RAJALAKSHMI ENGINEERING COLLEGE

(An Autonomous Institution Affiliated to Anna University Chennai)

B.E. ROBOTICS AND AUTOMATION

R-2023 CURRICULUM & SYLLABUS

(CHOICE BASED CREDIT SYSTEM)

DEPARTMENT OF ROBOTICS AND AUTOMATION

DEPARTMENT VISION:

To be a department of excellence in academics, research and technological advancement in Robotics and Automation with a concern for society.

DEPARTMENT MISSION:

- To impart high technical knowledge, strong fundamentals, practical skills and creative knowledge for making successful professionals in Robotics and Automation
- To foster students by infusing leadership qualities to become successful Engineer
- To inculcate the entrepreneurial qualities for creating, developing and managing global engineering ventures

PROGRAMME EDUCATIONAL OBJECTIVES (PEOS):

PEO I

To impart students with strong and comprehensive knowledge in the analytical, scientific and engineering fundamentals for solving engineering problems

PEO II

To disseminate students with necessary skills, knowledge and leadership qualities for successful careers in industry

PEO III

To instill students with technical expertise, ethical practices and team spirit and a concern towards greener society

PROGRAM OUTCOMES (POs):

Engineering Graduates will be able to:

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 analyze 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 multidisciplinary 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.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO 1: Design and develop efficient Automation system to enhance the quality of life by applying fundamentals of Basic Science, Mechanical and Mechatronics Engineering

PSO 2: Analyze and improve the performance of Manufacturing and Production system by implementing the Soft and hard Computing methods

PSO 3: Manage and lead a professional or an entrepreneur career in industries by applying modern Engineering, management principles and best practices

RAJALAKSHMI ENGINEERING COLLEGE

(An Autonomous Institution Affiliated to Anna University Chennai)

CURRICULUM AND SYLLABUS REGULATIONS – 2023

CHOICE BASED CREDIT SYSTEM

B.E. ROBOTICS AND AUTOMATION

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY COURSE								
1.	HS23111	Technical Communication I	HSMC	2	2	0	0	2
2.	MA23112	Algebra and Calculus	BS	4	3	1	0	4
3.	GE23111	Engineering Graphics	ES	6	2	0	4	4
4	RO23111	Introduction To Mechanical Systems	ES	3	2	1	0	3
LAB ORIENTED THEORY COURSE								
5.	EE23132	Basic Electrical Engineering	ES	5	3	0	2	4
LABORATORY COURSE								
6.	GE23121	Engineering Practices – Civil and Mechanical	ES	2	0	0	2	1
7.	GE23122	Engineering Practices- Electrical and Electronics	ES	2	0	0	2	1
MANDATORY COURSE								
8.	MC23112	Environmental Science and Engineering	MC	3	3	0	0	0
9.	GE23117	தமிழர்மரபு /Heritage of Tamils	HSMC	1	1	0	0	1
			TOTAL	**28**	**16**	**2**	**12**	**20**

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY COURSE								
1.	MA23212	Differential Equations and Complex Variables	BS	4	3	1	0	4
LAB ORIENTED THEORY COURSE								
2.	CY23131	Chemistry for Electronics Engineering	BS	5	3	0	2	4
3.	PH23131	Physics of Materials	BS	5	3	0	2	4
4.	GE23233	Problem solving and Python programming	ES	6	2	0	4	4
LABORATORY COURSE								
5.	HS23221 / HS23222	Technical Communication II / English for Professional Competence	HSMC	2	0	0	2	1
6.	RO23221	Computer Aided Modeling Laboratory	ES	4	0	0	4	2
MANDATORY COURSE								
7.	GE23217	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology	HSMC	1	1	0	0	1
8.	MC23111	Indian Constitution and Freedom Movement	MC	3	3	0	0	0
			TOTAL	**30**	**15**	**1**	**14**	**20**

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY COURSE								
1.	MA23311	Transforms And Applied Partial Differential Equations	BS	4	3	1	0	4
2.	RO23311	Analog and Digital Electronics	PC	3	3	0	0	3
3.	RO23312	Theory of Mechanisms and Machines-I	PC	4	3	1	0	4
4.	RO23313	Sensors in Automation	PC	3	3	0	0	3
LAB ORIENTED THEORY COURSE								
5.	RO23331	Elements of Manufacturing Processes	PC	5	3	0	2	4
6.	RO23332	Mechanics of Materials	ES	5	3	0	2	4
LABORATORY COURSE								
7.	CS23422	Python Programming for Machine Learning	ES	4	0	0	4	2
			TOTAL	**28**	**18**	**2**	**8**	**24**

SEMESTER IV

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY COURSE								
1.	RO23411	Fluid Power Systems	PC	3	3	0	0	3
2.	RO23412	Industrial Automation and Control	PC	3	3	0	0	3
3.	RO23413	Microcontrollers and Real Time Embedded Systems	PC	3	3	0	0	3
4.	RO23414	Robot Kinematics	PC	4	3	1	0	4
LAB ORIENTED THEORY COURSE								
5.	MA23432	Statistics and Numerical Methods	BS	5	3	0	2	4
LABORATORY COURSE								
6.	RO23421	Mechanisms and Robotics laboratory	PC	4	0	0	4	2
7.	RO23422	Industrial Automation Laboratory-I	PC	4	0	0	4	2
8.	GE23421	Soft skills – I	EEC	2	0	0	2	1
			TOTAL	**28**	**15**	**1**	**12**	**22**

SEMESTER V

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY COURSE								
1.	RO23511	AI for Robotics	PC	3	3	0	0	3
2.	RO23512	Theory of Mechanisms and Machines-II	PC	4	3	1	0	4
3.	ME23511	Machine Design	PC	3	3	0	0	3
4.		Open Elective – I	OE	3	3	0	0	3
5.		Professional Elective –I	PE	3	3	0	0	3
LABORATORY COURSE								
6.	RO23521	Mobile Robotics laboratory	PC	4	0	0	4	2
7.	RO23522	Industrial Automation Laboratory-II	PC	4	0	0	4	2
8.	RO23523	Internship	EEC	2	0	0	2	1
9.	GE23521	Soft Skills – II	EEC	2	0	0	2	1
			TOTAL	**28**	**15**	**1**	**12**	**22**

SEMESTER VI

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY COURSE								
1.	ME23612	Design of Transmission systems	PC	3	3	0	0	3
2.		Professional Elective – II	PE	3	3	0	0	3
3.		Professional Elective – III	PE	3	3	0	0	3
LAB ORIENTED THEORY COURSE								
4.	RO23631	Robot operating System	PC	4	2	0	2	3
5.	RO23632	Robot Vision and Intelligence	PC	5	3	0	2	4
6.	RO23633	Robot Dynamics and Motion Planning	PC	5	3	0	2	4
LABORATORY COURSE								
7.	GE23627	Design Thinking and Innovation	EEC	4	0	0	4	2
8.	GE23621	Problem solving Techniques	EEC	2	0	0	2	1
			TOTAL	**29**	**17**	**0**	**12**	**23**

SEMESTER VII

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY COURSE								
1.	RO23711	Aerial Robotics	PC	3	3	0	0	3
2.	RO23712	Humanoid Robotics	PC	3	3	0	0	3
3.	RO23713	Resource Management Techniques	HSMC	4	3	1	0	4
4.		Professional Elective – IV	PE	3	3	0	0	3
5.		Open Elective – II	OE	3	3	0	0	3
LABORATORY COURSE								
6.	RO23721	Robotics and Automation Problem Solving using AI, ML and DL	PC	4	0	0	4	2
7.	RO23722	Project Work- Phase I	EEC	6	0	0	6	3
			TOTAL	**26**	**15**	**1**	**10**	**21**

SEMESTER VIII

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY COURSE								
1.		Professional Elective - V	PE	3	3	0	0	3
2.		Professional Elective - VI	PE	3	3	0	0	3
PRACTICAL COURSE								
3.	RO23821	Project Work- Phase II	EEC	14	0	0	14	7
TOTAL				**20**	**6**	**0**	**14**	**13**

TOTAL NO. OF CREDITS: 165

SUMMARY

DEPARTMENT OF ROBOTICS AND AUTOMATION											
	Subject Area	**Credits Per Semester**								Credits Total	Percentage %
	Semester	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**		
1.	Humanities, Social Studies and management science (HSMC)	3	2					4		9	5.4
2.	Basic Sciences (BS)	4	12	4	4					24	14.6
3.	Engineering Sciences (ES)	13	6	6						25	15.2
4.	Professional Core (PC)			14	17	14	14	8		67	40.6
5.	Professional Electives (PE)					3	6	3	6	18	10.9
6.	Open Electives (OE)					3		3		6	3.6
7.	Project Work/ Employability Enhancement Course (PR/EEC)				1	2	3	3	7	16	9.7
	TOTAL	20	20	24	22	22	23	21	13	165	
8.	Non-Credit*/ (Mandatory)	√	√	–	-	-	-	-	-		

Professional Elective Verticals

Category	COMMON VERTICALS		DEPT. VERTICALS- R&A			DIVERSIFIED
	VERTICAL 1	VERTICAL 2	VERTICAL 3	VERTICAL 4	VERTICAL 5	VERTICAL 6
Offered in	**COMPUTATIONAL ENGINEERING**	**LOGISTICS AND SUPPLY CHAIN MANAGEMENT**	**APPLIED ROBOTICS**	**DESIGN AND MANUFACTURING**	**INTELLIGENT SYSTEMS**	**DIVERSIFIED**
V/VI SEM	ME23A11-Machine Learning for Intelligent Systems	ME23B11-Reliability and Maintenance Engineering	RO23C11- Marine Robotics	**ME23611- Additive Manufacturing Technologies**	RO23E11-Fuzzy Logic and Neural Networks	RO23F11- Basics of Thermal Engineering
V/VI SEM	ME23A12-CAD and CAE	ME23B12-Warehousing Automation	RO23C12-Machine Learning and Cognitive Robotics	**ME23D16-Design for X**	**EC23A18- Introduction to Deep Learning**	RO23F12-Object Oriented Programming in C++
V/VI SEM	ME23A13-Numerical heat transfer	ME23B13-Operations Management	RO23C13-Farm Automation	RO23D11-CNC Machine Tools and Programming	RO23E12-Industrial Network Protocols	ME23G15 – Principles of Management
VII SEM	ME23A14-Theory on Computation and Visualization	ME23B14-Material Handling Equipment, Repair and Maintenance	RO23C14-Collaborative Robotics	RO23D12-Computer Integrated Manufacturing	RO23E13-Condition Monitoring and Fault Diagnostics	RO23F13- Production and Operation Management
VII SEM	ME23A15-Computational Bio-Mechanics	ME23B15-Container Logistics	RO23C15-Field and Service Robots	RO23D13-Advanced Manufacturing Systems	RO23E14-Applied Signal Processing	RO23F14- IoT Devices
VII SEM	ME23A16-Advanced Statistics and Data Analytics	ME23B16-Production Planning and Control	RO23C16-Space Robotics	**ME23E17-Electronics Manufacturing Technology**	RO23E15-Applied Image Processing	**MT23D12-Virtual Instrumentation**
VIII SEM	ME23A17-Noise acoustics & vibration	ME23B17-Operations Research	RO23C17- Micro Robotics	RO23D14-Computer Aided Inspection and Testing	**ME23C18- Haptics and Immersive Technologies**	**ME23G12-Industrial Safety**
VIII SEM	ME23A18-Computational Solid Mechanics	ME23B18-Supply chain and Logistics Management	**BM23D12 -Medical Robotics**	RO23D15-Integrated Product Development	RO23E16-Total Integrated Automation	RO23F15-Project Management
VIII SEM	ME23A19-Computational Fluid Dynamics	ME23B19-Data Science	RO23C18-Parallel Manipulators	**ME23E18-Digital Twin and Industry 4.0**	RO23E17-Advanced Optimization Techniques	**ME23G17-Marketing Management**

SEMESTER I

Course Code	Course Title (Theory Course)	Category	L	T	P	C
HS23111	Technical Communication I	HS	2	0	0	2
Common to all branches of I sem. B.E./ B.Tech. programmes						

Objectives:	
●	To facilitate students, develop their comprehension skills
●	To enable students to improve their receptive skills
●	To equip learners with better vocabulary and enhance their writing skills
●	To aid students speak effectively in all kinds of communicative contexts.
●	To improve the learners' basic proficiency in workplace communication

UNIT-I	DEVELOPING COMPREHENSION SKILLS	6
Listening: Introduction to Informational listening – Listening to Podcasts, News **Reading**: Intentional Reading - Short Narratives and Passages. **Speaking:** Introducing Oneself, Narrating a Story / Incident. **Writing:** Sequential Writing – connecting ideas using transitional words (Jumbled Sentences), Process Description **Grammar:** Verbs – Main & Auxiliary: Simple Tenses – Form, Function and Meaning. **Vocabulary**: Word formation – Prefix, Suffix, Compound Words.		
UNIT-II	**LISTENING AND EXTENDED READING**	6
Listening: Deep Listening – Listening to Talk Shows and Debates **Reading**: In-depth Reading - Scanning Passages **Speaking**: Describing Current Issues, Happenings, etc.., **Writing**: Note Making, Note Taking – Paragraph Writing **Grammar**: Continuous Tenses, Prepositions, Articles **Vocabulary**: One Word Substitutes, Phrasal Verbs.		
UNIT-III	**FORMAL WRITING AND VERBAL ABILITY**	6
Listening: Listening to Lectures and Taking Notes **Reading:** Interpretation of Tables, Charts and Graphs **Speaking:** SWOT Analysis on Oneself **Writing:** Formal Letter Writing and Email Writing **Grammar:** Perfect Tenses, Phrases and Clauses, Discourse Markers **Vocabulary :** Verbal Analogy / Cloze Exercise		
UNIT-IV	**ENHANCING SPEAKING ABILITY**	6
Listening: Listening to eminent voices of one's interest (Martin Luther King, APJ Abdul Kalam, etc..) **Reading:** Timed Reading, Filling KWL Chart. **Speaking:** Just a Minute, Impromptu **Writing:** Check-list, Instructions. **Grammar:** 'Wh' Questions / 'Yes' or 'No' Questions, Imperatives **Vocabulary:** Synonyms, Antonyms, Different forms of the same words.		
UNIT-V	**LANGUAGE FOR WORKPLACE**	6
Listening: Extensive Listening (Audio books, rendering of poems, etc.) **Reading**: Extensive reading (Jigsaw Reading, Short Stories, Novels) **Speaking**: Short Presentations on Technical Topics **Writing:** Recommendations, Essay Writing **Grammar:** Impersonal Passive, Reported Speech, Concord **Vocabulary:** Informal Vocabulary and Formal Substitutes		
Total Contact Hours: 30		

Course Outcomes: On completion of the course students will be able to	
●	apply their comprehension skills and interpret different contents effortlessly
●	read and comprehend various texts and audio-visual contents
●	infer data from graphs and charts and communicate it efficiently in varied contexts
●	participate effectively in diverse speaking situations
●	to present, discuss and coordinate with their peers in workplace using their language skills

SUGGESTED ACTIVITIES

- Ice breaker
- Just A Minute
- Ship wreck
- Hot seat
- Vocabulary building
- Chinese whispers
- Case study

SUGGESTED EVALUATION METHODS

- Assignment topics
- Quizzes
- Class Presentation/Discussion
- Continuous Assessment Tests

Text Book (s):	
1	Effective Technical Communication by M. Ashraf Rizvi (Author) 2nd Edition Paperback 2017
2	Sylvan Barnet and Hugo Bedau, 'Critical Thinking Reading and Writing', Bedford/st. Martin's: Fifth Edition (June 28, 2004)
3	Meenakshi Upadhyay, Arun Sharma – Verbal Ability and Reading Comprehension.
4	Teaching Speaking: A Holistic Approach, Book by Anne Burns and Christine ChuenMeng Goh, Cambridge University Press

Reference Books(s) / Web links:	
1	Basic Vocabulary in Use: 60 Units of Vocabulary Practice in North American English With Answers 2nd Edition by Michael McCarthy (Author), Felicity O'Dell (Author), John D. Bunting (Contributor)
2	Reading Development and Difficulties By Kate Cain
3	The 7 Habits of Highly Effective People by Stephen Covey, Simon and Schuster, UK
4	Everybody Writes: Your Go-To Guide to Creating Ridiculously Good Content Hardcover by Ann Handley (Author)

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
HS23111.1	-	-	-	1	-	-	-	-	-	3	-	-	-	-	1
HS23111.2	-	-	-	1	-	-	-	-	-	3	-	-	-	-	1
HS23111.3	-	1	-	1	-	-	-	-	-	3	-	-	-	-	1
HS23111.4	-	-	-	2	-	-	-	-	1	3	-	-	-	-	1
HS23111.5	-	-	-	1	-	-	-	-	1	3	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

.

Course Code	Course Title (Theory Course)	Category	L	T	P	C
MA23112	Algebra and Calculus	BS	3	1	0	4

Common to I sem. B.E. – Aeronautical Engineering, Automobile Engineering, Mechanical Engineering, Mechatronics, Robotics & Automation, Civil Engineering and B.Tech. - Biotechnology, Food Technology & Chemical Engineering

Objectives:

- To introduce the matrix techniques and to illustrate the nature of the matrix.
- To address data and synthesis of the information to provide valid conclusions.
- To explain techniques of calculus which are applied in the solutions of engineering problems.
- To analyze special types of integrals by analytical methods and numerical techniques.
- To practice the techniques of Integration in finding area and volumes.

UNIT-I	**MATRICES**	12
Matrices - Eigenvalues and eigenvectors - Diagonalization of matrices using orthogonal transformation - Cayley-Hamilton Theorem(without proof) -Quadratic forms- Reduction to canonical form using orthogonal transformation- Numerical computation of Eigen value using Power method		
UNIT-II	**FUNCTIONS OF SEVERAL VARIABLES**	12
Partial differentiation–Total derivative–Change of variables–Jacobians–Partial differentiation of implicit functions–Taylor's series for functions of two variables–Maxima and minima of functions of two variables–Lagrange's method of undetermined multipliers.		
UNIT-III	**INTEGRAL CALCULUS**	12
Integral Calculus: Definite Integrals as a limit of sums - Applications of integration to area, volume - Improper integrals: Beta and Gamma integrals - Numerical computation of integrals: Trapezoidal rule - Gaussian Two point quadrature		
UNIT-IV	**MULTIPLE INTEGRALS**	12
Double integrals – Change of order of integration – Area enclosed by plane curves–Triple integrals–Volume of solids–Numerical computation of double integrals: Trapezoidal rule.		
UNIT-V	**REGRESSION**	12
Scatter diagram - Karl Pearson coefficient of correlation for raw data –Spearman rank correlation coefficient - Lines of regression - Regression equation X on Y and Y on X- Curve fitting by Principle of least squares - Fitting a straight-line $y = ax+b$ and a parabola $y = ax^2 + bx + c$.		
		Total Contact Hours:60

Course Outcomes:

On completion of the course students will be able to

- Demonstrate the matrix techniques in solving the related problems in engineering and technology.
- Analyze and interpret data, and synthesize information to provide valid conclusions.
- Interpret the problems in Engineering and Technology using the principles of mathematical calculus.
- Apply the analytical methods and numerical techniques to solve the related engineering problems.
- Evaluate multiple integrals to conduct investigations of complex problems.

SUGGESTED ACTIVITIES

- Problem solving sessions
- Activity Based Learning
- Implementation of small module

SUGGESTED EVALUATION METHODS

- Problem solving in Tutorial sessions
- Assignment problems
- Quizzes and class test
- Discussion in classroom

Text Book (s):	
1	Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2	Gupta S.C. and Kapoor V.K." F u n d a m e n t a l s of Mathematical Statistics", Sultan and Sons 10th Edition, 2000.
3	T Veerarajan, "Engineering Mathematics –I", McGraw Hill Education, 2018.
4	I.R. Miller, J.E. Freund and R. Johnson, "Probability and Statistics for Engineers ", 4th Edition, Pearson, 2018.
5	A. Goon, M. Gupta and B. Dasgupta, "Fundamentals of Statistics ", Vol. I & Vol. II, World Press, 2019.

Reference Books(s) / Web links:	
1	Ramana. B.V., "Higher Engineering Mathematics ", McGraw Hill Education Pvt. Ltd, New Delhi, 2018.
2	T Veerarajan , "Fundamentals of Mathematical Statistics", yesdee publications, 2017.
3	Erwin Kreyszig ," Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2016.
4	Bali, N.P. and Manish Goyal, A Text Book of Engineering Mathematics, Lakshmi Publications Pvt. Ltd., New Delhi, 2006.
5	N. Draper & H. Smith, "Applied Regression Analysis" 3rd Edition, Wiley, 1998.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MA23112.1	3	2	1	-	-	-	-	-	-	-	1	-	1	-	-
MA23112.2	3	2	-	1	-	-	-	-	-	-	1	1	1	-	-
MA23112.3	2	2	-	-	-	-	-	-	-	-	1	1	1	-	-
MA23112.4	3	3	1	-	-	-	-	-	-	-	1	1	1	-	-
MA23112.5	2	2	-	-	-	-	-	-	-	-	-	-	1	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory Course)	Category	L	T	P	C
GE23111	**Engineering Graphics**	ES	**2**	**2**	**0**	**4**

Objectives:	
●	To understand the importance of the drawing in engineering applications
●	To develop graphic skills for communication of concepts, ideas and design of engineering products
●	To expose them to existing national standards related to technical drawings.
●	To improve their visualization skills so that they can apply these skill in developing new products.
●	To improve their technical communication skill in the form of communicative drawings

CONCEPTS AND CONVENTIONS (Not for Examination)	**1 Hour**
Importance of graphics in engineering applications–Use of drafting instruments– BIS conventions and specifications– Size, layout and folding of drawing sheets– Lettering and dimensioning. Basic Geometrical constructions.	

UNIT-I	**PLANE CURVES AND PROJECTION OF POINTS**	**5+12**
Curves used in engineering practices: Conics–Construction of ellipse, parabola and hyperbola by eccentricity method – Cycloidal Curves–Construction of cycloid, epicycloid and hypocycloid – Construction of involutes of square and circle–Drawing of tangents and normal to the above curves. Principles of Projection and Projection of points.		
UNIT-II	**PROJECTION OF LINES AND PLANE SURFACES**	**6+12**
Projection of straight lines (First angle projection) inclined to both the principal planes – Determination of true lengths and true inclinations by rotating line method Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.		
UNIT-III	**PROJECTION OF SOLIDS AND PROJECTION OF SECTIONED SOLIDS**	**6+12**
Projection of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to one of the principal planes by rotating object method. Sectioning of solids in simple vertical position when the cutting plane is inclined to HP and perpendicular to VP – obtaining true shape of the section. Practicing three-dimensional modeling of simple objects by CAD software (Not for examination)		
UNIT-IV	**DEVELOPMENT OF SURFACE AND ISOMETRIC PROJECTIONS**	**6+12**
Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones. Principles of isometric projection–isometric scale–Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders and cones Model making of isometric projection of combination of solids as assignment (Not for End semester)		
UNIT-V	**FREE HAND SKETCHING AND PERSPECTIVE PROJECTIONS**	**6+12**
Free Hand sketching: Freehand sketching of multiple views from pictorial views of objects - Freehand sketching of pictorial views of object from multiple views Perspective projection of simple solids-Prisms, pyramids, cylinder and cone by visual ray method.		
		Total Contact Hours: (L=30; P=60) 90 Periods

Course Outcomes: On completion of the course students will be able to	
●	To construct different plane curves and to comprehend the theory of projection
●	To draw the basic views related to projection of lines and planes
●	To draw the projection of simple solids and to draw the projection of development of surfaces of Sectioned solids in simple vertical position
●	To draw the orthographic projection from pictorial objects and Isometric projections of simple solids
●	To visualize Perspective view of simple solids

Text Book (s):	
1	Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 50th Edition, 2010.
2	Natrajan K.V., "A text book of Engineering Graphics", DhanalakshmiPublishers, Chennai, 2017.

Reference Books(s) / Web links:	
1	Varghese P I., "Engineering Graphics", McGraw Hill Education (I) Pvt.Ltd., 2013.
2	V.B Sikka "Civil Engineering Drawing", S.K Kataria & Sons, New Delhi,2022.
3	Venugopal K. and PrabhuRaja V., "Engineering Graphics", New Age International (P)Limited, 2008.
4	Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Stores, Bangalore, 2017.
5	Basant Agarwal and Agarwal C.M., "Engineering Drawing", McGraw Hill Publishing Company Limited, New Delhi, 2018.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
GE23111.1	3	2	2	1	-	1	-	2	2	2	-	2	2	2	1
GE23111.2	3	2	2	1	-	1	-	2	2	2	-	2	2	2	1
GE23111.3	3	2	2	1	-	1	-	2	2	2	-	2	2	2	1
GE23111.4	3	2	2	1	-	1	-	2	2	2	-	2	2	2	1
GE23111.5	3	2	2	1	-	1	-	2	2	2	-	2	2	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory Course)	Category	L	T	P	C
RO23111	Introduction to Mechanical Systems	ES	2	1	0	3

Objectives:	
●	To understand the basics of mechanics and to solve problems of equilibrium of a Particle in Space.
●	To understand the concept of equilibrium and to solve problems of rigid bodies.
●	To learn about the center of gravity and moment of inertia of surfaces and solids.
●	To learn the concepts in kinematics and kinetics of rigid bodies in plane motion.
●	To know the types of robotics.

UNIT-I	STATICS OF PARTICLES	9
Introduction to Mechanics, Units and Dimensions, Force on a Particle, Resultant of Two Forces, Equilibrium of a Particle, Free body diagram, Newton's First Law of Motion, Equilibrium of a Particle in Space.		
UNIT-II	**EQUILIBRIUM OF RIGID BODIES**	9
Introduction, External and Internal Forces, Principle of Transmissibility, Moment of a Force about a Point, Varignon's Theorem, Reactions at Supports and Connections for a Two-dimensional Structure, Equilibrium of a Rigid Body in Two Dimensions, Statically Indeterminate Reactions, Equilibrium of Rigid bodies in two dimensions.		
UNIT-III	**CENTER OF GRAVITY AND MOMENT OF INERTIA**	9
First and second moment of area and mass, radius of gyration, parallel axis theorem, perpendicular axis theorem, product of inertia. Problems- T section, I section, rectangular section, circular section.		
UNIT-IV	**DYNAMICS**	9
Introduction to Dynamics, Rectilinear and Projectile Motion of particles, Kinetics of particle - Newton's Second Law of Motion and work - Energy Equations, Introduction to Kinematics of Rigid Bodies-Translation, Rotation about a Fixed Axis, Equations Defining the Rotation of a Rigid Body about a Fixed Axis, General Plane Motion-Absolute and Relative Velocity in Plane Motion.		
UNIT-V	**INTRODUCTION TO ROBOTICS**	9
History and growth of Robotics, Laws of Robotics, types of joints used in robots, degrees of freedom of planar and spatial manipulator, Introduction and application of autonomous mobile robots (AMRs), automated guided vehicles (AGVs), articulated robots, humanoids, cobots.		
	Total Contact Hours : 45	

Course Outcomes: On completion of the course students will be able to	
●	Comprehend and analysis the forces in the system.
●	Solve problems in engineering systems using the concept of static equilibrium.
●	Determine the centroid of objects such as areas and volumes, center of mass of body and moment of inertia of composite areas.
●	Solve problems involving kinematics and kinetics of rigid bodies in plane motion.
●	Select a robot for the application

Text Book (s):	
1	Beer, F.P and Johnston Jr. E.R, Cornwell and Sanghi., "Vector Mechanics for Engineers (In SI Units): Statics and Dynamics", 11th Edition, McGraw-Hill Publishing company, New Delhi (2017).
2	Mikell P Groover, Mitchell Weiss, Roger N Nagel, Nicholas Odrey, Ashish Dutta "Industrial Robotics (SIE):Technology, Programming and Applications", McGraw Hill Education India., 2012

Reference Books(s) / Web links:	
1	Meriam J.L. and Kraige L.G., "Engineering Mechanics- Statics - Volume 1, Dynamics- Volume 2", Third Edition, Wiley India,2017.
2	Hibbeller, R.C and Ashok Gupta, "Engineering Mechanics: Statics and Dynamics", 11th Edition, Pearson Education 2010.
3	Irving H. Shames and Krishna Mohana Rao. G., "Engineering Mechanics – Statics and Dynamics" 4th Edition, Pearson Education 2006.
4	S SBhavikatti, Engineering Mechanics, New Age International Publishers, 2019
5	Vela Murali, "Engineering Mechanics", Oxford University Press, 2010

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23111.1	3	3	3	1	1	-	1	1	1	1	1	1	3	2	1
RO23111.2	3	3	3	1	1	-	1	1	1	1	1	1	3	2	1
RO23111.3	3	3	3	1	1	-	1	1	1	1	1	1	3	2	1
RO23111.4	3	3	3	1	1	-	1	1	1	1	1	1	3	2	1
RO23111.5	3	3	3	1	1	1	1	1	1	1	1	1	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Subject Code	Subject Name (Lab oriented Theory Courses)	Category	L	T	P	C
EE23132	Basic Electrical Engineering	ES	3	0	2	4

Objectives:	
•	To provide knowledge on the analysis of DC circuits.
•	To teach methods of analysis of AC circuits.
•	To impart knowledge on principles of operation of electrical machines.
•	To teach the basics of electrical safety measures.
•	To provide hands on experience on electric circuits and machines

UNIT-I	DC CIRCUITS	9
Electrical circuit elements (R, L and C), voltage and current sources, Kirchhoff's laws, Mesh and Nodal Analysis, Superposition, Thevenin's, Norton's Theorems and Maximum Power Transfer Theorem		
UNIT-II	**AC CIRCUITS**	9
Representation of sinusoidal waveforms, Power and Power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations. Three phase balanced circuits.		
UNIT-III	**DC MOTORS AND TRANSFORMERS**	9
Construction, working and characteristics of DC motors. Construction, principle of operation of single-phase Transformer, EMF Equation.		
UNIT-IV	**AC ROTATING MACHINES**	9
Construction and basic working of three phase Alternators and Induction motors, Construction and Types of single-phase induction motors- Construction and basic working of Stepper motor, Permanent magnet Brushless Motor (PMBLDC) (Qualitative Treatment Only).		
UNIT-V	**ELECTRICAL SAFETY MEASURES**	9
Primary and secondary hazards- arc, blast, shocks-causes and effects-safety equipment- flash and thermal protection - Safety in the use of portable tools - Preventive maintenance- Types of earthing and its importance-Safety precautions for electrical appliances- National electrical Safety code - Indian electricity acts and rules		
	Total Contact Hours : 45	

List of Experiments	
1	Kirchhoff's laws.
2	Network theorems (Thevenin's , Norton's and Maximum Power Transfer Theorems)
3	Determination of Impedance and Current in RL, RC and RLC series circuits
4	Measurement of voltage and current in three phase balanced star & delta connected loads.
5	Load test on DC shunt motor (Virtual Lab)
6	Load test on single-phase transformer (Virtual Lab)
7	Load test on three phase induction motor (Virtual Lab)
8	Load test on Single phase induction motor.
Contact Hours	**: 30**
Total Contact Hours	**: 75**

Course Outcomes:	
On completion of the course, the students will be able to	
•	analyze DC circuits and apply circuit theorems.
•	calculate the power and power factor in AC circuits
•	comprehend the principles of electrical machines.
•	realise the electrical safety precautions.
•	experimentally analyze the electric circuits and machines.
Suggested Activities	
•	Problem solving sessions
Suggested Evaluation methods	

•	Quizzes
•	Class Presentation / Discussion

Text Book(s):	
1	E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.
2	J.B.Gupta, "Fundamentals of Electrical Engineering and Electronics" S.K. Kataria & Sons Publications, 2010.
3	K.Venkataratnam, —Special Electrical Machines , Universities Press (India) Private Limited, 2008.
4	John Cadick, P.E. Mary Capelli-Schellpfeffer, M.D., M.P.A. Dennis K. Neitzel, C.P.E. "Al Winfield Electrical Safety Hand Book, fifth edition, The McGraw-Hill 2012

Reference Books(s) / Web links:	
1	Joseph A. Edminister, Mahmood, Nahri, "Electric Circuits" – Shaum Series and Systems", Schaum"s Outlines, Tata McGraw Hill, Indian. 5th Edition , 2017
2	D. C. Kulshreshtha, "Basic Electrical Engineering", McGraw Hill, 2009.
3	D. Toro, "Electrical Engineering Fundamentals", Prentice Hall India, 1989.
4	L. S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press, 2011.
5	https://nptel.ac.in/courses/108108076
6	E G Janardanan, —Special Electrical Machines , Prentice Hall India Limited, 2013.
7	Maxwell Adams. J, "Electrical safety- a guide to the causes and prevention of electric hazards", The Institution of Electric Engineers, 1994.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EE23132.1	3	3	3	3	-	3	1	1	2	1	1	1	1	1	1
EE23132.2	3	3	3	3	-	3	1	1	2	1	1	1	1	1	1
EE23132.3	3	3	3	3	-	3	1	1	2	1	1	1	2	2	1
EE23132.4	3	3	3	3	-	3	1	1	2	1	1	1	1	2	1
EE23132.5	3	3	3	3	-	3	3	1	2	1	1	1	2	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Laboratory Course)	Category	L	T	P	C
GE23121	Engineering Practices Laboratory – Civil and Mechanical	ES	0	0	2	1

Objectives:	
●	To provide exposure to the students with hands on experience on various basic engineering practices in Civil and Mechanical Engineering.

List of Experiments				
CIVIL ENGINEERING PRACTICE				
1.	Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, and elbows in household fittings.			
2.	Preparation of basic plumbing line sketches for wash basins, water heaters, etc.			
3.	Hands-on-exercise: Basic pipe connections – Pipe connections with different joining components.			
Carpentry Works:				
4.	Study of joints in roofs, doors, windows and furniture.			
5.	Hands-on-exercise: Woodwork, joints by sawing, planning and chiselling.			
MECHANICAL ENGINEERING PRACTICE				
6.	Preparation of butt joints, lap joints and T- joints by Shielded metal arc welding.			
7	Gas welding practice.			
Basic Machining:				
8	Simple Turning and Taper turning			
9	Drilling Practice			
Sheet Metal Work:				
10	Forming & Bending:			
11	Model making – Trays and funnels			
12	Different type of joints.			
Machine Assembly Practice:				
13	Study of centrifugal pump			
14	Study of air conditioner			
		Total Contact Hours	**:**	**30**

Course Outcomes: On completion of the course students will be able to	
●	Perform plumbing activities for residential and industrial buildings considering safety aspects while gaining clear understanding on pipeline location and functions of joints like valves, taps, couplings, unions, reducers, elbows, etc.
●	Perform wood working carpentry activities like sawing, planning, cutting, etc. while having clear understanding of the joints in roofs, doors, windows and furniture.
●	Produce joints like L joint, T joint, Lap joint, Butt joint, etc. through arc welding process while acquiring in depth knowledge in the principle of operation of welding and other accessories
●	Perform operations like Turning, Step turning, Taper turning, etc. in lathe and Drilling operation in drilling machine
●	Perform sheet metal operations like Forming, Bending, etc. and fabricating models like Trays, funnels, etc.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
GE23121.1	1	1	1	-	-	2	1	-	2	-	-	2	1	1	1
GE23121.2	1	1	1	-	-	-	-	-	-	-	-	-	1	1	1
GE23121.3	2	1	-	2	-	-	2	-	-	-	-	-	1	1	1
GE23121.4	1	1	1	-	-	2	1	-	2	-	-	2	1	1	1
GE23121.5	1	1	1	-	-	2	1	-	2	-	-	2	1	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Subject Code	Subject Name	Category	L	T	P	C
GE23122	Engineering Practices - Electrical andElectronics	ES	0	0	2	1

Objectives:

- To provide hands-on experience on various basic engineering practices in Electrical Engineering.
- To provide hands-on experience on various basic engineering practices in Electronics Engineering.

