality statements and Strategic planning- Customer Satisfaction –Customer Perception of Quality, Feedback, Customer complaints, Service Quality, Kano Model and Customer retention – Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition & Reward and Performance Appraisal-- Continuous process improvement –Juran Trilogy, PDSA cycle, 5S and Kaizen - Supplier partnership – Partnering, Supplier selection, Supplier Rating and Relationship development.

UNIT III TQM TOOLS & TECHNIQUES I 9

The seven traditional tools of quality - New management tools - Six-sigma Process Capability- Bench marking - Reasons to benchmark, Benchmarking process, What to Bench Mark, Understanding Current Performance, Planning, Studying Others, Learning from the data, Using the findings, Pitfalls and Criticisms of Benchmarking - FMEA - Intent , Documentation, Stages: Design FMEA and Process FMEA.

UNIT IV TQM TOOLS & TECHNIQUES II 9

Quality circles – Quality Function Deployment (QFD) - Taguchi quality loss function – TPM – Concepts, improvement needs – Performance measures- Cost of Quality - BPR.

UNIT V QUALITY MANAGEMENT SYSTEM 9

Introduction-Benefits of ISO Registration-ISO 9000 Series of Standards-Sector-Specific Standards - AS 9100, TS16949 and TL 9000-- ISO 9001 Requirements-Implementation-Documentation-Internal Audits-Registration-ENVIRONMENTAL MANAGEMENT SYSTEM: Introduction—ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO 14001-Benefits of EMS.

TOTAL: 45 PERIODS

OUTCOMES:

CO1: Ability to apply TQM concepts in a selected enterprise.
CO2: Ability to apply TQM principles in a selected enterprise.
CO3: Ability to understand Six Sigma and apply Traditional tools, New tools, Benchmarking and FMEA.
CO4: Ability to understand Taguchi's Quality Loss Function, Performance Measures and apply QFD, TPM, COQ and BPR.
CO5: Ability to apply QMS and EMS in any organization.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓										✓
CO2						✓						✓
CO3					✓				✓			
CO4		✓			✓	✓	✓	✓				✓
CO5			✓			✓	✓	✓				

TEXT BOOK:

1. Dale H.Besterfiled, Carol B.Michna,Glen H. Bester field,MaryB.Sacre,HemantUrdhwareshe and RashmiUrdhwareshe, “Total Quality Management”, Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression,2013.

REFERENCES:

1. Joel.E. Ross, “Total Quality Management – Text and Cases”,Routledge.,2017.
2. Kiran.D.R, “Total Quality Management: Key concepts and case studies, Butterworth – Heinemann Ltd, 2016.
3. Oakland, J.S. “TQM – Text with Cases”, Butterworth – Heinemann Ltd., Oxford, Third Edition, 2003.
4. Suganthi,L and Anand Samuel, “Total Quality Management”, Prentice Hall (India) Pvt. Ltd., 2006 .

MF5501 METROLOGY AND COMPUTER AIDED INSPECTION L T P C
3 0 0 3

COURSE OBJECTIVES:

- To impart the basics of metrology, measurement concepts and perform measurement tasks accurately.
- To identify the right measurement practices for linear and angular measurements.
- To be familiarized with the right instrument and method of measurement for surface finish and form measurements
- To describe the various measurement techniques using laser metrology.
- To gain knowledge on computer aided inspection and advances in metrology.

UNIT I BASIC CONCEPTS OF MEASUREMENTS 9

Important terminologies - Elements of measurements, need for measurement - Factors influencing measurements - Precision and Accuracy - Methods of measurement - Errors in measurements - Causes - Standards and Calibration - Types-Handling of measuring instruments - Do's and Don'ts - Maintenance of Instruments - Clean room.

UNIT II LINEAR AND ANGULAR MEASUREMENTS 9

Measurement of engineering components - Comparators, Slip gauges, Rollers, Limit gauges - Design - Types - Principles - Applications: Auto collimator - Angle dekkor - Alignment telescope - Sine bar - Bevel protractors'.

UNIT III SURFACE FINISH AND FORM MEASUREMENTS 9

Measurement of various elements of screw threads and gears - Radius measurement - Surface finish measurement - Straightness, Flatness and roundness- Principles - Application – Computerized form measuring equipments.

