RAJALAKSHMI
ENGINEERING COLLEGE
An AUTONOMOUS Institution
Affiliated to ANNA UNIVERSITY, Chennai

DEPARTMENT OF MECHATRONICS ENGINEERING

B.E. MECHATRONICS ENGINEERING

CURRICULUM AND SYLLABUS – R2023
Choice Based Credit System

I Sem to VIII Sem

RAJALAKSHMI ENGINEERING COLLEGE
(An Autonomous Institution Affiliated to Anna University Chennai)
DEPARTMENT OF MECHATRONICS ENGINEERING
CURRICULUM AND SYLLABUS – R2023
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B.E. MECHATRONICS ENGINEERING

VISION:
To attain excellence in academics, research and technological advancement in Mechatronics Engineering with a concern for society.
MISSION:
- To impart high quality professional education and produce Mechatronics Engineers with all round knowledge of multi-disciplinary branches of engineering and technology.
- To foster skill sets required to be a global professional in the areas of automation, intelligent systems, robotics, research for technology management and to fulfill the expectations of industry and needs of the society.
- To inculcate entrepreneurial qualities for creating, developing and managing global engineering ventures.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):
PEO I: Graduates will have comprehensive knowledge in the analytical, scientific and engineering fundamentals necessary to model, analyse and solve engineering problems and to prepare them for graduate studies and for successful careers in industry.
PEO II: Graduates will effectively design and develop products in the areas such as automation, manufacturing, Internet of Things, machine vision, system simulation, intelligent systems and robotics.
PEO III: Graduates will acquire Technical expertise, Leadership skills, Ethical practices and Team spirit with 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and teamwork:** 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)
Engineering Graduates will be able:
PSO 1: To innovate a Mechatronics system to meet the requirements and specifications.
PSO 2: To analyze and improve the performance of a Mechatronics system and enhance the intellectual capabilities of the system
PSO 3: To lead professional career in industries or an entrepreneur by applying Engineering and Management principles and practices.

PEO / PO Mapping

PEO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
PEO I	3	3	2	2	2	1	1	-	2	1	1	1	3	2	2
PEO II	3	3	3	1	3	1	1	-	-	-	-	1	2	3	2
PEO III	-	-	-	-	-	3	3	3	3	2	2	2	2	2	3

CURRICULUM

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY COURSE								
1.	HS23111	Technical Communication I	HSM	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	GE23211	Engineering Mechanics	ES	3	2	1	0	3
5	GE23117	தமிழர்மரபு /Heritage of Tamils	MC	1	1	0	0	1
LAB ORIENTED THEORY COURSE								
6.	EE23132	Basic Electrical Engineering	ES	5	3	0	2	4
LABORATORY COURSE								
7.	GE23121	Engineering Practices – Civil and Mechanical	ES	2	0	0	2	1
8.	GE23122	Engineering Practices – Electrical and Electronics	ES	2	0	0	2	1
9.	MT23121	Computer Aided Drawing Laboratory	ES	2	0	0	2	1
MANDATORY COURSE								
10.	MC23112	Environmental Science and Engineering	MC	3	3	0	0	0
TOTAL				**30**	**16**	**2**	**12**	**21**

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
2	GE23217	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology	MC	1	1	0	0	1
LAB ORIENTED THEORY COURSE								
3.	CY23131	Chemistry for Electronics Engineering	BS	5	3	0	2	4
4.	PH23131	Physics of Materials	BS	5	3	0	2	4
5	GE23131	Programming Using C	ES	7	1	0	6	4
6.	MT23131	Elements of Mechatronics	ES	4	2	0	2	3
LABORATORY COURSE								
7.	HS23221 / HS23222	Technical Communication II / English for Professional Competence	HSM	2	0	0	2	1
MANDATORY COURSE								
8.	MC23111	Indian Constitution and Freedom Movement	MC	3	3	0	0	0
TOTAL				**31**	**16**	**1**	**14**	**21**

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
LAB ORIENTED THEORY COURSE								
2.	MT23331	Analog Devices and Drives	PC	4	2	0	2	3
3	MT23332	Digital System Design	PC	4	2	0	2	3
4	MT23333	Manufacturing Technology	PC	5	3	0	2	4
5	MT23334	Mechanics of Solids	PC	5	3	0	2	4
6.	CS23336	Introduction to Python Programming	ES	5	1	0	4	3
TOTAL				**27**	**14**	**1**	**12**	**21**

SEMESTER IV

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY COURSE								
1	MT23411	Fluid Mechanics and Thermal Sciences	PC	4	4	0	0	4
2		Open Elective - I	OE	3	3	0	0	3
LAB ORIENTED THEORY COURSE								
3.	MA23432	Statistics and Numerical Methods	BS	5	3	0	2	4
4.	MT23431	Microcontrollers and Embedded Systems	PC	5	3	0	2	4
5.	MT23432	Sensors and Instrumentation	PC	5	3	0	2	4
6.	MT23433	System Dynamics and Control	PC	5	3	0	2	4
LABORATORY COURSE								
7.	MT23421	Fluid Mechanics and Heat Transfer Laboratory	PC	2	0	0	2	1
8	GE23421	Soft skills – I	EEC	2	0	0	2	1
TOTAL				**31**	**19**	**0**	**12**	**25**

SEMESTER V

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY COURSE								
1	GE23311	Fundamentals of Management for Engineers	HSM	3	3	0	0	3
2	MT23511	Semiconductor Manufacturing	PC	3	3	0	0	3
3	MT23512	Industrial Electronics	PC	3	2	1	0	3
4	MT23513	Basic Engineering Research Methods	PC	3	3	0	0	3
5		Open Elective - II	OE	3	3	0	0	3
6	MT23PXX	Professional Elective -I	PE	3	3	0	0	3
LABORATORY COURSE								
7	CS23422	Python Programming for Machine Learning	ES	4	0	0	4	2
8	MT23522	Industrial Electronics Laboratory	PC	2	0	0	2	1
9	MT23523	Internship	EEC	2 weeks	0	0	2	1
10	GE23521	Soft Skills – II	EEC	2	0	0	2	1
TOTAL				**28**	**17**	**1**	**10**	**23**

SEMESTER VI

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY COURSE								
1	MT23611	Fundamentals of Machine Design	PC	3	2	1	0	3
2	MT23612	Ethics in Robotics and Artificial Intelligence	PC	3	3	0	0	3
3	MT23PXX	Professional Elective -II	PE	3	3	0	0	3
LAB ORIENTED THEORY COURSE								
4	MT23631	Industrial Robotics	PC	5	2	1	2	4
5	MT23632	Applied Hydraulics and Pneumatics	PC	5	2	1	2	4
LABORATORY COURSE								
6	GE23621	Problem Solving Techniques	EEC	2	0	0	2	1
7	GE23627	Design Thinking and Innovation	EEC	4	0	0	4	2
TOTAL				**25**	**12**	**3**	**10**	**20**

SEMESTER VII

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY COURSE								
1	MT23PXX	Professional Elective - III	PE	3	3	0	0	3
2	MT23PXX	Professional Elective - IV	PE	3	3	0	0	3
3	MT23711	Industrial Automation	PC	3	2	1	0	3
4	MT23712	Machine Vision	PC	4	3	1	0	4
LABORATORY COURSE								
5	MT23721	Computer Aided Engineering Laboratory	PC	2	0	0	2	1
6	MT23722	Industrial Automation Laboratory	PC	2	0	0	2	1
7	MT23723	Mechatronics Engineering Problem Solving Using AI, ML and DL	PC	4	-	-	4	2
8	MT23724	Project Work Phase I	EEC	4	-	-	4	2
TOTAL				**25**	**11**	**2**	**12**	**19**

SEMESTER VIII

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY COURSE								
1	MT23PXX	Professional Elective - V	PE	3	3	0	0	3
2	MT23PXX	Professional Elective - VI	PE	3	3	0	0	3
PRACTICAL COURSE								
3	MT23821	Project Work Phase II	EEC	16	-	-	16	8
TOTAL				**22**	**6**	**0**	**16**	**14**

TOTAL NO. OF CREDITS: 164

ELECTIVE COURSES LIST (VERTICALS)								
Category		**Vertical A**	**Vertical B**	**Vertical C**	**Vertical D**	**Vertical E**	**Vertical F**	**Vertical G**
Offered In	**Professional Elective**	**Computational Engineering**	**Logistics and Supply Chain Management**	**Mechanical & Industrial**	**Electronics & Electrical**	**Robotics & Automation**	**Diversified**	**Diversified**
Sem V	PE I	ME23A11 Machine Learning for Intelligent Systems	ME23B11 Reliability and Maintenance Engineering	AT23D11 Advanced Automotive Materials	EE23D11 Analysis of Electrical Machines	RO23C14 Collaborative Robotics	CS23A31 Business Analytics	MT23G11 Social Innovation in Industry 4.0
		ME23A12 CAD and CAE	ME23B12 Warehousing Automation	MT23C11 Technology Management	MT23D11 Neural Networks and Fuzzy Systems		CD23C22 Data Visualization	EC23E18 Industry 4.0 and IIoT
Sem VI	PE II	ME23A13 Numerical Heat Transfer	ME23B13 Operations Management	ME23611 Additive Manufacturing Technologies	MT23D12 Virtual Instrumentation	ME23C11 Drone Technologies	CS23A33 Cyber Security and Forensics	MT23G12 New Spinning Technologies
		ME23A14 Theory on Computation and Visualization	ME23B14 Material Handling Equipment, Repair and Maintenance				MT23F11 Enterprise resource Planning	AT23D18 Vehicle Control Systems
Sem VII	PE III	ME23A15 Computational Bio-Mechanics	ME23B15 Container Logistics	MT23C12 Work System Design and Ergonomics	EE23C11 High Voltage Direct Current Transmission	MT23E11 Medical Robotics	ME23F14 Hybrid and Electrical Vehicles	MT23G13 Fundamentals of Digital Twin
		ME23A16 Advanced Statistics and Data Analytics	ME23B16 Production Planning and Control	MT23C13 Theory of Metal Cutting	MT23D13 Intelligent Control Systems	MT23E12 Mechatronics System Design	MT23F12 Smart Hospitality Management	MT23G14 Research Paper Writing and Research Funding
	PE IV	ME23A17 Noise Acoustics and Vibrations	ME23B17 Operations Research	MT23C14 Theory of Metal Forming	ME23C18 Haptics and Immersive Technologies	MT23E13 Underwater Robotics	MT23F13 Introduction to Large Language Models	ME23D11 Product Design and Development
				MT23C15 Lean Manufacturing and Six Sigma	MT23D14 Battery Management System	MT23E14 Wireless Networks for Industrial Automation	MT23F14 Computer Vision and Deep Learning	MT23G16 Smart Industrial Wastewater Treatment
Sem VIII	PE V	ME23A18 Computational Solid Mechanics	ME23B18 Supply Chain and Logistics Management	MT23C16 Advanced Welding Technologies	EE23A14 Energy Storage Systems	MT23E15 Agricultural Robotics	MT23F15 Internet Tools and Java Programming	EC23E13 BioMEMS
	PE VI	ME23A19 Computational Fluid Dynamics	ME23B19 Data Science	ME23E19 Non-Destructive Testing and Evaluation	MT23D15 VLSI and FPGA	MT23E16 CNC Technology	MT23F16 Introduction to Database Systems	MT23G16 Environmental Impact Assessment
						MT23E17 Automotive Mechatronics	AI23632 Natural Language Processing	ME23G16 Entrepreneurship Development

SUMMARY

DEPARTMENT OF MECHATRONICS ENGINEERING											
S. No.	**Subject Area**	**Credits Per Semester**								**Credits Total**	**Percentage %**
	Semester	I	II	III	IV	V	VI	VII	VIII		
1	Humanities, Social Studies and Management Science (HSM)	3	2	0	0	3	0	0	0	8	4.88%
2	Basic Sciences (BS)	4	12	4	4	0	0	0	0	24	14.63%
3	Engineering Sciences (ES)	14	7	3	0	2	0	0	0	26	15.85%
4	Professional Core (PC)	0	0	14	17	10	14	11	0	66	40.24%
5	Professional Electives (PE)	0	0	0	0	3	3	6	6	18	10.98%
6	Open Electives (OE)	0	0	0	3	3	0	0	0	6	3.66%
7	Project Work/ Employability Enhancement Course (PR/EEC)	0	0	0	1	2	3	2	8	16	9.76%
	TOTAL	21	21	21	25	23	20	19	14	164	
8.	Non-Credit*/ (Mandatory)	√	√	–	-	-	-	-	-		

SEMESTER I

HS23111	TECHNICAL COMMUNICATION I	Category	L	T	P	C
	Common to all branches of B.E/B. Tech programs	HSM	2	0	0	2

Objectives: The course shall
Facilitate students develop their comprehension skills
Enable students to improve their receptive skills
Equip learners with better vocabulary and enhance their writing skills
Aid students speak effectively in all kinds of communicative contexts.
Improve the learners' basic proficiency in workplace communication

UNIT-I	**DEVELOPING COMPREHENSION SKILLS**	**06**
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**	06
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**	**06**
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**	**06**
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:** Checklist, Instructions. **Grammar:** 'Wh' Questions / 'Yes' or 'No' Questions, Imperatives **Vocabulary:** Synonyms, Antonyms, Different forms of the same words.		
UNIT-V	**LANGUAGE FOR WORKPLACE**	**06**
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	
CO1	Apply their comprehension skills and interpret different contents effortlessly
CO2	Read and comprehend various texts and audio visual contents
CO3	Infer data from graphs and charts and communicate it efficiently in varied contexts
CO4	Participate effectively in diverse speaking situations
CO5:	Present, discuss and coordinate with their peers in workplace using their language skills

Textbook(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	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
Average	**-**	**1**	**-**	**1.2**	**-**	**-**	**-**	**-**	**1**	**3**	**-**	**-**	**-**	**-**	**1**

MA23112	ALGEBRA AND CALCULUS	Category	L	T	P	C
	Common to I Sem. B.E. – AERO, AUTO, MECH, MCT, R&A, CIVIL, BIOTECH, FOOD TECH. AND CHEM	BS	3	1	0	4

Objectives: The course shall
● Provide knowledge in using matrix algebra techniques and the concepts of rank and nature of the matrix.
● Provide understanding of the techniques by numerical way of solving matrix Problems.
● Provide understanding of the techniques of analyzing the data and apply the concept of correlation and regression in real life problems.
● Provide the understanding of the techniques of calculus those are applied in the Engineering problems.
● Provide the understanding of the techniques of Integration those are applied 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	**STATISTICS**	**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 $y = ax^2 + bx + c$.		
UNIT-III	**FUNCTIONS OF SEVERAL VARIABLES**	**12**
Partialdifferentiation–Totalderivative–Changeofvariables–Jacobians–Partialdifferentiationofimplicitfunctions–Taylor'sseriesforfunctionsoftwovariables–Maximaandminimaoffunctionsoftwovariables–Lagrange's method of undetermined multipliers.		
UNIT-IV	**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-V	**MULTIPLE INTEGRAL**	**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.		
		Total Contact Hours: 60

Course Outcomes: On completion of the course students will be able to:	
CO1	Apply the concept of Eigenvalues and eigenvectors, diagonalization of a matrix for solving problems and numerical way of solving matrix problems
CO2	Apply the concept of analysis of data, correlation and regression in real life situation.
CO3	Analyse, sketch and study the properties of different curves and to handle functions of several variables and problems of maxima and minima.
CO4	Evaluate area and volume using single integration and numerical integration
CO5	Evaluate surface area and volume using multiple integrals.