List of Experiments

A. ELECTRICAL ENGINEERING PRACTICE	
1	Residential house wiring using switches, fuses, indicators, lamp and energy meter.
2	Fluorescent lamp wiring.
3	Stair case wiring.
4	Measurement of electrical quantities – voltage, current, power & power factor in RL circuit.
5	Measurement of earth resistance using Megger.
6	Study of Ceiling Fan and Iron Box
B. ELECTRONICS ENGINEERING PRACTICE	
1	Study of electronic components and equipment – Resistor, colour coding, measurement of AC signal parameters (peak-peak, rms period, frequency) using CRO/DSO.
2	(a) Measurement of electrical quantities using Multimeter (b) Testing of electronic components.
3	Study of logic gates: AND, OR, EXOR and NOT.
4	Generation of Clock Signals.
5	Soldering practice – Components Devices and Circuits – Using general purpose PCB.
6	Measurement of ripple factor of Half-wave and Full-wave Rectifiers.

Total Contact Hours	**:**	**30**

Course Outcomes:

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

- fabricate the basic electrical circuits
- implement the house wiring circuits
- fabricate the electronic circuits
- verify the truth table of logic gates
- design the Half-wave and Full-wave Rectifiers using diodes and passive components

SUGGESTED EVALUATION METHODS

- Experiment based Viva

REFERENCE

1. Bawa H.S., "Workshop Practice", Tata McGraw – Hill Publishing Company Limited, 2007.
2. Jeyachandran K., Natarajan S. & Balasubramanian S., "A Primer on Engineering Practices Laboratory", Anuradha Publications, 2007.
3. Jeyapoovan T., Saravanapandian M. &Pranitha S., "Engineering Practices Lab Manual", Vikas Publishing House Pvt. Ltd, 2006.
4. Rajendra Prasad A. &Sarma P.M.M.S., "Workshop Practice", SreeSai Publication, 2002.

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
GE23122.1	3	3	3	2	-	-	2	-	3	2	-	3	1	1	1
GE23122.2	3	3	2	2	-	-	2	-	3	2	-	3	1	1	1
GE23122.3	3	3	3	2	-	-	2	-	3	2	-	3	1	1	1
GE23122.4	3	3	3	2	-	-		-	3	2	-	3	1	1	1
GE23122.5	3	3	3	2	-	-		-	3	2	-	3	1	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory Course)	Category	L	T	P	C
MC23112	Environmental Science and Engineering	MC	3	0	0	0

Common to I sem. B.E. Aeronautical Engineering, Automobile Engineering, Biomedical Engineering, Civil Engineering, Mechanical Engineering, Mechatronics, and Robotics and Automation
and
B.Tech. – Biotechnology, Information Technology, Food Technology & Chemical Engineering
and
Common to II sem. B.E. – Electronics and Communication Engineering, Electrical and Electronics Engineering, Computer Science and Engineering, Computer Science and Design & Computer Science and Engineering (Cyber Security)
and
B.Tech. – Artificial Intelligence & Machine Learning and Artificial Intelligence & Data Science.

Objectives:	
●	To develop the understanding of environmental and associated issues
●	To develop an attitude of concern for the environment
●	To promote enthusiasm in participating environmental protection initiatives
●	To nurture skills to solve environmental degradation issues
●	To develop the knowledge about the environmental laws

UNIT-I	**AIR AND NOISE POLLUTION**	9

Definition –sources of air pollution –chemical and photochemical reactions in the atmosphere - formation of smog, PAN, acid rain, ozone depletion, particulate pollutants-Air quality standards-Air quality indices - control of particulate air pollutants-gravitational settling chambers, cyclone separators, wet collectors, fabric filters (Bag-house filter), electrostatic precipitators (ESP)-catalytic converters.

Noise pollution –sources - health effects - standards- measurement and control methods.

UNIT-II	**WATER POLLUTION AND ITS MANAGEMENT**	9

Definition-causes-effects of water pollution-point and nonpoint sources of wastewater-marine pollution - thermal pollution - Control of water pollution by physical, chemical and biological methods – wastewater treatment-primary, secondary and tertiary treatment-sources and
characteristics of industrial effluents- zero liquid discharge.

UNIT-III	**SOLID WASTE AND HAZARDOUS WASTE MANAGEMENT**	9

Solid waste – types- municipal solid waste management: sources, characteristics, collection, and transportation-sanitary landfill, recycling, composting, incineration, energy recovery options from waste - Hazardous waste – types, characteristics, and health impact - hazardous waste management: neutralization, oxidation reduction, precipitation, solidification, stabilization, incineration and final disposal.

E-waste-definition-sources-effects on human health and environment- E-waste management- steps involved - Role of E-waste management within the initiatives of the Govt. of India- Swachh Bharat Mission.

UNIT-IV	**SUSTAINABLE DEVELOPMENT**	9

Sustainable development- concept-dimensions-sustainable development goals - value education- gender equality – food security - poverty – hunger - famine - Twelve principles of green chemistry - Green technology - definition, importance - Cleaner development mechanism - carbon credits, carbon trading, carbon sequestration, eco labeling- International conventions and protocols-Disaster management.

UNIT-V	**ENVIRONMENTAL MANAGEMENT AND LEGISLATION**	9

Environmental Management systems - ISO 14000 series- Environmental Audit-Environmental Impact Assessment- life cycle assessment- human health risk assessment - Environmental Laws and Policy- Objectives - Polluter pays principle, Precautionary principle - The Environment (Protection) Act 1986 - Role of Information technology in environment and human health.

Total Contact Hours:45

Course Outcomes: On completion of the course students will be able to	
•	Associate air and noise quality standards with environment and human health.
•	Illustrate the significance of water and devise control measures for water pollution.
•	Analyze solid wastes and hazardous wastes.
•	Outline the goals of sustainable development in an integrated perspective
•	Comprehend the significance of environmental laws.

SUGGESTED EVALUATION METHODS

- Assignment topics
- Continuous Assessment Tests
- Continuous Assessment Tests

Text Book (s):	
1	Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2016
2	Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition, New Age International Publisher, 2018.
3	Johri R., E-waste: implications, regulations, and management in India and current global best practices, TERI Press, New Delhi

Reference Books(s) / Web links:	
1	R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media. 38. Edition 2010.
2	Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001.
3	Fowler B, Electronic Waste – 1st Edition (Toxicology and Public Health Issues), 2017 Elsevier
4	NPTEL course URL https://onlinecourses.nptel.ac.in/noc19_ge22/NPTEL https://news.mit.edu/2013/ewaste-mit
5	For downloading text/reference books the weblink is given below can be used **http://libgen.rs/**

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MC23112.1	1	2	3	1	-	2	2	2	1	1	1	2	1	-	-
MC23112.2	1	2	3	1	-	2	2	2	1	1	1	2	1	-	-
MC23112.3	-	-	3	1	-	2	3	2	1	-	1	2	1	-	-
MC23112.4	-	1	2	1	1	3	3	2	1	1	1	2	-	-	-
MC23112.5	-	1	2	-	-	2	2	2	1	2	2	2	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory Course)	Category	L	T	P	C
GE23117	தமிழர் மரபு	ES	1	0	0	1

அலகு I	**மொழி மற்றும் இலக்கியம்:**	**3**
இந்திய மொழிக் குடும்பங்கள் - திராவிட மொழிகள் - தமிழ் ஒரு செம்மொழி - தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமய சார்பற்ற தன்மை - சங்க இலக்கியத்தில் பகிர்தல் அறம் - திருக்குறளில் மேலாண்மைக் கருத்துக்கள் - தமிழிக் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் - சிற்றிலக்கியங்கள் - தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி - தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.		
அலகு II	**மரபு - பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை - சிற்பக் கலை:**	3
நடுகல் முதல் நவீன சிற்பங்கள் வரை - ஐம்பொன் சிலைகள் - பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் - தேர் செய்யும் கலை - சுடுமண் சிற்பங்கள் - நாட்டுப்புறத் தெய்வங்கள் - குமரிமுனையில் திருவள்ளுவர் சிலை - இசைக் கருவிகள் - மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் - தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.		
அலகு III	**நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்:**	3
தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.		
அலகு IV	**தமிழர்களின் திணைக் கோட்பாடுகள்:**	3
தமிழகத்தின் தாவரங்களும், விலங்குகளும் - தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் - தமிழர்கள் போற்றிய அறக்கோட்பாடு - சங்ககாலத்தில் தமிழத்தில் எழுத்தறிவும், கல்வியும் - சங்ககால நகரங்களும் துறை முகங்களும் - சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி - கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.		
அலகு V	**இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு:**	3
இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு - இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் - சுயமரியாதை இயக்கம் - இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு - கல்வெட்டுகள், கையெழுத்துப்படிகள் - தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.		
	Total Contact Hours : 15	

TEXT-CUM-REFERENCE BOOKS

	Reference Books(s) / Web links:
1	தமிழக வரலாறு - மக்களும் பண்பாடும் - கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2	கணினித் தமிழ் - முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3	கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4	பொருநை - ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5	Social Life of Tamils (Dr. K. K. Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6	Social Life of the Tamils – The Classical Period (Dr. S. Singaravelu)(Published by: International Institute of Tamil Studies.
7	Historical Heritage of the Tamils (Dr. S. V. Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8	The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies).
9	Keeladi – 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10	Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11	Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12	Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

SEMESTER II

Course Code	Course Title (Theory Course)	Category	L	T	P	C
MA23212	Differential Equations and Complex Variables	BS	3	1	0	4

Common to II Sem. B.E. –Aeronautical Engineering, Automobile Engineering, Biomedical Engineering, Civil Engineering, Electrical and Electronics Engineering, Electronics and Communication Engineering, Mechanical Engineering, Mechatronics & Robotics & Automation
and
B. Tech. – Biotechnology, Food Technology & Chemical Engineering

Objectives:	
●	To provide students with an introduction to the theory of ordinary differential equations through applications, methods of solution, and numerical approximations
●	To introduce students to how to solve linear Partial Differential with different methods.
●	To enable the students to study the Laplace Transforms, properties of Laplace Transform, inverse Laplace Transform and some applications to solve the differential equations and integral equations.
●	To explain the concept of a vector integration in a plane and in space.
●	To describe basic properties of complex variables and to have the ability to compute complex integrals.

UNIT-I	**ORDINARY DIFFERENTIAL EQUATIONS**	**12**
Second and higher order Linear differential equations with constant coefficients - Method of variation of parameters – Legendre's linear equations – Numerical solution of ODE - Single Step methods: Taylor's series method, Euler's method.		
UNIT-II	**PARTIAL DIFFERENTIAL EQUATIONS**	**12**
Formation of partial differential equations - Classification of PDE – Solutions of standard types of first order partial differential equations - Lagrange's linear equation –Linear homogeneous partial differential equations of second and higher order with constant coefficients.		
UNIT-III	**LAPLACE TRANSFORM**	**12**
Laplace transform –Basic properties – Transforms of derivatives and integrals of functions - Transforms of unit step function and impulse functions, periodic functions. Inverse Laplace transform – Problems using Convolution theorem – Solution of linear ODE of second order with constant coefficients using Laplace transformation techniques		
UNIT-IV	**VECTOR CALCULUS**	**12**
Gradient, divergence and curl – Directional derivative – Irrotational and Solenoidal vector fields – Vector integration – Green's theorem in a plane, Gauss divergence theorem and Stokes' theorem (excluding proofs) – Simple applications involving cubes and rectangular parallelopipeds.		
UNIT-V	**COMPLEX VARIABLES**	**12**
Analytic functions — Construction of analytic function - Bilinear transformation –Singularities – Cauchy's integral theorem (without proof) - Residues – Residue theorem (without proof) - Simple problems - Contour integral over $\|z\|=1$.		
		Total Contact Hours: 60

Course Outcomes: On completion of the course students will be able to	
●	Apply the methods as a potent tool in the solution of a variety of problems in the natural sciences and technology.
●	Develop specific methodologies, techniques and resources in Partial differential equations to conduct research and produce innovative results in the area of specialization.
●	Use Laplace transform and inverse transform techniques to solve the complex problems in engineering and technology.
●	Apply the concepts in multivariable analysis, including space curves; directional derivative; gradient; multiple integrals; line and surface integrals; vector fields; divergence, curl; the theorems of Green and Stokes, and the divergence theorem in different fields of engineering.
●	Demonstrate the concept of Analytic functions, conformal mapping and complex integration in solving Engineering problems.

SUGGESTED ACTIVITIES

- Problem solving sessions
- Activity Based Learning

SUGGESTED EVALUATION METHODS

- Problem solving in Tutorial sessions
- Assignment problems
- Quizzes and class test
- Discussion in classroom

Text Book (s):	
1	Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2	Veerarajan. T, Engineering Mathematics –II, Mc Graw Hill Education, 2018.
3	Erwin Kreyszig," Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2016.
4	Glyn James, "Advanced Modern Engineering Mathematics", Pearson Education, 4th Edition, New Delhi, 2011.
5	Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", Narosa Publications, 5th Edition, New Delhi, 2017.

Reference Books(s) / Web links:	
1	Ramana. B.V., "Higher Engineering Mathematics ", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
2	T. Veerarajan, Transforms and Partial Differential Equations, Third Edition, 2018.
3	Bali, N.P. and Manish Goyal, A Text Book of Engineering Mathematics, Lakshmi Publications Pvt. Ltd., New Delhi, 4th Edition 2006.
4	Peter V.O Neil, "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, 7th Edition, New Delhi, 2012.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MA23212.1	3	2	1	-	-	-	-	-	-	-	-	1	1	-	-
MA23212.2	3	2	1	-	-	-	-	-	-	-	-	1	1	-	-
MA23212.3	3	2	1	-	-	-	-	-	-	-	-	-	1	-	-
MA23212.4	2	2	1	-	-	-	-	-	-	-	-	-	1	-	-
MA23212.5	3	2	1	-	-	-	-	-	-	-	-	1	1	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Lab oriented Theory Course)	Category	L	T	P	C
CY23131	Chemistry for Electronics Engineering	BS	3	0	2	4

Common to I sem. B.E. – Electronics and Communication Engineering, Biomedical Engineering and Electrical and Electronics Engineering
And
Common to II sem. B.E. - Mechatronics and Robotics & Automation

Objectives:	
●	To understand the principles of electrochemical processes
●	To explore the functioning of sensors and their applications in industries and health care
●	To get familiarized with the functioning of batteries and fuel cells
●	To acquire knowledge on polymeric materials used in electronics
●	To develop proficiency in nanomaterials

UNIT-I	**DYNAMIC ELECTROCHEMISTRY**	**9**

Applied Electrochemistry: Electrode Potential - EMF series - Corrosion- Causes, Consequences and Prevention. Surface Preparation- electropolishing -Electroplating of copper, electrophoretic deposition - Electrochemical machining, electrochemical etching - electrochemical etching of Cu from PCB.

UNIT-II	**ELECTROCHEMICAL SENSORS**	**9**

Electrodes - reference electrodes - ion-selective electrode, determination of electrode potential- Galvanic and concentration cells - potentiometric, amperometric and conductometric methods of analysis - potentiometric sensor, optical sensor, thermal sensor, chemical biosignals- sensors for health care – glucose and urea sensors, gas sensors for CO_2, O_2 and NH_3 sensing- blood oxygen sensor.

UNIT-III	**ELECTROCHEMICAL ENERGY SYSTEMS**	**9**

Batteries- types - characteristics-fabrication and working of lead-acid battery- NICAD battery – Nickel metal hydride batteries -lithium-ion battery - Supercapacitors- introduction - types - electrochemical double layer capacitor - activated carbon - carbon aerogels.
Fuel cells - classification – principle, working and applications of hydrogen-oxygen fuel cell - solid oxide fuel cell - direct methanol fuel cell and proton exchange membrane fuel cells-biofuel cells.

UNIT-IV	**POLYMERS IN ELECTRONICS**	**9**

Conducting polymers - **c**onducting mechanisms- polyaniline, Poly pyrrole - photonic polymers - photo resists - Introduction, Liquid crystalline phases, Identification of the mesophases, Lyotropic main chain liquid crystalline polymers, Thermotropic main chain liquid crystal polymers, Applications of liquid Crystals in Displays (LCDs) - Organic LEDs- functioning-advantages and disadvantages over conventional LEDs- commercial uses.

UNIT-V	**NANO MATERIALS**	**9**

Introduction-Types of nanomaterials-Emergence and challenges in nanotechnology- Synthesis routes for nanomaterials: Bottom-up and top-down approaches- Sol-gel, precipitation, Hydrothermal, Solvothermal, Microwave irradiation, Chemical Vapour Deposition (CVD), Electro deposition- Properties of nanomaterials- Mechanical properties, Chemical, Optical, Electrical and Magnetic properties-applications of nanomaterials.

Total Contact Hours: 45

List of Experiments	
1	Construction and determination of EMF of simple electrochemical cells and concentration cells
2	Estimation of acids by pH metry
3	Determination of corrosion rate on mild steel by weight loss method
4	Estimation of mixture of acids by conductometry
5	Estimation of extent of corrosion of iron pieces by potentiometry
6	Estimation of copper / ferrous ions by spectrophotometry
7	Estimation of DO by using sensors
8	Estimation of concentration of ions in the given sample solution.
9	Determination of molecular weight of a polymer by viscometry method
10	Synthesis of nanomaterials by simple precipitation method
	Total Contact Hours: 30

Course Outcomes: On completion of the course students will be able to	
●	Apply the knowledge of electrochemistry in exploring electrochemical processes.
●	Associate the knowledge of sensors in health care and in pollution abatement
●	Recognize the types of batteries and fuel cells
●	Employ advanced materials in industrial applications and display techniques
●	Develop nano and biomaterials for medical applications

Suggested Activities	
●	Electroplating process by group of students
●	Ceramic coating on implant materials
●	Electro polishing of metals and alloys
Suggested Evaluation methods	
●	Continuous assessment tests
●	Assignments
●	Model lab examination
●	End semester examination
Text Book(s):	
1	P. C. Jain and Monika Jain, “Engineering Chemistry”, DhanpatRai Publishing Company (P) Ltd,New Delhi, 2015
2	O.G.Palanna, “Engineering Chemistry”, McGraw Hill Education (India) Pvt, Ltd, New Delhi, 2017
3	Shikha Agarwal “Engineering Chemistry-Fundamentals and applications”, Cambridge University Press, New Delhi, 2015
Reference Books(s) / Web links:	
1	Gowarikar V. R., Viswanathan N.V. and Jayadev Sreedhar, ―Polymer Science, New Age International (P) Ltd., New Delhi, 2011
2	Sujata V Bhat, “Biomaterials”, Narosa Publishing House, New Delhi, 2002
3	PradeepT, “A Text Book of Nanoscience and Nanotechnology”, Tata McGraw Hill, New Delhi, 2012
4	Asim K DAS, Mahua Das, “An Introduction to Nanomaterials and Nanoscience”, CBS publishers and distributors Pvt. Ltd.,2020
5	NPTEL course Elementary Electrochemistry course url **https://onlinecourses.nptel.ac.in/noc23_cy19/preview**
6	1.For downloading text/reference books the weblink is given below can be used **http://libgen.rs/**

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CY23131.1	2	2	1	-	-	-	-	-	-	-	-	1	1	-	-
CY23131.2	3	2	1	-	-	1	1	-	-	-	-	1	1	-	-
CY23131.3	2	1	1	-	-	-	-	-	-	-	-	-	1	-	-
CY23131.4	2	1	1	-	-	-	-	-	-	-	-	1	1	-	-
CY23.131.5	3	2	2	-	-	-	-	-	-	-	-	1	1	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Lab oriented Theory Course)	Category	L	T	P	C
PH23131	Physics of Materials	BS	3	0	2	4

Common to I sem. B.E. – Aeronautical Engineering, Automobile Engineering, Civil Engineering, Mechanical Engineering
and
Common to II sem. B.E. Mechatronics and Robotics & Automation

Objectives:	
●	To enhance the fundamental knowledge of elasticity and its applications relevant to engineering streams.
●	To become proficient in crystal growth and crystal systems.
●	To introduce the essential of phase transformation in materials.
●	To impart knowledge on the structure, properties, treatment, testing and applications of metals and alloys.
●	To familiarize students with thermal properties and applications.

UNIT-I	**PROPERTIES OF MATTER**	**9**
Elasticity–Hooke's law-stress–strain-modulus of elasticity-stress-strain diagram-Poisson's ratio-rigidity modulus-twisting couple on a cylinder-moment of inertia - torsional pendulum method. Bending of beams -bending moment-cantilever depression-theory and experiment - Young's modulus determination–uniform and non-uniform bending-I-shape girders. Viscosity-flow of motion-Reynolds number.		
UNIT-II	**THERMAL PHYSICS**	**9**
Transfer of heat energy – thermal expansion of solids and liquids – expansion joints - bimetallic strips - thermal conduction, convection and radiation –rectilinear heat flow – thermal conductivity - Forbe's and Lee's disc method: theory and experiment - conduction through compound media (series and parallel) – thermal insulation – applications: heat exchangers, refrigerators, ovens and solar water heaters.		
UNIT-III	**PHASE DIAGRAMS**	**9**
Solid solutions - Hume-Rothery's rules –Gibb's phase rule – unary phase diagram- binary phase diagrams - isomorphous systems - tie-line and lever rule - eutectic, eutectoid, peritectic, peritectoid, monotectic and syntectic systems - formation of microstructures-homogeneous and non-homogenous cooling – nucleation (Qualitative)– iron-carbon phase diagram - eutectoid steel – hypo-eutectoid and hyper-eutectoid steel – diffusion - Fick's laws – T-T-T diagrams.		
UNIT-IV	**CRYSTAL PHYSICS**	**9**
Basis – lattices – unit cell-crystal systems – Bravais lattices –number of atoms, atomic radius, co-ordination number and packing fraction - SC, BCC, FCC, HCP lattices and diamond structure - polymorphism and allotropy-graphite structure - Miller indices – determination of d-space-crystal growth techniques-solution growth –melt growth-Bridgmann and Czochralski - crystal defects.		
UNIT-V	**ADVANCED MATERIALS & TESTING**	**9**
Metallic glasses – preparation, properties and applications - Composites – types and properties - Shape memory alloys – properties and applications - Nano-materials – top down and bottom up approaches –sol-gel method-pulsed laser deposition-ball milling- properties-applications - Tensile strength – Hardness – Fatigue - Impact strength – Creep - Fracture – types of fracture.		
		Total Contact Hours: 45

List of Experiments				
1	Determination of Young's modulus of given material by non-uniform bending method.			
2	Determination of moment of inertia of a disc and rigidity modulus of a given wire using Torsional pendulum.			
3	Determination of Young's modulus of given beam by cantilever method.			
4	Determination of viscosity of the given liquid using Poiseuille's method.			
5	Determination of Thermal conductivity of a bad conductor – Lee's Disc method.			
6	Determination of Velocity of ultrasound and compressibility of given liquid – Ultrasonic interferometer.			
7	Determination of the wavelength of Laser and particle size of given powder.			
8	Determination of the Hysteresis loss of ferromagnetic material by B-H curve experiment.			
9	Find the thickness of a given thin wire – Air wedge method.			
10	Study the characteristics of solar cell parameters.			
		Contact Hours	**:**	**30**
		Total Contact Hours	**:**	**75**

Course Outcomes:	
On completion of the course, students will be able to	
●	apply the elastic nature of materials and determine the elastic moduli of different materials.
●	apply the basic knowledge of crystal structure in solids.
●	analyze and measure the properties of alloys.
●	analyze various material testing methods and use them in suitable applications.
●	understand the concepts of heat transfer in various applications.

SUGGESTED ACTIVITIES

- Problem solving sessions

SUGGESTED EVALUATION METHODS

- Quizzes
- Class Presentation / Discussion

Text Book(s):	
1.	Bhattacharya, D.K. &Poonam, T. "Engineering Physics", Oxford University Press, 2018.
2.	Gaur, R.K. & Gupta, S.L. "Engineering Physics", Dhanpat Rai Publishers, 2018.
3.	Raghavan V. "Physical Metallurgy: Principles and Practice", PHI Learning, 2019.

Reference Books(s) / Web links:	
1.	Balasubramaniam, R. "Callister's Materials Science and Engineering".Wiley India Pvt. Ltd., 2017
2.	Resnick, R., Halliday, D., & Walker, J. "Principles of Physics", Wiley India Pvt., 2018.
3.	Raghavan, V. "Materials Science and Engineering: A First course". PHI Learning, 2019.
4.	https://nptel.ac.in/courses/113104068
5.	https://archive.nptel.ac.in/courses/115/105/115105099/

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
PH23131.1	3	3	2	-	-	-	-	-	-	-	-	-	1	-	-
PH23131.2	3	3	2	-	-	-	-	-	-	-	-	1	1	-	-
PH23131.3	3	3	2	-	-	-	-	-	-	-	-	1	1	-	-
PH23131.4	3	2	1	-	-	-	-	-	-	-	-	-	1	-	-
PH23131.5	3	2	2	-	-	-	-	-	-	-	-	1	1	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Lab Oriented Theory Course)	Category	L	T	P	C
GE23233	Problem Solving and Python Programming	ES	2	0	4	4

Objectives:	
•	To know the basics of algorithmic problems solving
•	To develop Python programs with conditionals and loops
•	To define Python functions and call them
•	To use Python data structures–-lists, tuples, dictionaries
•	To do input/output with files in Python

UNIT-I	ALGORITHMIC PROBLEM SOLVING	6
Introduction to computers-characteristics-basic organization of a computer– algorithms-building blocks of algorithms (instructions / statements, state, control flow, functions)-notation (pseudo code, flow chart, programming language) - algorithmic problem solving - simple strategies for developing algorithms (iteration,recursion).		
UNIT-II	**DATA, EXPRESSIONS, STATEMENTS AND CONTROL FLOW**	**6**
Python interpreter and interactive mode - values and types - data types – variables – keywords – expressions and statements- python I/O - operators- precedenceof operators– comments. Conditionals:conditional(if)-alternative(if-else)-chained conditional (if- elif- else)–nested conditional.		
UNIT-III	**CONTROL FLOW – II AND FUNCTIONS**	**7**
Iteration: while – for - break – continue – pass. Illustrative programs: exchange the values of two variables- circulate the values of n variables-test for leap year. Function calls – type conversion– math function– composition- definition and use - flow of execution - parameters and arguments. Fruitful functions: return values – parameters - scope: local and global - recursion.		
UNIT-IV	**STRINGS**	**5**
Strings: string slices – immutability - string functions and methods – string comparison. Illustrative programs: square root– GCD– exponentiation-sum the array of numbers linear search- binary search.		
UNIT-V	**LISTS, TUPLES AND DICTIONARIES**	**6**
Lists - list operations - list slices - list methods - list loop – mutability – aliasing - cloning lists - listparameters. Tuples – immutable - tuple assignment - tuple as return value. Dictionaries: operations and methods– dictionaries and tuples– dictionaries and lists. Advanced list processing- list comprehension. Illustrative programs: Sorting.		
	Contact Hours : 30	

List of Experiments				
1	Introduction to Python Programming and Python IDLE/Anaconda distribution.			
2	Experiments based on Variables, Data types and Operators in Python.			
3	Coding Standards and Formatting Output.			
4	Algorithmic Approach: Selection control structures.			
5	Algorithmic Approach: Iteration control structures.			
6	Experiments based on Strings and its operations.			
7	Experiments based on Lists and its operations.			
8	Experiments based on Tuples and its operations.			
9	Experiments based on Sets and its operations.			
10	Experiments based on Dictionary and its operations.			
11	Functions: Built-in functions.			
12	Searching techniques: Linear and Binary.			
13	Sorting techniques: Bubble and Merge Sort.			
	Contact Hours	**:**	**60**	
	Total Contact Hours	**:**	**90**	

Course Outcomes: On completion of the course, students will be able to	
●	Understand the working principle of a computer and identify the purpose of a computer programming language and ability to identify an appropriate approach to solve the problem.
●	Write, test, and debug simple Python programs with conditionals and loops.
●	Develop Python programs step - wise by defining functions and calling them.
●	Use Python lists, tuples, dictionaries for representing compound data.
●	Apply searching, sorting on data and efficiently handle data using flat files.

Text Books:	
1.	Allen B. Downey, Think Python:How to Think Like a Computer Scientist, Second edition,UpdatedforPython3, Shroff/ O'Reilly Publishers, 2016 (http://greenteapress.com/wp/think-python/)
2.	Guido Van Rossum and Fred L. Drake Jr, An Introduction to Python-Revised and updated for Python3.2, Network Theory Ltd., 2011.
Reference Books:	
1.	JohnVGuttag, Introduction to Computation and Programming Using Python, Revised and expanded Edition, MIT Press,2013.
2.	Robert Sedgewick, Kevin Wayne, Robert Dondero, Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt.Ltd., 2016.
3.	Timothy A.Budd, Exploring Python, Mc-Graw Hill Education(India)PrivateLtd.,2015.
4.	Kenneth A. Lambert, Fundamentals of Python: First Programs, CengageLearning,2012.
5.	Charles Dierbach, Introduction to Computer Science using Python: A Computational Problem-Solving Focus, Wiley India Edition,2013.
6.	Paul Gries, Jennifer Campbell and Jason Montojo, Practical Programming: An Introduction to Computer Science using Python3, Second edition, Pragmatic Programmers, LLC, 2013.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO2	PSO3
GE23233.1	2	2	2	2	1	-	-	-	1	1	1	1	2	2	2
GE23233.2	2	1	1	1	1	-	-	-	-	-	1	1	2	2	2
GE23233.3	1	1	2	1	2	-	-	-	-	-	1	1	2	2	2
GE23233.4	2	2	3	2	2	-	-	-	-	-	2	1	2	2	2
GE23233.5	2	2	3	2	3	-	-	-	-	-	2	1	2	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Laboratory Course)	Category	L	T	P	C
HS 23221	Technical Communication II	HS	0	0	2	1
Common to all branches of II sem. B.E./ B.Tech. programmes						

Objectives:	
•	To facilitate students to improve their vocabulary for a better communication
•	To enable learners to understand and reproduce language
•	To aid students to write technical reports in a convincing manner
•	To expose students to different sentence structures
•	To equip learners to present their ideas in an efficient manner

UNIT-I	VOCABULARY FOR BETTER COMMUNICATION	6
Listening: Telephonic Conversations and TV News **Reading:** Newspapers and Magazines **Speaking**: Conversational Practice: Speaking in a given situation, Asking permission and requesting etc.., **Writing:** Job Application Letter and Resume **Grammar:** Reference words: pronouns and determiners **Vocabulary:** Guessing meanings of words in different contexts.		
UNIT-II	**FUNCTIONAL LANGUAGE ASPECTS**	**6**
Listening: Motivational listening – listening to real life challenges **Reading:** Articles and Technical reports **Speaking:** Using Polite Expressions, Indirect Questions **Writing:** Paraphrasing a Text, Poem **Grammar:** Purpose Statements, Cause and Effect Expressions **Vocabulary:** Neologisms.		
UNIT-III	**TECHNICAL REPORTWRITING**	**6**
Listening: Empathetic Listening – Giving Solutions to Problems **Reading:** Inferential Reading **Speaking:** Dialogues – Interviewing Celebrities / Leaders / Sportspersons, etc.., **Writing:** Report Writing **Grammar:** Functional Usage of Expressions – used to, gone / been, etc.., **Vocabulary:** Words Often Confused		
UNIT-IV	**STRUCTURAL GRAMMAR**	**6**
Listening: Comprehension (IELTS practice tests) **Reading:** Intensive Reading for specific information **Speaking:** Pick and Talk **Writing:** Proposals **Grammar:** Sentence Structures – Simple, Compound, Complex Sentences **Vocabulary:** Replacing dull words with vivid ones		
UNIT-V	**PRESENTATION SKILLS**	**6**
Listening: Discriminative listening – sarcasm, irony, pun, etc.., **Reading:** Practice of chunking – breaking up reading materials **Speaking:** Mini presentation on some topic **Writing:** Minutes of the meeting **Grammar:** Correction of Errors **Vocabulary:** Advanced vocabulary – fixing appropriate words in the given context.		
Total Contact Hours: 30		

Course Outcomes: On completion of the course, students will be able to	
•	communicate effectively using appropriate vocabulary
•	use the acquired language skills to comprehend various types of language contents
•	evaluate different texts and write effective technical content
•	use appropriate sentence structures to convey their thoughts in varied contexts
•	present their concepts and ideas in an effective manner

SUGGESTED ACTIVITIES

- Story Lines
- One truth and two lies
- Hang Man
- Pictionary
- Word Scramble
- Case study

SUGGESTED EVALUATION METHODS

- Assignment topics
- Quizzes
- Class Presentation/Discussion
- Continuous Assessment Tests

Text Book(s):	
1.	Raymond Murphy, "Intermediate English Grammar," Second Edition , Cambridge University Press, 2018
2.	Meenakshi Raman & Sangeeta Sharma, "Technical Communication" Third Edition, Oxford University Press, 2015
3.	Teaching Speaking: A Holistic Approach, Book by Anne Burns and Christine ChuenMeng Goh, Cambridge University Press

Reference Books(s) / Web links:	
1.	Michael McCarthy (Author), Felicity O'Dell (Author), John D. Bunting (Contributor), "Basic Vocabulary in Use: 60 Units of Vocabulary Practice in North American English With Answers" 2nd Edition
2.	Dale Carnegie, "The Art of Public Speaking," Insight Press
3.	Jack C. Richards & Theodore S. Rodgers, " Approaches and Methods in Language Teaching, Second Edition, Cambridge University Press

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
HS 23221.1	-	-	-	1	-	-	-	-	-	2	-	-	-	-	1
HS 23221.2	-	-	-	1	-	-	-	-	-	3	-	-	-	-	1
HS 23221.3	-	2	-	1	-	-	-	-	-	3	-	-	-	-	1
HS 23221.4	-	-	-	1	-	-	-	-	2	3	-	-	-	-	1
HS 23221.5	-	-	-	1	-	-	-	-	2	2	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Laboratory Course)	Category	L	T	P	C
HS23222	English for Professional Competence	HS	0	0	2	1
Common to all branches of II sem. B.E./ B.Tech. programmes						

Objectives:	
•	To facilitate the learners in acquiring listening and reading competence
•	To enable the learners to communicate effectively through written and oral medium
•	To assist the learners in preparing for competitive examinations
•	To train the students in acquiring corporate skills
•	To inculcate professional standards among the students and make them realize their responsibility in addressing the challenges

UNIT-I	RECEPTIVE SKILLS	6
Listening – Comprehensive Listening – Watching the news – Listening to a peer giving presentation, etc. – Critical Listening – Watching a televised debate, Listening to poems – **Reading** – Extensive Reading – Short stories and One-act Plays – Intensive Reading – Articles or Editorials in Magazines, Blog posts on topics like science and technology, arts, etc.		
UNIT-II	**PRODUCTIVE SKILLS**	**6**
Speaking – Demonstrative Speaking – Process description through visual aids – Persuasive Speaking – Convincing the listener with the speaker's view – **Writing** – Descriptive Writing - Describing a place, person, process – Subjective Writing – Autobiography, Writing based on personal opinions and interpretations.		
UNIT-III	**ENGLISH FOR COMPETITIVE EXAMS**	**6**
An introduction to International English Language Testing System (IELTS) – Test of English as a Foreign Language (TOEFL) – Graduate Record Examination (GRE) – Civil Service, Indian Economic Service Examination, Indian Statistical Service Examination, Combined Defence Services Examination, Staff Selection- (Language Related) – Aptitude tests.		
UNIT-IV	**CORPORATE SKILLS**	**6**
Critical Thinking and Problem Solving – Case Study, Brainstorming, Q & A Discussion – **Team work and Collaboration** – Activities like Office Debates, Perfect Square, Blind Retriever, etc. – **Professionalism and Strong Work Ethics** – Integrity, Resilience, Accountability, Adaptability, Growth Mind set.		
UNIT-V	**PROJECT WORK**	**6**
Case Study based on the challenges faced by the employers and the employees – Devise Plan, Provide Solution		
Total Contact Hours: 30		

Course Outcomes:	
On completion of the course students will be able to	
•	interpret and respond appropriately in the listening and reading contexts.
•	express themselves effectively in spoken and written communication
•	apply their acquired language skills in writing the competitive examinations
•	exhibit their professional skills in their work place
•	identify the challenges in the work place and suggest strategies solutions

SUGGESTED ACTIVITIES

- Online Quizzes on Vocabulary
- Online Quizzes on grammar
- Communication Gap Exercises
- Presentations
- Word Building Games
- Case study

SUGGESTED EVALUATION METHODS

- Assignment topics
- Quizzes
- Class Presentation/Discussion
- Continuous Assessment Tests

Text Book(s):	
1.	How to Read Better & Faster, Norman Lewis, Goyal Publishers
2.	Teaching Speaking: A Holistic Approach, Book by Anne Burns and Christine Chuen Meng Goh, Cambridge University Press
3.	The Official Cambridge Guide To IELTS by Pauline Cullen, Cambridge University Press
4.	The 7 Habits of Highly Effective People by Stephen Covey, Simon and Schuster, UK

Reference Books(s) / Web links:	
1.	Board of Editors. Sure Outcomes. A Communication Skills Course for Undergraduate Engineers and Technologists. Orient Black Swan Limited, Hyderabad, 2013.
2.	Hartley, Mary. "The Power of Listening," JaicoPublishing House; First Edition (2015).
3.	Chambers, Harry. "Effective Communication Skills for Scientific and Technical Professionals," Persues Publishing, Cambridge, Massachusetts, 2000.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
HS 23222.1	1	3	-	2	-	2	1	-	3	3	-	1	1	-	1
HS 23222.2	-	-	2	2	1	2	3	3	3	1	-	3	1	-	1
HS 23222.3	-	-	-	1	-	1	1	1	3	3	3	3	1	-	1
HS 23222.4	-	-	1	-	-	2	2	2	2	2	1	1	1	-	1
HS 23222.5	-	-	-	1	-	2	2	-	1	2	3	3	1	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Laboratory Course)	Category	L	T	P	C
RO23221	Computer Aided Modeling Laboratory	ES	0	0	2	1

Objectives:	
●	To introduce the engineering drawing symbols and abbreviation used on the drawing.
●	To provide hands on experience to develop 2D and 3D models of engineering components.
●	To provide knowledge to use Drawing/Modeling software.