UNIT IV LASER METROLOGY 9

Precision instrument based on Laser - Use of Lasers - Principle –Interferometers, Interference microscope -Optical flats - Laser Interferometer - Application in Linear and Angular measurements - Testing of machine tools using Laser Interferometer.

UNIT V COMPUTER AIDED INSPECTION AND ADVANCES IN METROLOGY 9

Co-ordinate Measuring Machines - Constructional features - Types - Applications of CMM - CNC CMM applications - Measurement arms, Laser tracker - Fundamentals of Computer Aided Inspection - Machine Vision and applications in Metrology - Introduction to Nanometrology.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the student shall be able to:

- CO1: Recognize the basics of metrology, measurement concepts and perform measurement tasks accurately.
- CO2: Identify the right measurement practices for linear and angular measurements.
- CO3: Identify the right instrument and method of measurement for surface finish and form measurements
- CO4: Describe various measurement techniques using laser metrology.
- CO5: Recognize the computer aided inspection and advances in metrology.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	0.6	0.9	0.3	0.9	0.9	0.3	0.3	0.6	0.9	0.6	0.3	0.9	0.9	0.9	0.6
2	0.6	0.3	0.6	0.6	0.9	0.3		0.6	0.3	0.3		0.6	0.6	0.9	0.3
3	0.6	0.3	0.6	0.6	0.9	0.6	0.3	0.6	0.3	0.3		0.6	0.6	0.9	0.3
4	0.6	0.6	0.3	0.9	0.9	0.9	0.6	0.3	0.6	0.3		0.6	0.9	0.9	0.6
5	0.6		0.3	0.3	0.9	0.3		0.3		0.3	0.3	0.6	0.9	0.9	0.9

TEXT BOOKS:

1. Bewoor A.K., and Kulkarni,V.A., "Metrology and Measurement", Tata McGraw-Hill., India, 2009.ISBN: 978-0070140004.
2. Jain R.K., "Engineering Metrology", 19th Edition, Khanna Publishers., India, 2005, ISBN13: 978-8174091536.

REFERENCES:
1. "ASTE Handbook of Industries Metrology", Prentice Hall of India Ltd., India, 1992.
2. Galyer J.F.W. and Shotbolt C.R., "Metrology for Engineers", Cassel O.R., London, 1993,ISBN-13: 978-0304318445
3. Rajput R.K., "Engineering Metrology and Instrumentations", Kataria & Son Publishers., India, 2001.
4. Thomas, "Engineering Metrology", Butthinson & Co., 1984.
5. Whitehouse D.J., "The Handbook of Surface and Nanometrology", 2nd Edition, CRC Press., United States, 2011, ISBN: 9781420082029.

PR5022 INTEGRATED PRODUCT DEVELOPMENT L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand the global trends and development methodologies of various types of products and services
- To conceptualize, prototype and develop product management plan for a new product based on the type of the new product and development methodology integrating the hardware, software, controls, electronics and mechanical systems
- To understand requirement engineering and know how to collect, analyze and arrive at requirements for new product development and convert them in to design specification
- To understand system modeling for system, sub-system and their interfaces and arrive at the optimum system specification and characteristics
- To develop documentation, test specifications and coordinate with various teams to validate and sustain up to the EOL (End of Life) support activities for engineering customer

UNIT I FUNDAMENTALS OF PRODUCT DEVELOPMENT 9

Global Trends Analysis and Product decision - Social Trends - Technical Trends- Economic Trends - Environmental Trends - Political/Policy Trends - Introduction to Product Development Methodologies and Management - Overview of Products and Services - Types of Product Development - Overview of Product Development methodologies - Product Life Cycle – Product Development Planning and Management.

UNIT II REQUIREMENTS AND SYSTEM DESIGN 9

Requirement Engineering - Types of Requirements - Requirement Engineering - traceability Matrix and Analysis - Requirement Management - System Design & Modeling - Introduction to System Modeling - System Optimization - System Specification - Sub-System Design - Interface Design.