Textbook(s):		
1	1.	Grewal B.S., " Higher Engineering Mathematics ", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2	2.	T Veerarajan ,Fundamentals of Mathematical Statistics , yesdee publications, 2017.
3	3.	T Veerarajan, Engineering Mathematics –I , Mc Graw Hill Education, 2018.

Reference Books(s) / Web links:

1	Ramana. B.V., " Higher Engineering Mathematics ", McGraw Hill Education Pvt.Ltd, New Delhi, 2016.
2	Gupta S.C. and Kapoor V.K."Fundamentals of Mathematical Statistics", Sultan and Sons.
3	Erwin Kreyszig ," Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2016.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MA23112.1	3	2	1	-	-	-	-	-	-	-	1	-	-	-	-
MA23112.2	3	2	-	1	-	-	-	-	-	-	1	1	1	-	-
MA23112.3	2	2	-	-	-	-	-	-	-	-	1	1	-	-	-
MA23112.4	3	3	1	-	-	-	-	-	-	-	1	1	-	-	-
MA23112.5	2	2	-	-	-	-	-	-	-	-	-	-	1	-	-
Average	2.6	2.2	1	1	-	-	-	-	-	-	1	1	1	-	-

GE23111	ENGINEERING GRAPHICS	Category	L	T	P	C
	Common to I sem. B.E. – Aeronautical Engineering, Automobile Engineering, Civil Engineering, Mechanical Engineering, Mechatronics & Robotics and Automation	ES	2	0	4	4

Objectives: The course shall	
●	Teach the importance of drawing in engineering applications.
●	Develop students' graphic skills for the communication of concepts, ideas, and the design of engineering products.
●	Expose students to existing national standards related to technical drawings.
●	Improve students' visualization skills to enable the development of new products.
●	Enhance students' technical communication skills through the use of communicative drawings.

CONCEPTS AND CONVENTIONS (Not for Examination)		**01**
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 :	**90**

Textbook(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", Dhanalakshmi Publishers, Chennai, 2017.

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

Course Outcomes: On completion of the course students will be able to	
CO1	Construct different plane curves and to comprehend the theory of projection
CO2	Draw the basic views related to projection of lines and planes
CO3	Draw the projection of simple solids and to draw the projection of development of surfaces of Sectioned solids in simple vertical position
CO4	Draw the orthographic projection from pictorial objects and Isometric projections of simple solids
CO5	Visualize Perspective view of simple solids

CO/PO	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	-	1	1
GE23111.2	3	2	2	1	-	1	-	2	2	2	-	2	-	1	1
GE23111.3	3	2	2	1	2	1	-	2	2	2	-	2	-	1	1
GE23111.4	3	2	2	1	-	1	-	2	2	2	-	2	-	1	1
GE23111.5	3	2	2	1	-	1	-	2	2	2	-	2	-	1	1
Average	**3**	**2**	**2**	**1**	**2**	**1**	**-**	**2**	**2**	**2**	**-**	**2**	**-**	**1**	**1**

GE23211	ENGINEERING MECHANICS	Category	L	T	P	C
	Common to I Sem BE- AERO, AUTO, MECH, MCT, R&A, CIVIL , BIOTECH, FOOD TECH. AND CHEM	ES	2	1	0	3

Objectives: The course shall	
●	Provide a thorough understanding of the basics of mechanics and apply the concept of equilibrium of system of forces.
●	Provide a thorough understanding of the concept of equilibrium and to solve problems of rigid bodies.
●	Teach about the centroid and center of gravity of objects and moment of inertia
●	Introduce the basic concepts of friction.
●	Teach the concepts in kinematics and kinetics of rigid bodies in plane motion.

UNIT-I	**STATICS OF PARTICLES**	**09**
Introduction – Units and Dimensions – Laws of Mechanics – Lami's theorem, Parallelogram and triangular Law of forces – Resolution of forces – Vector operations of forces - Coplanar Forces – rectangular components – Equilibrium of a particle – Forces in space – Equilibrium of a particle in space – Equivalent systems of forces – Principle of transmissibility.		
UNIT-II	**EQUILIBRIUM OF RIGID BODIES**	**09**
Free body diagram – Types of supports –Action and reaction forces –stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis – Vectorial representation of moments and couples – Scalar components of a moment – Varignon's theorem – Single equivalent force - Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in two and three dimensions (classroom lecture only) – (Descriptive treatment only)		

UNIT-III	**PROPERTIES OF SURFACES AND SOLIDS**	**12**
Centroids - First moment of area – Second moment of area and centre of mass – Centroids of lines and areas - Rectangular, circular, triangular areas by integration – T section, I section, Angle section, Hollow section by using standard formula –Theorems of Pappus - Area moments of inertia of plane areas – Rectangular, circular, triangular areas by integration – T section, I section, Angle section, Hollow section by using standard formula – Parallel axis theorem and perpendicular axis theorem – Principal moments of inertia of plane areas – Principal axes of inertia-Mass moment of inertia –mass moment of inertia for prismatic, cylindrical and spherical solids from first principle – Relation to area moments of inertia.		
UNIT-IV	**DYNAMICS OF PARTICLES**	**07**
Displacements, Velocity and acceleration, their relationship – Relative motion – Curvilinear motion - Newton's laws of motion – Work Energy Equation– Impulse and Momentum – Impact of elastic bodies.		
UNIT-V	**FRICTION AND RIGID BODY DYNAMICS**	**08**
Friction force – Laws of sliding friction - Characteristics of dry friction – equilibrium analysis of simple systems with sliding friction –wedge friction, Ladder friction, Rolling resistance -Translation and Rotation of Rigid Bodies – Velocity and acceleration – General Plane motion of simple rigid bodies such as cylinder, disc/wheel and sphere.		
	Total Contact Hours :	**45**

Textbook(s):	
1	Beer, F.P and Johnston Jr. E.R, Cornwell and Sanghi ., "Vector Mechanics for Engineers (In SI Units): Statics and Dynamics", 12th Edition, McGraw-Hill Publishing company, New Delhi (2018).
2	Rajasekaran S and Sankarasubramanian G., "Engineering Mechanics Statics and Dynamics", 3rd Edition, Vikas Publishing House Pvt. Ltd., 2005.

Reference Books(s) / Web links:	
1	Meriam J.L. and Kraige L.G., "Engineering Mechanics- Statics - Volume 1, Dynamics- Volume 2", 7th Edition, Wiley India, 2018.

2	Hibbeller, R.C and Ashok Gupta, “Engineering Mechanics: Statics and Dynamics”, 14th Edition, Pearson Education 2017.
3	Irving H. Shames and Krishna Mohana Rao. G., “Engineering Mechanics – Statics and Dynamics” 4th Edition,
4	Pearson Education 2006.
5	Bhavikatti S S, Engineering Mechanics, New Age International Publishers, 2016
6	Vela Murali, “Engineering Mechanics”, Oxford University Press 2010

Course Outcomes: On completion of the course students will be able to	
CO1	Analyze the forces in the system and to understand vectorial and scalar representation of forces and moments
CO2	Study about the rigid body in equilibrium and to analyze the problems in engineering systems using the concept of static equilibrium
CO3	Determine the properties of surfaces and solids by means of finding centroid, centre of gravity and moment of inertia.
CO4	Solve problems involving kinematics and kinetics of rigid bodies in plane motion.
CO5	Solve problems involving frictional phenomena in machines by understanding the concept of friction and the effects by the laws of friction

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
GE23211.1	3	3	1	2	-	-	1	-	2	1	3	2	3	-	1
GE23211.2	3	3	1	2	-	-	1	-	2	1	3	2	3	-	1
GE23211.3	3	3	1	2	-	-	1	-	1	1	3	2	3	-	1
GE23211.4	3	3	1	2	-	-	1	-	3	1	3	2	3	-	1
GE23211.5	3	3	1	2	-	-	1	-	3	1	3	2	3	-	1
Average	**3**	**3**	**1**	**2**	-	-	**1**	-	**2**	**1**	**3**	**2**	**3**	-	**1**

GE23117	**தமிழர் மரபு / Heritage of Tamils**	**Category**	**L**	**T**	**P**	**C**
		MC	**1**	**0**	**0**	**1**

அலகு I	**மொழி மற்றும் இலக்கியம்**	**03**
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**	**03**
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**	**03**
தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்		
அலகு IV	**தமிழர்களின் திணைக் கோட்பாடுகள்**	**03**
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**	**03**
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	

Course Outcomes: After the successful completion of the course, the student will be able to:	
CO1	Analyze the properties and behavior of fluids in motion and at rest.
CO2	Apply the principles of fluid mechanics to solve basic engineering problems.

CO3	Design and analyze simple thermal systems including heat exchangers.
CO4	Evaluate the performance of fluid and thermal systems using theoretical methods.
CO5	Utilize computational tools to simulate fluid flow and thermal processes.

Text-cum-Reference Books	
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. Subramanian, 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 Textbook and Educational Services Corporation, Tamil Nadu)
12	Journey of Civilization Indus to Vaigai (R. Balakrishnan) (Published by: RMRL) – Reference Book.

EE23132	**BASIC ELECTRICAL ENGINEERING**	**Category**	**L**	**T**	**P**	**C**
		ES	3	0	2	4

Objectives: The course shall:	
●	Provide knowledge on the analysis of DC circuits.
●	Teach methods of analysis of AC circuits.
●	Impart knowledge on principles of operation of electrical machines.
●	Teach the basics of electrical safety measures.
●	Provide hands on experience on electric circuits and machines

UNIT-I	**DC CIRCUITS**	**09**
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**	**09**
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**	**09**
Construction, working and characteristics of DC motors. Construction, principle of operation of single-phase Transformer, EMF Equation.		
UNIT-IV	**AC ROTATING MACHINES**	**09**
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**	**09**
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		
	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: After the successful completion of the course, the student will be able to:	
CO1	Analyse DC circuits and apply circuit theorems.
CO2	Calculate the power and power factor in AC circuits
CO3	Comprehend the principles of electrical machines.
CO4	Realise the electrical safety precautions.
CO5	Experimentally analyze the electric circuits and machines.

Textbook (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 Caddick, 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 McGrawHill, Indian. 5th Edison , 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	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
EE2313.1	3	3	3	3	-	3	1	1	2	1	1	1	1	2	-
EE2313.2	3	3	3	3	-	3	1	1	2	1	1	1	1	2	-
EE2313.3	3	3	3	3	-	3	1	1	2	1	1	1	1	2	-
EE2313.4	3	3	3	3	-	3	1	1	2	1	1	1	1	2	-
EE2313.4	3	3	3	3	-	3	3	1	2	1	1	1	1	2	-
Average	3	3	3	3	-	3	1.4	1	2	1	1	1	1	2	-

GE23121	**ENGINEERING PRACTICES – CIVIL AND MECHANICAL**	**Category**	**L**	**T**	**P**	**C**
		ES	0	0	2	1

Objectives: The course shall:	
•	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.
4. Carpentry Work:

a. Study of joints in roofs, doors, windows and furniture.

b. Hands-on-exercise: Woodwork, joints by sawing, planning and chiseling.

MECHANICAL ENGINEERING PRACTICE

5. Preparation of butt joints, lap joints and T- joints by Shielded metal arc welding.
6. Gas welding practice.
7. Basic Machining:

a. Simple Turning and Taper turning

b. Drilling Practice

8. Sheet Metal Work:

a. Forming & Bending:

b. Model making – Trays and funnels

c. Different types of joints.

9. Machine Assembly Practice:

a. Study of centrifugal pump

b. Study of air conditioner

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

Course Outcomes: After the successful completion of the course, the student will be able to:	
CO1	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.
CO2	Perform wood working carpentry activities like sawing, planning, cutting, etc. while having clear understanding of the joints in roofs, doors, windows and furniture.
CO3	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
CO4	Perform operations like Turning, Step turning, Taper turning, etc. in lathe and Drilling operation in drilling machine
CO5	Perform sheet metal operations like Forming, Bending, etc. and fabricating models like Trays, funnels, etc.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
GE23121.1	1	1	1	-	-	2	1	-	2	-	-	2	-	2	1
GE23121.2	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
GE23121.3	2	1	-	2	-	-	2	-	2	1	-	-	-	-	-
GE23121.4	1	1	1	-	-	2	1	-	2	-	-	2	-	2	1
GE23121.5	1	1	1	-	-	2	1	-	2	-	-	2	-	2	1
Average	**1.2**	**1**	**1**	**2**	**-**	**2**	**1.25**	**-**	**2**	**1**	**-**	**2**	**-**	**2**	**1**

GE23122	ENGINEERING PRACTICES - ELECTRICAL AND ELECTRONICS	Category	L	T	P	C
		ES	0	0	2	1

Objectives: The course shall:	
●	Provide hands-on experience on various basic engineering practices in Electrical Engineering.
●	Impart hands-on experience on various basic engineering practices in Electronics Engineering.

List of Experiments

ELECTRICAL ENGINEERING PRACTICE

1. Residential house wiring using switches, fuse, indicator, 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 resistance to earth of electrical equipment.
6. Study of Ceiling Fan and Iron Box

ELECTRONICS ENGINEERING PRACTICE

1. Study of electronic components and equipment's – Resistor, colour coding, measurement of AC signal parameter (peak-peak, rms period, frequency) using CRO.
2. Study of Multimeter
3. Testing of electronic components.
4. Study of logic gates AND, OR, EXOR and NOT.
5. Generation of Clock Signals.
6. Soldering practice – Components Devices and Circuits – Using general purpose PCB.
7. Measurement of ripple factor of HWR and FWR.

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

Course Outcomes: After the successful completion of the course, the student will be able to:	
CO1	Fabricate the electrical circuits
CO2	Construct the house wiring circuits
CO3	Fabricate the electronic circuits
CO4	Verify the truth table of logic gates
CO5	Design the AC-DC converter using diodes and passive components

Reference Books(s) / Web links:

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.