List of Experiments			
1	Creating Sketched Geometry		
2	Practice the additional sketching tools-Edit, Move, Copy and Pattern,		
3	Constructing Features-planes, axis and points		
4	Perform Additional Features and Operations-shell, draft, rib, split face, thread, sweep and loft		
5	Perform Detailing Drawings- Dimensions Other Annotations Parts List and Balloons Annotation and Dimension Settings Drawing Output.		
6	prepare assembly models - Plummer Block		
7	prepare assembly models -Flange Coupling		
8	prepare assembly models - Screw Jack		
9	prepare assembly models -Robot gripper		
10	prepare assembly models -2R manipulator		
	Total Contact Hours	**:**	**30**

Course Outcomes: On completion of the course students will be able to	
●	Develop engineering drawing and dimensioning for the industrial component
●	Use CAD software for drafting machine components.
●	Develop 2D and 3D models of the component using software.
●	Perform assembly modeling using software.
●	Perform Detailing of assembly drawings using software.

Web links for virtual lab (if any)	
1	Engineering Graphics and Design, Khanna Publishers, 2020.
2	Parametric Modeling with SOLIDWORKS 2023, SDC Publications, 2023
3	CATIA V5-6R2018 for Designers, CADCIM Technologies, 2018.
4	Mastering CAD/CAM, McGraw Hill Education, 2010.
5	Machine Drawing with AutoCAD, New Age International Publishers, 2018.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23221.1	1	1	1	1	3	1	-	1	2	1	1	3	2	2	1
RO23221.2	1	1	1	1	3	1	-	1	2	1	1	3	2	2	1
RO23221.3	1	1	1	1	3	1	-	1	2	1	1	3	2	2	1
RO23221.4	1	1	1	1	3	1	-	1	2	1	1	3	2	2	1
RO23221.5	1	1	1	1	3	1	-	1	2	1	1	3	2	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory Course)	Category	L	T	P	C
GE23217	தமிழரும் தொழில்நுட்பமும்	MC	1	0	0	1

அலகு I	**நெசவு மற்றும் பானைத் தொழில்நுட்பம்:**	**3**
சங்க காலத்தில் நெசவுத் தொழில் - பானைத் தொழில்நுட்பம் - கருப்பு சிவப்பு பாண்டங்கள் - பண்டங்களில் கீறல் குறியீடுகள்		
அலகு II	**வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்:**	3
சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப்பொருட்களில் வடிவமைப்பு - சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் - சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் - மாமல்லபுரச் சிற்பங்களும், கோவில்களும் - சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் - நாயக்கர் காலக் கோயில்கள் - மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் - செட்டிநாடு வீடுகள் - பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ - சாரோசெனிக் கட்டிடக் கலை.		
அலகு III	**உற்பத்தித் தொழில் நுட்பம்:**	3
கப்பல் கட்டும் கலை - உலோகவியல் - இரும்புத் தொழிற்சாலை - இரும்பை உருக்குதல், எஃகு - வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் - நாணயங்கள் அச்சடித்தல் - மணி உருவாக்கும் தொழிற்சாலைகள் - கல்மணிகள், கண்ணாடி மணிகள் - சுடுமண் மணிகள் - சங்கு மணிகள் - எலும்புத்துண்டுகள் - தொல்லியல் சான்றுகள் - சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.		
அலகு IV	**வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்:**	3
அணை, ஏரி, குளங்கள், மதகு - சோழர்காலக் குமுழித் தூம்பின் முக்கியத்துவம் - கால்நடை பராமரிப்பு - கல்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் - வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் - கடல்சார் அறிவு - மீன்வளம் - முத்து மற்றும் முத்துக்குளித்தல் - பெருங்கடல் குறித்த பண்டைய அறிவு - அறிவுசார் சமூகம்.		
அலகு V	**அறிவியல் தமிழ் மற்றும் கணித்தமிழ் :**	3
அறிவியல் தமிழின் வளர்ச்சி - கணித்தமிழ் வளர்ச்சி - தமிழ் நூல்களை மின்பதிப்பு செய்தல் - தமிழ் மென்பொருட்கள் உருவாக்கம் - தமிழ் இணையக் கல்விக்கழகம் - தமிழ் மின் நூலகம் - இணையத்தில் தமிழ் அகராதிகள் - சொற்குவைத் திட்டம்.		
	Total Contact Hours : 15	

Reference Books(s) / Web links:	
1	தமிழக வரலாறு - மக்களும் பண்பாடும் - கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2	கணினித் தமிழ் - முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3	கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4	பொருநை - ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5	Social Life of Tamils (Dr. K. K. Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6	Social Life of the Tamils – The Classical Period (Dr. S. Singaravelu)(Published by: International Institute of Tamil Studies.
7	Historical Heritage of the Tamils (Dr. S. V. Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8	The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies).
9	Keeladi – 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10	Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11	Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12	Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

Course Code	Course Title (Theory Course)	Category	L	T	P	C
MC23111	Indian Constitution and Freedom Movement	MC	3	0	0	0

Common to I sem. B. E. – Computer Science and Engineering, Electronics and Communication Engineering, Electrical and Electronics Engineering & Computer Science and Design & Computer Science and Engineering (Cyber Security)
and
B.Tech. - Computer Science and Business Systems,
Artificial Intelligence and Machine Learning and Artificial Intelligence & Data Science
and
Common to II sem. B.E. – Aeronautical Engineering, Automobile Engineering, Biomedical Engineering, Civil Engineering, Mechanical Engineering, Mechatronics and Robotics & Automation
and
B.Tech. - Chemical Engineering, Food Technology & Information Technology
and
IV sem. - B.Tech. – Biotechnology.

Objectives:

- To apprehend the sacrifices made by the freedom fighters.
- To inculcate the values enshrined in the Indian constitution.
- To instill a sense of responsibility as the citizens of India.
- To familiarise about the functions of the various levels of Government.
- To be informed about Constitutional and Non- Constitutional bodies.

UNIT-I	**INDIAN FREEDOM MOVEMENT**	9

British Colonialism in India-Colonial administration till 1857- Revolt of 1857- Early Resistance to British Rule-Rise of Nationalism in India-**Indian Freedom Struggle under Mahatma Gandhi-**Non- Cooperation Movement-Civil Disobedience Movement- Quit India Movement-British Official response to National movement- Independence of India Act 1947-Freedom and Partition.

UNIT-II	**CONSTITUTION OF INDIA**	9

Historical Background – Indian Constitution: Constitution' meaning of the term, Sources and constitutional history, Constituent Assembly of India – Philosophical foundations of the Indian Constitution – Preamble – Fundamental Rights – Directive Principles of State Policy – Fundamental Duties – Citizenship – Constitutional Remedies for citizens.

UNIT-III	**STRUCTURE AND FUNCTIONS OF CENTRAL GOVERNMENT**	9

Union Government – Structure of the Union Government and Functions – President – Vice President – Prime Minister – Cabinet – Parliament – Supreme Court of India – Judicial Review.

UNIT-IV	**STRUCTURE AND FUNCTION OF STATE GOVERNMENT AND LOCAL BODY**	9

State Government – Structure and Functions – Governor – Chief Minister – Cabinet – State Legislature – Judicial System in States – High Courts and other Subordinate Courts- Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation, Pachayati Raj: Introduction, Elected officials and their roles, Village level: Role of Elected and Appointed officials.

UNIT-V	**CONSTITUTIONAL FUNCTIONS AND BODIES**	9

Indian Federal System – Centre – State Relations – President's Rule – Constitutional Functionaries – Assessment of working of the Parliamentary System in India- CAG, Election Commission, UPSC, GST Council and other Constitutional bodies-. NITI Aayog, Lokpal, National Development Council and other Non –Constitutional bodies.

Total Contact Hours: 45

Course Outcomes:
On completion of the course students will be able to

- appreciate the sacrifices made by freedom fighters during freedom movement.
- be responsible citizens and abide by the rules of the Indian constitution.
- be aware of the functions of the Indian government.
- be knowledgeable about the functions of the state Government and the Local bodies.
- apply the knowledge on constitutional functions and role of constitutional bodies and non-constitutional bodies.

SUGGESTED ACTIVITIES

- Famous speeches from around the world relating to independence
- Case study
- Quiz on Portfolio and Cabinet
- Discussions on International Associations like the UN, BRICS, QUAD
- Presentation on issues around the world

SUGGESTED EVALUATION METHODS

- Assignment topics
- Quizzes
- Class Presentation/Discussion
- Continuous assessments (CAT)

Text Book(s):	
1.	M. Laxmikanth , "Indian Polity:, McGraw-Hill, New Delhi.
2.	Durga Das Basu, "Introduction to the Constitution of India ", Lexis Nexis, New Delhi. 21st ed 2013.
3.	P K Agarwal and K N Chaturvedi, Prabhat Prakashan, New Delhi, 1st ed , 2017.

Reference Books(s) / Web links:	
1.	Sharma, Brij Kishore, "Introduction to the Constitution of India: Prentice Hall of India, New Delhi.
2.	U.R.Gahai, "Indian Political System ", New Academic Publishing House, Jalandhar
3.	Bipan Chandra, India's Struggle for Independence, Penguin Books, 2016.
4.	Maciver and Page, "Society: An Introduction Analysis ", Mac Milan India Ltd., New Delhi.2nd ed, 2014.
5.	Bipan Chandra, History of Modern India, Orient Black Swan, 2009.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MC23111.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MC23111.2	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-
MC23111.3	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
MC23111.4	-	-	-	-	-	1	-	1	1	-	-	-	-	-	-
MC23111.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SEMESTER III

Course Code	Course Title	Category	L	T	P	C
MA23311	Transforms and Applied Partial DifferentialEquations	BS	3	1	0	4
Common to III sem. B.E. – Aeronautical Engineering, Mechatronics, Robotics & Automation and B.Tech. – Biotechnology, Food Technology and Chemical Engineering						

Objectives:	
•	To express Fourier series to study the behaviour of periodic functions and their applications in system communications, digital signal processing and field theory.
•	To show continuous function arising in wave and heat propagation, signals and systems using Fourier Transforms.
•	To obtain solution of one-dimensional wave equation with finite difference techniques.
•	To solve one- and two-dimensional heat flow equations using finite difference methods and numerical techniques.
•	To make use of Z-transform to illustrate discrete function arising in wave and heat propagation, signals and systems.

UNIT-I	FOURIER SERIES	12
Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series – Half range cosine series –Parseval's identity – Harmonic analysis.		
UNIT-II	**FOURIER TRANSFORMS**	**12**
Statement of Fourier integral theorem – Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity - Application to boundary value problems.		
UNIT-III	**WAVE EQUATION**	**12**
Solution of one-dimensional wave equation - Finite difference techniques for the solution for PDE- One Dimensional Wave Equation by Explicit method		
UNIT-IV	**HEAT EQUATION**	**12**
One dimensional equation of heat conduction – Steady state solution of two-dimensional equation of heat conduction (excluding insulated edges)- Numerical computation: O n e dimensional heat flow equation by implicit and explicit methods		
UNIT-V	**Z-TRANSFORMS**	**12**
Z- transforms - Elementary properties – Inverse Z - transform (using residues) - Formation of difference equations – Solution of difference equations using Z- transform.		
Total Contact Hours: 60		

Course Outcomes: On completion of the course, students will be able to	
•	Demonstrate Fourier series to study the behaviour of periodic functions and their applications in engineering problems such as system communications, digital signal processing and field theory.
•	Apply the shifting theorems, Fourier integral theorems, Inverse Fourier sine and cosine transforms appropriate problems in engineering and technology.
•	Evaluate solution of one-dimensional wave equation arising in various field of engineering using finite difference techniques.
•	Apply the numerical techniques of differentiation to solution of heat flow equations arising in various branches of engineering.
•	Use Z-transform to illustrate discrete function arising in wave and heat propagation, signals and systems.

SUGGESTED ACTIVITIES

- Problem solving sessions
- Activity Based Learning
- Online MATLAB session can be implemented

SUGGESTED EVALUATION METHODS

- Problem solving in Tutorial sessions
- Assignment problems
- Quizzes and class test
- Discussion in classroom

Text Books:	
1	Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India, 2015.
2	Veerarajan. T., "Transforms and Partial Differential Equations", Tata McGraw Hill Education Pvt. Ltd., New Delhi, Second reprint, 2012.
3	Grewal B.S., "Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, Delhi, 2014.
4	Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.
5	P. Kandasamy, K. Gunavathy, Thilagavathy., "Engineering Mathematics Transforms and Partial Differential Equations", S.Chand & Company, 2002.

Reference Books / Web links:	
1	N. Subramaniam, K. S. Ramaswami., "Transforms and Partial Differential Equations", Pearson Education, 2018.
2	Glyn James, "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, 2007.
3	Ray Wylie C and Barrett.L.C, "Advanced Engineering Mathematics" Tata McGraw Hill Education Pvt Ltd, Sixth Edition, New Delhi, 2012.
4	Bali N., Goyal M. and Watkins C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), 7th Edition, New Delhi, 2009.
5	Peter V.O'Neil, "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, 7th Edition, New Delhi, 2012. https://drspmaths.files.wordpress.com/2020/01/advanced-engineering-mathematics-peter-v.-o-neil.pdf

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MA23311.1	3	3	3	2	1	-	-	-	-	-	-	1	2	1	2
MA23311.2	3	3	3	2	1	-	-	-	-	-	-	1	2	1	2
MA23311.3	3	3	3	3	2	-	-	-	-	-	-	2	1	2	2
MA23311.4	3	3	2	3	2	-	-	-	-	-	-	2	1	-	1
MA23311.5	2	3	2	-	-	-	-	-	-	-	-	-	1	1	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory Course)	Category	L	T	P	C
RO23311	Analog and Digital Electronics	PC	3	0	0	3

Objectives:	
●	To acquire knowledge about Diode & Transistors operation and characteristic.
●	To learn the IC fabrication procedure and applications of op-amp.
●	To impart knowledge on design and implementation of IC 555 timer, VCO, PLL, FVR, VVR, ICL.
●	To learn the basic postulates of Boolean algebra and infer the methods for simplifying Boolean expressions and design of various Combinational circuits.
●	Design of Synchronous and Asynchronous Sequential circuits and its problems.

UNIT-I	INTRODUCTION TO ANALOG CIRCUITS	9
PN junction & Zener diodes: Forward and Reverse bias, VI characteristics- BJT: Input and Output Characteristics of CE, CB and CC - JFET AND MOSFET: Drain and Transfer Characteristics.		
UNIT-II	**FUNDAMENTALS AND CHARACTERISTICS OF OP-AMP**	9
Fundamentals of monolithic IC technology and fabrication, Inverting and Non-inverting Amplifiers – Voltage follower – Summing amplifier – Difference amplifier –V/I and I/V converter – Differentiator – Integrator – Instrumentation amplifier–log and antilog amplifier- Oscillators- Comparators – Multivibrators.		
UNIT-III	**REGULATOR & SPECIAL ICS OF OP-AMP**	9
Functional block, characteristics: 555 Timer IC – IC566 Voltage Controlled Oscillator (VCO) – IC 565 Phase Locked Loop (PLL) – LM79XX – Fixed voltage regulators – LM 723 Variable voltage regulators, – SMPS – ICL 8038 function generator IC.		
UNIT-IV	**NUMBER SYSTEMS & COMBINATIONAL CIRCUITS**	9
Review of number systems, Boolean laws, K maps – simplification and implementation of combinational logic, Binary codes - code converters, adders, subtractors, multiplexers and de-multiplexer, encoders and decoders.		
UNIT-V	**SYNCHRONOUS & ASYNCHRONOUS SEQUENTIAL CIRCUITS**	9
Sequential logic- SR, JK, D and T flip flops – level triggering and edge triggering – asynchronous and synchronous counters – Shift registers, Analysis of asynchronous sequential logic circuits -Transition table, flow table-race conditions, hazards & errors in digital circuits.		
Total Contact Hours:45		

Course Outcomes: On completion of the course, students will be able to	
●	Demonstrate and Developing of Diode & Transistors operation and characteristic.
●	Realize the various applications of OP-AMP & generate a Waveforms.
●	Develop functional systems of various OP-AMP
●	Simplify the Boolean expressions with suitable minimization techniques, Design and Implement Combinational circuits.
●	Design & Construct Synchronous and Asynchronous Sequential circuits and analyze its problems

SUGGESTED ACTIVITIES

- Industrial visit
- Mini Project

SUGGESTED EVALUATION METHODS

- Assignment topics
- Class Presentation/Discussion
- Continuous Assessment Tests

Text Books:	
1	D. Roy Choudhary, Sheilb.Jani, ―Linear Integrated Circuits, fifth edition, New Age, 2018.
2	Morris Mano & Michael D Ciletti, "Digital Design: With an Introduction to Verilog HDL, 5th Edition, Pearson Education, 2013

Reference Books / Web links:	
1	Robert L. Boylestad, Louis Nashelsky, "Electronic Devices and Circuit Theory," 11th Edition, Prentice Hall, 2012.
2	D. Neamen , D. Biswas "Semiconductor Physics and Devices," 4/e, Mc Graw-Hill Education, 2012.
3	Ramakant A.Gayakwad, ―Op-amps and Linear Integrated Circuits , fourth edition, Pearson Education, 2015.
4	Charles H.Roth. "Fundamentals of Logic Design", 7th Edition, Thomson Learning, 2014.
5	Thomas L. Floyd, "Digital Fundamentals", 10th Edition, Pearson Education Inc, 2011.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23311.1	3	2	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23311.2	3	3	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23311.3	3	3	3	3	2	2	-	-	1	1	1	2	3	2	1
RO23311.4	3	3	3	2	2	2	-	-	1	1	1	1	3	2	1
RO23311.5	3	3	2	2	2	1	-	-	1	1	1	1	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory Course)	Category	L	T	P	C
RO23312	Theory of Mechanisms And Machines-I	PC	3	1	0	4

Objectives:	
●	To understand the basic concepts of mechanisms
●	To develop the velocity, and acceleration diagram of mechanisms
●	To understand the fundamentals of lower pair mechanisms
●	To understand the cam mechanisms
●	To understand the basic concepts of cam mechanism, gears and gear trains

UNIT-I	FUNDAMENTALS AND TYPE OF MECHANISMS	12
Introduction to statics, kinematics, kinetics - Classification of mechanisms – Basic kinematic concepts and definitions – Kinematic links. Joints, pairs, chains and its types. Degree of freedom - constrained motion and its types - Mobility – Kutzbach criterion, Gruebler's criterion – Grashof's Law- Inversions, Mechanism, Machineand Structure. Kinematic inversions of four-bar chain and slider crank chains – Limit positions – Mechanical advantage – Transmission Angle.		
UNIT-II	**VELOCITY AND ACCELERATION ANALYSIS**	**12**
Velocity of a Point on Rotating Rigid Body - Relative Velocity between Two Points on the Same Link - Displacement, velocity and acceleration analysis of simple mechanisms – Graphical method– Velocity and acceleration polygons – velocity analysis using instantaneous centers - Aronhold-Kennedy's Theorem of Three Centres – kinematic analysis of simple mechanisms – Coincident points – Introduction to linkage synthesis problem.		
UNIT-III	**MECHANISMS WITH LOWER PAIRS**	**12**
Offset Slider-Crank Mechanism as a Quick Return Mechanism - The Pantograph - Straight Line Motion Mechanisms. Exact Straight Line Motion Mechanisms - Peaucellier Mechanism, The Hart Mechanism, The Scott-Russel Mechanism. Approximate Straight-Line Motion - Watt Mechanism, Grasshopper Mechanism, Roberts Straight Line Motion Mechanism. Davis Steering Gear mechanism - Ackerman Steering Gear mechanism - Hooke's Joint or Universal Coupling - Toggle Mechanism - Scotch Yoke Mechanism.		
UNIT-IV	**KINEMATICS OF CAM MECHANISMS**	**12**
Classification of cams and followers – Terminology and definitions – Displacement diagrams –Uniform velocity, parabolic, simple harmonic and cycloidal motions – Derivatives of follower motions – Layout of plate cam profiles – Specified contour cams – Circular arc and tangent cams – Pressure angle and undercutting – sizing of cams.		
UNIT-V	**GEARS AND GEAR TRAINS**	**12**
Classification of Gears - Nomenclature for Straight Spur Gears – Fundamental Law of toothed gearing – Involutes and cycloidal tooth profiles – Length of Path of Contact– Length of arc of Contact - contact ratio – Interference and undercutting. Gear trains – Speed ratio, train value – Parallel axis gear trains – Epicyclic Gear Trains - Algebraic Method of Analyzing Epicyclic Gear Trains – Tabulation Method for Analyzing Epicyclic Gear Train		
	Total Contact Hours : 60	

Course Outcomes: On completion of the course students will be able to	
●	Analyze the mechanisms
●	Construct the velocity and acceleration diagrams for a given mechanism
●	Analyze the mechanisms with lower pairs.
●	Design and analyze the cam mechanisms.
●	Analyze the given gear trains

SUGGESTED ACTIVITIES

- Industrial visit
- Mini Project

SUGGESTED EVALUATION METHODS

- Assignment topics
- Class Presentation/Discussion
- Continuous Assessment Tests

Text Books:	
1	Uicker, J.J., Pennock G.R and Shigley, J.E., ―Theory of Machines and Mechanisms, Oxford University Press, 4th Edition, Reprint: 2017
2	Rattan, S.S, ―Theory of Machines, McGraw-Hill Education Pvt. Ltd., 5th edition, 2019.

Reference Books(s) / Web links:	
1.	Amitabha Ghosh and Asok Kumar Mallik, ―Theory of Mechanisms and Machines, Affiliated East-West Pvt. Ltd., 3rd edition, 1988.
2.	Rao J.S. and Dukkipati. R.V. ―Mechanism and Machine Theory, New Age International Pvt. Ltd., 2nd Edition, 2014
3.	Singh.V.P, ―Theory of Machine , Dhanpat Rai & Co., 6th Edition, 2017
4.	Ashok G. Ambedkar – Mechanism and Machine Theory, Prentice-Hall of India Private Limited, New Delhi, 2007
5.	https://nptel.ac.in/courses/112/104/112104121/
6.	https://nptel.ac.in/courses/112105268/
7.	https://nptel.ac.in/courses/112101096/

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23312.1	3	2	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23312.2	3	3	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23312.3	3	3	3	3	2	2	-	-	1	1	1	2	3	2	1
RO23312.4	3	3	3	2	2	2	-	-	1	1	1	1	3	2	1
RO23312.5	3	3	2	2	2	1	-	-	1	1	1	1	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory Course)	Category	L	T	P	C
RO23313	Sensors in Automation	PC	3	0	0	3

Objectives:	
•	To understand the concepts of measurement and various sensors.
•	To Understand the practical approach in design of technology based on different sensors
•	To Learn various sensor materials and technology used in designing sensors.
•	To demonstrate different sensors working principle.
•	To Develop a sense for recognizing bad data and an intuition of how to resolve problems.

UNIT-I	SENSORS FUNDAMENTALS AND CHARACTERISTICS	9
Basics of measurement – Calibration techniques – Errors in measurement – Generalizedmeasurement system – Modules of Measurements - Sensors and Transducers – Classification of transducer – Static and dynamic characteristics of transducer – Sensor calibration techniques.		
UNIT-II	**PHYSICAL PRINCIPLES OF SENSING**	9
Electric Charges, Fields, and Potentials; Capacitance; Magnetism; Induction; Resistance; Piezoelectric Effect; Hall Effect; Temperature and Thermal Properties of Material; Heat Transfer;Light; Dynamic Models of Sensor Elements.		
UNIT-III	**INTERFACE ELECTRONIC CIRCUITS**	9
Input Characteristics of Interface Circuits, Amplifiers, Excitation Circuits, Analog to Digital Converters, Direct Digitization and Processing, Bridge Circuits, Data Transmission, Batteries forLow Power Sensors.		
UNIT-IV	**SENSORS IN DIFFERENT APPLICATION**	9
Area Occupancy and Motion Detectors; Position, Displacement, and Level; Velocity andAcceleration; Force, Strain, and Tactile Sensors; Pressure Sensors, Temperature Sensors.		
UNIT-V	**ADVANCED SENSOR TECHNOLOGY**	9
Smart sensors, MEMS based sensors, Innovations in sensor technology Actuators and its selectionwhile designing a robot system. Types of transmission systems.		
Total Contact Hours:45		

Course Outcomes: On completion of the course, students will be able to	
●	Familiar with various measurements, calibration techniques and types of transducers
●	Good knowledge of working of different types of sensors
●	Interfacing of electronic circuits with different sensors for its applications in different fields.
●	Select suitable sensors for all applications.
●	Analyze innovations in sensor technology.

SUGGESTED ACTIVITIES

- Industrial visit
- Mini Project

SUGGESTED EVALUATION METHODS

- Assignment topics
- Class Presentation/Discussion
- Continuous Assessment Tests

Text Book(s):	
1.	D. Patranabis, “Sensors and Transducers”, PHI Publication, New Delhi,2019.
2.	Ganesh S. Hegde, “Mechatronics”, Laxmi Publication Private Limited, India,2016.

Reference Books(s) / Web links:	
1.	J. Fraden, “Handbook of Modern Sensors: Physical, Designs, and Applications”, AIP Press, Springer.
2.	Jon S. Wilson, “Sensor Technology Handbook”, Elsevier, 2005.
3.	Devdas Shetty, Richard A. Kolk, “Mechatronics system design”, 2nd Edition, Cengage Learning, 2011.
4.	Sawhney A K and Puneet Sawhney, “A Course in Mechanical Measurements and Instrumentation and Control”, 12th edition, Dhanpat Rai & Co, New Delhi, 2013.
5.	Braünl, T., “Embedded robotics: mobile robot design and applications with embedded systems”, 3rd edition Berlin; Heidelberg: Springer, 2008. ISBN 9783540705338.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23313.1	3	2	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23313.2	3	3	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23313.3	3	3	3	3	2	2	-	-	1	1	1	2	3	2	1
RO23313.4	3	3	3	2	2	2	-	-	1	1	1	1	3	2	1
RO23313.5	3	3	2	2	2	1	-	-	1	1	1	1	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory Course)	Category	L	T	P	C
RO23331	Elements of Manufacturing Processes	PC	3	0	2	4

Objectives:	
•	To understand the basic concepts of sand-casting technique and special casting technique.
•	To learn about the principles of different welding and joining techniques.
•	To study the working principle and applications of Turning machines.
•	To understand the working principles of shaper, milling and gear cutting machines.
•	To know about Unconventional machining processes.

UNIT-I	METAL CASTING	9
Sand Casting : Sand Mould – Type of patterns - Pattern Materials – Pattern allowances –Moulding sand Properties and testing – Cores –Types and applications – Moulding machines– Types and applications; Cupola Furnaces; Principle of special casting processes : Shell - investment – Ceramic mould – Pressure die casting - Vacuum casting- CO2 process Defects in Sand casting.		
UNIT-II	**METAL JOINING AND FORMING PROCESSES**	9
Operating principle of Fusion welding processes, Gas welding, metal arc welding, Laser welding, Friction Stir welding Brazing and soldering; Weld defects: types, causes and cure– Forging processes – Open, impression and closed die forging – forging operations. Rolling of metals– Types of Rolling, Extrusion, Principle of rod and wire drawing		
UNIT-III	**TURNING MACHINES**	9
Centre lathe, constructional features, specification, operations – taper turning methods, thread cutting methods, special attachments, machining time and power estimation. Capstan and turret lathes- tool layout – automatic lathes: semi-automatic – single spindle: Swiss type, automatic screw type – multi spindle, Introduction to CNC machines.		
UNIT-IV	**SHAPER, MILLING AND GEAR CUTTING MACHINES**	9
Shaper - Types of operations. Drilling, reaming, boring, Tapping. Milling operations-types of milling cutter. Gear cutting – forming and generation principle and construction of gear milling, hobbing and gear shaping processes – finishing of gears.		
UNIT-V	**INTRODUCTION TO UNCONVENTIONAL MACHINING PROCESS**	9
Unconventional machining Process–Need–classification–merits, demerits and applications. Abrasive Jet Machining–Water Jet Machining–Abrasive Water Jet Machining-Ultrasonic Machining, Laser Beam Machining. Working Principles–equipment used–Process parameters–MRR-Applications.		
		Total Contact Hours:45

	LIST OF EXPERIMENTS
1	Preparation of sand mould using single & split piece pattern.
2	Step turning and Taper turning using lathe.
3	Knurling and external thread cutting using lathe.
4	Performing Drilling and tapping.
5	Cube formation using shaper.
6	Hexagonal milling and Spur gear cutting using vertical milling machine.
7	Gear generation in gear hobbing machine
8	Study of Laser cutting
	Total Contact Hours: 30
	Total Contact Hours: 75

Course Outcomes: On completion of the course students will be able to	
●	Develop components using special casting processes.
●	Select welding techniques based on applications
●	Perform machining in turning machines
●	Produce Gear components.
●	Select suitable non-conventional machining process.

SUGGESTED ACTIVITIES

- Industrial visit
- Internship
- Fabrication project
- Seminar

SUGGESTED EVALUATION METHODS

- CAT 1, CAT 2, CAT 3
- Assignment- 1, Assignment- 2, Assignment- 3.
- End Semester Examination.