UNIT III DESIGN AND TESTING 9

Conceptualization - Industrial Design and User Interface Design - Introduction to Concept generation Techniques – Challenges in Integration of Engineering Disciplines - Concept Screening & Evaluation - Detailed Design - Component Design and Verification – Mechanical, Electronics and Software Subsystems - High Level Design/Low Level Design 98 of S/W Program - Types of Prototypes, S/W Testing- Hardware Schematic, Component design, Layout and Hardware Testing – Prototyping - Introduction to Rapid Prototyping and Rapid Manufacturing - System Integration, Testing, Certification and Documentation

UNIT IV SUSTENANCE ENGINEERING AND END-OF-LIFE (EOL) SUPPORT 9

Introduction to Product verification processes and stages - Introduction to Product Validation processes and stages - Product Testing Standards and Certification - Product Documentation - Sustenance -Maintenance and Repair – Enhancements - Product EoL - Obsolescence Management – Configuration Management - EoL Disposal

UNIT V BUSINESS DYNAMICS – ENGINEERING SERVICES INDUSTRY 9

The Industry - Engineering Services Industry - Product Development in Industry versus Academia –The IPD Essentials - Introduction to Vertical Specific Product Development processes -Manufacturing/Purchase and Assembly of Systems - Integration of Mechanical, Embedded and Software Systems – Product Development Trade-offs - Intellectual Property Rights and Confidentiality – Security and Configuration Management.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to:

- Define, formulate and analyze a problem
- Solve specific problems independently or as part of a team
- Gain knowledge of the Innovation & Product Development process in the Business Context
- Work independently as well as in teams
- Manage a project from start to finish

TEXT BOOKS:

1. Book specially prepared by NASSCOM as per the MoU.
2. John W Newstorm and Keith Davis, "Organizational Behavior", Tata McGraw Hill, Eleventh Edition, 2005.

REFERENCES:

1. Hiriyappa B, “Corporate Strategy – Managing the Business”, Author House, 2013.
2. Mark S Sanders and Ernest J McCormick, "Human Factors in Engineering and Design", McGraw Hill Education, Seventh Edition, 2013
3. Peter F Drucker, “People and Performance”, Butterworth – Heinemann [Elsevier], Oxford, 2004.
4. Vinod Kumar Garg and Venkita Krishnan N K, “Enterprise Resource Planning – Concepts”, Second Edition, Prentice Hall, 2003.
5. Karl T Ulrich and Stephen D Eppinger, "Product Design and Development", Tata McGraw Hill, Fifth Edition, 2011.

RO5023 HUMANOID ROBOTICS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To know the basic knowledge about Humanoid robots.
2. To impart knowledge in kinematics of humanoids.
3. To learn about the dynamics in humanoid robots.
4. To understand the basic in biped walking.
5. 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.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO 1: Describe about the evolution of Humanoid robots
CO 2: Expose the basic knowledge in kinematics of humanoids.
CO 3: Calculate the Humanoid Robot Motion and Ground Reaction Force.
CO 4: Identify Two-Dimensional Walking pattern on different terrain.
CO 5: Summarize the Walking Pattern models.

Mapping of COs with POs and PSOs

COs/POs & PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1	1		2						1	1	2	3
CO2	3	2	1	1		2						1	1	2	3
CO3	3	2	1	1		2						1	1	2	3
CO4	3	2	1	1		2						1	1	2	3
CO5	3	2	1	1		2						1	1	2	3
CO/PO & PSO Average	3	2	1	1		2						1	1	2	3

1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOKS:

1. Dragomir N. Nenchev, Atsushi Konno, "Humanoid Robots Modeling and Control", Butterworth Heinemann, 2019.
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.

REFERNCES:

1. A. Goswami, P. Vadakkepat (Eds.), "Humanoid Robotics: A Reference", Springer, Netherlands, Dordrecht, 2018.
2. J K. Harada, E. Yoshida, K. Yokoi (Eds.), "Motion Planning for Humanoid Robots", Springer, London, 2010.
3. Lorenzo Sciavicco and Bruno Siciliano, "Modelling and Control of Robot Manipulators", second edition, Springer, 2000.
4. Jean-Claude Latombe, "Robot Motion Planning", Kluwer Academy Publishers, 2004.