CO/PO	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
GE23122.2	3	3	2	2	-	-	2	-	3	2	-	3	-	-	1
GE23122.3	3	3	3	2	-	-	2	-	3	2	-	3	-	-	1
GE23122.4	3	3	3	2	-	-	-	-	3	2	-	3	-	-	1
GE23122.5	3	3	3	2	-	-	-	-	3	2	-	3	-	-	1
Average	**3**	**3**	**3**	**2**	**-**	**-**	**2**	**-**	**3**	**2**	**-**	**3**	**-**	**-**	**1**

MT23121	COMPUTER AIDED DRAWING LABORATORY	Category	L	T	P	C
		PC	0	0	2	1

Objectives: The course shall:	
●	To introduce the students the Indian standard code of practice for engineering drawing and general 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.	Projection of points and lines.		
2.	Projection of planes.		
3.	Projection of Solids I		
4.	Projection of Solids II		
5.	Development of lateral surfaces		
6.	2D assembly drawing of mechanical screw jack.		
7.	2D assembly drawing of plummer block.		
8.	Reverse engineering an assembly in CAD.		
	Total Contact Hours	**:**	**30**

Course Outcomes: After the successful completion of the course, the student will be able to:	
CO1	Develop engineering drawing and dimensioning for the industrial component using Indian Standard code of practice.
CO2	Implement Geometric Dimensioning & Tolerancing principles in production drawing.
CO3	Use CAD software for drafting machine components.
CO4	Recognize various working principles of different machine elements.
CO5	Develop 2D and 3D models of the component using manual/software.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	-	-	3	-	-	-	-	2	-	2	2	1	1
CO2	1	1	-	-	3	-	-	-	-	2	-	2	2	1	1
CO3	1	1	-	-	3	-	-	-	-	2	-	2	2	1	1
CO4	1	1	-	-	3	-	-	-	-	2	-	2	2	1	1
CO5	1	1	-	-	3	-	-	-	-	2	-	2	2	1	1
Average	**1**	**1**	**-**	**-**	**3**	**-**	**-**	**-**	**-**	**2**	**-**	**2**	**2**	**1**	**1**

MC23112	ENVIRONMENTAL SCIENCE AND ENGINEERING	Category	L	T	P	C
		MC	3	0	0	0

Objectives: The course shall:	
●	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 develop skills to solve environmental degradation issues

UNIT-I	AIR AND NOISE POLLUTION	09
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**	**09**

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-wastewater recycling and zero liquid discharge		
UNIT-III	**SOLID WASTE AND HAZARDOUS WASTE MANAGEMENT**	**09**
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: Treatment Methods – neutralization, oxidation reduction, precipitation, solidification, stabilization, incineration and final disposal E-waste-definition-sources-effects on human health and environment- E-waste management- recovery of metals-Role of E-waste management within the initiatives of the Govt. of India- Swachh Bharat Mission-soil contamination and leaching of contaminants into groundwater		
UNIT-IV	**SUSTAINABLE DEVELOPMENT**	**09**
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: Treatment Methods – neutralization, oxidation reduction, precipitation, solidification, stabilization, incineration and final disposal E-waste-definition-sources-effects on human health and environment- E-waste management- recovery of metals-Role of E-waste management within the initiatives of the Govt. of India- Swachh Bharat Mission-soil contamination and leaching of contaminants into groundwater		
UNIT-V	**ENVIRONMENTAL MANAGEMENT AND LEGISLATION**	**09**
Environmental Management systems - ISO 14000 series- Environmental audit-Environmental Impact Assessment- Life cycle assessment- Human health risk assessment-Environmental Law and Policy- Objectives; Polluter pays principle, Precautionary principle; The Water and Air Acts with amendments-The Environment (Protection) Act (EPA) 1986; Role of Information technology in environment and human health.		
	Total Contact Hours : 45	

Course Outcomes: After the successful completion of the course, the student will be able to:	
CO1	Associate air and noise quality standards with environment and human health.
CO2	Illustrate the significance of water and devise control measures for water pollution.
CO3	Analyze solid wastes and hazardous wastes.
CO4	Outline the goals of sustainable development in an integrated perspective.
CO5	Comprehend the significance of environmental laws.

Textbook (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 Publishers ,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 – 1 st Edition (Toxicology and Public Health Issues), 2017Elsevier
4	https://onlinecourses.nptel.ac.in/noc19_ge22/
5	NPTEL
6	https://news.mit.edu/2013/ewaste-mit

CO/PO	**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	-	-	-
MC23112.3	-	-	3	1	-	2	3	2	1	-	1	2	-	-	-
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
Average	**1**			**1**	**1**			**2**	**1**			**2**	**-**	**1**	**1**

SEMESTER II

MA23212	DIFFERENTIAL EQUATIONS AND COMPLEX VARIABLES	Category	L	T	P	C
	Common to II Sem. B.E. –AERO, AUTO, BME, CIVIL, EEE, ECE, MECH, MCT, R&A	BS	3	1	0	4

Objectives: The course shall:	
•	Provide students with an introduction to the theory of ordinary differential equations through applications, methods of solution, and numerical approximations.
•	Introduce students to how to solve linear Partial Differential with different methods.
•	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.
•	Explain the concept of a vector integration in a plane and in space.
•	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: After the successful completion of the course, the student will be able to:	
CO1	Apply the methods as a potent tool in the solution of a variety of problems in the natural sciences and technology.
CO2	Develop specific methodologies, techniques and resources in Partial differential equations to conduct research and produce innovative results in the area of specialization.
CO3	Use Laplace transform and inverse transform techniques to solve the complex problems in engineering and technology.
CO4	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.
CO5	Demonstrate the concept of Analytic functions, conformal mapping and complex integration in solving Engineering problems.

Textbook (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,
4	2016.
5	Glyn James, "Advanced Modern Engineering Mathematics", Pearson Education, 4th Edition, New Delhi,

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	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	-	-	-	-	-	-	-	-	-	-	-	-
MA23212.4	2	2	1	-	-	-	-	-	-	-	-	-	-	-	-
MA23212.5	3	2	1	-	-	-	-	-	-	-	-	1	-	-	-
Average		**2**	**1**	-	-	-	-	-	-	-	-	**1**	**1**	-	-

GE23217	**தமிழரும் தொழில்நுட்பமும் / Tamils and Technology**	**Category**	**L**	**T**	**P**	**C**
		MC	**1**	**0**	**0**	**1**

அலகு I	**தெசவு மற்றும் பொனைத் ததொழில்நுட்பம்**	**03**
சங்க காலத்தில் நெசவுத் நதாழில் - பானைத் நதாழில்நுட்பம் - கருப்பு சிவப்பு பாண்டங்கள் - பண்டங்களில் கீறல் குறியீடுகள்.		
அலகு II	**வடிவனமப்பு மற்றும் கட்டிடத் ததொழில்நுட்பம்**	**03**
சங்க காலத்தில் வடிவனமப்பு மற்றும் கட்டுமாைங்கள் & சங்க காலத்தில் வீட்டுப்நபாருட்களில் வடிவனமப்பு - சங்க காலத்தில் கட்டுமாை நபாருட்களும் ெடுகல்லும் - சிலப்பதிகாரத்தில் மமனட அனமப்பு பற்றிய விவரங்கள் - மாமல்லபுரச் சிற்பங்களும், மகாவில்களும் - மசாழர் காலத்துப் நபருங்மகாயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் - ெ்ாயக்கர் காலக் மகாயில்கள் - மாதிரி கட்டனமப்புகள் பற்றி அறிதல், மதுனர மீை்ாட்சி அம்மை ஆலயம் மற்றும் திருமனல ெ்ாயக்கர் மஹால் - நசட்டிெ்ாடு வீடுகள் - பிரிட்டிஷ் காலத்தில் நசன்னையில் இெமதா - சாமராநசிக் கட்டிடக் கனல.		
அலகு III	**உற்பத்தித் ததொழில் நுட்பம்**	**03**
கப்பல் கட்டும் கனல - உமலாகவியல் - இரும்புத் நதாழிற்சானல - இரும்னப உருக்குதல், எஃகு - வரலாற்றுச் சாை்றுகளாக நசம்பு மற்றும் தங்க ெ்ாணயங்கள் - ெ்ாணயங்கள் அச்சடித்தல் - மணி உருவாக்கும் நதாழிற்சானலகள் - கல்மணிகள், கண்ணாடி மணிகள் - சுடுமண் மணிகள் - சங்கு மணிகள் - எலும்புத்துண்டுகள் - நதால்லியல் சாை்றுகள் - சிலப்பதிகாரத்தில் மணிகளிை் வனகைள்.		
அலகு IV	**வவளொண்ணம மற்றும் ெ்ீர்ப்பொசைத் ததொழில் நுட்பம்**	**03**
அனண, ஏரி, குளங்கள், மதகு - மசாழர்காலக் குமுழித் தூம்பிை் முக்கியத்துவம் - கால்ெனட பராமரிப்பு - கல்ெனடகளுக்காக வடிவனமக்கப்பட்ட கிணறுகள் - மவளாண்ணம மற்றும் மவளாண்ணமச் சார்ை்த நசயல்பாடுகள் - கடல்சார் அறிவு - மீை்வளம் - முத்து மற்றும் முத்துக்குளித்தல் - நபருங்கடல் குறித்த பண்னடய அறிவு - அறிவுசார் சமூகம்.		
அலகு V	**அறிவியல் தமிழ் மற்றும் கணித்தமிழ்**	**03**
அறிவியல் தமிழிை் வளர்ச்சி - கணித்தமிழ் வளர்ச்சி - தமிழ் நூல்கனள மிை்பதிப்பு நசய்தல் - தமிழ் நமைநபாருட்கள் உருவாக்கம் - தமிழ் இனணயக் கல்விக்கழகம் - தமிழ் மிை் நூலகம் - இனணயத்தில் தமிழ் அகராதிகள் - நசாற்குனவத் திட்டம்.		
	Total Contact Hours :	**15**

Textbook (s):	
1	தமிழக வரலாறு - மக்களும் பண்பாடும் - மக.மக. பிள்னள (நவளியீடு: தமிழ்ெ்ாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2	கணிமை்ித் தமிழ் - முனைவர் இல. சுெ்தரம். (விகடைட் பிரசுரம்).
3	கீழடி - னவனக ெ்திக்கனரயில் சங்ககால ெ்கர ெ்ாகரிகம் (நதால்லியல் துனற நவளியீடு)
4	நபாருனை - ஆற்றங்கனர ெ்ாகரிகம். (நதால்லியல் துனற நவளியீடு)
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)
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.

CY23131	CHEMISTRY FOR ELECTRONICS ENGINEERING	Category	L	T	P	C
	Common to B.E. – ECE, BME, EEE, MCT and R&A	BS	3	0	2	4

Objectives: The course shall:	
●	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 batteries of and fuel cells
●	To acquire knowledge on polymeric materials used in electronics
●	To develop proficiency in nanomaterials

UNIT-I	**DYNAMIC ELECTROCHEMISTRY**	**09**
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**	**09**
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 CO2, O2 and NH3 sensing- blood oxygen sensor.		
UNIT-III	**ELECTROCHEMICAL ENERGY SYSTEMS**	**09**
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**	**09**
Conducting polymers - conducting 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**	**09**
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.		
	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

Contact Hours	**:**	**30**
Total Contact Hours	**:**	**75**

Course Outcomes: After the successful completion of the course, the student will be able to:	
CO1	Apply the knowledge of electrochemistry in exploring electrochemical processes.
CO2	Associate the knowledge of sensors in health care and in pollution abatement
CO3	Recognize the types of batteries and fuel cells
CO4	Employ advanced materials in industrial applications and display techniques
CO5	Develop nano and biomaterials for medical applications

Textbook (s):	
1	P. C. Jain and Monika Jain, “Engineering Chemistry”, Dhanpat Rai 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	AN INTRODUCTION TO NANOMATERIALS AND NANOSCIENCE (PB 2020) : Asim K DAS, Mahua Das, CBS publishers and distributors Pvt. Ltd.
5	NPTEL course Elementary Electrochemistry course url **https://onlinecourses.nptel.ac.in/noc23_cy19/preview**
6	For downloading text/reference books the weblink is given below can be used **http://libgen.rs/**

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CY23131. 1	2	2	1	-	-	-	-	-	-	-	-	1	-	1	1
CY23131.2	3	2	1	-	-	1	1	-	-	-	-	1	-	1	1
CY23131.3	2	1	1	-	-	-	-	-	-	-	-	-	-	-	1
CY23131.4	2	1	1	-	-	-	-	-	-	-	-	1	-	-	1
CY23131.5	3	2	2	-	-	-	-	-	-	-	-	1	-	-	1
Average	**2.4**	**1.6**	**1.2**	**-**	**-**	**1`**	**1**	**-**	**-**	**-**	**-**	**1**	**-**	**1**	**1**

PH23131	PHYSICS OF MATERIALS	Category	L	T	P	C
	Common to I sem. B.E. - AERO, AUTO, CIVIL, MECH, MCT AND R&A	BS	3	0	2	4

Objectives: The course shall:	
●	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	09
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	**CRYSTAL PHYSICS**	**09**
Basis – lattices – unit cell-crystal systems – Bravais lattices –number of atoms, atomic radius, co-ordination number and packing fraction - SC, BCC, FCC, HCP lattices –diamond structure - polymorphism and allotropy-graphite structure - Miller indices – determination of d-space-crystal growth techniques-solution growth –melt growth- Czochralski and Bridgmann- crystal defects.		
UNIT-III	**PHASE DIAGRAMS**	**09**
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	**ADVANCED MATERIALS & TESTING**	**09**
Metallic glasses – preparation, properties and applications - Ceramics – types, manufacturing methods and properties –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-hydrothermal method- properties-applications - Tensile strength – Hardness – Fatigue - Impact strength – Creep - Fracture – types of fracture.		
UNIT-V	**THERMAL PHYSICS**	**09**
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.		
	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 and rigidity modulus of a wire by Torsional pendulum.
3.	Determination of Young’s modulus of given beam by cantilever method
4.	Determination of Velocity of ultrasound and compressibility of given liquid – Ultrasonic interferometer
5.	Find the wavelength of Laser and particle size of given powder.
6.	Study the Hysteresis loss of ferromagnetic material by B-H curve experiment

7.	Determination of Thermal conductivity of a bad conductor – Lee's Disc method.
8.	Study the solar cell parameters.
9.	Find the thickness of a given thin wire – Air wedge method
10.	Determination of viscosity of the given liquid using Poiseuille's method.

	Contact Hours	**:**	**30**
	Total Contact Hours	**:**	**75**

Course Outcomes: After the successful completion of the course, the student will be able to:	
CO1	Apply the elastic nature of materials and determine the elastic moduli of different materials.
CO2	Apply the basic knowledge of crystal structure in solids.
CO3	Analyse and measure the properties of alloys.
CO4	Analyse various material testing methods and use them in suitable applications.
CO5	Understand the concepts of heat transfer in various applications.

Textbook (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	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
PH23131.1	3	3	2	-	-	-	-	-	-	-	-	-	1	1	1
PH23131.2	3	2	1	-	-	-	-	-	-	-	-	-	-	1	-
PH23131.3	3	3	2	-	-	-	-	-	-	-	-	1	1	1	-
PH23131.4	3	2	2	-	-	-	-	-	-	-	-	1	1	1	1
PH23131.5	3	3	2	-	-	-	-	-	-	-	-	1	1	-	-
Average	**2.4**	**1.6**	**1.2**	**-**	**-**	**1`**	**1**	**-**	**-**	**-**	**-**	**1**	**-**	**1**	**1**

GE23131	**PROGRAMMING USING C**	**Category**	**L**	**T**	**P**	**C**
		ES	**1**	**0**	**6**	**4**

Objectives: The course shall make student able:	
●	To develop simple algorithms for arithmetic and logical problems.
●	To develop C Programs using basic programming constructs
●	To develop C programs using arrays and strings
●	To develop applications in C using functions , pointers and structures
●	To develop applications using structures and union

List of Experiments	
1.	Overview of C, Constants, Variables and Data Types
2.	Operators and Expressions, Managing Input and Output Operations
3.	Decision Making and Branching
4.	Decision Making and Looping
5.	Nested Loops - while and for, Jumps in Loops
6.	One-Dimensional Arrays
7.	Pointers
8.	Searching Algorithms - Linear and Binary
9.	Sorting Algorithms - Bubble and Selection
10.	Two-Dimensional and Multi-dimensional Arrays
11.	Character Arrays and Strings Handling Functions
12.	User-Defined Functions - Recursive Functions
13.	Passing Arrays and Strings to Functions
14.	Scope, Visibility and Lifetime of Variables
15.	Structures and Unions
16.	The Preprocessor
Platform Needed: GCC Compiler for Windows/Linux	

	Total Contact Hours	**:**	**105**

Course Outcomes: After the successful completion of the course, the student will be able to:	
CO1	To formulate simple algorithms for arithmetic and logical problems.
CO2	To implement conditional branching, iteration.
CO3	To decompose a problem into functions and synthesize a complete program.
CO4	To use arrays, pointers and structures to formulate algorithms and programs.
CO5	To apply programming to solve simple numerical method problems.