Text Book(s):	
1	HajraChoudhary. S.K and Hajra Choudhary. A.K., "Elements of Workshop Technology", volume I and II, Media Promoters and Publishers Private Limited, Mumbai, 2014.
2	Kalpakjian. S, "Manufacturing Engineering and Technology", 7th Edition, Pearson Education India Edition, 2018

Reference Books(s) / Web links:	
1	Roy A. Lindberg, "Processes and Materials of Manufacture", PHI / Pearson education, 2016
2	Black J.T and Ronald A. Kosher, "Degarmos Materials and Processes, in Manufacturing" 12th Edition, WileyPublishers, 2017.
3	Sharma, P.C., "A Text book of production Technology", S.Chand and Co. Ltd., 2006.
4	Rao, P.N. "Manufacturing Technology Foundry, Forming and Welding", Vol 1, 4th Edition, Mcgraw Hill-2017.
5.	https://nptel.ac.in/courses/112107144/

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
RO23331.1	3	2	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23331.2	3	3	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23331.3	3	3	3	3	2	2	-	-	1	1	1	2	3	2	1
RO23331.4	3	3	3	2	2	2	-	-	1	1	1	1	3	2	1
RO23331.5	3	3	2	2	2	1	-	-	1	1	1	1	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Lab oriented Theory Course)	Category	L	T	P	C
RO23332	Mechanics of Materials	PC	3	0	2	4

Objectives:	
•	To understand the fundamental concepts of stress, strain and elastic constants of solids under external loading
•	To learn about torsion of linearly elastic materials and shell structures like thin cylinders and pressure vessels
•	To learn about the shear force, bending moment and deflection of beams and study about that the analysis plane stress and strain
•	To learn about the deflection of beams and stability of columns and shell structures like thin cylinders, spheres and thick cylinders and study the mechanical properties of materials when subjected to different types of loadings and study the impact strength of given specimen.
•	To study the hardness properties of given specimen and understand the deflection of different beams

UNIT-I	CONCEPT OF STRESS AND STRAIN	9
Deformation of bars: Hooke's law, stress, strain, and elongation; Tensile, compressive and shear stresses in 2D solids; Elastic constants and their relations; Volumetric, linear and shear strains; Principal stresses and strain; Principal planes; Mohr's circle.		
UNIT-II	**MECHANICS OF BEAMS**	**9**
Transverse loading on beams, point and distributed loads; Shear force and bend moment diagrams; Type of beam supports – simply supported, over-hanging, cantilevers, fixed and guided beams; Static determinacy and indeterminacy; Theory of bending of beams, pure bending stress distribution and neutral plane, second moment of area; Different cross-sections of beams; Shear stress distribution.		
UNIT-III	**DEFLECTION OF BEAMS**	**9**
The elastic curve -slope and displacement by integration- Discontinuity function -Slope and displacement by moment area method -Method of super position-Statically indeterminate beams and shafts-statically indeterminate beams and shafts -Method of integration- statically indeterminate beams and shafts - Moment area method - statically indeterminate beams and shafts -Method of superposition.		
UNIT-IV	**COLUMN BUCKLING, TORSION AND TWIST**	**9**
Critical loads using Euler's theory; Different boundary conditions; Eccentric columns. Torsion stresses and deformation of circular and hollow shafts; Polar moment of area, stepped shafts; Deflection of shafts fixed at both ends; Stresses and deflection of helical springs.		
UNIT-V	**PRESSURE VESSELS**	**9**
Axial and hoop stresses in cylinders subjected to internal pressure; Deformation of thin and thick cylinders; Deformation in spherical shells subjected to internal pressure; Combined thermomechanical stress; Examples and case studies (boilers).		
		Contact Hours :45

	LIST OF EXPERIMENTS
1	Tension test on a mild steel rod
2	Double shear test on Mild steel and Aluminium rods
3	Torsion test on mild steel rod
4	Impact test on metal specimen (Charpy and Izod test)
5	Hardness test on metals – (Brinell and Rockwell Hardness Number)
6	Deflection test on beams (Simply supported beam)
7	Compression test on helical springs (Closed coil)
8	Beam Deflections using Maxwell Reciprocal Theorem
9	Strain Measurement
10	Deflection Of Continuous Beam.
	Total Contact Hours : 30
	Total Contact Hours 75

Course Outcomes:
On completion of the course, students will be able to:
• Apply the principal concepts behind stress, strain and deformation of solids for various engineering applications**.**
• Design beams for various loading conditions
• Calculate the deflection of beams and measure the deflection of a Continuous beam
• Perform Tension, shear test, Torsion, impact test and Hardness test on given material and determine the stiffness and modulus of rigidity of the spring wire.
• Design columns and pressure vessels

Text Books:	
1.	R.C Hibler , " Mechanics of Materials", 8th edition Pearson Education, India, 2018.
2.	Rajput R. K, "Strength of Materials (Mechanics of Solids)", S.Chand Publishers ,India, 2022
Reference Books:	
1.	Bansal, R.K., "Strength of Materials", Laxmi Publications (P) Ltd., 2015.
2.	Egor. P.Popov —Engineering Mechanics of Solids Prentice Hall of India, New Delhi, 2001.
3.	Ramamurtham S., "Strength of Materials", Dhanpat rai publishing company, New Delhi , 2011.
4.	Ferdinand P. Been, Russell Johnson, J.r. and John J. Dewole "Mechanics of Materials", Tata McGraw Hill
5.	Barry J. Goodno and James M. Gere "Mechanics of Materials", Cl-Engineering; 9th Edition., Canada, 2016.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23332.1	3	2	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23332.2	3	3	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23332.3	3	3	3	3	2	2	-	-	1	1	1	2	3	2	1
RO23332.4	3	3	3	2	2	2	-	-	1	1	1	1	3	2	1
RO23332.5	3	3	2	2	2	1	-	-	1	1	1	1	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title	Category	L	T	P	C
CS23422	**Python Programming for Machine learning** (with effect from 2023 batch onwards)	ES	0	0	4	2

Objectives: This course is aimed at enabling the students to:	
●	To understand the relationship of the data collected for decision making.
●	To know the concept of principal components, factor analysis and cluster analysis for profiling and interpreting the data collected.
●	Lay the foundation of machine learning and its practical applications and prepare students for real-time problem-solving in data science.
●	Develop self-learning algorithms using training data to classify or predict the outcome of future datasets.
●	Distinguish overtraining and techniques to avoid it such as cross-validation.

List of Experiments			
1.	NumPy Basics: Arrays and Vectorized Computation		
2.	Getting Started with pandas		
3.	Data Loading, Storage, and File Formats		
4.	Data Cleaning and Preparation		
5.	Data Wrangling: Join, Combine, and Reshape		
6.	Plotting and Visualization		
7.	Data Aggregation and Group Operations		
8.	Time Series		
9.	Supervised Learning		
10.	Unsupervised Learning and Pre-processing		
11.	Representing Data and Engineering Features		
12.	Model Evaluation and Improvement		
	Contact Hours	**:**	**60**

Course Outcomes:	
On completion of the course, students will be able to:	
●	Develop a sound understanding of current, modern computational statistical approaches and their application to a variety of datasets.
●	Analyze and perform an evaluation of learning algorithms and model selection.
●	Compare the strengths and weaknesses of many popular machine learning approaches.
●	Appreciate the underlying mathematical relationships within and across machine learning algorithms and the paradigms of supervised and unsupervised learning.
●	Design and implement various machine learning algorithms in a range of real-world applications.

Text Books:	
1.	Wes McKinney, Python for Data Analysis - Data wrangling with pandas, Numpy, and ipython, Second Edition, O'Reilly Media Inc., 2017.
2.	Andreas C. Müller and Sarah Guido, Introduction to Machine Learning with Python - A Guide for Data Scientists, First Edition, O'Reilly Media Inc, 2016.

Reference Books:	
1.	Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 2nd Edition, O'Reilly Media Inc, 2019.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CS23422.1	2	2	2	2	1	-	-	-	1	1	1	1	2	2	2
CS23422.2	2	1	1	1	1	-	-	-	-	-	1	1	2	2	2
CS23422.3	1	1	2	1	2	-	-	-	-	-	1	1	2	2	2
CS23422.4	2	2	3	2	2	-	-	-	-	-	2	1	2	2	2
CS23422.5	2	2	3	2	3	-	-	-	-	-	2	1	2	2	2

SEMESTER IV

Course Code	Course Title	Category	L	T	P	C
RO23411	Fluid Power Systems	PC	3	0	0	3

Objectives:	
●	To understand the basics of fluid properties and flow characteristics.
●	To learn about losses in fluid flow through pipes.
●	To develop hydraulic circuits and systems.
●	To know the working principles of pneumatic power system and its components.
●	To learn the trouble shooting methods in fluid power systems.

UNIT-I	FLUID PROPERTIES AND FLOW CHARACTERISTICS	9
Properties of fluids-Pressure Measurements-U-tube manometer-Single column manometer- Differential manometer - Buoyancy and floatation-Flow characteristics-Eulerian and Lagrangian Principle of fluid flow– concept of control volume and system –Reynolds transportation theorem-continuity equation, energy equation and momentum equation-Applications.		
UNIT-II	**FLOW THROUGH PIPES**	**9**
Reynold‟s Experiment-Laminar flow through circular conduits-Darcy Welsbach equation –friction factor- - minor losses-Hydraulic and energy gradient –Pipes in series and parallel. Pumping Theory – Pump Classification – Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criteria of Linear and Rotary – Fixed and Variable displacement pumps		
UNIT-III	**HYDRAULIC ACTUATORS AND CIRCUIT DESIGN**	**9**
Hydraulic Actuators: Cylinders –Types and construction, Application, Hydraulic cushioning ,Hydraulic motors Direction Control, Flow control and pressure control valves –Types, Construction and Operation – Accessories ,Fluid Power ANSI Symbols –Problems, Accumulators, Intensifiers, Industrial hydraulic Circuit Design and Analysis, Hydrostatic transmission, Sensors used in Electro hydraulic systems, Electro hydraulic circuits,–Servo and Proportional valves –Applications-Mechanical , hydraulic servo systems.		
UNIT-IV	**PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS**	**9**
Properties of air –Air preparation and distribution –Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit –classification-single cylinder and multi cylinder circuits-Cascade method –Integration of fringe circuits, PLC-Architecture and types, Electro Pneumatic System – Elements –Ladder diagram –timer circuits-Problems.		
UNIT-V	**TROUBLE SHOOTING AND APPLICATIONS**	**9**
Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Conditioning of hydraulic fluids Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for metal working, handling, clamping counter and timer circuits. –Low- c o s t Automation –Hydraulic and Pneumatic power packs- Case studies of innovative applications of fluid power systems in automation		
	Total Contact Hours : 45	

Course Outcomes: On completion of course students will be able to	
●	Understand the behavior of fluids.
●	Calculate losses in fluid flow and design the effective fluid flow system.
●	Design hydraulic circuits and systems for various applications.
●	Design and develop pneumatic and electro pneumatic systems.
●	Select, Install and Maintain fluid power systems.

SUGGESTED ACTIVITIES

- Industrial visit
- Mini Project

SUGGESTED EVALUATION METHODS

- Assignment topics
- Class Presentation/Discussion
- Continuous Assessment Tests

Text Books:	
1	Anthony Esposito, "Fluid Power with Applications", Pearson New International Edition, England, 2014.
2	Modi P.N. and Seth, S.M. Hydraulics and Fluid Mechanics, Standard Book House, New Delhi, 2017.

Reference Books / Web links:	
1	Jagadeesha. T., "Pneumatics Concepts, Design and Applications ", Universities Press, 2015.
2	Joshi.P., Pneumatic Control", Wiley India, 2008.
3	Majumdar, S.R., "Oil Hydraulics Systems –Principles and Maintenance",TataMcGraw Hill, 2001
4	Shanmugasundaram.K., "Hydraulic and Pneumatic Controls". Chand & Co, 2006.
5	Srinivasan.R., "Hydraulic and Pneumatic Controls", Vijay Nicole Imprints, 2008.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23411.1	3	2	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23411.2	3	3	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23411.3	3	3	3	3	2	2	-	-	1	1	1	2	3	2	1
RO23411.4	3	3	3	2	2	2	-	-	1	1	1	1	3	2	1
RO23411.5	3	3	2	2	2	1	-	-	1	1	1	1	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory Course)	Category	L	T	P	C
RO23412	Industrial Automation and Control	PC	3	0	0	3

Objectives:	
•	To introduce the elements of control system and their modeling using various Techniques.
•	To perform frequency domain analysis of control systems required for stability analysis.
•	To design the compensation technique that can be used to stabilize control systems.
•	To study about the hardware and software involved in a PLC
•	To provide the control functions involved in DCS and SCADA

UNIT-I	INTRODUCTION TO CONTROL SYSTEM	9
Basic Elements of Control System – Open loop and Closed loop systems - Differential equation - Transfer function, Modeling of Electric systems, Translational and rotational mechanical systems -Block diagram – Signal flow graph – P, PI, PD and PID Compensation, Analysis of Compensation in Mechatronics systems		
UNIT-II	**ANALYSIS OF TIME AND FREQUENCY RESPONSE**	9
Time response analysis - First Order Systems - Impulse and Step Response - Analysis of second order systems-Frequency Response - Bode Plot, Polar Plot, Nyquist Plot - Frequency Domain specifications from the plots. Compensators - Lead, Lag, and Lead-Lag Compensators		
UNIT-III	**STABILITY ANALYSIS**	9
Stability, Routh-Hurwitz Criterion, Root Locus Technique, Construction of Root Locus, Stability, Dominant Poles, Application of Root Locus Diagram. – Transfer function from State Variable Representation – Solutions of the state equations - Concepts of Controllability and Observability.		
UNIT-IV	**PROGRAMMABLE LOGIC CONTROLLERS**	9
Introduction to Programmable Logic Controllers, Architecture of PLC, PLC programminglanguages, Relay Logic, Ladder logic, Timers and Counters, selection of PLC based on input and output. Application of PLC in automation.		
UNIT-V	**SCADA**	9
Introduction, Application areas of SCADA, Major elements of SCADA systems, Comparison of SCADA, DCS and PLC, Considerations and benefits of SCADA system. Introduction to field-programmable gate array (FPGA).		
Total Contact Hours:45		

Course Outcomes: On completion of the course students will be able to	
•	Write mathematical equations for model mechanical, electrical systems and compute transfer function using block diagram and signal flow graph methods.
•	Perform time domain and frequency domain analysis of control systems required for stability analysis in Robot Control.
•	Design the compensation technique that can be used to stabilize Robot control systems.
•	Program PLC based on applications.
•	Summarize the working of various elements of DCS and SCADA

SUGGESTED ACTIVITIES

- Mini Project
- Industrial visit

SUGGESTED EVALUATION METHODS

- Assignment topics
- Quizzes
- Class Presentation/Discussion
- Continuous Assessment Tests

Text Book(s):	
1.	Nagrath J and M.Gopal, "Control System Engineering", New Age International Publishers, 6th Edition, 2017.
2.	Levent Güvenç, Bilin Aksun Güvenç, Burak Demirel, Mümin Tolga Emirler, "Control of Mechatronic Systems", Institution of Engineering and Technology, 2017.

Reference Books(s) / Web links:	
1.	Benjamin.C.Kuo, "Automatic control systems", Prentice Hall of India, 9th Edition,2014.
2.	Gopal M, "Control System – Principles and Design", Tata McGraw Hill, 4nd Edition, 2012.
3.	Stuart A Boyer, "SCADA-supervisory control and data acquisition", International Society of automation, 3rd edition,2011.
4.	Georg Pelz, "Mechatronic Systems Modeling and Simulation with HDLs", wiley Publication, 2003.
5.	Richard Zurawski, "Industrial Communication Technology Handbook" 2nd Edition, CRC Press, 2015.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23412.1	3	2	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23412.2	3	3	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23412.3	3	3	3	3	2	2	-	-	1	1	1	2	3	2	1
RO23412.4	3	3	3	2	2	2	-	-	1	1	1	1	3	2	1
RO23412.5	3	3	2	2	2	1	-	-	1	1	1	1	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory Course)	Category	L	T	P	C
RO23413	Microcontrollers and Real Time EmbeddedSystems	PC	3	0	0	3

Objectives:	
●	To understand architecture of microcontroller and usage of built-in special function blocks.
●	To know the microcontroller programming methodology and to acquire the interfacing skills and data exchangemethods using various communication protocols.
●	To design the interface circuit and programming of I/O devices, sensors and actuators.
●	To impart knowledge on basics of embedded system architecture.
●	To provide essential knowledge on real time embedded operating system.

UNIT-I	INTRODUCTION TO MICROCONTROLLER	9
Introduction to 8085 Architecture-, addressing mode - instruction set, Architecture of 8051 – Memory organization - I/O Ports - Instruction set - Addressing modes - Assembly language programming, PIC Architecture – Programming Techniques – PIC Development Systems – Application Design – Program Debugging - Introduction to Arduino microcontroller, Raspberry Pi		
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, I2C, 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	**INTRODUCTION TO EMBEDDED SYSTEMS**	9
Embedded system Architecture - Design Process in Embedded system- Classification of Embedded system, Timer and Counting devices - Watchdog Timer - Real Time Clock - In circuit emulator - Target Hardware Debugging		
UNIT-V	**REAL TIME OPERATING SYSTEM**	9
Introduction to basic concepts of RTOS – Tasks and Data – Threads – Multiprocessing and Multitasking – Semaphores – Priority Inversion - Priority Inheritance – Queues – Pipes, Washing machines - Cruise control - antilock braking systems - Automatic chocolate vending machine – Automatic lubrication of supplier Conveyor belt.		
Total Contact Hours:45		

Course Outcomes: On completion of the course students will be able to	
●	Design and implement the programs of 8051.
●	Recognize the role of each functional units in microcontroller, processors and system- on chip based on thefeatures and specifications.
●	Interface the sensors, actuators and other I/O's with microcontroller, processors and system on chip basedinterfacing.
●	Construct the basic architecture and components of embedded system.
●	Develop embedded system in real time for simple applications.

SUGGESTED ACTIVITIES

- Industrial visit
- Mini Project

SUGGESTED EVALUATION METHODS

- Assignment topics
- Class Presentation/Discussion
- Continuous Assessment Tests

Text Book(s):	
1.	Muhammad Ali Mazidi and Janice GillispicMazdi, "The 8051 Microcontroller and Embedded Systems", Pearson Education, 2006.
2.	Muhammad Ali Mazidi, Rolin D. McKinlay and Danny Causey, "PIC Microcontroller and Embedded Systems:Using Assembly and C For Pic 18", Pearson Education, 2016

Reference Books(s) / Web links:	
1.	James W. Stewart, "The 8051 Microcontroller Hardware, Software and Interfacing", Regents Prentice Hall, 2003.
2.	Santanu Chattopadhyay, "Embedded system Design" 2nd Edition, PHI Learning Private Limited, 2013
3.	K C Wang, "Embedded and Real time Operating systems" Springer, 2017
4.	Subrata Ghoshal, "8051 Microcontroller: Internals, Instructions, Programming and Interfacing" Pearson Education,2010
5.	Raj Kamal, "Embedded Systems: Architecture, Programming and Design" Tata Mc Graw-Hill, 2015.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23413.1	3	2	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23413.2	3	3	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23413.3	3	3	3	3	2	2	-	-	1	1	1	2	3	2	1
RO23413.4	3	3	3	2	2	2	-	-	1	1	1	1	3	2	1
RO23413.5	3	3	2	2	2	1	-	-	1	1	1	1	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory Course)	Category	L	T	P	C
RO23414	**Robot Kinematics**	**PC**	**3**	**1**	**0**	**4**

Objectives:	
•	To understand the Robot types and its end effectors.
•	To introduce the concept of homogenous transformation matrices.
•	To understand the industrial robot kinematics.
•	To impart knowledge on singularity Analysis.
•	To learn the kinematics and dynamics of mobile robots.

UNIT-I	**BASICS OF INDUSTRIAL ROBOTICS**	**12**
Robot classifications, work envelope, Internal Grippers and External Grippers; Selection and Design Considerations, resolution, accuracy and repeatability of robot, applications, robot teaching, specification.		
UNIT-II	**SPATIAL DESCRIPTIONS AND TRANSFORMATIONS**	**12**
Representation of objects in 3-D space-position and orientation, Frame transformations-translation-rotation-translation and rotation combined- translation operator-rotation operator, composite rotation matrix representation of position in cylindrical, spherical coordinate system, representation of orientation using roll, pitch and yaw angles, representation of orientation using Euler angles. Forward and inverse kinematics of 2R planar robot using Geometry.		
UNIT-III	**ROBOT KINEMATICS**	**12**
Denavit-Hartenberg (D-H) notations- link and joint parameters-rules for coordinate assignments, forward and inverse kinematics using D-H representation - 2R planar robots - SCARA robot - Stanford arm. Introduction to Robot Kinematics with Screw-Based Mechanics - Rotation about a Screw Axis -Homogenous Transformations about a General Screw Axis Successive Screw-Based Transformations - Forward and Inverse Position Analysis of an Articulated Robot.		
UNIT-IV	**SINGULARITY ANALYSIS**	**12**
Manipulator Jacobians, Jacobian of Revolute-Revolute (RR) Manipulator, finding singularities of the 2-Link Manipulator, Introduction to parallel mechanisms and manipulators, Inverse and Forward Kinematics -RPR Planar Parallel Mechanism - Stewart–Gough Platform - General Parallel Mechanisms, Differential Kinematics- Stewart–Gough Platform - General Parallel Mechanisms, Singularities.		
UNIT-V	**MOBILE ROBOT KINEMATICS**	**12**
Introduction to mobile robots and mobile manipulators. Principle of locomotion and types of locomotion, Kinematics of wheeled mobile robot, degree of freedom and maneuverability, generalized wheel model, different wheel configurations, holonomic and non-holonomic robots.		
	Total Contact Hours : 60	

Course Outcomes: On completion of the course students will be able to	
•	Select the robot and its grippers based on application.
•	Calculate transformation and translation movements for spatial robots.
•	Develop DH parameters for robots.
•	Perform singularity analysis of serial and parallel manipulators.
•	Model mobile robots based on kinematics.

SUGGESTED ACTIVITIES

- Industrial visit
- Mini Project

SUGGESTED EVALUATION METHODS

- Assignment topics
- Class Presentation/Discussion
- Continuous Assessment Tests

Text Books:	
1.	John J. Craig, "Introduction to Robotics Mechanics and Control", Pearson Education India,2021
2.	Siegwart,R Nourbakhsh, and Scaramuzza, ―Introduction to Autonomous Mobile Robots, MIT Press, USA, 2011.

Reference Books / Web links:	
1.	Groover Mikell. P, "Industrial Robotics -Technology Programming and Applications", McGraw Hill, 2014
2.	Deb S.R., "Robotics Technology and Flexible Automation", Tata McGraw Hill Book Co., 2013.
3.	Koren Y.,"Robotics for Engineers", McGraw Hill Book Co., 1992
4.	Maja J Mataric, "The Robotics Primer", Universities Press. 2013.
5.	Fu. K.S, Gonzalez. R.C, Lee. C.S.G ―Robotics –Control, Sensing, Vision, and Intelligence, McGraw Hill, 2015.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23414.1	3	2	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23414.2	3	3	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23414.3	3	3	3	3	2	2	-	-	1	1	1	2	3	2	1
RO23414.4	3	3	3	2	2	2	-	-	1	1	1	1	3	2	1
RO23414.5	3	3	2	2	2	1	-	-	1	1	1	1	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title	Category	L	T	P	C
MA23432	Statistics and Numerical Methods	BS	3	0	2	4
Common to IV sem. B.E. – Aeronautical Engineering, Mechatronics and Robotics & Automation						

Objectives:	
•	To apply numerical methods to obtain approximate solutions to mathematical problems.
•	To derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear equations, and the solution of differential equations.
•	To analyze statistical experiments leading to reliability modelling and to identify reliability testing components for assessment of reliability in engineering design.
•	To solve the problems those are faced in testing of a hypothesis with reference to the errors in decision making.
•	To analyze the different mathematical models with the help of statistical deigns and appropriate data and made valuable conclusions by proper evaluation.

UNIT-I	SOLUTION OF EQUATIONS AND EIGEN VALUE PROBLEM	9
Newton Raphson method – Secant method – Gauss Jordan method – Iterative method of Gauss Seidel –Eigen value of a matrix by Jacobi method for symmetric matrix.		
UNIT-II	**INTERPOLATION, NUMERICAL DIFFERENTIATION AND INTEGRATION**	**9**
Lagrange's interpolations – Newton's forward and backward difference interpolation – Approximation of derivates using interpolation polynomials – Numerical integration – Simpsons 1/3 rule – Gaussian three-point quadrature.		
UNIT-III	**RELIABLITY**	**9**
Reliability Concepts: Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve - Failure Data Analysis: Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions - Reliability Hazard Models: Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model- Distribution functions and reliability analysis.		
UNIT-IV	**STATISTICAL TESTING**	**9**
Maximal Likelihood estimation – Parameters of Binomial and Poisson distribution - Tests of significance – Z test: Single mean, difference of means- Chi square - F test.		
UNIT-V	**ANOVA**	**9**
Design of Experiments - Completely randomized design – Randomized block design –Latin square design.		
Total Contact Hours: 45		

S.No	List of Experiment(using R Software)	Total Contact Hours: 30
1	Basic Functions in R and plotting	
2	Mathematical functions in R – Integration	
3	Control flow – Loops in R	
4	Probability Distributions using R- PDF, CDF for Binomial and Poisson.	
5	Testing of Hypothesis – Z, F and chi-square testing	
6	ANOVA – one way and two way	
7	Reliability – MTTF, MTBF	
8	Solution of equations – system of linear equations, Newton Raphson method	
9	Linear regression and cubic spline interpolation	
10	Reading, writing data in R and working with inbuilt data sets in R	

Course Outcomes: On completion of the course students will be able to	
•	Demonstrate common numerical methods and used to obtain approximate solutions of linear and system ofequations.
•	Derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation,integration, the solution of linear equations, and the solution of differential equations.
•	Illustrate the basic concepts and techniques of modern reliability engineering tools.
•	Apply the different testing tools like t-test, F-test, chi-square test to analyze the relevant real life problems.
•	Analyze the different mathematical models with the help of statistical deigns and appropriate data and made valuableconclusions by proper evaluation.

SUGGESTED ACTIVITIES

- Problem solving sessions
- Smart Class room sessions
- Activity Based Learning

SUGGESTED EVALUATION METHODS

- Problem solving in Tutorial sessions
- Assignment problems
- Quizzes and class test
- Discussion in classroom

Text Book(s):	
1.	Veerarajan T., 'Probability, Statistics and Random Processes with Queueing Theory and Queueing Networks', Mc Graw Hill, 2016
2.	Burden, R.L and Faires, J.D, "Numerical Analysis", 9th Edition, Cengage Learning, 2016.
3.	Kandasamy P., Thilagavathi and K. Gunavathi., "Statistics and Numerical Methods", S. Chand & CompanyLtd. (2010).
4.	Sastry S.S, "Introductory Methods of Numerical Analysis", Prentice- Hall of India PVT. LTD., 4th Edition, New Delhi, 2006.

Reference Books(s) / Web links:	
1.	Johnson R.A., "Miller and Freund's Probability and Statistics for Engineers",11th Edition, Pearson Education, Asia, 2011.
2.	Walpole R.E., Myers. R.H., Myers. S.L., and Ye. K., "Probability and Statistics for Engineers and Scientists", 8th Edition, Pearson Education, Asia, 2007.
3.	Spiegel M.R., Schiller. J., and Srinivasan. R.A., "Schaum's Outlines on Probability and Statistics", Tata McGraw Hill Edition, 2004.
4.	Grewal B.S., and Grewal. J.S., "Numerical Methods in Engineering and Science", 9th Edition, Khanna.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MA23432.1	2	2	1	-	-	-	-	-	-	-	1	-	1	2	-
MA23432.2	2	2	1	-	-	-	-	-	-	-	1	-	-	2	-
MA23432.3	2	2	1	-	-	-	-	-	-	-	1	-	1	2	-
MA23432.4	2	2	1	-	-	-	-	-	-	-	1	-	1	2	-
MA23432.5	2	2	2	-	-	-	-	-	-	-	1	-	1	2	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Laboratory Course)	Category	L	T	P	C
RO23421	Mechanisms and Robotics Laboratory	PC	0	0	4	2

Objectives:	
●	To study the kinematic analysis of mechanisms.
●	To study the transformation matrix usage.
●	To study the robot application for pick and place.
●	To understand Trajectory Control.
●	To calculate the joint torque of a robot.

List of Experiments				
1.	Simulation of four bar mechanism and analyze motion of the mechanism			
2.	Simulation of slider crank mechanism and analyze motion of the mechanism			
3.	Simulation of toggle mechanism and analyze motion of the mechanism			
4.	Determination of maximum and minimum position of links.			
5.	Verification of transformation (Position and orientation) with respect to gripper and world coordinate system			
6.	Estimation of accuracy, repeatability and resolution.			
7.	Robot programming and simulation for pick and place			
8.	Robot programming and simulation for Colour identification			
9.	Robot programming and simulation for Shape identification			
10.	Robot programming and simulation for assembly process			
11.	Trajectory Control Modeling with Inverse Kinematics			
12.	Check for Environmental Collisions with Manipulators			
13.	Robot programming for joint torque calculation.			
		Total Contact Hours	**:**	**60**

Course Outcomes: On completion of the course students will be able to	
●	Design and analyze mechanisms
●	Calculate robot position and orientation.
●	Develop optimal trajectory and path planning of robots.
●	Determine joint torques and forces in a robot.
●	Select sensors and actuators for anyrobotic system.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23421.1	3	2	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23421.2	3	3	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23421.3	3	3	3	3	2	2	-	-	1	1	1	2	3	2	1
RO23421.4	3	3	3	2	2	2	-	-	1	1	1	1	3	2	1
RO23421.5	3	3	2	2	2	1	-	-	1	1	1	1	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Laboratory Course)	Category	L	T	P	C
RO23422	Industrial Automation Laboratory-I	PC	0	0	4	2

Objectives:	
●	To provide exposure to the students with hands on experience to control motors
●	To understand the programming methods applied in programmable logic controllers
●	To know the working of load and level sensors.
●	To provide exposure to the students with hands on integrating sensors with PLC
●	To know about SCADA system

List of Experiments				
1.	Sequential start-up of multiple machines with chain electric latching			
2.	Controlling a machine from multiple different locations			
3.	Palindrome movement of worktable with memory			
4.	PLC Program to Control Lights in a Sequence using Bit Shift Registers			
5.	PLC Program to Control motor in a Sequence using Timers			
6.	PLC Program to Perform Pulse Width Modulation			
7	PLC Program to Operate multiple Outputs Simultaneously with Time Delay			
8	PLC Program to Control speed of Conveyor on sensor values			
9	PLC program to perform bottle labeling automatically			
10	PLC program to perform bottle capping automatically			
11	PLC program to control motors based on (level, torque & load) sensors			
12	Study of SCADA system			
		Total Contact Hours	**:**	**60**

Course Outcomes: On completion of the course students will be able to	
●	Design Automation circuits using electrical components
●	Control the machines using automation circuits
●	Program PLC using Ladder diagram method
●	Interface PLC with sensors and actuators
●	Control, collect data from all inputs and monitor all devices in an automation system

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23422.1	3	2	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23422.2	3	3	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23422.3	3	3	3	3	2	2	-	-	1	1	1	2	3	2	1
RO23422.4	3	3	3	2	2	2	-	-	1	1	1	1	3	2	1
RO23422.5	3	3	2	2	2	1	-	-	1	1	1	1	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

GE23421	Soft Skills-I	EEC	L	T	P	C
			0	0	2	1

Objectives:	
●	To help students break out of shyness.
●	To build confidence
●	To enhance English communication skills.
●	To encourage students' creative thinking to help them frame their own opinions,

Learning and Teaching Strategy:

The program is completely student centric where the focus is on activities led by students which include role plays, discussions, debates other games as well. These activities would be supplemented by interactive use of technology and brief trainer input.

Week	Activity Name	Description	Objective
1	Introduction	The trainer and the college facilitator talk to the students about the course and in turn the students introduce themselves.	To set expectations about the course and the students are made aware of the rules and regulations involved in this program
2	If I ruled the world	This is a quick and useful game by getting students to form a circle and provide their point of view. Each student then repeats what the other has said and comes up with their own opinion.	The aim of this activity is to for students to get to know each other and also develop their listening skills as well as learning how to agree and disagree politely.
3	Picture Narrating	This activity is based on several sequential pictures. Students are asked to tell the story taking place in the sequential pictures by paying attention to the criteria provided by the teacher as a rubric. Rubrics can include the vocabulary or structures they need to use while narrating.	The aim of this activity is to make the students develop creative way of thinking.
4	Brainstorming	On a given topic, students can produce ideas in a limited time. Depending on the context, either individual or group brainstorming is effective and learners generate ideas quickly and freely. The good characteristics of brainstorming are that the students are not criticized for their ideas so students will be open to sharing new ideas.	The activity aims at making the students speak freely without the fear of being criticized. It also encourages students to come up with their own opinions.

5	Debate	Is competition necessary in regards to the learning process?	The aim of this activity is to develop the students ability to debate and think out of the box
6	Short Talks	Here the students are given topics for which they take one minute to prepare and two minutes to speak. They can write down points but can't read them out they can only use it as a reference.	The activity aims at breaking the students' shyness and encouraging them to standup in front of the class and speak. It also aims at creating awareness that they are restricted for time so they only speak points that are relevant and important.
7	Debate	Will posting students' grades on bulletin boards publicly motivate them to perform better or is it humiliating?	This activity aims at enhancing the students unbiased thought process when it comes to exams and grades as well as develop their skills to debate
8	The Art of diplomacy	The facilitator proceeds to share multiple concepts of conversation and helps the participants to identify the various methods of being diplomatic and how do deal with misinformation.	The aim of the lesson is to provide an opportunity for the participants to learn about body language and choosing the appropriate words for conversation.
9	Debate	Are humans too dependent on computers?	The aim of this activity is to test the students debating skills and thought process with a topic that affects everybody in daily life.
10	Story Completion	The teacher starts to tell a story but after 2 sentences he/she asks students to work in groups to create the rest of the story which includes the plot and the ending.	This activity aims at building their narrating skills as well as their creativity and ability to work in a team.
11	Role play debate	Students scrutinize different points of view or perspectives related to an issue. For example, a debate about the question "Should students be required to wear uniforms at school?" might yield a range of opinions. Those might include views expressed by a student (or perhaps two students – one representing each side of the issue), a parent, a school principal, a police officer, a teacher, the owner of a clothing store, and others.	The aim of this activity is to get students to speak based on other people's perspective instead of their own. The students take the role of various characters and debate accordingly.
12	I Couldn't Disagree More	This is a game where students practice rebuttal techniques where one student provides a thought or an idea and the other students starts with the phrase I couldn't	The aim of this activity is to improve general communication skills and confidence.

		disagree more and continues with his opinion	
	Feedback	At the end of the session in the final week (12) the trainer would provide feedback to the students on best practices for future benefits	The aim is to do both give feedback to students as well as obtain feedback on the course from them.

Course Learning Outcome:

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

1. Be more confident
2. Speak in front of a large audience
3. Be better creative thinkers
4. Be spontaneous
5. Know the importance of communicating in English.

SEMESTER V

Course Code	Course Title (Theory Course)	Category	L	T	P	C
RO23511	AI for Robotics	PC	3	0	0	3

Objectives:	
•	To study the concepts of Artificial Intelligence.
•	To learn the methods of solving problems using Artificial Intelligence.
•	To introduce the concepts of Probabilistic reasoning and Speech recognition.
•	To understand about learning methods.
•	To understand the role of Artificial intelligence in Robotics

UNIT-I	Introduction to AI and Search Techniques	9

Historical background of Artificial Intelligence, state space search-simple search, Depth First Search (DFS), Breadth First Search (BFS), Comparison of BFS and DFS, Depth Bounded DFS, Depth First Iterative Deepening (DFID), Heuristic Search- Best First Search, Hill Climbing, local maxima, Solution Space Search, Variable Neighborhood Descent, Beam Search.