RO5024	VIRTUAL INSTRUMENTATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To introduce virtual instrumentation concepts and applications.
2. To train to program virtual instrumentation software for biomedical applications
3. To understand the data acquisition and control in VI
4. To obtain the knowledge in instrument interfaces
5. To analyze the applications of VI in Bio Medical Engineering

UNIT – I INTRODUCTION **9**

History of Virtual Instrumentation (VI), advantages, block diagram and architecture of a virtual instrument, Programming paradigms – Virtual Instrumentation – Lab VIEW software – Lab VIEW basics – Lab VIEW environment.

UNIT – II VI USING LABVIEW **9**

Creating, Editing and debugging a VI in Lab VIEW – Creating a sub VI – Loops and charts – Case and sequence structures – File I/O – VI customization.

UNIT – III DATA ACQUISITION AND CONTROL IN VI **9**

Plug-in DAQ boards – Organization of the DAQ VI System – Performing analog input and analog output – Scanning multiple analog channels – Driving the digital I/Os – Buffered data acquisition – Simple problems

UNIT – IV INSTRUMENT INTERFACES **9**

Current loop, RS 232C/RS 485, GPIB, System basics, Interface basics: USB, PCMCIA, networking basics for office & industrial application VISA & IVI, image acquisition & processing, Motion Control. ADC, DAC, DIO, DMM, waveform generator.

UNIT – V APPLICATION OF VI IN BIOMEDICAL ENGINEERING **9**

Design of virtual applications for Electrocardiography (ECG), Electromyography (EMG), Air Flow and Lung Volume, Heart Rate variability analysis, Noninvasive Blood Pressure Measurement, Biofeedback, Virtual Reality & 3D graphical modeling, Virtual Prototyping.

TOTAL: 45 PERIODS

COURSE OUTCOMES

At the end of the course students able to

CO1: To comprehend and appreciate the significance and role of this course in the present contemporary world.
CO2: Identify salient traits of a virtual instrument.
CO3: Understand the use of VI for data acquisition.
CO4: Experiment, analyze and document different types of interfaces.
CO5: Apply the virtual instrumentation technologies for medical applications

Mapping of COs with POs and PSOs															
COs/POs & PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	1	2	1	1		2					1	1	3	2	1
CO2	1	2	1	1		2					1	1	3	2	1
CO3	1	2	1	1		2					1	1	3	2	1
CO4	1	2	1	1		2					1	1	3	2	1
CO5	1	2	1	1		2					1	1	3	2	1
CO/PO & PSO Average	1	2	1	1		2					1	1	3	2	1
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS:

1. Gary Johnson, “LABVIEW Graphical Programming”, McGraw Hill, 4thedition,2006..
2. Lisa K. Wells and Jeffrey Travis, “LABVIEW for Everyone”, PHI, 1997.
3. Skolkoff, “Basic concepts of LABVIEW 4”, PHI, 1998.
4. Jerome, Jovitha, “Virtual Instrumentation and LABVIEW”, PHI Learning, New Delhi, 1st Edition, 2010.
5. Sanjay Gupta and Joseph John, “Virtual Instrumentation using Lab VIEW”, Tata Mc Graw – Hill Publishing Company Limited, New Delhi, 1st Edition, 2010.

REFERENCES:

1. Kevin James, “PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control”, Newnes, 2003.
2. S. Gupta, J.P. Gupta, “PC Interfacing for Data Acquisition and Process Control”, ISA, 2nd Edition, 1994.
3. Technical Manuals for DAS Modules of Advantech and National Instruments.
4. Jon B. Olansen, Eric Rosow, “Virtual Bio-Instrumentation: Biomedical, Clinical, and Healthcare Applications in Lab VIEW” Pearson Education, 2001.

MF5652 ADDITIVE MANUFACTURING L T P C
3 0 0 3

COURSE OBJECTIVES:

- To introduce the development of Additive Manufacturing (AM), various business opportunities and applications
- To familiarize various software tools, processes and techniques to create physical objects that satisfy product development / prototyping requirements, using AM.
- To be acquainted with vat polymerization and material extrusion processes.
- To be familiar with powder bed fusion and direct energy deposition.
- To gain knowledge on applications of binder jetting, material jetting and laminated object manufacturing processes

UNIT I INTRODUCTION 9

Overview – Need - Development of Additive Manufacturing (AM) Technology: Rapid Prototyping- Rapid Tooling – Rapid Manufacturing – Additive Manufacturing. AM Process Chain- Classification – Benefits. Applications: Building Printing-Bio Printing- Food Printing-Printing Electronics. Business Opportunities and Future Directions - Intellectual Property.