Textbook (s):	
1	Brian W. Kernighan and Dennis M. Ritchie, "The C Programming Language", Second Edition, PHI
2	Byron Gottfried, "Programming in C", Second Edition, Schaum Outline Series

Reference Books(s) / Web links:	
1	Herbert Schildt, "C: The Complete Reference", Fourth Edition, McGraw Hill.
2	Yashavant Kanetkar, "Let Us C", BPB Publications
3	E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill
4	NPTEL course , "Problem Solving Through Programming In C", By Prof. Anupam Basu, IIT Kharagpur

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
GE23131.1	2	2	2	2	1	-	-	-	1	1	1	1	3	3	-
GE23131.2	2	1	1	1	1	-	-	-	-	-	1	1	3	2	-
GE23131.3	1	1	2	1	2	-	-	-	-	-	1	1	2	3	2
GE23131.4	2	2	3	2	2	-	-	-	-	-	2	1	2	2	2
GE23131.5	2	2	3	2	3	-	-	-	-	-	2	1	2	2	2
Average															

MT23131	**ELEMENTS OF MECHATRONICS**	**Category**	**L**	**T**	**P**	**C**
		ES	**2**	**0**	**2**	**3**

Objectives: The course shall:	
●	Understand the fundamental knowledge of various elements of automation.
●	Understand the need for automation in process industries.
●	Impart basic knowledge of sensors and actuators
●	Teach the fundamental knowledge of hydraulic and pneumatic system
●	Provide a clear view on Programmable Logic Controllers (PLC) and its application

UNIT-I	**INTRODUCTION TO AUTOMATION**	**06**
Automated manufacturing systems - fixed /programmable /flexible automation - Need of automation, Basic elements of automated systems- power, program and control. Levels of automation; control systems: Continuous and discrete control; Low-cost automation, Economic and social aspects of automation.		
UNIT-II	**SENSORS AND TRANSDUCERS**	**06**
Introduction to sensors and transducers - Static and dynamic characteristics-Types - Displacement, position and proximity. Velocity and motion - force - fluid pressure - liquid flow and level - Temperature - Light - Selection of sensors.		
UNIT-III	**BASICS OF PNEUMATICS AND HYDRAULICS SYSTEM**	**06**
Operational principles and application, air compressors, Pneumatic cylinders and air motors, Pneumatic valves. Principles of hydraulics, Hydraulic fluids, Hydraulic- pumps, valves, and actuators.		
UNIT-IV	**MECHANICAL AND ELECTRICAL ACTUATION SYSTEMS**	**06**
Mechanical actuation System: Mechanical system - types of motion - Kinematic chain - cams - Gear Trains Belt and chain drives Mechanical aspects of Motor selection. Electrical actuation system: Stepper motor, Servo motor, Solenoid switches		
UNIT-V	**PROGRAMMABLE LOGIC CONTROLLER**	**06**
Introduction - Basic structure - Input/output processing – programming. Timers and counters - Analogue input/output - Selection of PLC - Simple problems		
	Contact Hours **:**	**30**

List of Experiments	
1.	Displacement measurement using potentiometer and LVDT and plotting the characteristic curves.
2.	Study of Characteristics and calibration of strain gauge and Load Cell
3.	Temperature measurement using Thermocouple, Thermistor and RTD and comparing the characteristics.
4.	Speed control of DC motor.
5.	Study of various types of transducers.

6. Study of hydraulic, pneumatic and electro-pneumatic circuits. **7.** Study of PLC and its applications.			
	Contact Hours	**:**	**30**
	Total Contact Hours	**:**	**60**

Course Outcomes: After the successful completion of the course, the student will be able to:	
CO1	Understand the fundamentals of automation system.
CO2	Classify and infer various types of sensors and transducers
CO3	Demonstrate various applications of hydraulic and pneumatic systems.
CO4	Illustrate the operations of mechanical and electrical actuation systems.
CO5	Acquire basic knowledge on PLC for various applications.

Textbook (s):	
1	Bolton W., Mechatronics: electronic control systems in mechanical and electrical engineering, Pearson Education (Singapore) Pvt. Ltd., New Delhi, 2013
2	Anthony Esposito, "Fluid Power with applications", Prentice Hall international, 2009.
3	Mikell P Groover, "Automation Production Systems and Computer- Integrated Manufacturing" Pearson Education, New Delhi, 2008.

Reference Books(s) / Web links:	
1	Kuo .B.C, "Automatic control systems", Prentice Hall India, New Delhi, 2007.
2	Bagad V. S., Mechatronics, Technical Publication, Pune, 2009.
3	Devdas Shetty and Richard A. Kolk, Mechatronics System Design, Cengage Delmar Learning India Pvt Learning, 2012.

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
MT23131.1	3	3	3	2	-	3	-	-	2	1	1	1	2	3	1
MT23131.2	3	3	3	2	-	3	-	-	2	1	1	1	2	3	1
MT23131.3	3	3	3	2	-	3	-	-	2	1	1	1	2	3	1
MT23131.4	3	3	3	2	-	3	-	-	2	1	1	1	2	3	1
MT23131.5	3	3	3	2	3	3	-	-	2	1	1	1	2	3	1
Average															

HS23221	**TECHNICAL COMMUNICATION II**	**Category**	**L**	**T**	**P**	**C**
		HSM	**0**	**0**	**2**	**1**

Objectives: The course shall be able	
●	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**	**06**
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**	**06**
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**	**06**
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	06
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**	**09**
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: After the successful completion of the course, the student will be able to:	
CO1	Communicate effectively using appropriate vocabulary
CO2	Use the acquired language skills to comprehend various types of language contents
CO3	Evaluate different texts and write effective technical content
CO4	Use appropriate sentence structures to convey their thoughts in varied contexts
CO5	Present their concepts and ideas in an effective manner

Textbook (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 Chen Meng 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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
HS23221. 1	-	-	-	1	-	-	-	-	-	2	-	-	-	-	-
HS23221. 2	-	-	-	1	-	-	-	-	-	3	-	-	-	-	-
HS23221. 3	-	2	-	1	-	-	-	-	-	3	-	-	-	-	-
HS23221. 4	-	-	-	1	-	-	-	-	2	3	-	-	-	-	-
HS23221. 5	-	-	-	1	-	-	-	-	2	2	-	-	-	-	-
Average		**2**		**1**					**2**	**2.6**					

HS23222	ENGLISH FOR PROFESSIONAL COMPETENCE	Category	L	T	P	C
	Common to all branches of B.E/B. Tech programs –Second Semester	**HS**	**0**	**0**	**2**	**1**

Objectives: The course shall:	
●	Facilitate the learners in acquiring listening and reading competence
●	Enable the learners to communicate effectively through written and oral medium
●	Assist the learners in preparing for competitive examinations
●	Train the students in acquiring corporate skills
●	Inculcate professional standards among the students and make them realize their responsibility in addressing the challenges

UNIT-I	RECEPTIVE SKILLS	06
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**	**06**
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**	**06**

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**	**06**
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**	**06**
Case Study based on the challenges faced by the employers and the employees – Devise Plan, Provide Solution		
	Total Contact Hours : 30	

Course Outcomes: After the successful completion of the course, the student will be able to:	
CO1	Interpret and respond appropriately in the listening and reading contexts.
CO2	Express themselves effectively in spoken and written communication
CO3	Apply their acquired language skills in writing the competitive examinations
CO4	Exhibit their professional skills in their work place
CO5	Identify the challenges in the work place and suggest strategies solutions

Textbook (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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
HS23222. 1	-	1	-	-	-	-	-	-	-	3	-	-	-	-	-
HS23222. 2	-	1	-	-	-	-	-	-	-	3	-	-	-	-	-
HS23222. 3	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-
HS23222. 4	-	-	-	-	-	-	2	2	-	3	-	-	-	-	-
HS23222. 5	-	-	1	-	-	-	2	-	-	3	-	-	-	-	-
Average	-	1	1	-	-	-	2	2	-	3	-	-	-	-	-

MC23111	**INDIAN CONSTITUTION AND FREEDOM MOVEMENT**	**Category**	**L**	**T**	**P**	**C**
	Common to all branches of B.E/B. Tech Programs – First / Second/third Semester	**MC**	**3**	**0**	**0**	**0**

Objectives: The course shall enable student:	
●	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 familiarize about the functions of the various levels of Government.
●	To be informed about Constitutional and Non- Constitutional bodies.

UNIT-I	**INDIAN FREEDOM MOVEMENT**	**09**
British Colonialism in India-Colonial administration till 1857- Revolt of 1857- Early Resistance to British Rule-Rise of Nationalism in India-I**ndian 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**	**09**
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**	**09**
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**	**09**

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, Panchayat Raj: Introduction, Elected officials and their roles, Village level: Role of Elected and Appointed officials.			
UNIT-V	**CONSTITUTIONAL FUNCTIONS AND BODIES**		**09**
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: After the successful completion of the course, the student will be able to:	
CO1	Appreciate the sacrifices made by freedom fighters during freedom movement.
CO2	Be responsible citizens and abide by the rules of the Indian constitution.
CO3	Be aware of the functions of the Indian government.
CO4	Be knowledgeable about the functions of the state Government and the Local bodies.
CO5	Apply the knowledge on constitutional functions and role of constitutional bodies and non-constitutional bodies.

Textbook (s):	
1	M. Laxmikanth , "Indian Polity:, McGraw-Hill, New Delhi.
2	Durga Das Basu, "Introduction to the Constitution of India ", Lexis Nexis, New Delhi. 21sted 2013.
3	P K Agarwal and K N Chaturvedi ,PrabhatPrakashan, New Delhi, 1sted , 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, Jalaendhar
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.2nded, 2014.
5	Bipan Chandra, History of Modern India, Orient Black Swan, 2009.

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

SEMESTER III

MA23311	TRANSFORMS AND APPLIED PARTIAL DIFFERENTIAL EQUATIONS	Category	L	T	P	C
	Common to B.E. Mechatronics, Robotics and Automation, Chemical, Biotech and Food technology	BS	3	1	0	4

Objectives: The course shall enable student to:	
●	To express Fourier series to study the behavior 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: One 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: After the successful completion of the course, the student will be able to:	
CO1	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.
CO2	Apply the shifting theorems, Fourier integral theorems, Inverse Fourier sine and cosine transforms appropriate problems in engineering and technology.
CO3	Evaluate solution of one-dimensional wave equation arising in various field of engineering using finite difference techniques.
CO4	Apply the numerical techniques of differentiation to solution of heat flow equations arising in various branches of engineering.
CO5	Use Z-transform to illustrate discrete function arising in wave and heat propagation, signals and systems.

Textbook (s):	
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(s) / 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.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MA23311.1	3	3	-	-	-	-	-	-	-	-	-	-	2	1	2
MA23311.2	3	3	-	-	-	-	-	-	-	-	-	-	2	1	2
MA23311.3	3	3	-	-	-	-	-	-	-	-	-	-	1	2	2
MA23311.4	3	3	-	-	-	-	-	-	-	-	-	-	1	-	1
MA23311.5	3	3	-	-	-	-	-	-	-	-	-	-	1	1	-
Average	**3**	**3**	-	-	-	-	-	-	-	-	-	-	**1.4**	**1.3**	**2**

MT23331	ANALOG DEVICES AND DRIVES	Category	L	T	P	C
		PC	2	0	2	3

Objectives: The course shall enable student:	
●	To analyze diodes, BJT, FET, and MOSFET operation.
●	To study the characteristics, design and implementation of basic op-amp applications.
●	To design different waveform generating circuits
●	To develop analytical skills in DC and Stepper motor drives
●	To inculcate knowledge on Induction and Servo Motor Drives

UNIT-I	DIODES, TRANSISTORS AND IC FABRICATION	06
PN junction diode, Zener Diode, Schottky Diode, Tunnel Diode, Varactor Diode– structure, operation and V-I characteristics. BJT Characteristics and Configurations, MOSFET – operation, Characteristics. Fundamentals of monolithic IC technology and fabrication.		
UNIT - II	**OP-AMP CHARACTERISTICS AND APPLICATIONS**	**06**
Ideal op-amp characteristics – DC, AC characteristics. Inverting and Non-inverting Amplifiers – Voltage follower – Summing amplifier – Difference amplifier – Differentiator – Integrator- Instrumentation amplifier–log and antilog amplifier- Low-pass, high-pass and band-pass Butterworth filters.		
UNIT-III	**OSCILLATORS AND WAVEFORM GENERATORS**	**06**
Multivibrators – monostable, bistable. Oscillators – Hartley, Colpits, - Crystal Oscillator-555 Timer: Monostable and Astable		
UNIT-IV	**DC AND STEPPER MOTOR DRIVES**	**06**
DC Motors, PMDC, BLDC motors and Servomotors – Types, Principle of Operation –-DC and BLDC Driver Circuits. H Bridge Circuits – 4 Quadrant Operation. Stepper Motor: Constructional Features – Principle of Operation – Types Stepper Motors – Position and Director Control - Drive Circuits		
UNIT-V	**INDUCTION AND SERVO MOTORS AND DRIVES**	**06**
AC Permanent Magnet Synchronous Servo Motors – Linear Electrical Motors – VFD Drives – AC Servo Drives - Modern Servo Drives – Overview of Motion Control		
	Contact Hours : 30	

List of Experiments:

1. Characteristics of CB, CE, CC Configurations
2. Measurement of Operational Amplifier parameter: - Common mode gain, difference mode gain, CMRR, slew rate.
3. Realization of types of Amplifiers using IC 741.
4. Characteristics curve of Instrumentation Amplifier
5. Design and develop types of filters using simulation tool.
6. Design and Testing of Multi Vibrators
7. Design and Testing of Astable using NE555 Timer
8. Design and Testing of Monostable multivibrators using NE555 Timer

Contact Hours	**:**	**30**
Total Contact Hours	**:**	**60**

Course Outcomes: After the successful completion of the course, the student will be able to:	
CO1	Understand diode and transistor fundamentals, IC technology, and fabrication.
CO2	Apply ideal op-amp characteristics to design and analyze various amplifier circuits.
CO3	Develop waveform generator circuits for simple applications
CO4	Implement advanced control strategies for DC and stepper motor drives, demonstrating proficiency in both theoretical understanding and practical application.
CO5	Use the appropriate motors for based on the specific requirements

Textbook (s):	
1	D. Roy Choudhary, Sheilb.Jani, ―Linear Integrated Circuits‖, fifth edition, New Age, 2018.
2	Ramakant A.Gayakwad, ―Op-amps and Linear Integrated Circuits, fourth edition, Pearson Education, 2015.
3	Mehta V.K. & Rohit Mehta, "Principles of Electrical Machines", 2nd Edition, S. Chand& Co. Ltd., New Delhi, 2016.