UNIT-II	Finding Optimal Paths	9

Brute force, Branch &Bound, Refinement Search, Dijkstra's Algorithm, Algorithm A*, Admissibility of A*, Iterative Deepening A*(IDA*), Simulated Annealing, Genetic Algorithm.

UNIT-III	Planning and Reasoning	9

Introduction to AI Planning-STRIPS Domain, Forward and Backward State Space Planning, Goal Stack Planning, Plan Space Planning, Uncertainty and Probabilistic Reasoning-Filtering and Prediction, Hidden Markov Models, Kalman Filters, Dynamic Bayesian Networks, Applications in AI-Speech Recognition, Decision-Making Processes.

UNIT-IV	Machine Learning in Robotics	9

Supervised Learning: Introduction to classification and regression, Decision Trees, k-Nearest Neighbors (k-NN), Support Vector Machines (SVM). Unsupervised Learning: Clustering methods like k-means and hierarchical clustering, Dimensionality Reduction - Principal Component Analysis (PCA) and Linear Discriminant Analysis (LDA). Reinforcement Learning: Basics of Markov Decision Processes, Q-learning, and applications in robot navigation and control.

UNIT-V	Neural Networks and Deep Learning for Robotics	9

Introduction to Neural Networks - Basic concepts, feedforward networks, and backpropagation. Convolutional Neural Networks (CNNs) - Architecture, applications in image recognition, and object detection. Recurrent Neural Networks (RNNs) and Long Short-Term Memory (LSTM) - Concepts and applications in sequence prediction and natural language processing for robotic control. Applications in Robotics - Using deep learning for object detection, scene understanding, and human-robot interaction.

	Total Contact Hours	:	45

Course Outcomes: On completion of the course students will be able to	
•	Identify problems that are amenable to solution by AI methods.
•	Identify appropriate AI planning methods to solve a given problem.
•	Implement basic AI algorithms for Speech recognition and making decisions.
•	Develop learning algorithms for autonomous driving tasks.
•	Apply appropriate AI methods to solve assembly problem.

SUGGESTED ACTIVITIES

- Industrial visit
- Mini Project

SUGGESTED EVALUATION METHODS

- Assignment topics
- Class Presentation/Discussion
- Continuous Assessment Tests

Text Books:	
1.	Stuart Russell, Peter Norvig, "Artificial Intelligence: A modern approach", Pearson Education, India, 2019.
2.	Negnevitsky, M, "Artificial Intelligence: A guide to Intelligent Systems", Harlow: Addison-Wesley, 2022.

Reference Books / Web links:	
1	David L. Poole and Alan K. Mackworth, "Artificial Intelligence: Foundations of Computational Agents", Cambridge University Press, 2010
2	Raju Bahubalendruni and Bibhuthi Bhushan Biswal, "Computer aided Optimal Robotic Assembly SequenceGeneration", Lap Lambert Academic Publishing; 1st edition, 2017.
3	Tim Jones M, "Artificial Intelligence: A Systems Approach", Jones & Bartlett Learning; 1st edition, 2008
4	Ian Good Fellow, Yoshua Bengio & Aaron Courville, "Deep Learning", MIT Press, USA, 2016.
5	Deepak Khemani, "A first course in Artificial Intelligence", McGraw Hill, India,2018.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
RO23511.1	3	2	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23511.2	3	3	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23511.3	3	3	3	3	2	2	-	-	1	1	1	2	3	2	1
RO23511.4	3	3	3	2	2	2	-	-	1	1	1	1	3	2	1
RO23511.5	3	3	2	2	2	1	-	-	1	1	1	1	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Name (Theory course)	Category	L	T	P	C
ME23511	Machine Design (Approved Design Data Book is Permitted)	PC	3	0	0	3

Objectives:	
•	To demonstrate the methods of determining steady and variable stresses in machine members.
•	To illustrate the principle involved in the design of shaft and couplings.
•	To build knowledge on the design of temporary and permanent joints.
•	To explain the design procedure of springs.
•	To outline the design steps and selection procedure involved in bearings.

UNIT-I	STEADY STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS	9

Introduction to the design process - Factors influencing machine design, Design consideration, Standards and codes. Modern design process: Digital design workflow, use of computer-aided design (CAD) - Selection of materials based on mechanical properties. Advanced materials: Focus on modern materials such as composites, high-strength alloys, and lightweight materials. - Preferred numbers, fits and tolerances –Direct, bending and torsional stress equations — Calculation of principal stresses for various load combinations, eccentric loading – Curved beams – crane hook and C frame - Factor of safety - Theories of failure – Design based on strength and stiffness – stress concentration – Design for variable loading.

UNIT-II	SHAFTS AND COUPLINGS	9

Design of solid and hollow Shaft – for static and varying loads, for strength and rigidity - Design of coupling-Types-flange, muff and flexible rubber bushed coupling– Keys, keyways and splines - Rigid and flexible couplings.

UNIT-III	TEMPORARY AND PERMANENT JOINT	9

Threaded fasteners - Design of bolts under static load, Design of bolts subjected to fatigue load – Design of knuckle joints, cotter joints – Design of riveted joints and welded Joints for structures - Theory of bonded joints and its applications in high strength and light weight joints.

UNIT-IV	SPRINGS	9

Helical springs: Stresses and deflection in round wire helical springs accounting for static and variable loading, concentric springs; Design of leaf springs - stress and deflection equation, nipping; Overview of the design of helical and leaf springs in automobile suspension system.

UNIT-V	BEARING	9

Selection of Sliding contact and rolling contact bearings – Antifriction Bearing - Reliability consideration - McKee‘s equation - Sommerfield Number - Raimondi & Boyd graphs - Design of hydrodynamic journal bearings – Design of sliding Contact and rolling contact bearings. Bearing damage and failure analysis.

	Total Contact Hours	:	45

Course Outcomes: At the end of the course the students would be able to	
•	Utilize the codes in general practice and design the machine members under various loading conditions.
•	Design the Shaft and Couplings under various loading conditions.
•	Make use of the design procedure of temporary and permanent joints.
•	Interpret the design of springs.
•	Design and select the standard bearing from the catalogue.

Text Books:	
1	Bhandari V, Design of Machine Elements, 4th Edition, McGraw-Hill Book Co, 2020.
2	Joseph Shigley, Richard G. Budynas and J. Keith Nisbett, “Mechanical Engineering Design”, 10th Edition, Tata McGraw-Hill, 2015.

Reference Books(s) / Web links:	
1	R.B. Patel, Design of Machine Elements, MacMillan Publishers India P Ltd., Tech-Max Educational resources, 2011.
2	Sundarajamoorthy T. V. Shanmugam. N, Machine Design, Anuradha Publications, Chennai, 2015.
3	P.C. Gope, Machine Design – Fundamental and Application, PHI Learning Private Ltd, New Delhi, 2012.
4	Robert C.Juvinall and Kurt M. Marshek, Fundamentals of Machine components Design,4th Edition, John Wileyand Sons,2011.
5	PSG Design Data Handbook, Data Book of Engineers, by PSG College of Technology, Coimbatore, 2023.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
ME23511.1	2	2	3	-	-	1	-	-	2	-	-	1	2	1	2
ME23511.2	2	2	3	-	-	1	-	-	2	-	-	1	2	1	2
ME23511.3	2	2	3	-	-	1	-	-	2	-	-	1	2	1	2
ME23511.4	2	2	3	-	-	1	-	-	2	-	-	1	2	1	2
ME23511.5	2	2	3	-	-	1	-	-	2	-	-	1	2	1	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory Course)	PC	L	T	P	C
RO23512	Theory of Mechanisms and Machines-II		3	1	0	4

Objectives:	
•	To understand the basic concepts of static and dynamic equilibrium.
•	To analyze the balancing of rotating masses and belt drives.
•	To understand the fundamentals of free vibration.
•	To understand the concept of forced vibration.
•	To understand the various control mechanism used for mobility.

UNIT-I	FORCE ANALYSIS	12
Dynamic force analysis — Inertia force and Inertia torque– D Alembert's principle –Dynamic Analysis in reciprocating engines — Gas forces — Inertia effect of connecting rod– Bearing loads — Crank shaft torque — Turning moment diagrams –Fly Wheels — Flywheels of punching presses— Dynamics of Cam- follower mechanism.		
UNIT-II	**BALANCING OF ROTATING MASSES AND BELT DRIVES**	**12**
Static and Dynamic Balancing, Balancing of single rotating mass by balancing masses in same plane and in different planes. Balancing of several rotating masses by balancing masses in same plane and in different planes. Belt drive — velocity Ratio, Belt Length, Limiting Ratio of Belt-Tensions — Maximum Effective Tension and H.P. Transmitted-Centrifugal Tension and Stresses in Belts—Maximum Tension in Belt-Initial Tension and its Role in Power Transmission—Condition for Maximum Power Transmission.		
UNIT-III	**FREE VIBRATION**	**12**
Basic features of vibratory systems — Degrees of freedom — single degree of freedom — Free vibration– Equations of motion — Natural frequency — Types of Damping — Damped vibration–Torsional vibration of shaft — Critical speeds of shafts — Torsional vibration — Two and three rotor torsional systems.		
UNIT-IV	**FORCED VIBRATION**	**12**
Undamped forced vibration of spring mass system, Damped forced vibrations, Rotating unbalance, Reciprocating unbalance, Vibration isolation, Support motion(absolute and relative motion), Transverse vibration of shaft with single concentrated load, several loads, uniformly distributed load, Critical speed.		
UNIT-V	**MECHANISM FOR CONTROL**	**12**
Governors — Types — Centrifugal governors — Gravity controlled and spring controlled centrifugal governors — Characteristics — Effect of friction — Controlling force curves. Gyroscopes –Gyroscopic forces and torques — Gyroscopic stabilization — Gyroscopic effects in Automobiles, ships and airplanes.		
	Total Contact Hours :	**60**

Course Outcomes: On completion of the course students will be able to	
•	Analyze the mechanisms for static and dynamic equilibrium.
•	Carry out the balancing of rotating masses
•	Determine the natural frequency, force and motion transmitted in vibrating systems.
•	Understand the forced vibration phenomenon.
•	Analyze different types of governors used in real life situation.

Text Books:	
1	Uicker, J.J., Pennock G.R and Shigley, J.E., "Theory of Machines and Mechanisms", Oxford University Press, 4th Edition, Reprint: 2017
2	Rattan, S.S, "Theory of Machines", McGraw-Hill Education Pvt. Ltd., 5th edition, 2019.

Reference Books(s) / Web links:	
1	Amitabha Ghosh and Asok Kumar Mallik, "Theory of Mechanisms and Machines", Affiliated East-West Pvt. Ltd.,3rd edition, 1988.
2	Rao.J.S. and Dukkipati.R.V. "Mechanism and Machine Theory", New Age International Pvt. Ltd., 2nd Edition, 2014
3	Singh.V.P, "Theory of Machine", Dhanpat Rai & Co., 6th Edition, 2017
4	Ashok G. Ambedkar, " Mechanism and Machine Theory", Prentice-Hall of India Private Limited, New Delhi, 2007
5.	https://nptel.ac.in/courses/112/104/112104121/
6.	https://nptel.ac.in/courses/112105268/
7.	https://nptel.ac.in/courses/112101096/

SUGGESTED ACTIVITIES

- Industrial visit
- Mini Project

SUGGESTED EVALUATION METHODS

- Assignment topics
- Class Presentation/Discussion
- Continuous Assessment Tests

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
RO23512.1	3	3	2	2	2	1	1	-	1	-	1	2	3	2	2
RO23512.2	3	2	3	2	2	2	1	-	1	2	2	2	3	3	2
RO23512.3	3	3	2	2	2	1	1	-	1	1	1	2	3	2	3
RO23512.4	3	2	2	3	2	2	2	1	1	2	2	2	3	3	3
RO23512.5	3	3	3	3	2	1	1	-	2	2	2	3	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Laboratory Course)	Category	L	T	P	C
RO23521	Mobile Robotics Laboratory	PC	0	0	4	2

Objectives:	
•	**Understand** the principles of kinematics in wheeled mobile robots.
•	Learn to integrate and configure sensors for enhanced robot perception and navigation.
•	Master the techniques of obstacle avoidance and line-following using mobile robots.
•	Explore and implement path-planning algorithms such as A*, Dijkstra's, and RRT.
•	Develop basic SLAM systems using LIDAR and camera sensors for environmental mapping.

List of Experiments				
1.	Study the kinematics of wheeled mobile robots.			
2.	Integrate sensors (e.g., ultrasonic, IR, LIDAR) with mobile robots.			
3.	Navigate mobile robot through a pre-defined obstacle field.			
4.	Program a robot to follow a line using optical sensors.			
5.	Implement algorithms for navigating a grid map			
6.	Implement A* path planning algorithm for a wheeled mobile robot.			
7.	Implement Dijkstra's path planning algorithm for a wheeled mobile robot.			
8.	Implement RRT path planning algorithm for a wheeled mobile robot.			
9.	Develop a simple SLAM program using LIDAR			
10.	Develop a simple SLAM program using camera sensors.			
		Total Contact Hours	**:**	**60**

Course Outcomes:	
On completion of the course students will be able to	
●	Analyze the kinematics of wheeled mobile robots for effective motion control.
●	Integrate and utilize sensors like ultrasonic, IR, and LIDAR for mobile robot navigation.
●	Develop algorithms to navigate robots through obstacle fields and follow paths using optical sensors.
●	Implement advanced path-planning techniques, including A*, Dijkstra's, and RRT for robot navigation.
●	Design and execute simple SLAM programs using LIDAR and camera sensors for environment mapping.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23521.1	3	2	1	1	2	1	1	1	1	1	1	1	3	1	1
RO23521.2	2	3	2	1	2	1	1	1	1	1	1	1	2	1	1
RO23521.3	1	2	3	2	3	1	1	1	1	1	1	1	2	2	1
RO23521.4	1	2	2	3	3	2	1	1	1	1	1	1	2	2	1
RO23521.5	1	1	2	2	3	2	1	1	1	1	1	1	3	2	2

1:

1:Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Laboratory Course)	Category	L	T	P	C
RO23522	Industrial Automation Laboratory-II	PC	0	0	4	2

Objectives:	
•	To provide exposure to the students with hands on experience to control motors, conveyors using PLC

List of Experiments				
1.	Simulating Cylinder Sequencing hydraulic circuit			
2.	Simulating Cylinder Reciprocating System using DCV's			
3.	Ladder PLC program using counters for alternate switching of two solenoid DCV			
4.	Ladder PLC program using counters for controlling various LED s at different time sequences.			
5.	Design and test two cylinders cascading in basic pneumatic trainer kit.			
6.	Design and test two cylinders cascading in electro pneumatic trainer kit.			
7	Design and test two cylinders cascading in electro pneumatic trainer kit with PLC			
8	Design and test two cylinders cascading in basic hydraulic trainer kit.			
9	Factory Floor SCADA System with IoT Integration			
10	Remote Monitoring of Industrial Assets using MQTT and SCADA system			
		Total Contact Hours	**:**	**60**

Course Outcomes: On completion of the course students will be able to	
•	Design and simulate cylinder sequencing and reciprocating systems in hydraulic circuits.
•	Develop and implement ladder PLC programs using counters for controlling solenoids and LEDs.
•	Test and evaluate the performance of two-cylinder cascading systems in pneumatic and electro-pneumatic trainer kits.
•	Integrate and monitor factory floor operations using SCADA systems with IoT connectivity.
•	Implement remote monitoring of industrial assets through MQTT protocols and SCADA systems.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23522.1	3	2	2	2	2	1	1	1	1	1	1	1	3	1	1
RO23522.2	2	3	2	1	3	1	1	1	1	2	1	1	2	1	1
RO23522.3	2	2	3	2	3	1	1	1	1	2	1	1	2	2	1
RO23522.4	2	2	3	3	3	2	2	1	1	2	1	1	3	3	2
RO23522.5	2	2	3	3	3	2	2	1	1	2	1	1	3	3	2

1:Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

RO23523	Internship	EEC	L	T	P	C
			0	0	2	1

Objectives:	
•	To enhance the knowledge of the students in professional engineering practice sought through industrial training ondifferent current technologies.
•	To expose students to real work life situations and to equip them with abreast of new technology that intensify theirjob acumen.
•	To employ the students in industrial projects and strengthen the practical skills of the students.
•	To develop significant commitment in the students' profession and specialization.

STRATEGY:
The students individually undertake training in reputed Mechanical, Mechatronics and Automation engineering companies for the specified duration. At the end of the training, a report on the work done will be prepared and presented**.** The students will be evaluated through a viva-voce examination by a team of internal staff.

(* Two weeks at the end of Fourth Semester)

Course Outcomes: On completion of the course students will be able to	
•	Apply prior acquired knowledge in a real-life environment.
•	Integrate classroom theory with workplace practice.
•	Acquire knowledge from the industrial experts.
•	Work on a research project or undertake work experience under the guidance of industry and academic supervision.
•	Extend the knowledge through research and development in the chosen fields of specialization.

GE23521	Soft Skills-II	EEC	L	T	P	C
			0	0	2	1

Objectives:	
•	To help students break out of shyness.
•	To build confidence
•	To enhance English communication skills.
•	To encourage students' creative thinking to help them frame their own opinions,

Learning and Teaching Strategy:

The program is completely student centric where the focus is on activities led by students which include role plays, discussions, debates other games as well. These activities would be supplemented by interactive use of technology and brief trainer input.

Week	Activity Name	Description	Objective
1	The News hour	Students are made to read news articles from the English newspapers. The students also have to find words and their meaning from the article they have not come across before and share it with the group. They then use these words in sentences of their own	The aim of this activity is not only to get the students to read the newspaper but also aims at enhancing the students' vocabulary.
2	Court Case	The facilitator provides the participants the premise of a story and proceeds to convert the story into a court case. The students are required, department-wise to debate and provide their points to win the case for their clients.	The aim of the lesson is to encourage creative and out-of-the - box thinking to ensure a good debate and defense skills.
3	The ultimate weekend	The students design activities they are going to do over the weekend and they have to invite their classmates to join in the activity. The students move around the class and talk to other students and invite them.	The aim of this activity is to develop the art of conversation among students. It also aims at practicing the grammatical structures of "going to" "have to" and asking questions.
4	The Four Corners	This is a debate game that uses four corners of the classroom to get students moving. The following is written on the 4 corners of the room "Strongly Agree, Somewhat Agree, Somewhat Disagree and Strongly Disagree". The topics are then given to the class and students move to the corner that they feel best explains their opinions	This activity aims at getting students to come up with their own opinions and stand by it instead of being overshadowed by others and forcing themselves to change based on others opinions.
5	Debate	Boarding school or day school? Which is more beneficial for a student?	The aim of this activity is to encourage students to draw up feasible points on the advantages and benefits of both. And enhance their debating ability
6	Grand Master	The facilitator starts the session by keeping an individual in mind, upon which the students guess it only through "Yes or No" questions.	The aim of the lesson is designed to teach the art of questioning. It

		Post few trials the students are given same opportunity to do the same with the crowd.	also helps to enhance the students' speaking and listening skills.
7	Debate	Does violence on the TV and Video games influence children negatively?	This activity aims at encouraging the students to debate on real life scenarios that most students spend a lot of time on.
8	Turn Tables	This is a speaking activity where the students need to speak for and against the given topics when the facilitator shouts out 'Turn Table'.	The aim of this activity is to make the participants become spontaneous and have good presence of mind.
9	Debate	Do marks define the capabilities of a student?	This debate activity aims at allowing the students to argue on this worrisome adage of marks.
10	FictionAD	The Participants are asked to create an Ad for a challenging topic only using fictional characters.	The activity aims at developing their creativity and presentation skills.
11	Debate	Are social networking sites effective, or are they just a sophisticated means for stalking people?	This activity aims at refining the students debating skills on a very real life situation
12	Talent Hunt	Talent Hunt is a fun activity where the students are selected at random and supported to present any of their own skills.	The aim of this activity is designed to evoke their inner talents and break the shyness and the fear of participating in front of a crowd
	Feedback	At the end of the session in the final week (12) the trainer would provide feedback to the students on best practices for future benefits.	The aim is to do both give feedback to students as well as obtain feedback on the course from them.

Course Learning Outcome:

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

- Be more confident.
- Speak in front of a large audience without hesitation.
- Think creatively.
- Speak impromptu.
- Communicate in English

SEMESTER VI

Course Code	Course Name	Category	L	T	P	C
ME23612	Design of Transmission Systems	PC	2	1	0	3

Objectives: The objective of this course is to prepare the students to know the design procedure
• For flexible elements like belt, ropes and chain drives for engineering applications.
• For spur and helical gear drives for power transmission.
• For bevel and worm drives for power transmission.
• For multi speed gear box for machine tool and automotive applications.
• For clutch and brake systems for engineering applications.

UNIT-I	**DESIGN OF FLEXIBLE ELEMENTS**	**9**
Introduction to Flexible drives - Transmission of power by Belt, Rope and Chain drives – Selection of drive materials – Design of Belt drives - Flat and V Belt types - Selection of wire ropes and pulleys - Design of Chain drives and Sprockets.		
UNIT-II	**ONE DIMENSIONAL BEAM ELEMENTS**	**9**
Gear materials - Design of straight tooth spur & helical gears based on speed ratios, number of teeth, Fatigue strength, Factor of safety, strength and wear considerations. Force analysis - Tooth stresses - Dynamic effects - Design of gears using AGMA procedure involving Lewis and Buckingham equations.		
UNIT-III	**BEVEL AND WORM GEARS**	**9**
Straight bevel gear: Gear materials - Tooth terminology, tooth forces and stresses, equivalent number of teeth, estimation of dimensions of straight bevel gears. Worm Gear: Gear materials - Tooth terminology, Thermal capacity, forces and stresses, efficiency, estimation of dimensions of worm gear pair.		
UNIT-III	**GEAR BOXES**	**9**
Design of Multi speed Gear Boxes for machine tool applications - Speed selection - Geometric progression - Standard step ratio - Ray diagram, Kinematic layout - Determination of number of teeth - Types of Gear Boxes, Sliding mesh, Constant mesh, Synchro mesh gear boxes, over drive torque converters for automotive applications.		
UNIT-IV	**CLUTCHES AND BRAKES**	**9**
Friction materials – Types of clutches – Uniform pressure and uniform wear theories – Design of single and multi-plate clutches - Cone clutches - Centrifugal clutches – Electromagnetic clutches. Types of mechanical brakes – Design procedure – Block brakes with short and long shoe – Internal expanding shoe brakes – Band brakes – Disc brakes – Thermal considerations.		
	Total Contact Hours : 45	

Text Book(s):

1. Keith Nisbett and Richard Budynas, - Shigley's Mechanical Engineering Design:,2024 Release, Tata McGraw-Hill, ISBN10: 1265472696.
2. Bhandari V.B, Design of Machine Elements, 2020, 5th edition, Tata Mc Graw Hill.

Reference Books(s) / Web links:

1. Bernard Hamrock, Steven Schmid, Bo Jacobson, - Fundamentals of Machine Elements,3rd Edition, CRC Press Inc, 2013.
2. Sundararajamoorthy. T. V. and Shanmugam. N., - Machine Design, Anuradha Publications, Chennai, 2018.
3. Sen and Bhattacharya, - Principles of Machine Tools, New Central Book Agencies, 2nd Edition, 2009.
4. Md. Jalaludeen , Machine Design, Volume II, Design of Transmission Systems, Anuradha Publications, 2017.
5. Prabhu. T.J., "Design of Transmission Elements", Mani Offset, Chennai, 2019.
6. PSG Design Data: Data Book of Engineers, Kalaikathir Achchagam, 2020.
7. https://nptel.ac.in/courses/112/106/112106137/

Course Outcomes: On successful completion of the course, the student will be able to	
•	Design flexible elements like belt, ropes and chain drives for engineering applications.
•	Apply to spur and helical gear drives for power transmission.
•	Design bevel and worm drives for power transmission.
•	Design multi speed gear box for machine tool and automotive applications.
•	Design clutch and brake systems for engineering applications.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
ME23611.1	3	1	1	-	-	-	-	-	1	1	-	2	2	1	2
ME23611.2	3	1	1	-	-	-	-	-	1	1	-	2	2	1	2
ME23611.3	3	1	1	-	-	-	-	-	1	1	-	2	2	1	2
ME23611.4	3	1	1	-	-	-	-	-	1	1	-	2	2	1	2
ME23611.5	3	1	1	-	-	-	-	-	1	1	-	2	2	1	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Lab oriented Theory Course)	Category	L	T	P	C
RO23631	**Robot Operating System**	PC	2	0	2	3

Objectives:	
●	To understand the architecture, core concepts, and command-line tools of ROS, and develop basic ROS nodes using Python/C++.
●	To explore ROS communication mechanisms, such as topics, services, actions, and parameter management, while developing custom messages and services.
●	To integrate and control various sensors (e.g., LIDAR, IMU, cameras) and actuators (e.g., motors) using ROS, and visualize robot models in simulation environments like Rviz and Gazebo.
●	To implement path planning, localization, SLAM, and obstacle avoidance in mobile robots using the ROS Navigation Stack and relevant algorithms like A* and Dijkstra's.
●	To analyze advanced ROS concepts, including ROS2, multi-robot systems, ROS-Industrial, and computer vision applications, and develop a ROS-based capstone project integrating navigation and sensor data.

UNIT-I	**Introduction to ROS**	**6**
Overview of ROS - History, architecture, and benefits, Installing ROS on Linux (Ubuntu), ROS file system and workspace structure, ROS core concepts: Nodes, topics, messages, services, and actions, Introduction to ROS command-line tools - roscore, rosrun, rosnode, rostopic. Writing and running a simple ROS node in Python/C++.		
UNIT-II	**ROS Communication and Parameter Management**	**6**
Deep dive into ROS communication: Topics, publishers, and subscribers, Creating custom messages and services. ROS Parameter Server: Setting and accessing parameters, Working with ROS services and actions. Introduction to ROS launch files: Automating node startup and configuration. ROS logging and debugging tools.		
UNIT-III	**Sensors and Actuators in ROS**	**6**
Integration of sensors with ROS: LIDAR, IMU, and cameras. ROS packages for common sensor types. Introduction to motor control with ROS: DC motors, stepper motors, and servo motors, Creating URDF models to describe robot structures. Visualizing robots in ROS using Rviz, Controlling simulated robots and sensors in Gazebo.		
UNIT-IV	**Robot Motion and Path Planning**	**6**
ROS Navigation Stack: Overview and configuration, Implementing localization and mapping (SLAM) with ROS,Path planning algorithms: A*, Dijkstra's, and integration with ROS. Obstacle detection and avoidance. Introduction to MoveIt! for robotic arm manipulation. Practical session: Creating an autonomous navigation system for a mobile robot.		
UNIT-V	**Advanced ROS and Project Implementation**	**6**
Introduction to ROS2: Differences from ROS1, advantages, and use cases, ROS in multi-robot systems: Communication and coordination. Using OpenCV for computer vision tasks in ROS.ROS-Industrial: Applications in manufacturing and industrial robotics. Capstone Project: Develop a ROS-based solution integrating navigation, manipulation, and sensor data. Case studies of real-world robotic applications using ROS.		
		Contact Hours :30

S.No	LIST OF EXPERIMENTS
1	Creating simple ROS nodes using Python or C++ and Communicate data
2	Implement a node that controls robot speed based on parameter values.
3	Load a predefined mobile robot model in Gazebo and Visualize the robot's motion in RViz.
4	Connect and configure a simulated LIDAR sensor in ROS
5	Implement Simultaneous Localization and Mapping (SLAM) using ROS.
6	Implement basic path planning and navigation.
7	Control a robotic arm using MoveIt! in ROS.
8	Implement communication and coordination between multiple robots.
	Lab Hours:30
	Total Contact Hours: 60

Course Outcomes:	
On completion of the course students will be able to	
•	Develop and run simple ROS nodes using Python or C++, and establish communication between nodes.
•	Implement ROS nodes to control robot parameters such as speed and configure parameters dynamically.
•	Visualize and simulate mobile robots in Gazebo and RViz by integrating sensors such as LIDAR and creating robot models.
•	Implement SLAM (Simultaneous Localization and Mapping) and basic path planning for autonomous robot navigation using ROS.
•	Control robotic arms using MoveIt! and implement multi-robot communication and coordination in ROS.

Text Books:	
1.	Francisco Martín Rico, "A Concise Introduction to Robot Programming with ROS2," CRC Press, United States, 2022.
2.	Edouard Renard, "ROS 2 from Scratch: Get Started with ROS 2 and Create Robotics Applications," Packt Publishing, United Kingdom, 2024.
1.	Anis Koubaa, "Robot Operating System (ROS): The Complete Reference," Springer, 2016.
2.	Lentin Joseph, "ROS Robotics Projects: Build and Control Robots Powered by the Robot Operating System," Packt Publishing, 2017.
3.	Wyatt Newman, "A Systematic Approach to Learning Robot Programming with ROS," CRC Press, 2017.
4.	Antonio Sandoval, "ROS by Example: A Do-It-Yourself Guide to the Robot Operating System," Lulu Press, 2016.
5.	Thangaraj Saminathan, "Practical Robotics in C++ and Python for Beginners," Kindle Direct Publishing, 2020.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23631.1	3	2	2	2	3	2	1	-	2	3	-	2	3	2	2
RO23631.2	3	3	2	3	3	-	1	-	2	2	-	2	3	2	2
RO23631.3	3	2	3	2	3	1	-	-	3	3	-	3	3	3	3
RO23631.4	3	3	3	3	3	2	-	-	3	3	2	2	3	3	3
RO23631.5	3	3	3	3	3	2	-	-	3	3	3	2	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Lab oriented Theory Course)	Category	L	T	P	C
RO23632	Robot Vision and Intelligence	PC	3	0	2	4

Objectives:	
●	To study the basics of the vision systems.
●	To expose the student on the algorithms used in vision systems.
●	To study the recognition technique for objects.
●	To understand the applications and software for vision systems.
●	To introduce the concept on the usage od Fuzzy Logic and Neural network.

UNIT-I	VISION SYSTEMS	9
Basic Components – Elements of visual perception, Lenses: Pinhole cameras, Gaussian Optics – Cameras – Camera-Computer interfaces		
UNIT-II	**VISION ALGORITHMS**	**9**
Fundamental Data Structures: Images, Regions, Sub-pixel Precise Contours – Image Enhancement: Gray value transformations, image smoothing, Fourier Transform – Geometric Transformation - Image segmentation – Segmentation of contours, lines, circles and ellipses – Camera calibration – Stereo Reconstruction.		
UNIT-III	**OBJECT RECOGNITION**	**9**
Object recognition, Approaches to Object Recognition, Recognition by combination of views – objects with sharp edges,using two views only, using a single view, use of depth values.		
UNIT-IV	**VISION TRACKING**	**9**
Transforming sensor reading, Mapping Sonar Data, aligning laser scan measurements - Vision and Tracking: Followingthe road, Iconic image processing, Multiscale image processing, Video Tracking - Learning landmarks: Landmark spatiograms, K-means Clustering, EM Clustering.		
UNIT-V	**MACHINE LEARNING FOR VISION AND ROBOTICS INTELLIGENCE**	**9**
Dimensionality Reduction Techniques -PCA and t-SNE for feature reduction, Sparse representation and its applications in robotics, Deep Learning Architectures- Convolutional Neural Networks (CNNs) for image recognition, YOLO, ResNet, Applications of Deep Learning in Robotics - Real-time object detection and scene interpretation, Case studies: Autonomous vehicles, object manipulation, and robotic perception.		
		Contact Hours :45

S.No	LIST OF EXPERIMENTS
1	Histogram Equalization
2	Image Stitching using SIFT
3	Counting similar shaped objects from image.
4	Classifying similar objects from image.
5	Calculate included angles between Lines in Images Using Hough transform.
6	Detecting cells using Image Segmentation.
7	Texture Segmentation of an image using Filters.
8	Color-Based Segmentation Using K-Means Clustering.
	Contact Hours :30
	Total Contact Hours: 75

Course Outcomes:
On completion of the course, students will be able to:
• Select the vision systems components.
• Apply suitable algorithm to recognize objects.
• Perform object recognition techniques for detecting the objects.
• Design vision system for robot applications.
• Implement soft computing techniques in vision systems.

Text Books:	
1.	Carsten Steger, Markus Ulrich, Christian Wiedemann, "Machine Vision Algorithms and Applications", WILEY-VCH, Weinheim,2018.
2.	Damian m Lyons,"Cluster Computing for Robotics and Computer Vision", World Scientific, Singapore, 2011.
Reference Books(s) / Web links:	
1.	Rafael C. Gonzalez and Richard E.woods, "Digital Image Processing", Addition – Wesley Publishing Company,New Delhi, 2017.
2.	Shimon Ullman, "High-Level Vision: Object recognition and Visual Cognition", A Bradford Book, USA, 2020.
3.	R.Patrick Goebel, " ROS by Example: A Do-It-Yourself Guide to Robot Operating System – Volume I", A Pi Robot Production, 2018.
4.	Timothy J. Ross, "Fuzzy Logic with Engineering Applications", McGraw Hill Inc, 2010
5.	Dilip K Pratihar, "Soft Computing fundamentals and applications", Narosa publishing house, India,2015.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23632.1	3	2	2	-	3	-	-	-	1	2	-	2	2	1	-
RO23632.2	3	3	3	2	3	-	-	-	2	2	-	2	3	3	2
RO23632.3	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23632.4	3	3	3	3	3	-	-	-	2	2	-	2	3	3	3
RO23632.5	3	3	3	3	3	2	-	-	3	3	2	2	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Lab oriented Theory Course)	Category	L	T	P	C
RO23633	Robot Dynamics and Motion Planning	PC	3	0	2	4

Objectives:	
●	To know about the dynamics of industrial manipulator
●	To familiarize on the control systems in robotics
●	To learn the mobile robot dynamics
●	To explore trajectory planning methods for smooth and efficient robotic movement in both joint and Cartesian spaces.
●	To investigate advanced motion planning algorithms for navigating complex environments, ensuring collision avoidance and optimal pathfinding.