UNIT II DESIGN FOR ADDITIVE MANUFACTURING (DFAM) 9

Concepts and Objectives- AM Unique Capabilities: Part Consolidation-Topology Optimization-Light weight Structure - DFAM for Part Quality Improvement. Data Processing - CAD Model Preparation -Part Orientation and Support Structure Generation -Model Slicing - Tool Path Generation-Customized Design and Fabrication for Medical Applications- Case Studies.

UNIT III VAT POLYMERIZATION AND MATERIAL EXTRUSION 9

Photo polymerization: Stereolithography Apparatus (SLA)- Materials -Process -Advantages-Limitations- Applications. Digital Light Processing(DLP) - Materials – Process - Advantages - Applications. Extrusion Based System: Fused Deposition Modeling (FDM)- Process-Materials - Applications and Limitations.

UNIT IV POWDER BED FUSION AND DIRECT ENERGY DEPOSITION 9

Powder Bed Fusion: Selective Laser Sintering (SLS): Process – Powder Fusion Mechanism – Process Parameters – Typical Materials and Application. Selective Laser Melting (SLM) and Electron Beam Melting (EBM): Materials – Process - Advantages and Applications.
Beam Deposition Process: Laser Engineered Net Shaping (LENS)- Process -Material Delivery - Process Parameters -Materials -Benefits -Applications.

UNIT V OTHER ADDITIVE MANUFACTURING PROCESSES 9

Binder Jetting: Three Dimensional Printing - Materials -Process - Benefits and Limitations. Material Jetting: Multijet Modeling- Materials - Process - Benefits. Sheet Lamination Process: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding – Thermal Bonding- Materials-Application and Limitation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course students shall be able to:

- CO1: Recognize the development of AM technology and how AM technology propagated into various businesses and developing opportunities.
- CO2: Acquire knowledge on process of transforming a concept into the final product in AM technology.
- CO3: Elaborate the vat polymerization and material extrusion processes and its applications.
- CO4: Acquire knowledge on process and applications of powder bed fusion and direct energy deposition.
- CO5: Evaluate the advantages, limitations, applications of binder jetting, material jetting and laminated object manufacturing processes.

CO	PO											PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	0.9						0.3	0.9		0.6		0.9	0.3	0.3	0.3
2	0.9	0.6	0.3	0.3	0.6		0.9	0.6		0.6		0.9	0.3	0.9	0.6
3	0.9	0.3					0.6			0.6		0.9	0.6	0.6	0.3
4	0.9	0.3					0.6			0.6		0.9	0.6	0.6	0.3
5	0.9	0.3					0.6			0.6		0.9	0.6	0.6	0.3

TEXT BOOKS:

1. Andreas Gebhardt and Jan-Steffen Hötter “Additive Manufacturing: 3D Printing for Prototyping and Manufacturing”, Hanser publications, United States, 2015, ISBN: 978-1-56990-582-1.

2. Ian Gibson, David W. Rosen and Brent Stucker “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing”, 2nd edition, Springer., United States, 2015, ISBN-13: 978-1493921126.

REFERENCES:

1. Amit Bandyopadhyay and Susmita Bose, “Additive Manufacturing”, 1st Edition, CRC Press., United States, 2015, ISBN-13: 978-1482223590.
2. Andreas Gebhardt, “Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing”, Hanser Gardner Publication, Cincinnati., Ohio, 2011, ISBN :9783446425521.
3. Kamrani A.K. and Nasr E.A., “Rapid Prototyping: Theory and practice”, Springer., United States ,2006, ISBN: 978-1-4614-9842-1.
4. Liou, L.W. and Liou, F.W., “Rapid Prototyping and Engineering applications: A tool box for prototype development”, CRC Press., United States, 2011, ISBN: 9780849334092.
5. Milan Brandt, “Laser Additive Manufacturing: Materials, Design, Technologies, and Applications”, Woodhead Publishing., United Kingdom, 2016, ISBN: 9780081004333.