Reference Books(s) / Web links:	
1	Rashid, ―Microelectronic Circuits Analysis and design: Cengage learning,3rd edition 2017.
2	Fiore, ―Op Amps & Linear Integrated Circuits Concepts & Applications, Cengage publications, 2018.
3	Floyd, Buchla, ―Fundamentals of Analog Circuits, Pearson, 2002.
4	Jacob Millman, Christos C.Halkias, ―Integrated Electronics – Analog and Digital circuits system, Tata McGraw Hill, 2010.
5	Theraja B.L. & Theraja A.K., "A Text Book of Electrical Technology", 2nd Edition, S.Chand & Co. Ltd., New Delhi, 2012.
6	Gobal K. Dubey, "Fundamentals of Electrical Drives", 2nd Edition, Narosal Publishing House, New Delhi, 2005.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT23331.1	3	2	1	-	-	-	-	-	1	1	-	-	2	1	-
MT23331.2	3	2	1	1	1	-	-	-	1	1	-	-	2	1	-
MT23331.3	1	2	3	2	1	-	-	-	1	1	-	-	1	2	1
MT23331.4	1	2	3	-	-	-	-	-	1	1	-	-	2	1	-
MT23331.5	1	2	3	-	-	-	-	-	1	1	-	-	1	2	-
Average	**1.8**	**2**	**2.2**	**1.5**	**1**	**-**	**-**	**-**	**1**	**1**	**-**	**-**	**1.6**	**1.4**	**1**

MT23332	DIGITAL SYSTEM DESIGN	Category	L	T	P	C
		PC	2	0	2	3

Objectives: The course shall enable student:	
●	To introduce basic postulates and minimization techniques of Boolean expressions
●	To outline the formal procedures for the analysis and design of combinational circuits
●	To outline the formal procedures for the analysis and design of sequential circuits
●	To illustrate the basic concept of Verilog Hardware Descriptive Language
●	To introduce the modeling concepts of Verilog HDL

UNIT-I	**LOGIC GATES AND MINIMIZATION TECHNIQUES**	**06**
Logic circuits using gates – Boolean Postulates and Laws – Minimization of Boolean expressions – SOP, POS – Karnaugh map Minimization – Don't Care Conditions – Quine-McCuskey Method of Minimization.		
UNIT-II	**DESIGN OF COMBINATIONAL CIRCUITS**	**06**
Adder, Subtractor, Carry Look Ahead Adder, BCD Adder – Encoder, Decoder – Multiplexer, Demultiplexer – Code Converter.		
UNIT-III	**DESIGN OF SEQUENTIAL CIRCUITS**	**07**
Introduction to Flip-Flops and its types – Realization of one Flip-Flop using other Flip-Flop – Registers and its types – Synchronous and Asynchronous Counters.		
UNIT-IV	**INTRODUCTION TO VERILOG HDL**	**05**
Verilog as HDL, Levels of Design Description, Concurrency, Simulation and Synthesis, Programming Language Interface, Module. Language Constructs and Conventions: Introduction, Keywords, Identifiers, White Space, Characters, Comments, Numbers, Strings, Logic Values, Data Types, Scalars and Vectors, Operators.		
UNIT-V	**MODELING IN VERILOG HDL**	**06**
Introduction to Gate level modeling - AND Gate Primitive, Module Structure, Other Gate Primitives, Design of Flip flops with Gate primitive. Introduction to Behavioral modeling - Operations and Assignments – Functional Bifurcation – Initial Construct – Always Construct – if AND if-else Construct – For Loop – While Loop – Forever Loop – Exercise.		
	Total Contact Hours : 30	

List of Experiments:

1. Verification of logic gates and flip flops.
2. Design and Implement 4-bit Parallel Adder / Subtractor using IC 7483.
3. Realize 3-variable function 8:1 Mux using IC 74151and Realize 1:8 Demux and 3:8 Decoder using IC 74138.
4. Conversion of Binary to Gray Code.
5. Conversion on BCD to Excess – 3 Code.
6. Verification of Flip Flops.
7. Design a Mod N Synchronous Counter using Simulation tool.
8. Design a Mod N Asynchronous Counter using Simulation tool.
9. Realization of Digital circuits using HDL – Combinational circuits.
10. Realization of Digital circuits using HDL – Sequential circuits.

Contact Hours	**:**	**30**
Total Contact Hours	**:**	**60**

Course Outcomes: After the successful completion of the course, the student will be able to:	
CO1	Perform minimization techniques on Boolean expressions.
CO2	Design and develop Combinational Logic Circuit for the given requirement.
CO3	Design and develop sequential logic circuits for simple applications.
CO4	Explain the basic concepts of Verilog HDL.
CO5	Compare and Analyze different modeling in Verilog HDL.

Textbook (s):

1	Morris Mano M., "Digital Design: With an Introduction to the Verilog HDL, VHDL and System Verilog", 6th Edition, Pearson Education Pvt.Ltd., New Delhi, 2018.
2	Charles H.Roth, "Fundamentals of Logic Design", 7th Edition, Thomson Learning, 2015.
3	T.R. Padmanabhan, B Bala Tripura Sundari, Design Through Verilog HDL, Wiley 2009

Reference Books(s) / Web links:	
1	Thomas L. Floyd, "Digital Fundamentals", 11th Edition, Pearson Education Inc, 2014
2	John F.Wakerly, "Digital Design", 5th Edition, Pearson/PHI, 2017
3	Donald P.Leach and Albert Paul Malvino, "Digital Principles and Applications", 8th Edition, TMH, 2014.
4	John.M Yarbrough, "Digital Logic Applications and Design", Thomson Learning, 2006.
5	Donald D.Givone, "Digital Principles and Design", McGraw Hill Education, 2017.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT23332.1	3	3	2	1	-	-	-	1	1	1	-	1	2	2	1
MT23332.2	3	3	3	1	1	-	1	1	1	1	-	1	3	3	3
MT23332.3	3	3	3	3	1	1	1	1	1	1	1	1	3	2	3
MT23332.4	3	-	-	-	-	-	-	1	-	-	1	-	1	1	2
MT23332.5	3	3	3	2	2	1	1	1	1	1	2	2	3	2	3
Average	**3**	**3**	**2.75**	**1.75**	**1.33**	**1**	**1**	**1**	**1**	**1**	**1.33**	**1.25**	**2.4**	**2**	**2.4**

MT23333	MANUFACTURING TECHNOLOGY	Category	L	T	P	C
		PC	3	0	2	4

Objectives: The course shall:	
●	Provide understanding of sand casting and forging processes.
●	Provide knowledge on various welding methods and principles of additive manufacturing techniques.
●	Present insights into operations and applications of conventional and non-conventional machining processes.
●	Facilitate skill development in operating CNC machines and essentials of CNC programming.
●	Convey the processes involved in fabricating various electronic components.

UNIT-I	**FOUNDRY AND FORGING**	**09**
Sand Casting: Basics of Sand Mold, Types of patterns and pattern materials, Pattern allowances; Special Casting Processes: Shell Casting, Investment Casting, Pressure Die Casting, Centrifugal Casting; Forging & Rolling Processes: Forging, Rolling, Extrusion.		
UNIT-II	**JOINING AND ADDITIVE MANUFACTURING PROCESSES**	**09**
Fusion Welding Processes: Gas Tungsten Arc Welding (GTAW), Gas Metal Arc Welding (GMAW), Submerged Arc Welding (SAW), and Electro Slag Welding (ESW); Advanced Welding Techniques: Plasma Arc Welding (PAW), Electron Beam Welding (EBW), and Laser Welding; Brazing, Soldering, Additive Manufacturing Processes: Fused Deposition Modelling (FDM), Stereolithography (SLA), Selective Laser Sintering (SLS), Direct Metal Laser Sintering (DMLS).		
UNIT-III	**MACHINING PROCESS**	**09**
Conventional Machining: Lathe, Shaper, Planer, Horizontal milling machine, Capstan and Turret lathe; Non-conventional Machining Processes: Abrasive Jet Machining (AJM), Water Jet Machining (WJM), Ice Jet Machining (IJM), Ultrasonic Machining (USM), Electric Discharge Machining (EDM), Electro Chemical Machining (ECM), Plasma Arc Machining (PAM), Electron Beam Machining (EBM), and Laser Beam Machining (LBM).		
UNIT-IV	**CNC MACHINES AND PROGRAMMING**	**09**
CNC Machine Tools and Constructional Details: Overview, Constructional aspects, Types of CNC control systems (open/closed, point-to-point/continuous); Turning and Machining Centers: Work holding methods in Turning and machining centers; CNC Programming Basics: Coordinates and motion (Absolute vs Incremental), Interpolators, Polar coordinates, introduction to program planning, G and M codes; Manual Part Programming: Techniques of manual part programming for CNC machining centers and Turning centers.		
UNIT-V	**ELECTRONIC COMPONENT MANUFACTURING**	**09**
Electronic Component Basic Fabrication Methods: Lithography, Etching, Doping, Deposition, Oxidation, Diffusion, Metallization; IC Fabrication Methods: Bipolar, Complementary Metal-Oxide-Semiconductor (CMOS), BiCMOS; LED Fabrication Methods: Epitaxial growth, Wafer bonding; High-speed fuse Fabrication Methods: Wire drawing and Spinning (Coiling).		
	Total Contact Hours :	**45**

List of Experiments:

1. Preparation of sand mould using single piece and split piece pattern
2. Fabrication of tray and funnel in sheet metal
3. Taper turning using lathe
4. Knurling and external thread cutting using lathe
5. Step turning and drilling using Capstan / Turret lathe
6. Drilling and Tapping
7. Cube formation using shaper
8. Study of Indexing mechanism in milling machine
9. Hexagonal milling using vertical milling machine
10. Spur gear cutting using milling machine
11. Gear generation in gear hobbing machine
12. Surface grinding and Cylindrical grinding

Contact Hours	:	**30**
Total Contact Hours	:	**75**

Course Outcomes: After the successful completion of the course, the student will be able to:	
CO1	Demonstrate practical skills in sand casting and describe theoretical aspects of forging processes.
CO2	Apply metal joining processes practically and describe the theoretical concepts of additive manufacturing.
CO3	Execute conventional machining operations and describe the theory of unconventional machining processes.
CO4	Describe the theoretical principles of CNC machine operation and programming.
CO5	Describe the various electronic component fabrication techniques.

Textbook (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, "DeGarmo's Materials and Processes, in Manufacturing" 13th Edition, Wiley Publishers, 2021.
3	Sharma, P.C., "A Text book of production Technology", S.Chand and Co. Ltd., 2022.
4	Rao, P.N. "Manufacturing Technology Foundry, Forming and Welding", Vol 1, 4th Edition, Mcgraw Hill-2017.
5	https://nptel.ac.in/courses/112107144/
6	Michael Quirk and Julian Serda, "Semiconductor Manufacturing Technology", Pearson, 2000

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
MT23333.1	3	1	2	-	-	-	1	-	3	3	-	-	2	2	1
MT23333.2	3	1	2	-	-	-	1	-	3	3	-	-	2	2	1
MT23333.3	3	1	2	-	-	-	1	-	3	3	-	-	2	2	1
MT23333.4	3	2	-	-	2	-	-	-	-	-	-	-	2	2	1
MT23333.5	3	1	1	-	-	-	1	-	-	-	-	-	2	2	1
Average	**3**	**1.2**	**1.75**	**-**	**2**	**-**	**1**	**-**	**3**	**3**	**-**	**-**	**2**	**2**	**1**

MT23334	**MECHANICS OF SOLIDS**	**Category**	**L**	**T**	**P**	**C**
		PC	3	0	2	4

Objectives: The course shall:	
●	Cover basic principles of stress, strain, and deformation in solids.
●	Focus on analyzing transverse loading effects and stress distribution in beams.
●	Examine torsional behavior in shafts and springs.
●	Explore methods to calculate deflections in beams and analyze column stability.
●	Evaluate stress distributions in thin-walled cylinders and spheres.

UNIT-I	**STRESS, STRAIN AND DEFORMATION OF SOLIDS**	**09**
Rigid bodies and deformable solids – Tension, Compression and Shear Stresses – Deformation of simple and compound bars – Thermal stresses – Elastic constants – Strain energy and unit strain energy – Strain energy in uniaxial loads – Volumetric strains – principal stresses and principal planes		
UNIT-II	**TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM**	**09**
Beams – types transverse loading on beams – Shear force and bending moment in beams – Cantilevers – Simply supported beams and overhanging beams. Theory of simple bending– bending stress distribution – Load carrying capacity of various beams.		
UNIT-III	**TORSION ON SHAFTS AND SPRINGS**	**09**
Torsion formulation stresses and deformation in circular and hollows shafts – Stepped shafts– Deflection in shafts fixed at the both ends – Stresses in helical springs – Maximum shear stress in spring section including Wahl Factor - Deflection of helical springs.		
UNIT-IV	**DEFLECTION OF BEAMS AND COLUMNS**	**09**
Double Integration method for computation of slopes and deflections in beams – Columns – End conditions – Equivalent length of a column – Euler equation – Slenderness ratio – Rankine formula for columns.		
UNIT-V	**THIN CYLINDERS, SPHERES AND THICK CYLINDERS**	**09**
Stresses in thin cylindrical shell due to internal pressure, circumferential and longitudinal stresses and deformation in thin and thick cylinders – spherical shells subjected to internal pressure		
	Total Contact Hours : 45	

List of Experiments:

1. Tension test on a mild steel rod
2. Double shear test on Mild steel and Aluminum 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.	Virtual lab experiments - https://sm-nitk.vlabs.ac.in/			
	Contact Hours	**:**	**30**	
	Total Contact Hours	**:**	**75**	

Course Outcomes: After the successful completion of the course, the student will be able to:	
CO1	Analyze stress and strain in materials and compute the principal stresses for given stress conditions.
CO2	Create shear force and bending moment diagrams for beams under different loading conditions.
CO3	Compute the deformation in shafts under torsional loads.
CO4	Determine the deflections of the beams and columns using double integration method and Euler's equation respectively
CO5	Assess stresses in thin cylinders and spheres and calculate their deformations.

Textbook (s):	
1	Bansal, R.K., "Strength of Materials", 7th edition, Laxmi Publications (P) Ltd., 2022.
2	Jindal U.C., "Strength of Materials", 2nd edition, Pearson Pvt. Ltd., New Delhi, 2017.

Reference Books(s) / Web links:	
1	Egor. P. Popov "Engineering Mechanics of Solids" 2nd edition, Prentice Hall of India, New Delhi, 2015.
2	Ramamurtham S., "Strength of Materials", 20th edition, Dhanpat rai publishing company, 2020.
3	Hibbeler, R.C., "Mechanics of Materials", 10 th edition, Pearson Education, 2022.
4	Ferdinand P. Been, Russell Johnson, J.r. and John J. Dewole "Mechanics of Materials", 8th edition, Tata McGraw Hill Publishing 'co. Ltd., New Delhi, 2020.
5	https://nptel.ac.in/courses/112107146/
6	Egor. P.Popov "Engineering Mechanics of Solids" 2nd edition, Prentice Hall of India, New Delhi, 2015.

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
MT23334.1	3	2	2	-	1	-	1	-	-	-	-	-	3	1	1
MT23334.2	3	3	2	-	2	-	0	-	-	-	-	-	3	1	1
MT23334.3	3	2	3	-	2	-	2	-	-	-	-	-	3	1	1
MT23334.4	3	3	2	-	1	-	2	-	-	-	-	-	3	1	1
MT23334.5	3	2	1	-	2	-	2	-	-	-	-	-	3	1	1
Average	**3**	**2.4**	**2**	**-**	**1.6**	**-**	**1.4**	**-**	**-**	**-**	**-**	**-**	**3**	**1**	**1**

CS23336	**INTRODUCTION TO PYTHON PROGRAMMING**	**Category**	**L**	**T**	**P**	**C**
		ES	1	0	4	3

Objectives: The course shall:	
●	To understand computers, programming languages and their generations and essential skills for a logical thinking for problem solving.
●	To write, test, and debug simple Python programs with conditionals, and loops and functions
●	To develop Python programs with defining functions and calling them
●	To understand and write python programs with compound data-lists, tuples, dictionaries
●	To search, sort, read and write data from /to files in Python.

List of Experiments:			
1.	Study of algorithms, flowcharts and pseudocodes.		
2.	Introduction to Python Programming and Python IDLE/Anaconda distribution.		
3.	Experiments based on Variables, Data types and Operators in Python.		
4.	Coding Standards and Formatting Output.		
5.	Algorithmic Approach: Selection control structures.		
6.	Algorithmic Approach: Iteration control structures.		
7.	Experiments based on Strings and its operations.		
8.	Experiments based on Lists and its operations.		
9.	Experiments based on Tuples and its operations.		
10.	Experiments based on Sets and its operations.		
11.	Experiments based on Dictionary and its operations.		
12.	Functions: Built-in functions.		
13.	Functions: User-defined functions.		
14.	Functions: Recursive functions.		
15.	Searching techniques: Linear and Binary.		
16.	Sorting techniques: Bubble and Merge Sort.		
17.	Experiments based on files and its operations.		
	Total Contact Hours	**:**	**75**

Course Outcomes: After the successful completion of the course, the student will be able to:	
CO1	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.
CO2	Write, test, and debug simple Python programs with conditionals and loops.
CO3	Develop Python programs step - wise by defining functions and calling them.
CO4	Use Python lists, tuples, dictionaries for representing compound data.
CO5	Apply searching, sorting on data and efficiently handle data using flat files.