UNIT-I	MANIPULATOR DYNAMICS	9
Lagrange's Equation, Kinetic and Potential Energy-Link inertia tensor, link Jacobian, Manipulator inertia tensor, gravity, Generalized force-actuators, friction. Lagrange-Euler Dynamic Model, Dynamic Model - two axis planar articulated robot, three axis SCARA robot, Direct and Inverse dynamics. Recursive Newton-Euler formulation-forward & backward Newton-Euler equations. Dynamic Model of one axis Robot (Inverted pendulum)-Lagrange & Newton-Euler formulations.		
UNIT-II	**ROBOT CONTROL**	**9**
State equations- Inverted pendulum, two axis planar articulated robot, three axis SCARA robot. Liapunov's first and second method, Linear feedback system-Transfer functions, steady state tracking and transient performance. Single axis PID control gravity control, Computed torque control, Variable structure control and impedance control.		
UNIT-III	**MOBILE ROBOT DYNAMICS**	**9**
General Robot Dynamic Modelling, Newton Euler equations- Dynamic Modelling of Nonholonomic and differential-drive wheeled mobile robot (WMR). Lagrange-Euler Dynamic Model - Nonholonomic and differential drive WMR. Dynamics model- WMR with Slip, car-like WMR, three-wheel omnidirectional robot & Four Mecanum-Wheel Omnidirectional Robot.		
UNIT-IV	**TRAJECTORY PLANNING**	**9**
Introduction, Path vs. Trajectory, Joint-Space vs. Cartesian-Space Descriptions, Basics of Trajectory Planning, Joint-Space Trajectory Planning, Third-Order Polynomial Trajectory Planning, Fifth-Order Polynomial Trajectory Planning, Linear Segments with Parabolic Blends, Linear Segments with Parabolic Blends and Via Points, Higher-Order Trajectories		
UNIT-V	**MOTION PLANNING**	**9**
Overview of Motion Planning, Types of Motion Planning Problems, Properties of Motion Planners, Motion Planning Methods, Foundations, Configuration Space Obstacles, Distance to Obstacles and Collision Detection, Graphs and Trees, Graph Search, Complete Path Planners, Grid Methods, multi-Resolution Grid Representation, Grid Methods with Motion Constraints, Sampling Methods, RRT Algorithm ,PRM Algorithm, Virtual Potential Fields, A Point in C-space , Navigation Functions , Workspace Potential, Use of Potential Fields in Planners.		
	Total Contact Hours : 45	

S.No	LIST OF EXPERIMENTS
1	Computing joint accelerations for a robot model given a robot state
2	Calculation of Manipulator Gravity Dynamics

3	Calculation of the velocity-induced torques for a robot manipulator
4	Computing Geometric Jacobian for a Manipulator
5	Design Position Controlled Manipulator Using Simscape
6	Modeling and simulation of unicycle model
7	Modeling and simulation of Ackermann Kinematic Model
8	Modeling and simulation of Differential Drive Kinematic Model
	Contact Hours: 30
	Total Contact Hours: 75

Course Outcomes:

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

- Understand and apply the principles of dynamics to analyze industrial manipulators, including the computation of link inertia tensors, Jacobians, and generalized forces.
- Demonstrate the ability to model and implement control strategies such as PID, computed torque, and impedance control for stability and effective robotic motion
- Develop dynamic models for mobile robots, including differential-drive and omnidirectional platforms, by applying Newton-Euler and Lagrange-Euler formulations to analyze robot movement.
- Construct and evaluate trajectory planning solutions using joint-space and Cartesian-space techniques, incorporating polynomial and parabolic blend trajectories for robotic path planning.
- Analyze and implement motion planning algorithms like RRT, PRM, and potential field methods for collision avoidance, workspace navigation, and obstacle handling in complex environments.

Text Books:

1. Sciavicco L., Siciliano B., "Modeling and Control of Robot Manipulators," 2nd Edition, Springer, 2010.
2. Choset H., Lynch K. M., Hutchinson S., et al., "Principles of Robot Motion: Theory, Algorithms, and Implementation," MIT Press, 2005.

Reference Books / Web links:

1. Spong M. W., Hutchinson S., Vidyasagar M., "Robot Modeling and Control," Wiley, 2020.
2. Craig J. J., "Introduction to Robotics: Mechanics and Control," 4th Edition, Pearson, 2022.
3. LaValle S. M., "Planning Algorithms," Cambridge University Press, 2006.
4. Nakamura Y., "Advanced Robotics: Redundancy and Optimization," Addison-Wesley, 1991.
5. Siciliano B., Khatib O. (Eds.), "Handbook of Robotics," 2nd Edition, Springer, 2016.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23633.1	3	2	2	-	3	-	-	-	1	2	-	2	2	1	-
RO23633.2	3	3	3	2	3	-	-	-	2	2	-	2	3	3	2
RO23633.3	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23633.4	3	3	3	3	3	-	-	-	2	2	-	2	3	3	3
RO23633. 5	3	3	3	3	3	2	-	-	3	3	2	2	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SEMESTER VII

Subject Code	Subject Name (Theory Courses)	Category	L	T	P	C
RO23711	**Aerial Robotics**		**3**	**0**	**0**	**3**

Objectives:	
•	To study about the mechanics involved in aerial robotics.
•	To enable the students to study the Flight control and the sensors operations in UAV.
•	To study about materials used in UAV.
•	To explain the concept of Flight control and the weather factors.
•	To describe the importance of Safety systems in aerial robotics.

UNIT-I	**AERIAL MECHANICS**	9
Introduction - UAV categories, Introduction – Modeling representation – Aerodynamic forces, Viscosity, Stall speed, Compressibility, Earth's atmosphere, Navier-Stockes equations – Frames - geodetic coordinate system, ECEF, NED, body coordinate system kinematic – Dynamic modeling – longitudinal – Lateral Mode-Quad rotor dynamics.		
UNIT-II	**FLIGHT CONTROL**	9
Introduction – Architecture –Auto pilot – Sensor – Sense and avoid technique – Camera and Control – Radio Communication – Ground control system – First person view – Data Fusion.		
UNIT-III	**MATERIALS AND SELECTION**	9
Components of UAV – Battery of UAV, UAV Materials- Properties and selection criteria for UAV materials, Advanced materials such as composites (carbon fiber, fiberglass), metals (aluminum alloys, titanium), polymers, and smart materials. Introduction to additive manufacturing (3D printing) in UAV component production. Material fatigue, corrosion resistance, and thermal stability in UAV design, Launching system, attachment of UAV and Applications.		
UNIT-IV	**FLIGHT OPERATION**	9
Introduction – Linear control methods – TRM trajectory generation – Situational awareness – Flight operation – Decision making – airport operations – preliminaries – analysis of weather factor – weather information.		
UNIT-V	**SAFETY SYSTEMS**	9
Introduction, hazardous operations, Safety promotion, Safety Standards and Regulations - International and national UAV safety standards (e.g., FAA, EASA, DGCA), Compliance with ISO standards for UAV operations and safety, Maintenance, Human Factor, Risk analysis and prevention.		
	Total Contact Hours : 45	

Course Outcomes:	
On completion of the course, the students will be able to	
•	Analyze and apply principles of aerial mechanics, including aerodynamic forces and dynamic modeling, to design and optimize UAV performance.
•	Develop a robust flight control system that integrates sensor data, vision systems, and data fusion for effective UAV navigation and collision avoidance.
•	Analyze UAV components and materials, including composites, metals, and polymers, and evaluate their properties and selection criteria for optimal performance
•	Plan and execute aerial operations, taking into account trajectory planning, situational awareness, decision-making strategies, and weather-related considerations.
•	Recognize the importance of safety systems in aerial robotics, including maintenance, risk analysis, and human factors in ensuring reliable UAV operations.

Text Books:	
1	Yasmina Bestaoui Sebbane,“A First Course in Aerial Robots and Drones”, CRC Press, 2022
2	“Autonomous Flying Robots” by Kenzo Nonami, Farid Kendoul, Satoshi Suzuki, Wei Wang, Daisuke Nakazawa
3	“Planning and Decision Making for Aerial Robots” by Yasmina Bestaoui Sebbane

Reference Books / Web links:	
1	Vachtsevanos,G.J. and Valavanis,K.P., “Handbook of Unmanned Aerial Vehicles”, 3rd Edition, Springer,2015.
2	Fahlstrom, P.G., and Gleason, T.J., “Introduction to UAV Systems”, 4th Edition, Wiley,2012.
3	Sheikh Muhammad Ibraheem, "Aerial Robotics: With STM32F100RB Microcontroller," Amazon Kindle Direct Publishing, 2020.
4	Randal W. Beard, Timothy W. McLain, "Small Unmanned Aircraft: Theory and Practice," Princeton University Press, United States, 2012.
5	Vijay Kumar, Aerial robotics, University of Pennsylvania, Link: https://www.coursera.org/learn/roboticsflight#syllabus

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23711.1	3	2	2	-	-	-	-	-	1	2	-	2	2	1	-
RO23711.2	3	3	3	2	3	-	-	-	2	2	-	2	3	3	2
RO23711.3	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23711.4	3	3	3	2	2	-	-	-	2	2	-	2	3	3	2
RO23711.5	3	3	3	3	3	2	-	-	3	3	2	2	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory Course)	Category	L	T	P	C
RO23712	Humanoid Robotics	PC	3	0	0	3

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

UNIT-I	INTRODUCTION	9
Historical development of Humanoids, Human Likeness of a Humanoid Robot, Trade-Offs in Humanoid 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. Learning-Based Walking Pattern Generation.		
	Contact Hours : 45	

Course Outcomes: On completion of the course, the student will be able to:	
•	Describe about the evolution of Humanoid robots
•	Expose the basic knowledge in kinematics of humanoids
•	Calculate the Humanoid Robot Motion and Ground Reaction Force.
•	Identify Two-Dimensional Walking pattern on different terrain.
•	Create the Walking Pattern models.

Text Books:	
1	Dragomir N. Nenchev, Atsushi Konno, "Humanoid Robots Modeling and Control", Butterworth Heinemann, 2018.
2	Shuuji K, Hirohisa H, Kensuke H, Kazuhito, Springer-Verlag GmbH, "Introduction to Humanoid Robotics", Springer, London, 2014.

Reference Books / Web links:	
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.
5	Devarajan Pillai G, "The Rise of Humanoid Robots: A Comprehensive Guide to the Latest Developments in Robotics," Independently Published, United States, 2024

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23712.1	3	2	2	-	-	-	-	-	1	2	-	2	2	1	-
RO23712.2	3	3	3	2	3	-	-	-	2	2	-	2	3	3	2
RO23712.3	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23712.4	3	3	3	2	2	-	-	-	2	2	-	2	3	3	2
RO23712.5	3	3	3	3	3	2	-	-	3	3	2	2	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory Course)	Category	L	T	P	C
RO23713	Resource Management Techniques	PC	3	1	0	4

Objectives:	
•	To expose the students to the concept of linear programming.
•	To learn various network optimization models.
•	To understand the various nonlinear optimization approaches.
•	To model the project management as network model and analyze the critical path.
•	To understand the nontraditional optimization techniques.

UNIT-I	LINEAR PROGRAMMING	12
Introduction to linear and non-linear programming formulation of different models. Geometry of linear programming, Graphical method,Linear programming (LP)in standard form, Solution of LP by simplex and revised simplex methods, Exceptional cases in LP, Duality theory, Dual Simple method, Sensitivity analysis.		
UNIT-II	**NETWORK ANALYSIS**	**12**
Transportation problem (with transshipment), Assignment problem, Traveling-Salesman Problem (TSP), Shortest routeproblem, Minimal Spanning Tree (MST), Maximum flow problem.		
UNIT-III	**NON-LINEAR PROGRAMMING**	**12**
Characteristics, Concepts of convexity, maxima and minima of functions of n-variables using Lagrange multipliers andKuhn-Tuker conditions, One dimensional search method- Fibonacci, golden section method and gradient methods forunconstrained problems		
UNIT-IV	**PROJECT MANAGEMENT**	**12**
Introduction to PERT and CPM, critical Path calculation, float calculation and its importance. Cost reduction byCrashing of activity. Inventory Control- Introduction to inventory control and its role in resource management, Types of inventory systems - deterministic and probabilistic models, Economic Order Quantity (EOQ) model, Economic Production Quantity (EPQ) model, Inventory control with price breaks, safety stock, and reorder point, ABC analysis, Just-In-Time (JIT) inventory, and other inventory management techniques.		
UNIT-V	**DYNAMIC PROGRAMMING AND GAME THEORY**	**12**
Dynamic Programming- Introduction to dynamic programming and its applications in optimization, Formulating problems as dynamic programs: Principle of Optimality, Applications - Inventory management, knapsack problem, shortest path, resource allocation. Solving multistage decision problems using dynamic programming. Game Theory -Introduction to game theory and decision-making strategies, Types of games - Two-person zero-sum games, non-zero-sum games, Solution concepts: Nash equilibrium, saddle point. Applications in resource management: competitive strategies, negotiation, and conflict resolution.		
	Total Contact Hours : 60	

Course Outcomes:	
On completion of the course students will be able to	
•	Formulate and solve the linear model optimization problems.
•	Apply network optimization models to solve transportation, assignment, traveling salesman, shortest route, and spanning tree problems
•	Implement nonlinear programming techniques using methods like Lagrange multipliers, Kuhn-Tucker conditions, and one-dimensional search methods to find optimal solutions for constrained and unconstrained problems.
•	Control and manage projects effectively using PERT, CPM, activity crashing, and inventory management techniques
•	Develop and analyze dynamic programming and game theory models to address multi-stage decision problems and competitive resource management scenarios in real-world applications.

SUGGESTED ACTIVITIES

- Industrial visit
- Mini Project

SUGGESTED EVALUATION METHODS

- Assignment topics
- Class Presentation/Discussion
- Continuous Assessment Tests

Text Books:	
1.	Hillier and Libeberman, "Operations Research", McGraw-Hill Higher Education, New York, 2020.
2.	Kalyanmoy Deb, "Optimization for Engineering Design Algorithms and Examples", PHI Learning PrivateLimited, New Delhi,2022.

Reference Books / Web links:	
1	Bazara M.J., Jarvis and Sherali H., "Linear Programming and Network Flows", John Wiley, 2009
2	Budnick F.S., "Principles of Operations Research for Management", McGraw-Hill Inc.,US, 2018
3	Philip D.T. and Ravindran A., "Operations Research", John Wiley, 2007
4	Shennoy G.V. and Srivastava U.K.,"Operation Research for Management", New Age International Publishers;India, 2018
5	Singiresu S.Rao, "Engineering Optimization: Theory and Practice", New Age International Publishers, India,2013

1: 1:

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
RO23713.1	3	3	3	2	1	1	1	1	1	1	1	2	1	2	3
RO23713.2	3	3	3	2	1	1	1	1	1	1	1	2	1	2	3
RO23713.3	3	3	3	2	1	1	1	1	1	1	1	2	1	2	3
RO23713.4	3	3	2	2	1	1	1	1	1	1	1	2	1	2	3
RO23713.5	3	3	2	2	1	1	1	1	1	1	1	2	1	2	3

1:Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

bject Code	Subject Name (Laboratory Course)	Category	L	T	P	C
RO23721	Robotics and Automation Problem Solving using AI,ML and DL	PC	0	0	4	2

Objectives:	
•	To understand the basics of Artificial intelligence, Machine and Deep learning.
•	To know about Multilayer Perceptron.
•	To learn Convolutional Neural Networks models.
•	To create awareness about RNN model.
•	To learn programming in Notebook.

List of Experiments			
1.	Study of Convolutional Neural Networks, LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet		
2.	Real-Time application of Google Net model for classification		
3.	Real-Time image classification using raspberry pi		
4.	Real-Time pose estimation using raspberry pi		
5.	Real-Time object detection using raspberry pi		
6.	AI algorithm-based blocks world problem solving.		
7.	Real-Time Speech Recognition and Command Execution using NLP on Raspberry Pi		
8.	Soldering defect identification in printed circuit board using Deep learning.		
9.	Defect Detection in Mechanical Parts using YOLOv5		
10.	Identify Shapes Using Machine Learning on Arduino Hardware		
11.	Autonomous Drone Navigation using Deep Reinforcement Learning		
12.	Drone-Based Object Tracking using Deep Learning		
	Contact Hours	**:**	**60**

Course Outcomes: On completion of the course students will be able to	
●	Differentiate between of machine and deep learning.
●	Apply the Multilayer Perceptron.
●	Program in notebook for object recognition and detection.
●	Implement Convolutional Neural Networks models.
●	Work on deep architectures used for solving various Vision and NLP tasks.

Text Books:	
1.	Ian J. Goodfellow,Yoshua Bengio and Aaron Courville. "Deep learning." An MIT Press book in preparation,2016.
2.	Yoshua Bengio, "Learning Deep Architectures for AI," Foundations and Trends in Machine Learning, 2009.

Reference Books:	
1.	François Chollet, "Deep Learning with Python," 2nd Edition, Manning Publications, United States, 2021
2.	Josh Patterson, “Deep Learning: A Practitioner's Approach”, Shroff/O'Reilly; First edition, 2017.
3.	Ethem Alpaydin, “Introduction to Machine Learning”, The MIT Press, USA,2014.
4.	Charles Dierbach, Introduction to Computer Science using Python: A Computational Problem-Solving Focus, WileyIndia Edition, 2013.

5.	Paul Gries, Jennifer Campbell and Jason Montojo, Practical Programming: An Introduction to Computer Scienceusing Python 3, Second edition, Pragmatic Programmers, LLC, 2013.

Course Code	Course Title	Category	L	T	P	C
RO23722	**Project Work Phase -I**	**EEC**	0	0	6	3

Objectives:
This laboratory course enables students to

- To develop the ability to solve a specific problem right from its identification and literature review till thesuccessful solution of the same
- To train the students in preparing project reports and to face reviews and viva voce examination

GUIDELINE FOR REVIEW AND EVALUATION

The students in a group of 3 to 4 works on a topic approved by the head of the department under the guidance of afaculty member and prepare a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

Each batch is required to select any new component or an integrated robotics /automation/mechatronics system thatinvolves various sub components which are to be designed in Project Work Phase - I

The project report shall carry a maximum of 20 marks. The project report shall be submitted as per the approved guidelines as given by Dean-Academics. Same mark shall be awarded to every student within the project group for the project report. The viva-voce examination shall carry 40 marks. Marks are awarded to each student of the project group based on the individual performance in the viva-voce examination.

Continuous Assessment 40 Marks			End semester Examination 60 Marks			
			Project Report Evaluation 20 marks		Viva-Voce 40 marks	
Review I	Review II	Review III	Internal	External	Internal	External
10	15	15	10	10	20	20

Total Contact Hours : 90

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

- Fabricate any components using appropriate manufacturing techniques.
- Use of design principles and develop conceptual and engineering design in robotics and automation field.
- Demonstrating the function of the fabricated model.
- Prepare the project as a technical report and deliver it in oral presentation.
- Show their team work and technical skills.

SEMESTER VIII

Course Code	Course Title	Category	L	T	P	C
RO23821	**Project Work Phase -II**	**EEC**	0	0	14	7

Objectives:
This laboratory course enables students to

- **To develop the ability to solve a specific problem right from its identification and literature review till the successful** solution of the same
- To train the students in preparing project reports and to face reviews and viva voce examination

GUIDELINE FOR REVIEW AND EVALUATION

The student in a group of 3 to 4 works on a topic approved by the head of the department under the guidance of a faculty member and prepares a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The **project work is evaluated based on oral presentation and the project report jointly by external and internal examiners** constituted by the Head of the Department.

The system designed in Phase-I need to be fabricated/ implemented in Phase II of the project.

The project report shall carry a maximum of 20 marks. The project report shall be submitted as per the approved guidelines as given by Dean-Academics. Same mark shall be awarded to every student within the project group for the project report. The viva-voce examination shall carry 40 marks. Marks are awarded to each student of the project group based on the individual performance in the viva-voce examination.

Continuous Assessment 40 Marks			End semester Examination 60 Marks			
			Project Report Evaluation 20 marks		Viva-Voce 40 marks	
Review I	Review II	Review III	Internal	External	Internal	External
10	15	15	10	10	20	20

Total Contact Hours	**:**	**210**

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

- Fabricate any components using appropriate manufacturing techniques.
- Use of design principles and develop conceptual and engineering design in robotics and automation field.
- Demonstrating the function of the fabricated model.
- Prepare the project as a technical report and deliver it in oral presentation.
- Show their team work and technical skills.

PROFESSIONAL ELECTIVES

RO23C11	Marine Robotics	PE	L	T	P	C
			3	0	0	3

Objectives:	
•	To understand the fundamental principles of marine robotics, including buoyancy, hydrostatics, and ability, and explore different types and classifications of marine robots.
•	To study the design, deployment, and operational aspects of robotic sailing and unmanned submersibles.
•	To learn about the structural, power, propulsion, and hydrodynamic considerations in the design and evelopment of marine robots.
•	To examine the components, construction, and control strategies for autonomous underwater vehicles AUVs) and gliders.
•	To analyze the dynamics, guidance, and control of underwater vehicles while addressing ethical and nvironmental concerns.

UNIT-I	**FUNDAMENTALS OF MARINE ROBOTICS**	**9**
Basic Principles: Archimedes' principle, buoyancy, and flotation. Buoyancy Control Mechanisms: Overview of ballast tanks, buoyancy engines, and variable buoyancy systems. Hydrostatics and Stability: Concepts of stability, trim, and hydrostatic forces. Types and Classification of Marine Robots: Overview of robotic sailing systems, submersibles, AUVs, ROVs, and gliders. Applications and Limitations: Applications of marine robots and limitations in marine autonomy.		
UNIT-II	**ROBOTIC SAILING AND SUBMERSIBLES**	**9**
Robotic Sailing: History, recent developments, and platforms like MOOP. Design and deployment of autonomous sailing vessels. Unmanned Submersibles: Towed vehicles and Remotely Operated Vehicles (ROVs). Design and Operational Aspects: ROV-specific components, design theory, control standards, and simulation. Applications of ROVs: Industry use cases, such as exploration, rescue, and maintenance		
UNIT-III	**DESIGN AND DEVELOPMENT OF MARINE ROBOTS**	**9**
Structural Design and Material Selection: Materials for pressure resistance and structural integrity in underwater environments. Power and Energy Systems: Types of batteries, power management strategies, and energy harvesting techniques. Propulsion Systems: Overview of thrusters, fins, and other propulsion methods. Hydrodynamics: Drag, lift, and fluid flow around underwater vehicles		
UNIT-IV	**AUTONOMOUS UNDERWATER VEHICLES (AUVS) AND GLIDERS**	**9**
Overview of AUVs and Gliders: Differences, use cases, and typical operational environments. Design and Construction of Gliders: Buoyancy-driven systems and specific construction techniques for underwater gliders. AUV Components and Systems: Key components like hulls, navigation sensors, and power systems. Control Strategies for AUVs: Depth control, path following, and autonomous navigation.		
UNIT-V	**DYNAMICS, GUIDANCE, AND CONTROL OF UNDERWATER VEHICLES**	**9**
Vehicle Dynamics: Modeling of kinematics and rigid body dynamics in underwater vehicles. Hydrodynamic orces and Motion: Analysis of water resistance, drag, lift, and the derivation of motion equations. Stability and Control: Stability analysis focusing on factors like roll, pitch, and yaw. Control Techniques: nplementation of control laws, including PID and adaptive control methods. Guidance Systems: Trajectory acking, station-keeping, and obstacle avoidance. Ethics and Environmental Impact: Marine ecosystem nteractions, sustainability, and ethical considerations. Overview of international regulations for marine robotics.		
	Total Contact Hours :	**45**

Course Outcomes: On completion of the course students will be able to	
•	Explain the fundamental principles and classify marine robots and evaluate their applications and limitations.
•	Design and analyze the deployment and operational aspects of robotic sailing systems and unmanned ıbmersibles.
•	Develop robust marine robot designs considering structural integrity, power, propulsion, and hydrodynamic erformance.
•	Construct AUVs and gliders, implementing effective control strategies for their autonomous operations.
•	Model and control the dynamics of underwater vehicles while addressing sustainability and ethical onsiderations.

SUGGESTED ACTIVITIES

- Industrial visit
- Mini Project

SUGGESTED EVALUATION METHODS

- Assignment topics
- Continuous Assessment Tests
- Continuous Assessment Tests

Text Book(s):	
1	Sabiha A. Wadoo, Pushkin Kachroo, "Autonomous underwater vehicles, modelling, control design and mulation", CRC press, 2021
2	Mae L. Seto, "Marine Robot Autonomy", Springer, 2020

Reference Books / Web links:	
1	Heidarsson, H. K., & Sukhatme, G. S., Marine Robot Autonomy: An Introduction to Planning and Control, MIT ress, 2014.
2	Antonelli, G, Underwater Robots: Motion and Force Control of Vehicle-Manipulator Systems, Springer, 2018.
3	Yuh, J., & West, M, Underwater Robotics: Science, Design, and Applications, Wiley-IEEE Press, 2001.
4	Singh, H, Introduction to Autonomous Underwater Vehicles, Springer, 2010.
5	Robert D. Christ,Robert L. Wernli, Sr. "The ROV Manual a User Guide for Remotely Operated Vehicles", Elsevier, cond edition, 2014

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23C11.1	3	2	2	-	3	-	-	-	1	2	-	2	2	1	-
RO23C11.2	3	3	3	2	3	-	-	-	2	2	-	2	3	3	2
RO23C11.3	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23C11.4	3	3	3	3	3	-	-	-	2	2	-	2	3	3	3
RO23C11.5	3	3	3	3	3	2	-	-	3	3	2	2	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

RO23C12	Machine Learning and Cognitive Robotics	PE	L	T	P	C
			3	0	0	3

Objectives:	
•	To introduce the fundamentals of machine learning and its integration into cognitive robotics, focusing on robotic perception and decision-making.
•	To explore supervised and unsupervised learning techniques and their applications in robotics tasks such as object recognition and mapping.
•	To study reinforcement learning algorithms and their implementation in robotic control and decision-making in dynamic environments.
•	To examine cognitive architectures, memory integration, and human-robot interaction for enhancing collaborative and social capabilities in robots.
•	To delve into advanced topics such as deep learning, transfer learning, ethics, and emerging trends in cognitive robotics.

UNIT-I	INTRODUCTION TO MACHINE LEARNING AND ROBOTICS	9
Overview of Machine Learning (ML): Fundamentals of ML, types of learning (supervised, unsupervised, and reinforcement learning), and key algorithms. Introduction to Cognitive Robotics: Definition, scope, and differences between cognitive and traditional robotics. Role of ML in Robotics: Applications of ML in robotic perception, navigation, and decision-making. Basics of Robotics Perception: Sensor data processing, feature extraction, and pattern recognition.		
UNIT-II	**SUPERVISED AND UNSUPERVISED LEARNING IN ROBOTICS**	**9**
Supervised Learning: Algorithms like linear regression, decision trees, support vector machines, and neural networks, with a focus on their applications in robotic tasks. Unsupervised Learning: Clustering techniques, principal component analysis (PCA), and their use in data-driven robotic perception and exploration. Application in Robotics: Use cases for supervised and unsupervised learning in object recognition, localization, and mapping.		
UNIT-III	**REINFORCEMENT LEARNING FOR ROBOTIC CONTROL**	**9**
Fundamentals of Reinforcement Learning (RL): Concepts of rewards, states, actions, and policies. RL Algorithms: Q-learning, deep Q-networks (DQNs), and policy gradient methods. Applications in Robotics: Implementing RL for robotic control, adaptive behaviors, and decision-making in dynamic environments. Case Studies: Examples of RL in robotic applications such as robotic arm manipulation, autonomous driving, and mobile robot navigation.		
UNIT-IV	**COGNITIVE ARCHITECTURES AND LEARNING SYSTEMS**	**9**
Cognitive Architectures for Robotics: SOAR, ACT-R, and other architectures for cognitive computing in robotics. Memory and Learning: Integration of short-term and long-term memory models, episodic memory, and learning from experience. Human-Robot Interaction (HRI): Techniques for natural interaction, understanding intent, and collaborative tasks. Social and Emotional Intelligence in Robots: Basics of affective computing and its role in developing socially aware robots.		
UNIT-V	**ADVANCED TOPICS IN COGNITIVE ROBOTICS**	**9**
Deep Learning in Robotics: Convolutional neural networks (CNNs) for image processing, recurrent neural networks (RNNs) for sequence learning, and their applications in robotics. Transfer Learning and Domain Adaptation: Enabling robots to adapt learned behaviors to new tasks or environments. Ethics and Safety in Cognitive Robotics: Addressing ethical considerations, human safety, and responsible AI use in cognitive robotics. Future Trends and Challenges: Emerging research areas such as explainable AI, continual learning, and brain-inspired computing for cognitive robotics.		
	Total Contact Hours :	**45**

Course Outcomes: On completion of the course students will be able to	
•	Explain the role of machine learning in cognitive robotics and apply basic robotic perception techniques for data processing and decision-making.
•	Utilize supervised and unsupervised learning techniques for robotic tasks such as object recognition, localization, and mapping.
•	Implement reinforcement learning algorithms for robotic control and adaptive behaviors in dynamic environments.
•	Design cognitive architectures for robotics, incorporating memory systems and enabling effective human-robot interaction.
•	Apply advanced learning techniques such as deep learning and transfer learning in robotics while addressing ethical and safety concerns.

SUGGESTED ACTIVITIES

- Industrial visit
- Mini Project

SUGGESTED EVALUATION METHODS

- Assignment topics
- Continuous Assessment Tests
- Continuous Assessment Tests

Text Book(s):	
1	Bishop, C. M, Pattern Recognition and Machine Learning. Springer, 2016.
2	Sutton, R. S., & Barto, A. G, Reinforcement Learning: An Introduction, MIT Press, 2018.

Reference Books / Web links:	
1	Goodfellow, I., Bengio, Y., & Courville, A., Deep Learning, MIT Press, 2016.
2	Russell, S., & Norvig, P., Artificial Intelligence: A Modern Approach, 4th Edition, Pearson, 2020.
3	Murphy, K. P., Machine Learning: A Probabilistic Perspective, MIT Press, 2012.
4	Siegwart, R., Nourbakhsh, I., & Scaramuzza, D., Introduction to Autonomous Mobile Robots, MIT Press, 2011.
5	Thrun, S., Burgard, W., & Fox, D, Probabilistic Robotics, MIT Press, 2005.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23C12.1	3	2	2	-	3	-	-	-	1	2	-	2	2	1	-
RO23C12.2	3	3	3	2	3	-	-	-	2	2	-	2	3	3	2
RO23C12.3	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23C12.4	3	3	3	3	3	-	-	-	2	2	-	2	3	3	3
RO23C12.5	3	3	3	3	3	2	-	-	3	3	2	2	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

RO23C13	Farm Automation	PE	L	T	P	C
			3	0	0	3

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

UNIT-I	**INTRODUCTION**	**9**
History of Mechanized Agriculture - Farming Operations and Related Machines - Tillage, Planting Cultivation, and Harvesting, Agricultural Automation, Introduction to Field Robots in Agriculture: Overview of robots used for tasks like crop monitoring, pesticide spraying, planting, and soil analysis; examples of autonomous field robots and drones for agricultural applications.		
UNIT-II	**PRECISION AGRICULTURE**	**9**
Sensors – types and agricultural applications, Global Positioning System (GPS) - GPS for civilian use, Differential GPS, Carrier-phase GPS, Real-time kinematic GPS, Military GPS, Geographic Information System, Variable Rate Applications and Controller Area Networks.		
UNIT-III	**TRACTION, AND TESTING**	**9**
Hitching- Principles of hitching, Types of hitches, Hitching and weight transfer, Control of hitches, Tires and Traction-Traction models, Traction predictor spreadsheet, 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 AND INTEGRATION**	**9**
Machinery Selection – Field capacity and efficiency, draft and power requirements, and cost analysis. Conveyors in Agriculture- Screw Conveyors, Pneumatic Conveyors, Bucket Elevators, Forage Blowers and Miscellaneous Conveyors. Automation Integration – Designing smart machinery networks for connected farming systems. IoT and Cloud Computing in Agriculture: Role in predictive analytics, farm monitoring, and decision-making. Hybrid Agricultural Systems – Integration of robotics, AI, IoT, and GIS in modern farming. Case Studies in Automation Applications- Fully automated greenhouses and robotic fleet management for large-scale farming.		
	Total Contact Hours :	**45**

Course Outcomes: On completion of the course students will be able to	
•	Design robot for agriculture purposes.
•	Integrate sensor and system for a required agricultural application.
•	Develop suitable testing and tracking devices.
•	Implement suitable Weed Management system.
•	Develop and select suitable machinery for specific tasks.

SUGGESTED ACTIVITIES

- Industrial visit
- Mini Project

SUGGESTED EVALUATION METHODS

- Assignment topics
- Continuous Assessment Tests
- Continuous Assessment Tests

Text Books:	
1	Ajit K. Srivastava, Carroll E. Goering, Roger P. Rohrbach, Dennis R. Buckmaster, "Engineering Principles of Agricultural Machines", ASAE Publication, 2006.
2	Myer Kutz, "Handbook of Farm, Dairy and Food Machinery Engineering", Academic Press, 2013

Reference Books / Web links:	
1	Qin Zhang, Francis J. Pierce , "Agricultural Automation Fundamentals and Practices", CRC Press, 2013.
2	StephenL.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, 2017.
4	Guangnan Chen , "Advances in Agricultural Machinery and Technologies", 1st Edition, CRC Press, 2018.
5	Mehta, M.L., Verma, S.R., Mishra, S.K., & Gupta, V.K., “Machine Design and Automation in Agriculture”, Standard Publishers Distributors, 2nd Edition, 2019.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23C13.1	3	2	2	-	3	-	-	-	1	2	-	2	2	1	-
RO23C13.2	3	3	3	2	3	-	-	-	2	2	-	2	3	3	2
RO23C13.3	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23C13.4	3	3	3	3	3	-	-	-	2	2	-	2	3	3	3
RO23C13.5	3	3	3	3	3	2	-	-	3	3	2	2	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

RO23C14	Collaborative Robotics	PE	L	T	P	C
			3	0	0	3

Objectives:	
•	To know the fundamentals of Collaborative Robotics
•	To introduce Swarm robot and trajectory planning for Swarm
•	To introduce Modular Robotics and its Mechanics
•	To learn about various Natural models of robot collaboration
•	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 Contact Hours : 45	

Course Outcomes: On completion of the course students will be able to	
•	Recognize the fundamentals of Collaborative Robotics
•	Apply Swarm robot technology in real time applications
•	Analyze and select the suitable concept of Modular Robotics and its Mechanics formodelling a collaborative robot
•	Create various Natural models for robot collaboration
•	Develop collaborative robots for various requirement in industrial tasks.

SUGGESTED ACTIVITIES

- Industrial visit
- Mini Project

SUGGESTED EVALUATION METHODS

- Assignment topics
- Continuous Assessment Tests
- Continuous Assessment Tests

Text Books:	
1	Guilin Yang, I-Ming Chen, Modular Robots: Theory and Practice, Springer, 2022.
2	Bruno Siciliano and Oussama Khatib, Handbook of Robotics, 2nd Edition, Springer, 2016.