RO5025	AIRCRAFT MECHATRONICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. The intention and purpose of this course is to study the basics of aircraft, controls , and its Importance in aerospace industy
2. To study the various sensors and actuators used in aerospace Industry
3. To understand various Data buses and protocols used in aircraft Industy
4. To understand the working principle of Display system and its importance in an aircraft
5. To Understand various engine control sensors and its measurements

UNIT – I INTRODUCTION 8

Role for Avionics in Civil and Military Aircraft systems, Avionics sub-systems -design-Introduction to control surface actuation system, Fly-by-wire, Actuators, defining avionics System/subsystem Requirements & importance of ‘ilities’- Avionics system architectures – Integrated Modular Avionics - Guidance and Certification Considerations

UNIT – II AIRCRAFT DATA BUSES AND PROTOCOLS 10

MIL-STD-1553B, ARINC-429, ARINC-629, CSDB, AFDX, CAN Bus, ARINC 825, ARINC 826, RS232

UNIT – III SENSOR AND ACTUATORS IN AUTOMOTIVES 7

Working principle and characteristics of gyroscope, Accelerometer, magnetometer, Rate gyro-rate of turn and slip indicator, Air data instruments - airspeed, altitude, Vertical speed indicators, Altitude alerting systems, Machmeter, Mach Warning system, Static Air temperature, Angle of attack measurement and Stall Warning system

UNIT – IV DISPLAY SYSTEMS 10

Trends in display technology, Civil and Military aircraft cockpits, MFDs, MFK, HUD, HDD, HMD, DVI, HOTAS, Synthetic and enhanced vision, situation awareness, Panoramic/big picture display, virtual cockpit-Civil and Military Electrical Power requirement

Attested

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UNIT – V ENGINE CONTROL SYSTEMS 10

Aircraft Pressure measurement, temperature measurement, fuel quantity measurement, engine power and control instruments-measurement of RPM, manifold pressure, torque, exhaust gas temperature, EPR, Engine Fuel Indicators, engine vibration monitoring, Cockpit Voice Recorder and Flight Data Recorder

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO1: Know the importance of avionics and its subsystem in an aircraft
CO2: Understand various data buses and protocols
CO3: Understand the working principle of various aircraft attitude sensors and its importance in Controls system design
CO4: Know the importance of Cockpit system and its importance in aircraft complex system.
CO5: Understand the importances of sensors in Engine control system.

Mapping of COs with POs and PSOs															
COs/POs & PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	1	1							1	1	2	1
CO2	3	2	1	1	1							1	1	2	1
CO3	3	2	1	1	1							1	1	2	1
CO4	3	2	1	1	1							1	1	2	1
CO5	3	2	1	1	1							1	1	2	1
CO/PO & PSO Average	3	2	1	1	1							1	1	2	1
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Collinson R.P.G. Introduction to Avionics, Chapman and Hall, 1996.

REFERENCES

2. Spitzer, C.R. Digital Avionics Systems, Prentice Hall, Englewood Cliffs, N.J., U.S.A., 1987.
3. Pallet, E.H.J. Aircraft Instruments & Integrated systems, Longman Scientific and Technical, McGraw-Hill, 1992.

RO5026 OPTIMIZATION TECHNIQUES

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

1. To understand the concept in operation research
2. To learn about the linear programing
3. To understand the various methods in one dimensional and multi-dimensional
4. To obtain the knowledge in constrained and unconstrained problems
5. To understand the various methods in evolutionary programming

UNIT – I INTRODUCTION TO OPERATIONS RESEARCH 9

Introduction to Operations Research – assumptions of linear programming problems - Formulations of linear programming problem – Graphical method

UNIT – II LINEAR PROGRAMMING 9

Solutions to LPP using simplex algorithm- Revised simplex method - primal dual relationships – Dual simplex algorithm - Sensitivity analysis - Computer programming linear methods

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UNIT – III ONE DIMENSIONAL AND MULTI-DIMENSIONAL 9

Introduction to descent methods – global convergence of decent algorithms – speed convergence –Fibonacci method – golden section search method – steepest descent – newton's method –polynomial approximation method- computer programming in one dimensional and multi-dimensional methods

UNIT – IV UNCONSTRAINED OPTIMIZATION FOR CONSTRAINED PROBLEMS 9

Lagrange method – inequality constraints – KKT conditions – quadratic programming – geometric programming – separable linear programming – sequential linear programming – feasible direction method