Textbook (s):	
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(s) / Web links:	
1	John V Guttag, 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	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
MT23334.1	2	2	2	2	1	-	-	-	1	1	1	1	3	3	-
MT23334.2	2	1	1	1	1	-	-	-	-	-	1	1	3	2	-
MT23334.3	1	1	2	1	2	-	-	-	-	-	1	1	2	3	2
MT23334.4	2	2	3	2	2	-	-	-	-	-	2	1	2	2	2
MT23334.5	2	2	3	2	3	-	-	-	-	-	2	1	2	2	2
Average	**1.5**	**1.33**	**1.83**	**1.33**	**1.5**	**-**	**-**	**-**	**1**	**1**	**1.16**	**1**	**2**	**2**	**2**

SEMESTER IV

MT23411	FLUID MECHANICS AND THERMAL SCIENCES	Category	L	T	P	C
		PC	4	0	0	4

Objectives: The course shall:

- Introduce fundamental fluid properties, fluid statics principles, and their applications in engineering.
- Focus on fluid dynamics, governing equations, and friction losses in internal flows.
- Provide a qualitative understanding of hydraulic pumps and turbines, with emphasis on their working principles and applications.
- Introduce the fundamental laws of thermodynamics and their applications.
- Introduce thermo-fluid applications in power plants, refrigeration, and CFD.

UNIT-I FLUID PROPERTIES AND FLUID STATICS **12**

Introduction to Fluid Mechanics: Definition of fluid; Importance of fluid mechanics in mechatronics; Differentiation between solid and fluid; Units and dimensions; Fluid Properties: Density, Specific weight, Specific Volume, Viscosity (dynamic and kinematic), Compressibility, Surface tension, Vapor pressure.

Pascal's law; Absolute, gauge, and vacuum pressures; Measurement of pressure using manometers and pressure gauges, Hydrostatic Forces on Surfaces; Applications of fluid mechanics in engineering.

UNIT-II FLUID DYNAMICS AND FLOW THROUGH PIPES **12**

Introduction to Fluid Kinematics: Types of fluid flow – Rate of flow – Continuity equation; Fluid dynamics – Equations of motion – Euler's equation along streamline – Bernoulli's equation – Flow Measurement Techniques: Orifice meter, Venturi meter, Pitot tube.

Darcy Weisbach equation - Friction factor – Major and minor energy losses - Flow through pipes in series and in parallel – Simple Problems.

UNIT-III PUMPS AND TURBINES **12**

Introduction to Pumps: Types of pumps – Construction and working principle of Reciprocating pump, Centrifugal pump.

Hydraulic Turbines: Classification of turbines – Pelton wheel, Francis turbine, Kaplan turbine – Applications of Pumps and Turbines. Industrial applications, Maintenance and troubleshooting. (Qualitative Only)

UNIT-IV LAWS OF THERMODYNAMICS **12**

Fundamental Concepts and Definitions: Thermodynamic System, control volume, properties, processes, and cycles – Thermodynamic equilibrium – Quasi-static process – Zeroth law of thermodynamics – Path and point functions – Concept of energy, work and heat. First Law of Thermodynamics: First law of thermodynamics applied to a closed system – Internal energy, Enthalpy, Specific heats.

Second law of thermodynamics applied to Heat engines, Refrigerators & Heat pumps – Simple Problems. Carnot's theorem.

UNIT-V THERMO-FLUID APPLICATIONS **12**

Simple Rankine Cycle – Layout and working of modern coal power plant. Introduction to types of Refrigeration and Air-Conditioning systems.

Basic concepts of heat transfer - Conduction, Convection and Radiation. Heat Exchanger – LMTD method. Computational Fluid Dynamics (CFD): Introduction to CFD; Applications in fluid flow and heat transfer analysis.

Total Contact Hours : 60

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

CO1	Analyze fluid properties and apply the principles of fluid statics in engineering applications.
CO2	Evaluate fluid flow dynamics using governing equations and assess friction losses in pipe systems.
CO3	Describe the working principles of various hydraulic machines and their applications.
CO4	Apply thermodynamics laws to engineering applications.
CO5	Understand thermo-fluid applications in engineering.

Textbook (s):

1. Bansal RK., "Fluid Mechanics and Hydraulics Machines", 11th edition, Laxmi publications (P) Ltd., New Delhi, 2023.
2. Nag P.K., "Engineering thermodynamics", 6th edition, Tata McGraw hill, 2017.
3. Cengel YA., Cimbala J M., "Fluid Mechanics – Fundamentals and applications", 4th Edition, McGraw-Hill higher education, 2018.

Reference Books(s) / Web links:

1. White FM., "Fluid Mechanics", 9th Edition, Tata McGraw-Hill, New Delhi, 2022
2. Yunus A. Cengel & Michael A. Boles, "Thermodynamics", 8th Edition 2015.
3. Holman, J.P," Heat Transfer", 10th Edition, McGraw-Hill, 2017.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT23411.1	3	3	2	1	1	-	1	-	-	-	-	1	2	2	-
MT23411.2	3	3	2	1	1	-	1	-	-	-	-	1	2	2	1
MT23411.3	3	2	2	1	2	-	1	-	-	-	-	1	2	2	2
MT23411.4	3	3	3	1	1	-	1	-	-	-	-	1	2	2	-
MT23411.5	3	2	3	1	2	-	2	-	-	-	-	2	2	2	2
Average	**2.8**	**2.6**	**2.4**	**1**	**1.4**	**-**	**1.5**	**-**	**-**	**-**	**-**	**1.2**	**2**	**2**	**1.7**

MA23432	STATISTICS AND NUMERICAL METHODS	Category	L	T	P	C
	Common to IV sem. B.E. - AERO, MCT and R&A	BS	3	0	2	4

Objectives: The course shall enable student:	
•	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 analyse 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 analyse 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	09
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**	**09**
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**	**09**
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**	**09**
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**	**09**
Design of Experiments - Completely randomized design – Randomized block design –Latin square design.		
	Contact Hours : 45	

List of Experiments (using R Software)

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

Contact Hours	**:**	**30**
Total Contact Hours	**:**	**75**

Course Outcomes: After the successful completion of the course, the student will be able to:	
CO1	Demonstrate common numerical methods and used to obtain approximate solutions of linear and system of equations.
CO2	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.
CO3	Illustrate the basic concepts and techniques of modern reliability engineering tools.
CO4	Apply the different testing tools like t-test, F-test, chi-square test to analyse the relevant real life problems.
CO5	Analyse the different mathematical models with the help of statistical deigns and appropriate data and made valuable conclusions by proper evaluation.

Textbook (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 & Company Ltd. (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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
Average	**3**	**3**	-	-	-	-	-	-	-	-	-	-	-	-	-

MT23431	MICROCONTROLLERS AND EMBEDDED SYSTEMS	PC	L	T	P	C
			3	**0**	**2**	**4**

Objectives:	
●	Understand the architecture and functionality of microcontrollers and embedded systems.
●	Develop skills in programming microcontrollers for various applications.
●	Integrate sensors and actuators with microcontrollers for embedded solutions.
●	Design and implement embedded systems for real-world applications.
●	Gain practical experience through lab-oriented projects and assignments.

UNIT-I	**INTRODUCTION TO MICROCONTROLLERS AND MICROPROCESSORS**	**08**

Overview of Microcontrollers: Evolution and comparison with microprocessors; Importance of microcontrollers in mechatronics; Microcontroller vs. Microprocessor. Architecture of 8085 Microprocessor and 8051 Microcontroller: Block diagram and functional units; CPU, memory organization, and registers. Microcontroller Features: I/O ports and pin configuration; Interrupts and interrupt handling; Timers and counters.

UNIT-II	**PIC MICROCONTROLLER PROGRAMMING (PIC18F458)**	**08**

Programming Basics: Assembly language programming: Syntax, structure, and basic concepts; C programming for microcontrollers: Basics, syntax, and use cases. PIC Architecture; Programming Tools: Integrated Development Environments (IDEs); Simulators and emulators. Practical Programming: Writing and debugging simple programs; Case studies: Toggle of bits in PIC 18F458 and Stepper motor control using PIC Microcontroller.

UNIT-III	**PERIPHERAL INTERFACING USING PIC18F458**	**12**

Basic Interfacing: Interfacing with LEDs, switches, LCDs, and seven-segment displays. Advanced Interfacing: ADC and DAC interfacing: Concepts, techniques, and applications; Sensor interfacing: Types of sensors (temperature, light, pressure), interfacing methods, and practical examples. Communication Protocols: UART, SPI, and I2C.

UNIT-IV	**EMBEDDED SYSTEM DESIGN**	**07**

Embedded Systems Overview: Definition, characteristics, and applications. Real-Time Operating Systems (RTOS): Basics, task scheduling, and management. Embedded System Design Flow: Requirements, design, implementation, and testing. Semaphores, Priority Inversion and Priority Inheritance.

UNIT-V	**ESP32 AND IoT APPLICATIONS**	**10**

Introduction to ESP32: Architecture, features, and capabilities. Programming the ESP32: Setting up the development environment; Writing and debugging programs. Introduction to Micropython: Pyboard; IoT Applications: Remote Web-based control using ESP32; Temperature and Humidity Sensor Data Transfer to Mobile Phone using ESP32.

	Contact Hours	**:**	**45**

List of Experiments

1. Toggle of bits in PIC 18F458.
2. Stepper motor control using PIC Microcontroller.
3. Monitoring and Control of sensors using Arduino UNO.
4. Line following and obstacle avoidance robot using Arduino UNO.
5. Actuator control using raspberry pi.
6. Monitoring and Control of sensors using raspberry pi.
7. Line following and obstacle avoidance robot using raspberry pi.
8. Remote Web based control using ESP32
9. Temperature and Humidity Sensor Data Transfer to Mobile Phone using ESP32.

	Contact Hours	**:**	**30**
	Total Contact Hours	**:**	**75**

Course Outcomes: Upon completion of this course the students will be able to	
CO1	Explain the architecture, instruction set, and basic programming concepts of microcontrollers.
CO2	Write and debug programs for microcontrollers using assembly and high-level languages.

CO3	Interface various peripherals and sensors with microcontrollers.
CO4	Design and implement embedded systems with real-time constraints.
CO5	Develop embedded solutions through hands-on lab projects and assignments.

Text Book (s):	
1	Mazidi, M. A., Mazidi, J. G., & McKinlay, R. D. (2007). The 8051 Microcontroller and Embedded Systems: Using Assembly and C (2nd ed.). Pearson Education.
2	Raj Kamal. (2011). Microcontrollers: Architecture, Programming, Interfacing and System Design (2nd ed.). Pearson Education India.
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
3	Tianhong Pan, Yi Zhu, "Designing Embedded Systems with Arduino – A Fundamental Technology for Makers", Springer Singapore, 2017
4	Gaonkar, R. S. (2002). Microprocessor Architecture, Programming, and Applications with the 8085 (5th ed.). Prentice Hall.

Reference Books(s) / Web links:	
1	Santanu Chattopadhyay, "Embedded system Design" 2nd Edition, PHI Learning Private Limited, 2013.
2	Derek Molloy, "Exploring Raspberry Pi Interfacing to the Real World with Embedded Linux", Wiley, 2016.
3	Martin Bates, "PIC Microcontrollers An Introduction to Microelectronics", Third Edition, 2011
4	Dogan Ibrahim, Ahmet Ibrahim, "The Official ESP32 Book", Elektor International Media, 2017.
5	J. M. Hughes, "Arduino: A Technical Reference A Handbook for Technicians, Engineers, and Makers", O'Reilly Media, 2016.

CO \ PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
MT23431.1	3	3	2	1	-	-	-	-	1	-	-	-	2	2	2
MT23431.2	3	3	2	2	-	-	-	-	1	-	-	-	3	2	3
MT23431.3	3	3	2	2	2	-	-	-	2	-	-	-	2	3	2
MT23431.4	3	3	3	3	2	1	1	-	2	1	1	-	3	2	3
MT23431.5	3	3	3	3	3	2	2	-	3	2	2	1	2	3	2
Average	**3**	**3**	**2.4**	**2.2**	**1.8**	**1**	**1**	**-**	**1.8**	**1**	**1**	**0.2**	**2.4**	**2.4**	**2.4**

MT23432	**SENSORS AND INSTRUMENTATION**	**PC**	**L**	**T**	**P**	**C**
			3	0	2	4

Objectives:	
●	Grasp measurement fundamentals, including units, calibration, and sensor characteristics.
●	Expertise in various sensors, emphasizing applications like strain gauges and thermosensitive sensors.
●	Deepen knowledge in sensors, exploring principles and applications of accelerometers, gyroscopes, and fiber optic sensors.
●	Introduce LabVIEW for graphical programming, emphasizing virtual instrumentation applications.
●	Apply data acquisition systems for signal conditioning and analysis.

UNIT-I	**INTRODUCTION TO SENSORS AND TRANSDUCERS**	**10**
Overview of Sensors and Transducers: Definition, types, and applications; Sensor Characteristics; Temperature Measurement; Performance measures of sensors; Error Analysis and Sensor Calibration Technique.		
UNIT-II	**SENSOR DESIGN AND SIMULATION**	**09**
Introduction to NI Multisim: Overview, features, and applications; Designing Sensor Circuits: Steps and best practices; Simulation of Sensor Circuits: Using NI Multisim to simulate various sensor circuits.		
UNIT-III	**SENSOR INTERFACING AND DATA ACQUISITION**	**10**
Microcontroller Basics: Overview of Arduino and Raspberry Pi; Interfacing Sensors with Microcontrollers: Techniques and best practices; Data Acquisition: Methods and tools; IoT Sensors: Introduction and applications; Practical Applications: Interfacing IoT sensors with Arduino/Raspberry Pi for data acquisition.		
UNIT-IV	**SPECIALIZED SENSORS AND APPLICATIONS**	**08**
Hall Effect Transducers: Working principle and characteristics; RFID Technology: Basics, device control, and authentication applications; Humidity Sensors: Types and measurement techniques; Biomedical Sensors: ECG, EMG, and EEG sensors: principles and applications; Environment Sensors: BME680 Environmental Sensor, Particulate Matter Sensor (ZH06-III, ZPH05).		
UNIT-V	**VIRTUAL INSTRUMENTATION AND SIMULATION**	**08**
Introduction to Virtual Instrumentation: Definition and benefits; LabVIEW Basics: Overview of LabVIEW environment, data flow programming, and VI development; Simulation of Bridge Circuits: Wheatstone bridge, Anderson's bridge, Maxwell's inductance bridge, and Maxwell's inductance capacitance bridge.		
	Theory Contact Hours : 45	

List of Experiments
1. Determination of Displacement using LVDT and Strain gauge.
2. Determine the Characteristics of Various Temperature Sensors.

3.	Utilize NI Multisim for designing and simulating sensor circuits.
4.	Interface with IoT sensors and acquire data using microcontrollers like Arduino or Raspberry Pi.
5.	Determination of characteristics of hall effect transducer.
6.	RFID-based Device Control and Authentication.
7.	Measurement of humidity using humidity sensor.
8.	Explore biomedical sensors for measuring signals like ECG, EMG, or EEG.
9.	Simulation of Wheatstone bridge and Anderson's bridge using DAQ.
10.	Simulation of Maxwell's inductance bridge and Maxwell's inductance capacitance bridge using DAQ.