Reference Books / Web links:	
1	Dmitry Tsetserukou, Toshio Fukuda, Collaborative and Modular Robotics, Springer, 2019.
2	Choset H., Lynch K., Hutchinson S., Principles of Robot Motion: Theory, Algorithms, and Implementation, MIT Press, 2005.
3	S. Kernbach, Handbook of Collective Robotics: Fundamentals and Challenges, CRC Press, 2011.
4	Gerhard Neumann, Katja Mombaur, Modular Robotics: Mechanics and Control, Springer, 2019.
5	Marco Dorigo, Mauro Birattari, Swarm Robotics: State-of-the-Art Survey, Springer, 2013.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23C14.1	3	2	2	-	2	-	-	-	1	2	-	2	2	1	-
RO23C14.2	3	3	3	2	3	-	-	-	2	2	-	2	3	3	2
RO23C14.3	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23C14.4	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23C14.5	3	3	3	3	3	2	-	-	3	3	2	2	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

RO23C15	Field and Service Robots	PE	L	T	P	C
			3	0	0	3

Objectives:	
•	To study the various parts of robots and fields of robotics
•	To learn the concept of localization
•	To familiarize the concept on planning and navigation.
•	To understand the different field robots.
•	To study about the humanoid robots

UNIT-I	INTRODUCTION	9
History of service robotics–Present status and future trends–Need for service robots-applications-examples and Specifications of service and field Robots. Non-conventional Industrial robots.		
UNIT-II	**LOCALIZATION**	**9**
Introduction-Challenges of Localization-Map Representation-Probabilistic Map based Localization-Monte carlo localization-Landmark based navigation-Globally unique localization-Positioning beacon systems-Route based localization		
UNIT-III	**PLANNING AND NAVIGATION**	**9**
Introduction-Path planning, Road map path planning, Cell decomposition path planning, Potential field path planning, Obstacle avoidance - Case studies: tiered robot architectures.		
UNIT-IV	**FIELD ROBOTS**	**9**
Ariel robots-Collision avoidance - Robots for agriculture, mining, exploration, underwater, civilian and military applications, nuclear applications, Space applications.		
UNIT-V	**HUMANOIDS**	**9**
Wheeled and legged, Legged locomotion and balance, Arm movement, Gaze and auditory orientation control, Facial expression, Hands and manipulation, Sound and speech generation, Motion capture/Learning from demonstration, Human activity recognition using vision, touch, sound, Vision, Tactile Sensing, Models of emotion and motivation. Performance, Interaction, Safety and robustness, Applications, Case studies.		
	Total Contact Hours : 45	

Course Outcomes:	
On completion of the course students will be able to	
•	Explain the basic concepts of working of robot.
•	Analyze the challenges in the localization of robot
•	Implement the required path planning methods
•	Describe the role of robots in civilian, military and other applications.
•	Describe on motion capture/learning techniques for humanoid robots.

SUGGESTED ACTIVITIES

- Industrial visit
- Mini Project

SUGGESTED EVALUATION METHODS

- Assignment topics
- Continuous Assessment Tests
- Continuous Assessment Tests

Text Books:	
1	Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza, Introduction to Autonomous Mobile Robots, Bradford Company Scituate, USA, 2004.
2	Zaier, The future of Humanoid Robots-Research and applications, Intech Publications, 2012.

Reference Books / Web links:	
1	Richard D Klafter, Thomas A Chmielewski, Michael Negin, Robotics Engineering–An Integrated Approach, Eastern Economy Edition, Prentice Hall of India P Ltd., 2006.
2	Kelly, Alonzo; Iagnemma, Karl; Howard, Andrew, Field and Service Robotics, Springer, 2011

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23C15.1	3	2	2	-	2	-	-	-	1	2	-	2	2	1	-
RO23C15.2	3	3	3	2	3	-	-	-	2	2	-	2	3	3	2
RO23C15.3	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23C15.4	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23C15.5	3	3	3	3	3	2	-	-	3	3	2	2	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

RO23C16	Space Robotics	PE	L	T	P	C
			3	0	0	3

Objectives:	
•	To provide an understanding of the history, evolution, and challenges of space robotics.
•	To equip students with knowledge of kinematics and dynamics modeling for space robots operating in microgravity.
•	To introduce sensing and perception systems for navigation and object detection in extraterrestrial environments.
•	To impart knowledge on advanced control strategies for space robotic systems.
•	To explore advanced applications, case studies, and future trends in space robotics, including AI and robotic autonomy.

UNIT-I	INTRODUCTION TO SPACE ROBOTICS	9
Overview of space robotics and its applications in space exploration, History and evolution of robotics in space missions, Challenges and constraints of operating in space environments, Types of space robots: planetary-rovers, robotic arms, satellites, and free-flyers, Basics of orbital mechanics and space mission planning		
UNIT-II	**KINEMATICS AND DYNAMICS OF SPACE ROBOTS**	**9**
Kinematic modeling for space robotic systems, Inverse and forward kinematics for robotic arms and rovers Dynamics of space robots under microgravity conditions, Attitude and orbit control systems for space robotics Simulation tools for analyzing space robot kinematics and dynamics.		
UNIT-III	**SENSING AND PERCEPTION IN SPACE ROBOTICS**	**9**
Sensors used in space robotics (cameras, LIDAR, RADAR, and IMUs), Object detection and localization techniques in space, Navigation and mapping in extraterrestrial environments, Autonomous perception systems for planetary exploration, Data fusion techniques and challenges in space applications.		
UNIT-IV	**CONTROL SYSTEMS FOR SPACE ROBOTICS**	**9**
Control strategies for robotic manipulation in space (PID, adaptive, and robust control) Guidance, navigation, and control (GNC) for space robotic systems, Autonomous control systems for rover *navigation*, *Teleoperation* and supervisory control for space missions, Motion planning and obstacle avoidance for space robots		
UNIT-V	**ADVANCED APPLICATIONS AND FUTURE TRENDS IN SPACE ROBOTICS**	**9**
Case studies of past and current space robotics missions (e.g., Mars rovers, ISS robots, and satellite servicing), Innovations in robotic exploration of asteroids, moons, and planets, Space robot collaboration and swarm robotics, Design considerations for long-duration space missions, Future trends: AI, machine learning, and robotic autonomy in space exploration		
	Total Contact Hours : 45	

Course Outcomes: On completion of the course students will be able to	
•	Analyze the evolution, applications, and operational challenges of space robotics, emphasizing the role of orbital mechanics and mission planning.
•	Develop kinematic and dynamic models for space robots operating under microgravity using simulation tools.
•	Analyze and implement sensing and perception systems, including navigation and mapping techniques, for extraterrestrial environments.
•	Design and implement control strategies for robotic manipulation and autonomous navigation in space

	missions.
•	Evaluate case studies and explore future trends, including AI and robotic autonomy, for innovative space exploration missions.

SUGGESTED ACTIVITIES

- Industrial visit
- Mini Project

SUGGESTED EVALUATION METHODS

- Assignment topics
- Continuous Assessment Tests
- Continuous Assessment Tests

Text Books:	
1	Siciliano B., Khatib O. (Eds.), Handbook of Robotics, 2nd Edition, Springer, 2016.
2	Siegwart R., Nourbakhsh I. R., Scaramuzza D., Introduction to Autonomous Mobile Robots, 2nd Edition, MIT Press, 2011.

Reference Books / Web links:	
1	Yoshida K., Wilcox B. (Eds.), Space Robotics: Dynamics and Control, Springer, 2019.
2	Elias M. Awad, Robotics in Space: Applications and Challenges, Wiley, 2018.
3	Choset H., Lynch K. M., Hutchinson S., et al., Principles of Robot Motion, MIT Press, 2005.
4	Siegwart R., et al., Autonomous Mobile Robots in Space, CRC Press, 2017.
5	Lavalle S. M., Planning Algorithms, Cambridge University Press, 2006.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23C16.1	3	2	2	-	2	-	-	-	1	2	-	2	2	1	-
RO23C16.2	3	3	3	2	3	-	-	-	2	2	-	2	3	3	2
RO23C16.3	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23C16.4	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23C16.5	3	3	3	3	3	2	-	-	3	3	2	2	3	3	3
Average															

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

RO23C17	Micro Robotics	PE	L	T	P	C
			3	0	0	3

Objectives:	
•	To expose students to the fundamental aspects of the emerging field of micro robotics.
•	To expose students to micro scale, technologies for fabricating small devices, bio-inspired design, and applications of the field.
•	To expose students to various Mathematical formalism for flexures, Electrostatic actuators, Piezoelectric actuators, Magneto-strictive actuator and other sensors.
•	To apply micro robotics to various applications
•	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 – Piezo resistivity, Piezoelectricity and Thermoelectricity		
UNIT-III	**FLEXURES, ACTUATORS AND SENSORS**	**9**
flexures - Flexure systems - Mathematical formalism for flexures - Electrostatic actuators - Piezoelectric 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 microtools - Micro-conveyors - Walking MEMS Micro-robots - Multi-robot system: Micro-robot powering, Micro-robot communication.		
	Total Contact Hours :	**45**

Course Outcomes:	
On completion of the course students will be able to	
•	Explain and apply the concepts of mass, energy, and momentum balance in microrobotics.
•	Apply adapt, and synthesize learned engineering skills to create microrobot.
•	Model microrobots for different robotics applications
•	Formulate the specifications and design of mechatronic systems.
•	Program the Microrobot for different robotics applications.

SUGGESTED ACTIVITIES

- Industrial visit
- Mini Project

SUGGESTED EVALUATION METHODS

- Assignment topics
- Continuous Assessment Tests
- Continuous Assessment Tests

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.

Reference Books / Web links:	
1	Nadim Maluf and Kirt Williams, An Introduction to Microelectromechanical systems Engineering, 2nd Edition, Artech House, 2004
2	Julian W Gardner, Microsensors: Principles and Applications, 2nd Edition, Wiley,2007
3	Metin Sitti, Mobile Micro robotics, MIT Press, 2017.
4	Nicolas Chaillet, Stephane Rangier Micro robotics for Micromanipulation, John Wiley & Sons, 2013.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23C17.1	3	2	2	-	2	-	-	-	1	2	-	2	2	1	-
RO23C17.2	3	3	3	2	3	-	-	-	2	2	-	2	3	3	2
RO23C17.3	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23C17.4	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23C17.5	3	3	3	3	3	2	-	-	3	3	2	2	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

RO23C18	Parallel Manipulators	PC	L	T	P	C
			3	0	0	3

Objectives:	
•	To understand the fundamental principles and design aspects of parallel manipulators.
•	To analyze the kinematics of parallel manipulators, including position, velocity, and acceleration.
•	To model and study the dynamics of parallel manipulators using analytical and numerical methods.
•	To explore control strategies for parallel manipulators and implement advanced control techniques.
•	To examine advanced topics such as workspace optimization, stiffness analysis, and practical applications in various fields.

UNIT-I	INTRODUCTION TO PARALLEL MANIPULATORS	9
Overview of parallel manipulators and their applications in robotics Types and classification of parallel manipulators Comparison between serial and parallel manipulators Kinematic chains and mobility analysis Fundamental principles of parallel mechanism design		
UNIT-II	**KINEMATICS OF PARALLEL MANIPULATORS**	**9**
Position analysis of parallel manipulators. Direct (forward) kinematics of parallel manipulators Inverse kinematics of parallel manipulators. Jacobian matrix and its derivation Velocity and acceleration analysis in parallel manipulators		
UNIT-III	**DYNAMICS OF PARALLEL MANIPULATORS**	**9**
Dynamic modeling approaches (Lagrange and Newton-Euler methods), *Force* and torque analysis Inverse dynamics of parallel manipulators, Dynamic simulations and analysis of motion Application of dynamics in control and stability		
UNIT-IV	**CONTROL OF PARALLEL MANIPULATORS**	**9**
Control strategies for parallel manipulators (PID, adaptive, and robust control), *Trajectory* planning and path *generation*, *Motion* control and *sensor integration*, *Redundancy* resolution and force control Advanced control techniques (feedback linearization and sliding mode control)		
UNIT-V	**ADVANCED TOPICS AND APPLICATIONS OF PARALLEL MANIPULATORS**	**9**
Workspace analysis and optimization *techniques*, *Stiffness*, compliance, and singularity analysis Calibration, error analysis, and compensation *techniques*, *Case* studies: Applications in manufacturing, medical robotics, and *simulators*, *Future* trends and research directions in parallel manipulators		
	Total Contact Hours : 45	

Course Outcomes: On completion of the course students will be able to	
•	Explain the principles, design, and classification of parallel manipulators and their applications in robotics.
•	Analyze the kinematics of parallel manipulators, including forward and inverse kinematics, velocity, and acceleration.
•	Model the dynamics of parallel manipulators using Lagrange and Newton-Euler methods for force and torque analysis.
•	Implement advanced control strategies for parallel manipulators, including trajectory planning and motion control.
•	Evaluate advanced topics such as workspace analysis, stiffness, and calibration, and apply parallel manipulators in real-world scenarios.

SUGGESTED ACTIVITIES

- Industrial visit
- Mini Project

SUGGESTED EVALUATION METHODS

- Assignment topics
- Continuous Assessment Tests
- Continuous Assessment Tests

Text Books:	
1	Tsai L. W., Robot Analysis: The Mechanics of Serial and Parallel Manipulators, Wiley, 1999.
2	Merlet J. P., Parallel Robots, 2nd Edition, Springer, 2006.

Reference Books / Web links:	
1	Siciliano B., Khatib O. (Eds.), Handbook of Robotics, 2nd Edition, Springer, 2016.
2	Angeles J., Fundamentals of Robotic Mechanical Systems: Theory, Methods, and Algorithms, Springer, 2003.
3	Gosselin C., Design and Control of Parallel Manipulators, Elsevier, 2017.
4	Kumar V., Robotic Systems: Dynamics, Analysis, and Control, Cambridge University Press, 2019.
5	Khalil W., Dombre E., Modeling, Identification, and Control of Robots, Taylor & Francis, 2002.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23C18.1	3	2	2	-	2	-	-	-	1	2	-	2	2	1	-
RO23C18.2	3	3	3	2	3	-	-	-	2	2	-	2	3	3	2
RO23C18.3	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23C18.4	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23C18.5	3	3	3	3	3	2	-	-	3	3	2	2	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High

RO23D11	CNC Machine Tools and Programming	PE	L	T	P	C
			3	0	0	3

Objectives:	
•	To introduce the basic concepts, types, and structural components of CNC machines, enabling students to understand their significance in modern manufacturing systems
•	To impart knowledge on the mechanical and electrical design elements of CNC machines, focusing on their structural dynamics and functional requirements.
•	To provide hands-on experience in writing and simulating CNC part programs for basic machining operations such as turning, milling, and drilling
•	To familiarize students with advanced programming concepts, including parametric programming, multi-axis machining, and CAD/CAM integration for complex manufacturing tasks.
•	To explore the applications of CNC machines in automation and Industry 4.0 while emphasizing maintenance practices, troubleshooting, and retrofitting techniques.

UNIT-I	FUNDAMENTALS OF CNC MACHINES	9
Introduction to CNC Machines: Definition, history, and evolution, Types of CNC Machines: Turning centers, machining centers, multi-axis machines, NC Machine Structure: Bed, headstock, tailstock, and slides, NC Control Systems: Open-loop and closed-loop control systems, NC Coordinate Systems: Machine axes, workpiece coordinate systems, and datum points, Spindle Drives and Feed Drives: Components, working principles, and applications, Sensors in CNC Machines: Position, speed, and load sensing		
UNIT-II	**DESIGN ASPECTS OF CNC MACHINES**	**9**
Mechanical Design of CNC Machines: Structural materials, guideways, and ball screws, Spindle Design: Requirements, material selection, and assembly, Tool Magazine and Automatic Tool Changers: Design and working principles, Machine Enclosures: Noise reduction and safety considerations, Coolant Systems: Design, components, and fluid selection, Electrical Design: Wiring, control panels, and power requirements, CNC Machine Dynamics: Vibration analysis, rigidity, and accuracy		
UNIT-III	**CNC PART PROGRAMMING BASICS**	**9**
Introduction to CNC Programming: Structure, codes, and syntax, G-Codes and M-Codes: Overview and commonly used commands, Programming for Turning Operations: Facing, turning, threading, and grooving, Programming for Milling Operations: Slotting, pocketing, contouring, and drilling, Tool Path Generation: Cartesian and polar coordinates, Tool Offsets and Compensation: Cutter radius compensation, tool length offset, Hands-on Practice: Writing and simulating basic CNC programs		
UNIT-IV	**ADVANCED CNC PROGRAMMING TECHNIQUES**	**9**
Subroutines and Macros: Functions, syntax, and usage, Parametric Programming: Variables, expressions, and loops, Multi-Axis Programming: Concepts, G-codes, and practical examples, Programming for Complex Features: Engraving, chamfering, and filleting, CAD/CAM Integration: Basics of CAM software, toolpath simulation, Tool Selection and Optimization: Material considerations, cutting speeds, and feeds, Hands-on Practice: Developing advanced programs and debugging		
UNIT-V	**CNC APPLICATIONS AND MAINTENANCE**	**9**
CNC Applications in Robotics and Automation: Material handling, pick-and-place, and assembly, Process Automation with CNC: Integration with AGVs, conveyors, and vision systems, Industry 4.0 and CNC Machines: Smart machines and IoT-enabled CNC systems, Troubleshooting and Diagnostics: Common issues and solutions, Preventive and Predictive Maintenance: Schedules, procedures, and tools, CNC Retrofitting: Upgrading conventional machines to CNC systems, Case Studies: Real-world CNC applications and innovations		
	Total Contact Hours :	**45**

Course Outcomes: On completion of the course students will be able to	
•	Understand the fundamentals of CNC machines and their components.
•	Understand the fundamentals of CNC machines and their components.
•	Develop CNC programs for basic and advanced machining operations.
•	Apply advanced programming techniques for multi-axis machining.
•	Explore the applications, maintenance, and future trends in CNC technology

SUGGESTED ACTIVITIES

- Industrial visit
- Mini Project

SUGGESTED EVALUATION METHODS

- Assignment topics
- Continuous Assessment Tests
- Continuous Assessment Tests

Text Books:	
1	Groover, M. P., "Fundamentals of Modern Manufacturing: Materials, Processes, and Systems", Wiley, 2013.
2	Michael Fitzpatrick, "Machining and CNC Technology", McGraw-Hill Education, 4th edition, 2019.

Reference Books / Web links:	
1	HMT Ltd., "Mechatronics," 3rd Edition, Tata McGraw Hill, 2017.
2	Koren, Y., "Computer Control of Manufacturing Systems," 2nd Edition, McGraw Hill, 2017.
3	Kalpakjian, S., and Schmid, S. R., "Manufacturing Engineering and Technology," 7th Edition, Pearson
4	Education, 2019.
5	Krar, S. F., Gill, A. R., and Smid, P., "Technology of Machine Tools," 8th Edition, McGraw Hill, 2018.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23D11.1	3	2	2	-	2	-	-	-	1	2	-	2	2	1	-
RO23D11.2	3	3	3	2	3	-	-	-	2	2	-	2	3	3	2
RO23D11.3	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23D11.4	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23D11.5	3	3	3	3	3	2	-	-	3	3	2	2	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

RO23D12	Computer Integrated Manufacturing	PE	L	T	P	C
			3	0	0	3

Objectives:	
•	To study the different types of production system.
•	To learn the computer aided process planning.
•	To introduce the concepts Group Technology and Cellular Manufacturing.
•	To understand flexible manufacturing system.
•	To know the database and CIM communication.

UNIT-I	INTRODUCTION	9
Concepts of CAD/CAM –CIM concepts and elements –Types of production –Manufacturing Metrics and Economics –Production Performance Metrics –Manufacturing Cost -Simple problems –Basic Elements of an Automated system –Advanced Automation Functions -Levels of Automation –Lean Production and Just-In-Time Production, Introduction to reverse engineering.		
UNIT-II	**PRODUCTION AND COMPUTER AIDED PROCESS PLANNING**	**9**
Production planning and Control System -Aggregate Production Planning and Master Production Schedule – Material Requirement Planning (MRP I) –Simple Problems –Capacity Planning –Shop Floor Control – Inventory Control –EOQ, WIP costs & Inventory Holding Costs -Simple Problems – Introduction to Manufacturing Resource Planning (MRP II) & Enterprise Resource Planning (ERP) - Process planning – Manual Process Planning and case studies Computer Aided Process Planning (CAPP)		
UNIT-III	**GROUP TECNOLOGY AND CELLULAR MANUFACTURING**	**9**
Group Technology(GT) -Part Families –Parts Classification and coding –Simple Problems in OPITZ Part Codingsystem –Production flow Analysis –Cellular Manufacturing –Composite part concept –Machine cell design and layout –Quantitative analysis in Cellular Manufacturing –Rank Order Clustering Method - Arranging Machines in a GT cell–Hollier Method –Simple Problems Performance Metrics in Cell Operation – Simple Problems.		
UNIT-IV	**FLEXIBLE MANUFACTURING SYSTEM**	**9**
Types of FMS & Flexibility –FMS Components –FMS Application & Benefits –FMS Planning and Implementation Issues –Quantitative analysis of Bottleneck Model on simple problems in FMS - Alternative Approach in Flexible Manufacturing-Automated Guided Vehicle System (AGVS) –Types of AGVS - Applications –Vehicle Guidance technologies –Vehicle Management & Safety		
UNIT-V	**COMMUNICATIONS AND DATABASE MANAGEMENT**	**9**
Information, Communications matrix, Computer communications, Network architecture, Tools and techniques, Manufacturing data, database technology, Database management, Management of CIM –role, cost justification, expert systems		
	Total Contact Hours : 45	

Course Outcomes: On completion of the course students will be able to	
•	Identify the production systems.
•	Select optimal inventory ordering system.
•	Group part and machine families for Cellular Manufacturing System.
•	Implement flexible manufacturing system
•	Design proper database and CIM communication system.

SUGGESTED ACTIVITIES

- Industrial visit
- Mini Project

SUGGESTED EVALUATION METHODS

- Assignment topics
- Continuous Assessment Tests
- Continuous Assessment Tests

Text Books:	
1	Mickel P Groover, "Automation production systems and computer integrated manufacturing", PHI, second edition, 2018.
2	Kant Vajpayee S, "Principles of Computer-Integrated Manufacturing", PHI, 2015.

Reference Books / Web links:	
1	Groover and Zimmers, CAD/CAM; "Computer Aided Design and Manufacturing, Pearson Education", New Delhi, 2006.
2	Paul G. Ranky, "Computer Integrated Manufacture, Prentice" – Hall International, UK, 1986.
3	Rao,PN "CAD/CAM: Principles and Applications" McGraw Hill Education; 3rd edition 2017.
4	Ibrahim Zeid, R Sivasubramanian CAD/CAM, "Theory and Practice", Tata McGraw Hill Ed, 2009.
5	Yoram Koren," Computer Control of Manufacturing Systems", McGraw Hill Education; 1st edition, 2017.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23D12.1	3	2	2	-	2	-	-	-	1	2	-	2	2	1	-
RO23D12.2	3	3	3	2	3	-	-	-	2	2	-	2	3	3	2
RO23D12.3	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23D12.4	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23D12.5	3	3	3	3	3	2	-	-	3	3	2	2	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

RO23D13	Advanced Manufacturing Systems	PE	L	T	P	C
			3	0	0	3

Objectives:	
•	The objective of this course is to teach the lean tools to attain optimum level in quality.
•	To enhance the ability to make decisions for new product development.
•	Aims to develop the students to conserve energy and natural resources, and to ensure that theyhave minimal impact on the environment and society.
•	To give students an introduction to an advanced information process technique
•	To learn about the various smart manufacturing techniques and applications.

UNIT-I	INTRODUCTION TO LEAN MANUFACTURING	9
Objectives of lean manufacturing-key principles and implications of lean manufacturing -traditional Vs lean manufacturing- flow-continuous improvement/Kaizen –worker involvement- 5S principles elements of JIT - uniform production rate - Kanban system - Lean implementation, Reconciling leanwith other systems - lean six sigma- lean and ERP - lean with ISO 9001:2000		
UNIT-II	**AGILE MANUFACTURING**	**9**
Agile Manufacturing Vs Mass Manufacturing - Agile practice for product development - Manufacturing agile practices - Implementing new technology - A checklist, technology applications that enhance agility - agile technology make or buy decisions. - Costing for Agile Manufacturing practices		
UNIT-III	**SUSTAINABLE MANUFACTURING**	**9**
Concepts of competitive strategy and manufacturing strategies and development of a strategic improvement programme - Manufacturing strategy in business success strategy formation and formulation - Structured strategy formulation - Sustainable manufacturing system design options - Approaches to strategy formulation - Realization of new strategies/system designs		
UNIT-IV	**INTELLIGENT MANUFACTURING**	**9**
Concepts of competitive strategy and manufacturing strategies and development of a strategic improvement programme - Manufacturing strategy in business success strategy formation and formulation - Structured strategy formulation - Sustainable manufacturing system design options - Approaches to strategy formulation - Realization of new strategies/system designs		
UNIT-V	**SMART MANUFACTURING**	**9**
introduction to various Smart Manufacturing Techniques-Supply chain management-Block chain of inventorymanagement-Plant Digitization-Predictive Maintenance-Supply chain visibility- Warehouse-Cost reduction Waste Management-Automated Systems-Applications		
	Total Contact Hours : 45	

Course Outcomes: On completion of the course students will be able to	
•	Demonstrate on basic lean manufacturing.
•	Integrate the knowledge on agile manufacturing.
•	Formulate strategy in sustainable manufacturing.
•	Apply artificial intelligence (AI) and fuzzy techniques to improve the efficiency of manufacturing systems.
•	Exposure to smart manufacturing and its various techniques

SUGGESTED ACTIVITIES

- Industrial visit
- Mini Project

SUGGESTED EVALUATION METHODS

- Assignment topics
- Continuous Assessment Tests
- Continuous Assessment Tests

Text Books:	
1	Womack J.P., Jones D.T., "Lean Thinking: Banish Waste and Create Wealth in Your Corporation," 2nd Edition, Free Press, 2003.
2	Groover M.P., "Automation, Production Systems, and Computer-Integrated Manufacturing," 4th Edition, Pearson, 2015.

Reference Books / Web links:	
1	Black J.T., Kohser R.A., "DeGarmo's Materials and Processes in Manufacturing," Wiley, 11th Edition, 2011.
2	Christian N. Madu, "Handbook of Environmentally Conscious Manufacturing," Springer, 2001.
3	John Schey, "Introduction to Manufacturing Processes," Tata McGraw-Hill Education, 3rd Edition, 1999.
4	Seliger G., "Sustainable Manufacturing: Shaping Global Value Creation," Springer, 2012.
5	Askin R.G., Goldberg J.B., "Design and Analysis of Lean Production Systems," John Wiley and Sons, 2003.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23D13.1	3	2	2	-	2	-	-	-	1	2	-	2	2	1	-
RO23D13.2	3	3	3	2	3	-	-	-	2	2	-	2	3	3	2
RO23D13.3	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23D13.4	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23D13.5	3	3	3	3	3	2	-	-	3	3	2	2	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

RO23D14	Computer Aided Inspection and Testing	PE	L	T	P	C
			3	0	0	3

Objectives:	
•	To familiar the measurement standards and to know the instruments used and various errors in measurements
•	To recognize the use of basic and advanced instruments for measurements.
•	To learn the applications of opto-electronics device for measurements.
•	To describe the various measurement techniques using laser metrology
•	To gain knowledge on computer aided inspection and advances in metrology.

UNIT-I	FUNDAMENTALS AND CONCEPTS IN METROLOGY	9
Standards of Measurement – Analog and Digital Measuring Instruments - Comparators – Limits, Fits and Tolerances – Gauge Design –Surface Roughness – Form Errors and Measurements		
UNIT-II	**INSPECTION AND GENERAL MEASUREMENTS**	**9**
Linear Measuring Instruments – Evolution – Types – Classification – Limit Gauges – Gauge Design – Terminology – Procedure – Concepts of Interchange Ability and Selective Assembly – Angular Measuring Instruments – Types – Bevel Protractor Clinometers Angle Gauges, Spirit Levels Sine Bar – Angle Alignment Telescope – Autocollimator – Applications - Inspection of Gears And Threads Tool Makers' Microscope – Universal Measuring Machine.		
UNIT-III	**OPTO ELECTRONICS IN ENGINEERING INSPECTION**	**9**
Use of Optoelectronics in Tool Wear Measurements – Micro hole Measurement and Surface Roughness –Applications in In-Process Measurement and On-Line Inspection		
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. Use of Laser Interferometer in Machine Tool Inspection – Uses of Laser in On-Line Inspection – Laser Micrometer – Laser Alignment Telescope.		
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 - Introduction to Nano metrology.		
	Total Contact Hours : 45	

Course Outcomes:	
On completion of the course students will be able to	
•	Practice the standards in measurements and to avoid the various forms of errors in measurements
•	Use of basic and advanced metrology instruments for measurements.
•	Acquire the knowledge on non-contact opto-electronics device for measurements.
•	Describe various measurement techniques using laser metrology.
•	Exposure to smart manufacturing and its various techniques

SUGGESTED ACTIVITIES

- Industrial visit
- Mini Project

SUGGESTED EVALUATION METHODS

- Assignment topics
- Continuous Assessment Tests
- Continuous Assessment Tests

Text Books:	
1	Beckwith, Marangoni, Lienhard, "Mechanical Measurements", Pearson Education, 2014.
2	Anil. K. Jain, "Fundamentals of Digital Image Processing", Prentice Hall of India Pvt. Ltd., 2006.

Reference Books / Web links:	
1	Charles Reginald Shotbolt, "Metrology for Engineers", Cengage Learning EMEA,5thedition, 1996.
2	Jain R.K., "Engineering Metrology", Khanna Publishers, 2012
3	Robert G. Seippel, "Opto-Electronics for Technology and Engineering", Prentice Hall,1989.
4	Robert J. Hocken, Paulo H. "Coordinate Measuring Machines and Systems", CRC Press, 2nd edition, 2016.
5	Alan S. Morris, "The Essence of Measurement", Prentice Hall of India, 2002.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23D14.1	3	2	2	-	2	-	-	-	1	2	-	2	2	1	-
RO23D14.2	3	3	3	2	3	-	-	-	2	2	-	2	3	3	2
RO23D14.3	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23D14.4	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23D14.5	3	3	3	3	3	2	-	-	3	3	2	2	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

RO23D15	Integrated Product Development	PE	L	T	P	C
			3	0	0	3

Objectives:	
•	To understand the global trends and development methodologies of various types of products andservices
•	To conceptualize, prototype and develop product management plan for a new product based on the typeof 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 sustainup 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 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 – ObsolescenceManagement – 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 Contact Hours :	**45**

Course Outcomes:	
On completion of the course 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

SUGGESTED ACTIVITIES

- Industrial visit
- Mini Project

SUGGESTED EVALUATION METHODS

- Assignment topics
- Continuous Assessment Tests
- Continuous Assessment Tests

Text Books:	
1	Ulrich K. T., Eppinger S. D., "Product Design and Development," 6th Edition, McGraw-Hill, 2020.
2	Pugh S., "Total Design: Integrated Methods for Successful Product Engineering," Addison-Wesley, 1991.

Reference Books / Web links:	
1	Otto K., Wood K., "Product Design: Techniques in Reverse Engineering and New Product Development," Pearson, 2001.
2	Baxter M., "Product Design: Practical Methods for the Systematic Development of New Products," Chapman & Hall, 1995.
3	Booz, Allen, and Hamilton, "New Product Management for the 1980s," Harper & Row, 1982.
4	Anderson D. M., "Design for Manufacturability and Concurrent Engineering," CIM Press, 2004.
5	Cross N., "Engineering Design Methods: Strategies for Product Design," Wiley, 2008.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23D15.1	3	2	2	-	2	-	-	-	1	2	-	2	2	1	-
RO23D15.2	3	3	3	2	3	-	-	-	2	2	-	2	3	3	2
RO23D15.3	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23D15.4	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23D15.5	3	3	3	3	3	2	-	-	3	3	2	2	3	3	3

RO23E11	Fuzzy Logic and Neural Networks	PE	L	T	P	C
			3	0	0	3

Objectives:	
•	To understand the fuzzy operations and fuzzy clustering.
•	To Familiarize and create awareness on fuzzy logic controller.
•	To learn the neural network models.
•	To impart knowledge on modeling of different ANN techniques.
•	To know the hybrid systems of ANN.

UNIT-I	INTRODUCTION TO FUZZY SETS	9
Crisp Sets, Notations Used in Set Theory, Crisp Set Operations, Properties of Crisp Sets, Fuzzy Sets, Representationof a Fuzzy Set, Difference Between Crisp Set and Fuzzy Set, Standard Operations in Fuzzy Sets and Relations, Properties of Fuzzy Sets, Measures of Fuzziness and Inaccuracy of Fuzzy Sets, Fuzzy Clustering, Fuzzy C-MeansClustering, Entropy-based Fuzzy Clustering.		
UNIT-II	**FUZZY REASONING**	**9**
Introduction, Fuzzy Logic Controller, Two Major Forms of Fuzzy Logic Controller, Hierarchical Fuzzy Logic Controller, Sensitivity Analysis, Advantages and Disadvantages of Fuzzy Logic Controller.		
UNIT-III	**FUNDAMENTALS OF NEURAL NETWORKS**	**9**
Introduction, Biological Neuron, Artificial Neuron, Layer of Neurons, Multiple Layers of Neurons, Static vs. Dynamic Neural Networks, Training of Neural Networks, Supervised Learning, Un-supervised Learning, Incremental Training, Batch Mode of Training. Multi-Layer Feed-Forward Neural Network (MLFFNN), Forward Calculation, Training of Network Using Back-Propagation Algorithm.		
UNIT-IV	**ANN MODELS**	**9**
Radial Basis Function Network (RBFN), Forward Calculations, Tuning of RBFN Using Back-Propagation Algorithm, Self-Organizing Map (SOM), Competition, Cooperation, Updating, Final Mapping, Counter-Propagation Neural Network (CPNN), Full CPNN, Forward-Only CPNN, Recurrent Neural Networks (RNNs), Elman Network, Jordan Network, Combined Elman and Jordan Network		
UNIT-V	**COMBINED GENETIC ALGORITHMS: FUZZY LOGIC**	**9**
Introduction to Genetic Algorithm, Fuzzy-Genetic Algorithm, Genetic-Fuzzy System, Working Principle of Genetic-Fuzzy Systems. Integration of Neural Networks with Fuzzy Systems (Neuro - Fuzzy Systems).		
	Total Contact Hours : 45	

Course Outcomes:	
On completion of the course students will be able to	
•	Apply fuzzy composition rules for different problems.
•	Implement different fuzzy models for prediction of operating parameters.
•	Implement supervised neural networks.
•	Design and control systems using different ANN models.
•	Develop an optimal hybrid control model.