UNIT – V EVOLUTIONARY PROGRAMMING 9

Genetic Engineering – Genetic Operators – Reproduction – Crossover – Mutation – Selection – Genetic Local Search – Simulated Annealing – Ant Colony Optimization – Particle Swarm Optimization

TOTAL HOURS: 45

COURSE OUTCOMES

At the end of the course students able to

CO1: Knowledge on the concept in operation research
CO2: Understand about the linear programing
CO3: Analyze the various methods in one dimensional and multi-dimensional
CO4: Knowledge in constrained and unconstrained problems
CO5: Perform the various methods in evolutionary programming

Mapping of COs with POs and PSOs															
COs/POs & PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	1	2		1							1	2	3	1
CO2	2	1	2		1							1	2	3	1
CO3	2	1	2		1							1	2	3	1
CO4	2	1	2		1							1	2	3	1
CO5	2	1	2		1							1	2	3	1
CO/PO & PSO Average	2	1	2		1							1	2	3	1
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS:

1. Harvey M Wagner, "Principles of Operations Research", Prentice Hall of India, 2010.
2. Hitler Libermann, "Operations Research, McGraw Hill Pub, 2009.
3. Pant J C, "Introduction to Optimisation: Operations Research", Jain Brothers, Delhi, 2008.

REFERENCES:

1. Pannerselvam, "Operations Research", Prentice Hall of India, 2016.
2. Taha H A, "Operations Research, An Introduction", PHI, 2016.
3. Singiresu S Rao, "Engineering Optimization: Theory and Practice", Wiley, 5th Edition, 2019.
4. David G.Luenberger, "Linear and Nonlinear Programming", Springer Publications, 3rd Edition, 2008.
5. Hamdy A Taha, "Operations Research – An Introduction", Pearson, 10th Edition, 2018.
6. Stephen Boyd, Lieven Vandenberghe, "Convex Optimization", Cambridge, 2016.
7. Bertsekas, Dimitri P. "Nonlinear Programming". 3rd Edition. Athena Scientific Press, Belmont, Massachusetts 2016

Attested

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RO5027 TOTAL INTEGRATED AUTOMATION

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To gain knowledge in automation in industries.
2. To gain knowledge in various electrical and electronic programmable automations and their applications.
3. To know about the basic in SCADA and DCS systems.
4. To gain knowledge in communication protocols in an integrated system
5. To know about the advanced in automation industries

UNIT – I TOTALLY INTEGRATED AUTOMATION 9

Need, components of TIA systems, advantages, Programmable Automation Controllers (PAC), Vertical Integration structure.

UNIT – II HUMAN MACHINE INTERFACE (HMI) 9

Necessity and Role in Industrial Automation, Need for HMI systems. Types of HMI- Text display - operator panels - Touch panels - Panel PCs - Integrated displays (PLC & HMI).

UNIT – III SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA) 9

Overview – Developer and runtime packages – architecture – Tools – Tag – Internal &External graphics, Alarm logging – Tag logging – structured tags– Trends – history– Report generation, VB & C Scripts for SCADA application.

UNIT – IV COMMUNICATION PROTOCOLS OF SCADA 9

Proprietary and open Protocols – OLE/OPC- UPC UA/DA – DDE – Server/Client Configuration – Messaging – Recipe – User administration – Interfacing of SCADA with PLC, drive, and other field device

UNIT – V DISTRIBUTED CONTROL SYSTEMS (DCS) 9

DCS – architecture – local control unit- programming language – communication facilities – operator interface – engineering interfaces. APPLICATIONS OF PLC & DCS: Case studies of Machine automation, Process automation, Introduction to SCADA Comparison between SCADA and DCS.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO 1: Knowledge of PLC & PAC automation
CO 2: Knowledge in HMI systems and to integrate it with other systems.
CO 3: Ability to apply SCADA and usage of C programming for report generation
CO 4: Acquiring information's on communication protocols in automation systems
CO 5: Ability to design and develop automatic control system using distributed control systems.