	Lab Contact Hours	**:**	**30**
	Total Contact Hours	**:**	**75**

Course Outcomes: After the completion of the course, the student will be able to:	
CO1	Explain the working principles and characteristics of various sensors and transducers.
CO2	Design and simulate sensor circuits using software tools.
CO3	Interface sensors with microcontrollers and acquire data.
CO4	Apply sensors in IoT and biomedical applications.
CO5	Develop practical skills through hands-on lab experiments.

Text Book (s):	
1	Sawhney A K and Puneet Sawhney, "A Course in Mechanical Measurements and Instrumentation and Control", 12th edition, Dhanpat Rai & Co, New Delhi, 2013.
2	Ernest O Doebelin, "Measurement Systems – Applications and Design", Tata McGraw-Hill, 2009.
3	Albert D.Helfrick and William D. Cooper. Modern Electronic Instrumentation and Measurement Techniques, Prentice Hall of India, 1stedition, 2016

Reference Books(s) / Web links:	
1	Patranabis D, "Sensors and Transducers", 2nd Edition, PHI, New Delhi, 2011.
2	Jacob Fraden, "Handbook of Modern Sensors, Physics, Design and Applications", Third Edition, Springer, 2004.
3	Jovitha Jerome, "Virtual Instrumentation Using LabVIEW", PHI, New Delhi, 2010.
4	Devdas Shetty, Richard A. Kolk, "Mechatronics system design", 2nd Edition, Cengage Learning, 2011.
5	Steve Mackay, John Park, "Practical Data Acquisition for Instrumentation and Control Systems", Elsevier, 2003.

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
MT23432.1	3	3	2	1	-	-	-	-	1	-	-	-	2	3	1
MT23432.2	3	3	2	2	-	-	-	-	1	-	-	-	2	3	1
MT23432.3	3	3	2	2	2	-	-	-	2	-	-	-	2	3	1
MT23432.4	3	3	3	3	2	1	1	-	2	1	1	-	2	3	1
MT23432.5	3	3	3	3	3	2	2	-	3	2	2	1	2	3	1
Average	**3**	**3**	**2.4**	**2.2**	**1.8**	**1**	**1**	**-**	**1.8**	**1**	**1**	**0.2**	**2**	**3**	**1**

MT23433	**SYSTEM DYNAMICS AND CONTROL**	PC	**L**	**T**	**P**	**C**
			3	**0**	**2**	**4**

Objectives:	
●	To derive the elements of control system and their modeling using various techniques.
●	To calculate time domain specifications of control systems required for steady state analysis.
●	To analyze the frequency domain specifications of control systems required for stability analysis.
●	To examine the conditions for stability, controllability and observability.
●	To compute the digital control techniques for control of applications.

UNIT-I	**CONTROL SYSTEM MODELING**	**09**
Basic Elements and types of Control System - Transfer function, Mathematical Modeling of Mechanical and Electrical systems – Reduction Techniques - Block diagram, Signal flow graph.		
UNIT-II	**TIME RESPONSE ANALYSIS**	**09**
Time response specifications - Analysis of first order and second order systems - Steady state errors – P, PI, PD and PID Controllers.		
UNIT-III	**FREQUENCY RESPONSE ANALYSIS**	**09**
Frequency response specifications – Analysis: Bode Plot, Polar Plot, and Nyquist Plot - Compensators.		
UNIT-IV	**STABILITY AND STATE VARIABLE ANALYSIS**	**09**
Routh-Hurwitz Criterion, Root Locus Technique. State space representation of Continuous Time systems – State equations – Transfer function from State Variable Representation - Controllability and Observability.		

UNIT-V	DIGITAL CONTROL SYSTEMS	09
Z Transform – Properties, Inversion, Digital and Discrete Time Systems – Discrete Time Signals – Causal Signals- Linear Discrete Time Systems – Role of Z Transform in Linear Differential Equations- Stability of Discrete Time System.		
	Theory Contact Hours : 45	

List of Experiments

1. Modelling of Physical Systems using Simulation Software (Mechanical and Electrical systems).
2. Block Diagram Reduction of Linear Systems Using Simulation Software.
3. Time response analysis of Linear Systems Using Simulation Software.
4. Frequency response analysis of Linear Systems Using Simulation Software
5. Stability Analysis of Linear Systems Using Simulation Software (Root Locus, Bode and Nyquist plot).
6. Time Response analysis of Second Order System.
7. Magnitude and phase plot of Lag and lead compensators.
8. Determination of transfer function and effect of feedback on DC servo motor.
9. Effect of P, PD, PI, PID controllers on Temperature control system.
10. Study the Effect of P, PD, PI, PID controllers on second order systems.

Lab Contact Hours	**:**	**30**
Total Contact Hours	**:**	**75**

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

CO1	Derive the transfer function of mechanical and electrical systems.
CO2	Analyze the time domain speciation's for 1st and 2nd order systems.
CO3	Perform frequency domain analysis of control systems required for stability analysis.
CO4	Derive the stability and state variable analysis of continuous time systems.
CO5	Analyze the discrete time signals for digital control.

Text Books:

1	Nagrath J and M.Gopal, "Control System Engineering", New Age International Publishers, 6th Edition, 2017.
2	Smarajit Ghosh, "Control Systems: Theory and Applications", Pearson India, 2013

Reference Books / 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	Schaum's Outline Series, "Feed back and Control Systems" Tata McGraw-Hill, 2007.
4	Katsuhiko Ogata, "Modern Control Engineering", Prentice Hall, 2015
5	Richard C. Dorf and Robert H. Bishop, "Modern Control Systems", 13th Edition, Pearson Education Ltd, 2017.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT23433.1	1	2	3	-	3	-	-	-	2	2	2	-	2	3	1
MT23433.2	3	2	1	2	3	2	2	-	2	2	2	1	3	2	2
MT23433.3	3	2	1	-	3	2	2	-	2	2	2	1	3	2	2
MT23433.4	3	3	3	2	3	2	2	-	2	2	2	1	2	3	2
MT23433.5	3	2	2	2	-	-	-	-	2	2	2	1	2	3	3
Average	**2.6**	**2.2**	**2**	**2**	**3**	**2**	**2**	**-**	**2**	**2**	**2**	**1**	**2.4**	**2.6**	**2**

MT23421	FLUID MECHANICS AND HEAT TRANSFER LABORATORY	PC	L	T	P	C
			0	0	2	1

Objectives: The course shall:

- Provide an understanding of the mechanical properties of various materials under diverse loading conditions.
- Cover standardized testing methods to evaluate the impact strength and hardness of materials.
- Outline the steps involved in investigating the behavior of beams and springs under deflection and compression tests.
- Facilitate the experimental validation of fundamental fluid mechanics principles.
- Cover the assessment of the performance and efficiency of hydraulic machines using experimental methods.

List of Experiments			
1.	Determination of the Coefficient of discharge of given Orifice meter.		
2.	Determination of the Coefficient of discharge of given Venturi meter.		
3.	Determination of friction factor for a given set of pipes.		
4.	Measure and analyze the flow rate using a Rota meter.		
5.	Evaluate the heat transfer coefficient in forced convection.		
6.	Measure the head, power, and efficiency of a centrifugal pump.		
7.	Evaluate the performance characteristics of the Pelton wheel turbine.		
8.	Measure the thermal conductivity of materials using the guarded plate method.		
9.	Evaluate the coefficient of performance (COP) of an air-conditioning system.		
10.	Determine and compare the effectiveness of parallel and counter-flow heat exchangers.		
		Total Contact Hours	**: 30**

Course Outcomes: On completion of the course, the student is expected to be able to	
CO1	Determine fluid properties and understand fluid statics through experiments.
CO2	Analyze fluid flow dynamics and measure flow rates using various techniques.
CO3	Evaluate the performance characteristics of pumps and turbines.
CO4	Apply thermodynamic principles in practical experiments.
CO5	Conduct experiments on heat transfer and energy conservation.

CO\ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1	-	-	-	-	1	-	-	-	2	1	1
CO2	3	3	2	2	-	-	-	-	1	-	-	-	2	1	1
CO3	3	3	2	2	2	-	-	-	2	-	-	-	2	1	1
CO4	3	3	3	3	2	1	1	-	2	1	1	-	2	1	1
CO5	3	3	3	3	3	2	2	-	3	2	2	1	2	1	1
Avg	3	3	2.4	2.2	1.8	1	1	-	1.8	1	1	0.2	2	1	1

GE23421	SOFT SKILLS-I	Category	L	T	P	C
		EEC	0	0	2	1

Objectives: The course shall,	
●	Help students break out of shyness.
●	Build confidence
●	Enhance English communication skills.
●	Encourage students' creative thinking to help them frame their own opinions,

Course Description

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	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.

		that the students are not criticized for their ideas so students will be open to sharing new ideas.	
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 disagree more and continues with his opinion	The aim of this activity is to improve general communication skills and confidence.
	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 Outcomes: After the successful completion of the course, the student will be able to:	
CO1	Be more confident
CO2	Speak in front of a large audience
CO3	Be better creative thinkers
CO4	Be spontaneous
CO5	Know the importance of communicating in English.

Reference Books(s) / Web links:
Kings Learning work sheets.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
GE23421.1	-	-	-	-	-	-	-	-	1	3	-	1	-	-	1
GE23421.2	-	-	-	-	-	-	1	-	1	3	1	1	-	-	1
GE23421.3	1	-	-	-	-	-	-	-	-	3	-	-	-	-	1
GE23421.4	-	-	-	-	-	-	-	-	-	3	-	-	-	-	1
GE23421.5	-	-	-	-	-	-	-	-	-	3	-	-	-	-	1
Average	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**3**	**1**	**1**	**0**	**0**	**1**

SEMESTER V

GE23311	FUNDAMENTALS OF MANAGEMENT FOR ENGINEERS	Category	L	T	P	C
		HSM	3	0	0	3

Objectives: The course shall:	
•	Expose the students to the basic concepts of management in order to aid in understanding how an organization functions, and in understanding the complexity and wide variety of issues managers face in today's business firms.

UNIT-I	**INTRODUCTION TO MANAGEMENT**	09
Definition, Nature and Scope, Functions, Managerial Roles, Levels of Management, Managerial Skills, Challenges of Management; Evolution of management thought. Organization: Types and environmental factors.		
UNIT-II	**PLANNING AND DECISION MAKING**	09
General Framework for Planning – Planning Process, Types of Plans, Management by Objectives; Decision making and Problem Solving - Steps in Problem Solving and Decision Making.		
UNIT-III	**ORGANIZATION & HRM**	09
Principles of Organization: Organizational Design & Organizational Structures; Departmentalization, Delegation; Empowerment, Centralization, Decentralization. Human Resource Management & Business Strategy: Talent Management and Strategic Human Resource Planning; Recruitment and Selection; Training and Development; Performance Appraisal.		
UNIT-IV	**LEADING AND MOTIVATION**	09
Leadership, Power and Authority, Leadership Styles, Leadership Skills, Leader as Mentor and Coach, Team Leadership. Motivation – Types of Motivation; Relationship between Motivation, Performance and Engagement, Content Motivational Theories – Needs Hierarchy Theory, Two Factor Theory, Theory X and Theory Y.		
UNIT-V	**CONTROLLING**	09
Control, Types and Strategies for Control, Steps in Control Process, Budgetary and Non- Budgetary Controls. Characteristics of Effective Controls, Establishing control systems. Managing productivity- Cost control- Purchase control- Maintenance control- Quality control- Planning operations. Managing globally- Strategies for International business.		
	Total Contact Hours : 45	

Course Outcomes: At the end of this course students be able to:	
CO1	Understand and apply the basic principles of management.
CO2	Understand and apply the planning, organizing and control processes.
CO3	Understand and design organization as well as manage and develop human resource.
CO4	Understand various theories related to the development of leadership skills, motivation techniques and teamwork.
CO5	Understand and apply controlling practices in all applications.

Textbooks:	
1	Principles of Management, Prakash Chandra Tripathi, Tata McGraw-Hill Education, 2008.
2	Fundamentals of Management, Stephen P. Robbins, Pearson Education, 2009.

Reference Books(s) / Web links:	
1	Essentials of Management, Koontz Kleihrich, Tata Mc – Graw Hill.
2	Management Essentials, Andrew DuBrin, 9e, Cengage Learning, 2012.

CO\ PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
GE23311.1	3	3	2	2	1	-	-	-	-	-	-	-	2	2	1
GE23311.2	3	3	3	2	2	-	-	-	-	-	-	-	2	2	1
GE23311.3	3	3	3	2	3	-	-	-	-	-	-	-	2	2	1
GE23311.4	3	2	3	3	2	-	-	-	-	-	-	-	2	2	1
GE23311.5	3	2	3	3	3	-	-	-	-	-	-	-	2	2	1
Average	**3**	**2.6**	**2.8**	**2.4**	**2.2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**1**

MT23511	SEMICONDUCTOR MANUFACTURING	Category	L	T	P	C
		PC	3	0	0	3

Objectives: The course shall	
●	Provide comprehensive knowledge of semiconductor manufacturing processes.
●	Develop the ability to analyze and design semiconductor manufacturing systems.
●	Impart knowledge on the application of semiconductor principles in various industries.
●	Enhance problem-solving skills in semiconductor fabrication and process control.
●	Integrate theoretical concepts with practical applications through theoretical studies and simulations.

UNIT-I	INTRODUCTION TO SEMICONDUCTOR MANUFACTURING	09
Overview of Semiconductor Manufacturing: History and significance, Major industry players; Semiconductor Materials: Types, properties, and applications, Silicon, Gallium Arsenide, other materials; Crystal Growth and Wafer Preparation: **Electronic Grade Silicon**, Czochralski process, Float-zone process, Silicon Shaping - Wafer slicing, cleaning, polishing.		
UNIT-II	**LITHOGRAPHY AND ETCHING PROCESSES**	09
Photolithography: Principles, Mask design, Photoresist application, Exposure, development; Advanced Lithography Techniques: Electron-beam lithography, X-Ray lithography, Ion lithography, Extreme ultraviolet lithography; Etching Processes: Wet etching, Dry etching, Plasma etching, Selectivity, anisotropy in etching.		
UNIT-III	**DEPOSITION TECHNIQUES**	09
Chemical Vapor Deposition (CVD): Principles, Types (LPCVD, PECVD), Applications, limitations; Physical Vapor Deposition (PVD): Sputtering, Evaporation, Molecular beam epitaxy (MBE); Atomic Layer Deposition (ALD): Process fundamentals, Advantages, applications in semiconductor manufacturing.		
UNIT-IV	**DOPING AND THERMAL PROCESSES**	09
Doping Techniques: Diffusion, Ion implantation, Control of doping profiles and concentrations; Thermal Processes: Oxidation, Annealing, Rapid thermal processing (RTP), Furnace types, operation; Defect Control and Yield Enhancement: Sources of defects, Techniques for defect reduction, Yield analysis and improvement strategies.		
UNIT-V	**PACKAGING, TESTING AND CHARACTERIZATION**	09
Semiconductor Packaging: Types of packages, Packaging materials, Techniques (wire bonding, flip-chip); Reliability and Failure Analysis: Thermal management, Stress testing, Failure modes, mechanisms; Testing and Characterization: Electrical testing, Optical testing; Advanced characterization techniques: AFM, SEM, TEM.		
	Total Contact Hours :	**45**

Course Outcomes: At the end of this course students be able to:	
CO1	Analyze the fundamentals of semiconductor materials and their properties.
CO2	Apply lithography and etching processes in semiconductor fabrication.
CO3	Utilize various deposition techniques for thin film formation.
CO4	Implement doping and thermal processes in semiconductor device manufacturing.
CO5	Evaluate packaging and testing methods for semiconductor devices.

Textbooks:	
1	May, Gary S., Spanos, Costas J. Fundamentals of Semiconductor Manufacturing and Process Control. Germany: Wiley, 2006.
2	Yoo, Chue San. Semiconductor Manufacturing Technology. Singapore: World Scientific, 2008.
3	Handbook of Semiconductor Manufacturing Technology. United States: CRC Press, 2017.