SUGGESTED ACTIVITIES

- Industrial visit
- Mini Project

SUGGESTED EVALUATION METHODS

- Assignment topics
- Continuous Assessment Tests
- Continuous Assessment Tests

Text Books:	
1	Dilip K. Pratihar, "Soft Computing Fundaments and Applications", Narosa Publishing House,2015
2	Laurence Fausett, Fundamentals of Neural Networks, Prentice Hall, Englewood Cliffs, N.J., 2012

Reference Books / Web links:	
1	Zhang Huaguang and Liu Derong—Fuzzy Modeling and Fuzzy Control Series: Control Engineering , 2000
2	Millon W.T., Sutton R.S. and Webrose P.J., —Neural Networks for Control, MIT press, 1992
3	Kevin M. Passino and Stephen Yurkovich, Fuzzy Control, Addison Wesley Longman, Menlo Park, 1998.
4	Timothy J. Ross, —Fuzzy Logic with Engineering Applications , McGraw Hill Inc, 2010
5	Erdal Kayacan, Mojtaba Ahmadieh Khaneswar, — Fuzzy neural networks for Real time control applications,Elsevier, 2015

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23E11.1	3	2	2	-	2	-	-	-	1	2	-	2	2	1	-
RO23E11.2	3	3	3	2	3	-	-	-	2	2	-	2	3	3	2
RO23E11.3	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23E11.4	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23E11.5	3	3	3	3	3	2	-	-	3	3	2	2	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

RO23E12	Industrial Network Protocols	PE	L	T	P	C
			3	0	0	3

Objectives:	
•	To study the various types wired protocols for electronic system.
•	To know the various types wireless protocols for electronic system.
•	To aware the various industrial wired protocols in automation.
•	To study the various types wireless protocols for industrial automation.
•	To develop the wired and wireless functions of various protocols.

UNIT-I	**WIRED BUSES AND PROTOCOLS**	**9**
Wireless - Wired Networks Comparison - Serial Communication Protocols - RS232-UART- SPI - I2C –UNI/O Bus - 1 Wire -Camera Link - Parallel Communication -PPI - Wishbone Bus –AMBA – JTAG - Fireware IEEE 1394 Bus - Ethernet Overview - RS485		
UNIT-II	**WIRELESS PROTOCOLS**	**9**
Antenna Technology- Network Topologies - Wireless Local Area Networks (WLAN) - Wireless Personal Area Networks (WPAN) - Wimedia – Wimax - RF – Bluetooth- Wi-Fi – Zigbee – Wireless Industrial Automation Protocols.		
UNIT-III	**INDUSTRIAL AND AUTONOMOUS SYSTEMS WIRED NETWORKS**	**9**
Overview of Industrial Wired Networks – Terminal Bus- Modbus - HART Network Mechatrolink- II – EtherCAT- Sercos II/III – CAN- Canopen - Modbus IDA-PROFINET-PROFIBUS-Ethernet/IP- Ethernet Powerlink- AG Automation and Drives (AS-I) - Device Net		
UNIT-IV	**INDUSTRIAL WIRELESS NETWORKS**	**9**
Overview of Industrial Wireless Networks - IWLAN - ISA100 Standards – Remote Networks- Controller-Based Networks - Wireless HART Technology - 3G/4G for Automation – RFID Data Tags.		
UNIT-V	**APPLICATION OF COMMUNICATION PROTOCALS**	**9**
Wired Machine Networking of Sub-elements and Machines - Wireless Machine Networking of Sub-elements and Machines – Networking of Industry - Communication Network Layout Design - Networking for TIA- Cloud Computing – IOT , Integration of Industrial Protocols with Edge Computing, Case Studies in Automation Applications.		
	Total Contact Hours :	**45**

Course Outcomes: On completion of the course students will be able to	
•	Design wired protocols for electronic system.
•	Use wireless protocols for electronic system.
•	Practice industrial wired protocols in automation.
•	Select wireless protocols for industrial automation.
•	Demonstrate the wired and wireless functions of various protocols in application development.

SUGGESTED ACTIVITIES

- Industrial visit
- Mini Project

SUGGESTED EVALUATION METHODS

- Assignment topics
- Continuous Assessment Tests
- Continuous Assessment Tests

Text Books:	
1	Borko Furht, "Encyclopaedia of Wireless and Mobile Communications - Three Volume Set", CRC Press, 2012.
2	Dick Caro, "Wireless Networks for Industrial Automation", 2014.

Reference Books / Web links:	
1	MMC-SD SERCOS Drive, "G&L Motion Control", Hardware Manual, 2005.
2	Olaf Pfeiffer, Andrew Ayre and Christian Keydel, "Embedded Networking with CAN andCANopen", Copperhill Technologies Corporation, 2016.
3	Richard Zurawski, "Industrial Communication Technology", CRC Press, 2017.
4	Siemens IK, "Industrial Ethernet: IEEE 802.3", 2005.
5	Wolfram Behardt and Jorg Wollert, "The wireless B: Evolution and Communication", Stetue Germany, 2016.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23E12.1	3	2	2	-	2	-	-	-	1	2	-	2	2	1	-
RO23E12.2	3	3	3	2	3	-	-	-	2	2	-	2	3	3	2
RO23E12.3	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23E12.4	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23E12.5	3	3	3	3	3	2	-	-	3	3	2	2	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

RO23E13	Condition Monitoring and Fault Diagnostics	PE	L	T	P	C
			3	0	0	3

Objectives:	
•	To Understand the basics of various condition monitoring methods.
•	To Identify the selection of condition monitoring sensors for various applications
•	To study various signal processing for condition monitoring applications
•	To Know about various failure analysis, maintenance and machine learning
•	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 monitoringsensors - Gas leakage monitoring - sensors Air pollution monitoring sensors - Liquid contamination monitoring sensors - Non-destructive testing techniques - Optical examination - Temperature sensing.		
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 – Breakdownanalysis - 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 Contact Hours : 45	

Course Outcomes: On completion of the course students will be able to	
•	Understand the basics of various condition monitoring methods.
•	Select suitable condition monitoring sensors for various applications.
•	Recall various signals processing for condition monitoring applications
•	Know about various failure analysis, maintenance and machine learning
•	Apply different fault diagnosis method for various applications.

SUGGESTED ACTIVITIES

- Industrial visit
- Mini Project

SUGGESTED EVALUATION METHODS

- Assignment topics
- Continuous Assessment Tests
- Continuous Assessment Tests

Text Books:	
1	R. Keith Mobley, "An Introduction to Predictive Maintenance," 2nd Edition, Butterworth-Heinemann, 2002.
2	M. J. Neale, "Condition Monitoring and Diagnostic Engineering Management," Wiley, 1996.

Reference Books / Web links:	
1	Robert Bond Randall, "Vibration-Based Condition Monitoring," Wiley, 2011.
2	J. Davidson, "Condition Monitoring of Mechanical Systems," Springer, 2012.
3	R. Collacott, "Mechanical Fault Diagnosis and Condition Monitoring," Chapman and Hall, 2014.
4	B. K. N. Rao, "Handbook of Condition Monitoring," Elsevier, 1996.
5	Amiya Ranjan Mohanty, "Machinery Condition Monitoring: Principles and Practices," CRC Press, 2015.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23E13.1	3	2	2	-	2	-	-	-	1	2	-	2	2	1	-
RO23E13.2	3	3	3	2	3	-	-	-	2	2	-	2	3	3	2
RO23E13.3	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23E13.4	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23E13.5	3	3	3	3	3	2	-	-	3	3	2	2	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

RO23E14	Applied Signal Processing	PE	L	T	P	C
			3	0	0	3

Objectives:	
•	To understand the characteristics of various types of signals.
•	To carry out the preprocessing of continuous time signals and systems.
•	To learn DTFT, FFT and Z-Transform methods in signals processing
•	To design digital IIR, FIR filters for signal processing
•	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 Contact Hours : 45	

Course Outcomes:	
On completion of the course students will be able to	
•	Understand the characteristics of various types of signals.
•	Analyze continuous time signals and systems
•	Understand DTFT, FFT and Z-Transform methods in signals processing
•	Design digital IIR, FIR filters for signal processing
•	Analyze and Apply various signal processors and its applications of signals.

SUGGESTED ACTIVITIES

- Industrial visit
- Mini Project

SUGGESTED EVALUATION METHODS

- Assignment topics
- Continuous Assessment Tests
- Continuous Assessment Tests

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

Reference Books / Web links:	
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.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23E14.1	3	2	2	-	2	-	-	-	1	2	-	2	2	1	-
RO23E14.2	3	3	3	2	3	-	-	-	2	2	-	2	3	3	2
RO23E14.3	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23E14.4	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23E14.5	3	3	3	3	3	2	-	-	3	3	2	2	3	3	3
Average															

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

RO19E15	Applied Image Processing	PE	L	T	P	C
			3	0	0	3

Objectives:	
•	To introduce various image processing and preprocessing techniques.
•	To learn about feature detection and matching using Image processing.
•	To learn about segmentation using Image processing techniques.
•	To learn about computational photography.
•	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 - 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		
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		
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**
Photometric calibration - Radiometric response function - Noise level estimation - Vignetting - Optical blur - High dynamic range imaging - Super resolution and blur removal - Color image demosaicing –application.		
	Total Contact Hours : 45	

Course Outcomes: On completion of the course students will 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

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, 2004.

Reference Books / Web links:	
1	Forsyth D A, Ponce J, “Computer Vision: A Modern Approach”, 2nd Edition Bostan 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 UniversityPress, New York, 2014

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23E15.1															
RO23E15.2															
RO23E15.3															
RO23E14.4															
RO23E11.5															
Average															

RO23E16	Total Integrated Automation	PE	L	T	P	C
			3	0	0	3

Objectives:	
•	To gain knowledge on automation in industries
•	To gain knowledge in various electrical and electronic programmable automations and theirapplications
•	To know about the basic in SCADA and DCS systems.
•	To gain knowledge in communication protocolsin an integrated system
•	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	**HMI SYSTEMS**	**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). Check with PLC 502 and remove		
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 – 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 Contact Hours : 45	

Course Outcomes: On completion of the course students will be able to	
•	Implement PLC & PAC in an automation system.
•	Develop HMI systems and integrate it with other systems.
•	Develop SCADA system and generate reports.
•	Acquire information‘s on communication protocols in automation systems.
•	Design and develop automatic control system using distributed control systems.

SUGGESTED ACTIVITIES

- Industrial visit
- Mini Project

SUGGESTED EVALUATION METHODS

- Assignment topics
- Continuous Assessment Tests
- Continuous Assessment Tests

Text Books:	
1	John.W.Webb & Ronald A. Reis, ―Programmable logic controllers: Principles and Applications , Prentice Hall India, 2003.
2	Michael P. Lukas, ―Distributed Control systems , ―Van Nostrand Reinfold Company 1995 .

Reference Books / Web links:	
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

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23E16.1	3	2	2	-	2	-	-	-	1	2	-	2	2	1	-
RO23E16.2	3	3	3	2	3	-	-	-	2	2	-	2	3	3	2
RO23E16.3	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23E16.4	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23E16.5	3	3	3	3	3	2	-	-	3	3	2	2	3	3	3
Average															

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

RO23E17	Advanced Optimization Techniques	PE	L	T	P	C
			3	0	0	3

Objectives:	
•	To understand the basics of Optimization
•	To know about constraints in optimization problems
•	To introduce the concept of Nonlinear programming
•	To learn about different nonlinear models.
•	To create awareness about advanced methods

UNIT-I	INTRODUCTION	9
Introduction, Historical Development, Engineering Applications of Optimization, Statement of an Optimization Problem, Design Vector, Design Constraints, Constraint Surface, Objective Function, Objective Function Surface, Classification of Optimization Problems, Classification Based- Existence of Constraints- Design Variables – Physical Structure of the Problem- Equations Involved- Permissible Values of the Design Variables- the Deterministic Nature of the Variables-the Separability of the Functions - Number of Objective Functions		
UNIT-II	**CLASSICAL OPTIMIZATION TECHNIQUES**	**9**
Introduction, Single-Variable Optimization, Multivariable Optimization with Constraints, Saddle Point, Multivariable Optimization with Equality Constraints, Solution by Direct Substitution, Solution by the Method of Constrained Variation, Solution by the Method of Lagrange Multipliers.		
UNIT-III	**NONLINEAR PROGRAMMING I**	**9**
Unrestricted Search, Search with Fixed Step Size, Search with Accelerated Step Size, Exhaustive Search, Dichotomous Search, Interval Halving Method, Fibonacci Method, Golden Section Method, Comparison of Elimination Methods. Direct Root Methods- Newton Method- Quasi-Newton Method - Secant Method.		
UNIT-IV	**NONLINEAR PROGRAMMING II**	**9**
Random Search Methods, Random Jumping Method, Random Walk Method, Random Walk Method with Direction Exploitation, Advantages of Random Search Methods, Grid Search Method, Univariate Method, Pattern Directions, Powell‘s Method.		
UNIT-V	**ADVANCED METHODS**	**9**
Zoutendijk‘s Method of Feasible Directions, Determination of Step Length, Rosen‘s Gradient Projection Method, Firefly Algorithm, Artificial Bee Colony (ABC) algorithm.		
	Total Contact Hours : 45	

Course Outcomes: On completion of the course students will be able to	
•	Differentiate between various Optimization models.
•	Apply suitable techniques for constrained and unconstrained models
•	Formulate and solve One-Dimensional Minimization Methods.
•	Understand the problem and Solve using Unconstrained Optimization Techniques.
•	Provide solution to complex models.

SUGGESTED ACTIVITIES

- Industrial visit
- Mini Project

SUGGESTED EVALUATION METHODS

- Assignment topics
- Continuous Assessment Tests
- Continuous Assessment Tests

Text Books:	
1.	Singiresu S.Rao, ―Engineering Optimization: Theory and Practice, New Age International Publishers,India, 2013
2.	Kalyanmoy Deb, ―Optimization for Engineering Design Algorithms and Examples, PHI Learning Private Limited, New Delhi,2012.

Reference Books / Web links:	
1	Bazara M.J., Jarvis and Sherali H., Linear Programming and Network Flows, John Wiley, 2009
2	Budnick F.S., Principles of Operations Research for Management, McGraw-Hill Inc., US, 1998
3	Philip D.T. and Ravindran A., Operations Research, John Wiley, 2007
4	Shennoy G.V. and Srivastava U.K., Operation Research for Management, New Age InternationalPublishers; India, 2018
5	Hillier and Libeberman, Operations Research, McGraw-Hill Higher Education, New York, 2010

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23E17.1	3	2	2	-	2	-	-	-	1	2	-	2	2	1	-
RO23E17.2	3	3	3	2	3	-	-	-	2	2	-	2	3	3	2
RO23E17.3	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23E17.4	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23E17.5	3	3	3	3	3	2	-	-	3	3	2	2	3	3	3
Average															

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

RO23F11	Basics of Thermal Engineering	PE	L	T	P	C
			3	0	0	3

Objectives:	
•	To introduce the fundamental concepts of thermodynamics and their application in engineering systems.
•	To familiarize students with the properties of gases and their behavior under various conditions.
•	To understand the basics of heat transfer modes and their practical applications.
•	To study thermodynamic cycles and their relevance to power generation.
•	To introduce the principles and applications of heat engines and refrigeration systems.

UNIT-I	FUNDAMENTALS OF THERMODYNAMICS	9
Basic Concepts: Systems, surroundings, and types of systems (open, closed, isolated). Properties of Matter: Intensive and extensive properties, state, process, and cycles. Laws of Thermodynamics: Zeroth and First Laws, energy conservation, and internal energy. Applications: Simple examples of energy conservation in engineering systems.		
UNIT-II	**PROPERTIES OF GASES AND GAS LAWS**	**9**
Properties of Ideal Gases: Pressure, temperature, and volume. Gas Laws: Boyle's Law, Charles's Law, and Ideal Gas Equation. Real Gases: Deviations from ideal behavior and basic introduction to real gas models. Applications: Calculating gas properties and understanding their role in thermal systems.		
UNIT-III	**HEAT TRANSFER BASICS**	**9**
Modes of Heat Transfer: Conduction, convection, and radiation. Thermal Conductivity: Concept and factors affecting conduction. Newton's Law of Cooling: Basics of convective heat transfer. Applications: Simple calculations for heat loss/gain in materials and fluids		
UNIT-IV	**THERMODYNAMIC CYCLES**	**9**
Introduction to Cycles: Carnot Cycle, Rankine Cycle, and their significance. Efficiency of Cycles: Basic concepts of thermal efficiency. Applications: Overview of practical cycles used in power generation (e.g., steam power plants).		
UNIT-V	**INTRODUCTION TO HEAT ENGINES AND REFRIGERATION**	**9**
Heat Engines: Working principles and examples (e.g., internal combustion engines). Refrigeration: Basics of refrigeration cycles, coefficient of performance (COP), and applications. Applications: Understanding household refrigeration and air conditioning systems.		
	Total Contact Hours : 45	

Course Outcomes:	
On completion of the course students will be able to	
•	Explain the fundamental concepts of thermodynamics, including systems, properties, and energy conservation principles.
•	Analyze the properties of gases and apply gas laws to calculate their behavior in thermal systems.
•	Demonstrate an understanding of heat transfer mechanisms and perform basic calculations related to heat exchange.
•	Describe thermodynamic cycles such as the Carnot and Rankine cycles and evaluate their efficiencies.
•	Understand the working principles of heat engines and refrigeration systems and their applications in daily life.

SUGGESTED ACTIVITIES

- Industrial visit
- Mini Project

SUGGESTED EVALUATION METHODS

- Assignment topics
- Continuous Assessment Tests
- Continuous Assessment Tests

Text Books:	
1	Cengel, Y. A., & Boles, M. A, "Thermodynamics: An Engineering Approach", McGraw-Hill Education, 9th Edition, 2019.
2	Nag, P. K., "Engineering Thermodynamics", Tata McGraw-Hill Education, 6th Edition, 2020.

Reference Books / Web links:	
1	Eastop, T. D., & McConkey, A.," Applied Thermodynamics for Engineering Technologists", Pearson Education, 1993
2	Sonntag, R. E., Borgnakke, C., & Van Wylen, G. J., "Fundamentals of Thermodynamics", Wiley.2016
3	Sukhatme, S. P., "A Textbook on Heat Transfer", University Press. 2005
4	Moran, M. J., & Shapiro, H. N., "Fundamentals of Engineering Thermodynamics", Wiley.2014
5	Incropera, F. P., DeWitt, D. P., Bergman, T. L., & Lavine, A. S. "Introduction to Heat Transfer", Wiley 2011

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23F11.1	3	2	1	2	1	1	-	-	-	-	-	1	3	2	-
RO23F11.2	3	3	2	2	-	-	-	-	-	-	-	1	2	3	-
RO23F11.3	3	2	2	3	-	-	-	-	-	-	-	1	2	3	-
RO23F11.4	3	3	3	2	-	-	-	-	-	-	-	2	3	2	1
RO23F11.5	3	2	2	3	-	-	2	-	-	-	-	2	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

RO23F12	Object Oriented Programming in C++	PE	L	T	P	C
			3	0	0	3

Objectives:	
•	To understand the basics in OOPS and control structures
•	To Know about the various functions in C++
•	To obtain the knowledge in Constructors and Deconstructors
•	To understand the concepts in pointers, virtual functions and polymorphism
•	To aware of the modelling and abstraction models

UNIT-I	INTRODUCTION TO OBJECT-ORIENTED PROGRAMMING IN C++	9
Fundamentals of C++ Programming: Basic syntax, data types, operators, control structures, and functions. Introduction to Object-Oriented Concepts: Classes, objects, encapsulation, and abstraction. Robotic Application: Writing a C++ program to create and manage basic robot sensor data using classes andobjects.		
UNIT-II	**CLASSES AND OBJECTS IN ROBOTICS**	**9**
Advanced Class Concepts: Constructors, destructors, member functions, and static members. Friend Functions and Inline Functions: Enhancing access and performance. Robotic Application: Developing a program to simulate a robotic arm, utilizing classes and objects to represent joints and links.		
UNIT-III	**INHERITANCE AND POLYMORPHISM FOR ROBOTIC SYSTEMS**	**9**
Inheritance: Single, multiple, and multilevel inheritance, along with access specifiers. Polymorphism: Function overloading, operator overloading, virtual functions, and dynamic polymorphism. Robotic Application: Implementing a robotic vehicle simulation with hierarchical classes for different vehicletypes, demonstrating polymorphic behavior for various navigation methods.		
UNIT-IV	**ENCAPSULATION AND DATA ABSTRACTION IN ROBOTICS CONTROL**	**9**
Encapsulation: Creating modular, secure code using private, protected, and public access. Data Abstraction: Interface classes and abstract classes. Robotic Application: Programming a C++ class to control a robotic sensor network, encapsulating dataacquisition and processing functions to simulate a multi-sensor environment.		
UNIT-V	**TEMPLATES, EXCEPTION HANDLING, AND FILE HANDLING IN ROBOTICS APPLICATIONS**	**9**
Templates: Function templates and class templates for generic programming. Exception Handling: Using try, catch, and throw to handle errors and exceptions in robotics applications.File Handling: Reading from and writing to files for data logging and configuration. Robotic Application: Designing a template-based C++ program for a robotic fleet management system,incorporating exception handling for robust operation and file handling for data logging.		
	Total Contact Hours : 45	

Course Outcomes: On completion of the course students will be able to	
•	Develop C++ programs using basic syntax, data types, control structures, and object-oriented concepts like classes and objects, demonstrating encapsulation and abstraction.
•	Design and implement advanced class-based solutions, including constructors, destructors, and member functions, to simulate robotic systems such as a robotic arm.
•	Apply inheritance and polymorphism concepts to build scalable and reusable class hierarchies, enabling dynamic behaviors for robotic vehicle simulations.
•	Create modular and secure C++ programs by encapsulating data and employing abstraction techniques to control and manage robotic sensor networks.
•	Develop robust and efficient robotics applications using templates for generic programming, exception handling for error management, and file handling for data storage and logging.

SUGGESTED ACTIVITIES

- Industrial visit
- Mini Project

SUGGESTED EVALUATION METHODS

- Assignment topics
- Continuous Assessment Tests
- Continuous Assessment Tests

Text Books:	
1	E. Balagurusamy, "Object-Oriented Programming with C++", 8th Edition, McGraw-Hill Education, 2021.
2	Bjarne Stroustrup, "The C++ Programming Language", 4th Edition, Addison-Wesley, 2013.

Reference Books / Web links:	
1	James Rumbaugh, "Object-Oriented Modeling and Design", Pearson, 1991.
2	Robert Lafore, "Object-Oriented Programming in Turbo C++", Galgotia Publications, 2004.
3	Herbert Schildt, "C++: The Complete Reference", 4th Edition, McGraw-Hill, 2003.
4	Stanley B. Lippman, Josée Lajoie, and Barbara E. Moo, "C++ Primer", 5th Edition, Addison-Wesley, 2012.
5	Paul Deitel and Harvey Deitel, "C++ How to Program", 10th Edition, Pearson, 2017.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23F12.1	3	3	2	2	1	-	-	-	-	-	-	1	3	2	-
RO23F12.2	2	2	3	2	2	2	-	1	-	1	-	1	3	3	-
RO23F12.3	3	3	3	3	2	-	-	3	-	-	-	1	3	3	-
RO23F12.4	2	2	2	3	2	-	-	-	2	3	2	3	2	2	-
RO23F12.5	2	1	2	1	1	-	-	-	3	3	3	3	2	2	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

RO23F13	Production and Operation Management	PE	L	T	P	C
			3	0	0	3

Objectives:	
•	Recognize and appreciate the concept of Production and Operations Management in creating and enhancing a firm's competitive advantages.
•	Describe the concept and contribution of various constituents of Production and Operations Management (both manufacturing and service) .
•	Relate the interdependence of the operations function with the other key functional areas of a firm.
•	Teach analytical skills and problem-solving tools to the analysis of the operations problems.
•	Apply scheduling and Lean Concepts for improving System Performance.

UNIT-I	**INTRODUCTION**	**9**
Objectives of Operations Management, Scope of Operations Management, Relationship of Operations with other Functional areas, Manufacturing Vs Service sector, Operations Decision making, Phases in Product Design and Development, Product Life Cycle, Process Selection.		
UNIT-II	**FORECASTING**	**9**
Need, Determinants of Demand, Demand Patterns, Qualitative Forecasting Methods-Delphi techniques. Market Research, Nominal Group Technique.Quantitative Forecasting methods – Moving Average Methods, Exponential Smoothing Methods, Regression methods, Monitoring and Control of Forecasts, Requirements and Selection of Good forecasting methods.		
UNIT-III	**AGGREGATE PLANNING AND MATERIAL REQUIREMENT PLANNING**	**9**
Role of aggregate Product planning, Managerial inputs to Aggregate planning, Pure and Mixed strategies, Mathematical Models for Aggregate planning – Transportation Method, Linear programming Formulation, Linear Decision Rues, Master Production Schedule(MPS), Procedure for developing MPS, MRP -Lot sizing methods – Implementation issues, MRP – II, Introduction to ERP.		
UNIT-IV	**CAPACITY MANAGEMENT**	**9**
Measures of capacity, Factors affecting capacity, Capacity Planning, Systematic approach to capacity planning, Long-term and short-term capacity decisions, Tools for capacity planning, Capacity Requirement Planning- Business Process Outsourcing		
UNIT-V	**PRODUCTION ACTIVITY CONTROL AND LEAN MANUFACTURING**	**9**
Objectives and Activities of Production Activity Control -JIT- Kanban- Introduction to Scheduling in different types of Production Systems. Lean Manufacturing - Principles – Activities - Tools and techniques - Case studies.		
	Total Contact Hours : 45	

Course Outcomes:	
On completion of the course students will be able to	
•	The students will appreciate the role of Production and Operations management in enabling and enhancing a firm's competitive advantages in the dynamic business environment
•	The students will obtain sufficient knowledge and skills to forecast demand for Production and Service Systems.
•	The students will able to Formulate and Assess Aggregate Planning strategies and Material Requirement Plan.
•	The students will be able to develop analytical skills to calculate capacity requirements and developing capacity alternatives
•	The students will be able to apply scheduling and Lean Concepts for improving System Performance

SUGGESTED ACTIVITIES

- Industrial visit
- Mini Project

SUGGESTED EVALUATION METHODS

- Assignment topics
- Continuous Assessment Tests
- Continuous Assessment Tests

TEXT BOOK:	
1	Panneerselvam. R, "Production and operations Management", PHI, 3rd Edition, 2012.
2	Krajewski, Lee J., Manoj K. Malhotra, and Larry P. Ritzman, "Operations Management: Processes and Supply Chains", Pearson Education, 12th Edition, 2018.

Reference Books / Web links:	
1	Lee J. Krajewski, Manoj K. Malhotra, Larry P. Ritzman, "Operations Management: Processes and Supply Chains", Pearson Education,11th Edition,2015
2	Norman Gaither, Greg Frazier, "Operations Management", Thomson Learning, 9th Edition, 2002.
3	William J Stevenson, "Operations Management", McGraw Hill, 13th Edition, 2018.
4	Chary S. N., "Production and Operations Management", McGraw Hill Education, 5th Edition, 2019.
5	Heizer, Jay, Barry Render, and Chuck Munson, "Operations Management: Sustainability and Supply Chain Management", Pearson Education, 13th Edition, 2020.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23F13.1	3	2	2	-	2	-	-	-	1	2	-	2	2	1	-
RO23F13.2	3	3	3	2	3	-	-	-	2	2	-	2	3	3	2
RO23F13.3	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23F13.4	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23F13.5	3	3	3	3	3	2	-	-	3	3	2	2	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

RO23F14	IoT Devices	PE	L	T	P	C
			3	0	0	3

Objectives:	
•	To understand the fundamental components and architectures of IoT systems and their applications in various industries.
•	To study various sensors and actuators used in IoT systems and their interfacing techniques.
•	To understand the communication protocols and networking fundamentals for IoT devices.
•	To familiarize students with IoT development platforms, programming environments, and device-to-cloud integration.
•	To explore the applications of IoT in various domains and understand emerging technologies and trends in IoT devices.

UNIT-I	INTRODUCTION TO IOT AND DEVICES	9
Overview of the Internet of Things (IoT) and its impact on various industries, Key components of IoT systems: devices, sensors, connectivity, and cloud,IoT architectures and protocols device classifications and applications in robotics and automation, Design considerations for IoT devices (power, size, connectivity, etc.)		
UNIT-II	**IOT SENSORS AND ACTUATORS**	**9**
Types of sensors used in IoT devices (temperature, pressure, humidity, proximity, etc.),Actuators and their role in IoT systems,Sensor interfacing and data acquisition techniques,Signal conditioning and processing for IoT devices,Wireless communication protocols for IoT sensors and actuators (e.g., Zigbee, Bluetooth, Wi-Fi, LoRa)		
UNIT-III	**IOT DEVICE COMMUNICATION AND NETWORKING**	**9**
Networking fundamentals for IoT (IP addressing, DNS, and routing),IoT communication protocols (MQTT, CoAP, HTTP, AMQP),Cloud and edge computing for IoT devices,Data transmission and storage in IoT networks,Security challenges in IoT device communication and best practices.		
UNIT-IV	**IOT DEVICE PROGRAMMING AND PLATFORMS**	**9**
Overview of popular IoT development platforms (Arduino, Raspberry Pi, ESP8266/ESP32),IoT device programming languages and environments (C/C++, Python, Node-RED),Device-to-cloud integration using cloud platforms (AWS IoT, Azure IoT, Google IoT Core),Data logging, visualization, and analysis for IoT applications, Developing a basic IoT device application: from sensor data collection to cloud visualization		
UNIT-V	**APPLICATIONS AND FUTURE TRENDS IN IOT DEVICES**	**9**
Case studies of IoT applications in robotics, automation, smart cities, and healthcare, Industrial IoT (IIoT) and its impact on manufacturing and supply chain, Emerging IoT technologies: 5G, LPWAN, and IoT Edge,IoT device security, privacy, and ethical considerations, Future trends: AI integration, predictive maintenance, and IoT-enabled autonomous systems		
	Total Contact Hours : 45	

Course Outcomes: On completion of the course students will be able to	
•	Explain the key components, architectures, and design considerations of IoT devices, emphasizing their applications in robotics and automation.
•	Analyze the types, roles, and interfacing methods of sensors and actuators in IoT systems, including wireless communication protocols.
•	Demonstrate knowledge of IoT communication protocols, cloud computing integration, and security practices in IoT networks.
•	Develop basic IoT applications using platforms like Arduino or Raspberry Pi, enabling sensor data collection, cloud visualization, and analysis.
•	Analyze IoT applications in robotics, smart cities, and healthcare, and evaluate emerging trends like AI integration and IoT-enabled autonomous systems.

SUGGESTED ACTIVITIES

- Industrial visit
- Mini Project

SUGGESTED EVALUATION METHODS

- Assignment topics
- Continuous Assessment Tests
- Continuous Assessment Tests

Text Books:	
1.	Bahga A., Madisetti V., "Internet of Things: A Hands-On Approach," University Press, 2015.
2.	Raj P., Raman A., "The Internet of Things: Enabling Technologies, Platforms, and Use Cases," CRC Press, 2017.

Reference Books / Web links:	
1	McEwen A., Cassimally H., "Designing the Internet of Things," Wiley, 2013.
2	Holler J., Tsiatsis V., Mulligan C., "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence," Academic Press, 2014.
3	Bellavista P., Cardone G., Corradi A., "The Internet of Things for Smart Cities: Technologies and Applications," Springer, 2017.
4	Z. Shelby, C. Bormann, "6LoWPAN: The Wireless Embedded Internet," Wiley, 2009.
5	Khan S., Anwar S., "Internet of Things: Concepts and System Design," Springer, 2019.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23F14.1	3	2	2	-	2	-	-	-	1	2	-	2	2	1	-
RO23F14.2	3	3	3	2	3	-	-	-	2	2	-	2	3	3	2
RO23F14.3	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23F14.4	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23F14.5	3	3	3	3	3	2	-	-	3	3	2	2	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

RO23F15	Project Management	PE	L	T	P	C
			3	0	0	3

Objectives:	
•	To familiarize the tasks of planning and implementation of the projects
•	To teach the concepts of project monitoring and control.
•	To impart knowledge on evaluation and selection of the most desirable projects
•	To provide knowledge on accounting the rate of return in the projects.
•	To learn the source of finance and capital structure.

UNIT-I	INTRODUCTION	9
Objectives of project management: Types of Projects: Project Management Life Cycle: Project Selection: Feasibility study: Estimation of Project Cost, Cost of Capital, Network analysis Techniques : PERT,CPM, Government regulations and statutory for various projects:		
UNIT-II	**PROJECT MONITORING AND CONTROL**	**9**
Project representation: Role of project Managers, relevance with objective of organization, preliminary Manipulations, Basic Scheduling concepts: Resource Leveling, Resource Allocation, Setting a base line, Project management information system: Importance of contracts in projects: Team work in Project Management: Formation of Effective terms.		
UNIT-III	**PROJECT EVALUATION**	**9**
Project Evaluation: Project auditing: Phase of project audit Project closure reports, computers, e-markets in Project Management:		
UNIT-IV	**WORKING CAPITAL MANAGEMENT AND CAPITAL BUDGETING**	**9**
Current assets management: Estimation of working capital requirements: Capital budgeting: Capital budgeting methods: Present value method: Accounting rate of return methods.		
UNIT-V	**FINANCE AND ACCOUNTING**	**9**
Source of finance: Term Loans: Capital Structure: Financial Institution Accounting Principles: Preparation and Interpretation of balance sheets, profit and loss statements , Fixed Assets, Current assets, Depreciation methods : Break even analysis:		
	Total Contact Hours :	**45**

Course Outcomes: On completion of the course students will be able to	
•	Analyze the current market trends and choose projects.
•	Control resource and allocate resources effectively.
•	Undertake project auditing and prepare reports.
•	Maintain assets and calculate the asset‘s revenue.
•	Arrange various sources of finance and Prepare balance sheets.

SUGGESTED ACTIVITIES

- Industrial visit
- Mini Project

SUGGESTED EVALUATION METHODS

- Assignment topics
- Continuous Assessment Tests
- Continuous Assessment Tests

Text Books:	
1.	Arun Kanda, ―Project Management A Life Cycle Approach, Prentice Hall of India, 2011.
2.	Palanivelu VR, ―Accounting for Management, Laxmi Publication (P) Ltd., 2007.

Reference Books / Web links:	
1	Panneerselvam R and Senthilkumar P, ―Project Management, Prentice Hall of India,2009.
2	Khanna R B, ―Project Management, Prentice Hall of India, 2011.
3	Bhattacharya. S.K. and John Deardon, ―Accounting for Management –Text and cases, Vikas publishing House, New Delhi, 1996.
4	James, Van Horne, ―Fundamental of Financial Management Pearson Education, 12th Edition, 2012
5	Prasanna Chandra, ―Financial Management, Tata McGraw-Hill,2008

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23F15.1	3	2	2	-	2	-	-	-	1	2	-	2	2	1	-
RO23F15.2	3	3	3	2	3	-	-	-	2	2	-	2	3	3	2
RO23F15.3	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23F15.4	3	3	3	3	3	2	-	-	2	3	-	3	3	3	3
RO23F15.5	3	3	3	3	3	2	-	-	3	3	2	2	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)