Mapping of COs with POs and PSOs

COs/POs & PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1	1			2					1	2	1	3
CO2	3	2	1	1			2					1	2	1	3
CO3	3	2	1	1			2					1	2	1	3
CO4	3	2	1	1			2					1	2	1	3
CO5	3	2	1	1			2					1	2	1	3

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CO/PO & PSO Average	3	2	1	1			2					1	2	1	3
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS:

1. John. W. Webb & Ronald A. Reis, "Programmable logic controllers: Principles and Applications", Pearson Publications, 5th Edition, 2015.
2. Michael P. Lukas, "Distributed Control systems- The Evaluation and design", Van Nostrand Reinfold Company, 2016.

REFERENCES:

1. Win C C Software Manual, Siemens, 2003
2. RS VIEW 32 Software Manual, Allen Bradly, 2005
3. CIMPLICITY SCADA Packages Manual, Fanuc India Ltd, 2004

RO5028 ADVANCED DRIVER ASSISTANCE SYSTEM

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

The objectives of the course are:

1. To introduce students with various fundamentals related to advanced driver assistance technologies
2. To impart knowledge on sensors, control and actuation methodologies and create impact of automating vehicles
3. To acquire skills on vehicle prognostics and impaired driver technology
4. To learn about various commonly available Advanced Driver Assistance Systems.
5. To study about Center Console Technology and other display technology.

UNIT – I AUTOMOTIVE FUNDAMENTALS 9

Power System-Running System-Comfort System– Engine Components – Drive train – suspension system, ABS, Steering System

UNIT – II AUTOMOTIVE SENSORS 9

Knock sensors, oxygen sensors, crankshaft angular position sensor, temperature sensor, speed sensor, Pressure sensor, Mass air flow sensor, Manifold Absolute Pressure Sensors, crash sensor, Coolant level sensors, Brake fluid level sensors – operation, types, characteristics, advantage and their applications. Radar, Ultrasonic Sonar Systems, Lidar Sensor Technology and Systems, Camera

UNIT – III OVERVIEW OF DRIVER ASSISTANCE TECHNOLOGY 9

Basics of Theory of Operation, Applications, Integration of ADAS Technology into Vehicle Electronics, System Examples, Role of Sensor Data Fusion. Vehicle Prognostics Technology

UNIT – IV ADAS TECHNIQUES 9

Advanced Driver Assistance Systems - Lane Departure (LDW), Active Cruise Control (ACC), Blind Spot Detection, Parking Assist, Autonomous Emergency Braking (AEB), Night Vision, Traffic Sign Recognition (TSR), Intelligent High beam Assistant (IHC), Tire Pressure Monitoring (TPMS), Front Collision Warning System (FCWS), Front Vehicle Departure Warning (FVDW), Adaptive Lighting, Driver Drowsiness Detection, Hill Decent Control, Rear Cross Traffic

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UNIT – V ADAS DISPLAY & IMPAIRED DRIVER TECHNOLOGY 9

Center Console Technology, Gauge Cluster Technology, Heads-Up Display Technology, and Warning Technology – Driver Notification. Impaired Driver Technology -Driver Impairment Sensor Technology, Sensor Technology for Driver Impairment Detection, Transfer of Control Technology

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO1: Understand the rational for and evolution of automotive electronics

CO2: Identify various sensors used in automobile

CO3: Become familiar with the theory and operation of legacy, new, and emerging ADAS systems and proposed autonomous vehicle systems.

CO4: Understand the fundamentals of sensor data fusion as it relates to ADAS

CO5: Become aware of the possible evolution of vehicle prognostics and impaired driver technology

Mapping of COs with POs and PSOs

COs/POs & PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1	1		1						1	2	1	
CO2	3	2	1	1		1						1	2	1	
CO3	3	2	1	1		1						1	2	1	
CO4	3	2	1	1		1						1	2	1	
CO5	3	2	1	1		1						1	2	1	
CO/PO & PSO Average	3	2	1	1		1						1	2	1	

1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOKS

1. Tom Denton, “Automobile Electrical and Electronic systems, Roultedge”, Taylor & Francis Group, 5th Edition, 2018.
2. William B Ribbens, “Understanding Automotive Electronic: An Engineering Perspective”, Elsevier Science, 8th Edition, 2017.

REFERENCES

1. “Intelligent Transportation Systems and Connected and Automated Vehicles”, Transportation Research Board, 2016.
2. Radovan Miucic, “Connected Vehicles: Intelligent Transportation Systems”, Springer, 2019.

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