Reference Books(s) / Web links:	
1	Gary S. May, Simon M. Sze, "Fundamentals of Semiconductor Fabrication," Wiley, 2004.
2	Michael Quirk, Julian Serda, "Semiconductor Manufacturing Technology," Prentice Hall, 2nd Edition, 2001.
3	Yuan Taur, Tak H. Ning, "Fundamentals of Modern VLSI Devices," Cambridge University Press, 2nd Edition, 2009.
4	Swayam-NPTEL course on Semiconductor Devices and Circuits
5	Swayam-NPTEL course e: Introduction to Semiconductor Devices
6	S. M. Sze, "VLSI Technology" Tata McGraw Hill, 2003. (Kindly refer to this book)

CO\ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT23511.1	3	3	2	2	1	-	-	-	-	-	-	-	2	2	1
MT23511.2	3	3	3	2	2	-	-	-	-	-	-	-	2	2	1
MT23511.3	3	3	3	2	3	-	-	-	-	-	-	-	2	2	1
MT23511.4	3	2	3	3	2	-	-	-	-	-	-	-	2	2	1
MT23511.5	3	2	3	3	3	-	-	-	-	-	-	-	2	2	1
Average	**3**	**2.6**	**2.8**	**2.4**	**2.2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**1**

MT23512	INDUSTRIAL ELECTRONICS	PC	L	T	P	C
			2	1	0	3

Objectives: The course shall	
●	Provide comprehensive knowledge of industrial electronics and its applications.
●	Develop the ability to analyze and design electronic circuits for industrial use.
●	Impart knowledge on the integration of electronic systems in various industrial processes.
●	Enhance problem-solving skills in industrial electronics.
●	Integrate theoretical concepts with practical applications through case studies and simulations.

UNIT-I	POWER SEMICONDUCTOR DEVICES	09
Study of Switching Devices: SCR, TRIAC, GTO, BJT, MOSFET, IGBT, and IGCT; Static Characteristics: SCR, MOSFET, and IGBT; Triggering and Commutation Circuit for SCR; Introduction to Driver and Snubber Circuits		
UNIT-II	**PHASE-CONTROLLED CONVERTERS**	09
Single-Phase Half and Full Converters; Three-Phase Half Converters and Three-Phase Full Converters; Use of Flywheel Diode in Controlled Rectifier Configurations; Thyristor Triggering Circuits.		
UNIT-III	**INVERTERS AND CHOPPERS**	09
Classification of Inverters: Single-Phase and Three-Phase Voltage Source Inverters (both 120° mode and 180° mode); Introduction to Integrated Power Modules (IPMs), Voltage Open Loop Multi-step Constant-Current Charging (VOOC). Buck-Boost Converter; Voltage and Current Commutated Choppers; PWM Inverters; Principle of Chopper; Chopper Classification; Step-Up and Step-Down Chopper.		
UNIT-IV	**AC TO AC CONVERTERS**	09
Introduction to AC Converters; Types of Regulators; Single-Phase AC Voltage Controller; Multistage Sequence Control; Introduction to VFD, Step-Up and Step-Down Cycloconverters; Single-Phase and Three-Phase Cycloconverters.		
UNIT-V	**INDUSTRIAL APPLICATIONS**	09
Solid-State Switching Circuits, Relays, Electronic Timer, Sawtooth Generator; Applications in Industrial Process Control; Motor Drive Applications; Electronic Regulator; Induction Heating; Dielectric Heating.		
	Total Contact Hours : 45	

Course Outcomes: At the end of this course students be able to:	
CO1	Analyze the characteristics and operations of power semiconductor devices.
CO2	Design and implement phase-controlled converters for various applications.
CO3	Utilize inverters and choppers in industrial electronics
CO4	Apply AC to AC converters in industrial systems.
CO5	Implement industrial applications using solid-state switching circuits and heating methods.

Textbooks:	
1	Biswanath Paul, "Industrial Electronics and Control," PHI Learning, 2014.
2	Sen, P. C.. Principles of Electric Machines and Power Electronics. United Kingdom: Wiley, 1997.
3	Bimbhra P.S. “Power Electronics” Khanna Publishers, Fifth Edition, 2012.
4.	Rashid M.H., ‘Power Electronics: Circuits, Devices and Applications’, Pearson Education, PHI Fourth Edition, New Delhi, 2013

Reference Books(s) / Web links:	
1	M.H. Rashid, "Power Electronics: Circuits, Devices and Applications," Pearson, 2014.
2	James A. Rehg, Glenn J. Sartori, "Industrial Electronics," Prentice Hall, 2005.
3	Swayam-NPTEL course on Power Electronics Applications in Power Systems
4	Swayam-NPTEL course on Fundamental of Power Electronics
5.	Swayam-NPTEL course on Advance Power Electronics and Control

CO\ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT23512.1	3	3	2	2	1	-	-	-	-	-	-	-	2	2	1
MT23512.2	3	3	3	2	2	-	-	-	-	-	-	-	2	2	1
MT23512.3	3	3	3	2	3	-	-	-	-	-	-	-	2	2	1
MT23512.4	3	2	3	3	2	-	-	-	-	-	-	-	2	2	1
MT23512.5	3	2	3	3	3	-	-	-	-	-	-	-	2	2	1
Average	**3**	**2.6**	**2.8**	**2.4**	**2.2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**1**

MT23513	BASIC ENGINEERING RESEARCH METHODS	Category	L	T	P	C
		HSM	3	0	0	3

Objectives: The course shall	
●	Provide an understanding of the fundamental principles of engineering research.
●	Develop skills in designing and conducting engineering research.
●	Impart knowledge on data collection, analysis, and interpretation.
●	Enhance abilities in scientific writing and presentation.
●	Integrate theoretical knowledge with practical research applications.

UNIT-I	INTRODUCTION TO ENGINEERING RESEARCH	09
Definition and Scope of Engineering Research: Importance, Objectives, and Types; Research Process: Steps in the research process, Defining the research problem, Formulation of hypothesis; Literature Review: Purpose, Process, Sources of literature, Writing a literature review.		
UNIT-II	**RESEARCH DESIGN AND METHODOLOGY**	09
Research Design: Types of research design, Characteristics of good research design; Sampling Techniques: Probability and non-probability sampling methods, Sample size determination; Data Collection Methods: Primary and secondary data, Data collection instruments (surveys, interviews, observations), Design of experiments.		
UNIT-III	**DATA ANALYSIS AND INTERPRETATION**	09
Data Analysis: Descriptive and inferential statistics, Measures of central tendency and variability, Hypothesis testing, Correlation and regression analysis; Data Interpretation: Techniques for data interpretation, Use of statistical software for data analysis (e.g., SPSS, R, MATLAB).		
UNIT-IV	**SCIENTIFIC WRITING AND PRESENTATION**	09
Scientific Writing: Structure and components of a research paper, Writing proposals, Abstracts, Introductions, Literature reviews, Methods, Results, Discussions, Conclusions, and References; Presentation Skills: Effective presentation techniques, Use of visual aids, Poster presentations, Oral presentations.		
UNIT-V	**ETHICS AND PATENTS IN RESEARCH**	09
Research Ethics: Ethical issues in research, Plagiarism, Informed consent, Confidentiality, Ethical approval process; Intellectual Property Rights: Patents, Trademarks, Copyrights, Filing patents, Case studies on patents in engineering.		
	Total Contact Hours :	**45**

Course Outcomes: At the end of this course students be able to:	
CO1	Understand the fundamental principles and objectives of engineering research.
CO2	Design and conduct engineering research using appropriate methodologies.
CO3	Analyze and interpret research data using statistical tools.
CO4	Write scientific documents and present research findings effectively.
CO5	Apply ethical standards in research and understand the process of patenting inventions.

Textbooks:	
1	C.R. Kothari, "Research Methodology: Methods and Techniques," New Age International, 2004.
2	Ranjit Kumar, "Research Methodology: A Step-by-Step Guide for Beginners," Sage Publications, 2014.
3	John W. Creswell, "Research Design: Qualitative, Quantitative, and Mixed Methods Approaches," Sage Publications, 2014.

Reference Books(s) / Web links:	
1	Wayne C. Booth, Gregory G. Colomb, Joseph M. Williams, "The Craft of Research," University of Chicago Press, 2008.
2	Nicholas Walliman, "Research Methods: The Basics," Routledge, 2011.
3	NPTEL Course on Research Methodology and Statistical Analysis

CO\ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT23513.1	3	2	1	3	1	-	-	2	2	2	-	1	1	2	1
MT23513.2	2	3	3	3	2	-	1	2	1	3	-	1	1	2	-
MT23513.3	1	2	3	3	3	-	2	2	2	3	-	2	-	1	2
MT23513.4	1	1	2	3	3	-	1	1	1	3	-	1	-	1	2
MT23513.5	1	1	2	2	3	-	3	3	2	2	-	1	-	3	2
Average	**1.60**	**1.80**	**2.20**	**2.80**	**2.40**	**-**	**1.75**	**2**	**1.60**	**2.60**	**-**	**1.20**	**1**	**1.80**	**1.75**

CS23422	PYTHON PROGRAMMING FOR MACHINE LEARNING	Category	L	T	P	C
		ES	0	0	4	2

Objectives: The course shall enable student:	
●	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.

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		
	Total Contact Hours	**:**	**60**

Course Outcomes: At the end of this course students be able to:	
CO1	Develop a sound understanding of current, modern computational statistical approaches and their application to a variety of datasets.
CO2	Analyze and perform an evaluation of learning algorithms and model selection.
CO3	Compare the strengths and weaknesses of many popular machine learning approaches.
CO4	Appreciate the underlying mathematical relationships within and across machine learning algorithms and the paradigms of supervised and unsupervised learning.
CO5	Design and implement various machine learning algorithms in a range of real-world applications.

Textbooks:	
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(s) / Web links:	
1	Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 2nd Edition, O'Reilly Media Inc, 2019.

CO\ PO	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	3	3	-
CS23422.2	2	1	1	1	1	-	-	-	-	-	1	1	3	2	-
CS23422.3	1	1	2	1	2	-	-	-	-	-	1	1	2	3	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
Average	**1.80**	**1.60**	**2.20**	**1.60**	**1.80**	**-**	**-**	**-**	**1**	**1**	**1.40**	**1**	**2.40**	**2.40**	**2**

MT23522	INDUSTRIAL ELECTRONICS LAB	PC	L	T	P	C
			0	0	2	1

Objectives: The course shall:	
●	Provide comprehensive knowledge of semiconductor manufacturing processes.
●	Develop the ability to analyze and design semiconductor manufacturing systems.
●	Impart knowledge on the application of semiconductor principles in various industries.
●	Enhance problem-solving skills in semiconductor fabrication and process control.
●	Integrate theoretical concepts with practical applications through theoretical studies and simulations.

1.	Analysis of V-I Characteristics of SCR and Impact of Gate Current on Operation			
2.	Investigation of Bidirectional Conducting Properties of TRIAC through V-I Characteristics			
3.	Comparative Study of V-I Characteristics and Operation Modes of MOSFET and IGBT			
4.	Analysis of Output Voltage in Single-Phase Half and Full-Controlled Rectifiers			
5.	Efficiency Analysis of a Step-Up Chopper Using IGBT			
6.	Efficiency Analysis of a Step-Down Chopper Using IGBT			
7.	Control and Analysis of Output Voltage in Single-Phase AC Voltage Controllers			
8.	Speed Control and Performance Analysis of PMDC Motor Using a Chopper Circuit			
9.	Investigation of average output voltage using SCR Phase Control			
10.	Investigation of average output voltage using TRIAC Phase Control			
		Total Contact Hours	**:**	**30**

Course Outcomes: At the end of this course students be able to:	
CO1	Design and test circuits using SCR, TRIAC, MOSFET, and IGBT.
CO2	Implement and evaluate the performance of phase-controlled rectifiers.
CO3	Construct and analyze the operation of DC-DC converters.
CO4	Develop and test inverter circuits for various applications.
CO5	Apply electronic controls in simulated industrial applications.

Textbooks & Reference Materials	
1	Lab manuals and equipment guides will be provided.
2	Access to datasheets for various industrial electronic components.
3	Reference to simulation software for circuit testing and validation.

CO\ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT23522.1	3	3	2	2	3	-	-	-	1	2	-	1	3	-	1
MT23522.2	3	3	3	3	3	-	-	-	2	2	-	2	3	-	2
MT23522.3	2	2	3	2	3	-	-	-	1	3	-	2	2	-	1
MT23522.4	2	2	3	3	3	-	-	-	2	3	-	2	2	-	2
MT23522.5	2	2	3	3	3	-	-	-	2	2	-	2	2	-	2
Average	**2.40**	**2.40**	**2.80**	**2.60**	**3**	**-**	**-**	**-**	**1.60**	**2.40**	**-**	**1.80**	**2.40**	**-**	**1.60**

MT23523	INTERNSHIP	PC	L	T	P	C
			0	0	2	1

Objectives: The course shall:	
●	Provide students with practical experience in an industrial setting.
●	Apply theoretical knowledge gained in the classroom to real-world engineering problems.
●	Enhance professional skills such as teamwork, communication, and problem-solving.
●	Expose students to current industry practices and technologies.
●	Foster networking opportunities and professional relationships.

Internship Details:

- **Duration:** 2 weeks full-time, or the equivalent in part-time hours.
- **Location:** Host companies in relevant industries, matching students' fields of interest and study.
- **Roles:** Students will be placed in roles that align with engineering/service discipline to ensure relevant experience.

Responsibilities:

- Students are expected to engage with assigned projects or daily tasks that contribute to their understanding of the engineering processes in an industrial context.
- Participation in meetings, workshops, and other activities organized by the host company.
- Completion of a daily log or journal detailing their activities and learning experiences.

Assessment:

- **Internship Report:** A comprehensive report detailing the work done, learning outcomes, and personal reflections must be submitted at the end of the internship.
- **Supervisor Evaluation:** Feedback from the industry supervisor focusing on performance, engagement, and professional behaviour.
- **Presentation:** A formal presentation outlining their internship experience, key learnings, and how the experience integrates with their academic knowledge.

Preparation and Support:

- **Pre-Internship Workshops:** Sessions on resume writing, interview preparation, and professional etiquette.
- **Mentorship:** Allocation of a faculty advisor and an industry mentor to provide guidance throughout the internship.
- **Feedback Sessions:** Post-internship sessions with faculty to discuss experiences and integrate learnings into their academic and career planning.

	Total Contact Hours	**:**	**24**

Course Outcomes: At the end of this course students be able to:	
CO1	Apply engineering knowledge in a professional setting.
CO2	Develop professional workplace skills, including teamwork, communication, and problem-solving.
CO3	Comprehend the operational and business aspects of engineering industries.
CO4	Integrate academic knowledge with practical applications.
CO5	Build professional networks and understand industry expectations.

CO\ PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
MT23523.1	3	2	3	3	2	1	-	-	2	2	-	1	2	-	-
MT23523.2	2	2	2	2	3	3	-	2	3	3	-	2	1	-	-
MT23523.3	2	3	1	1	1	2	3	1	1	1	3	2	-	2	1
MT23523.4	3	3	3	3	3	2	2	1	2	3	2	3	3	1	2
MT23523.5	1	2	1	2	1	3	2	2	3	3	2	2	1	3	3
Average	**3**	**2**	**3**	**3**	**2**	**1**	**-**	**-**	**2**	**2**	**-**	**1**	**2**	**-**	**-**

GE23521	**SOFT SKILLS - II**	**Category**	**L**	**T**	**P**	**C**
		EEC	**0**	**0**	**2**	**1**

Objectives: The course shall:	
●	Help students break out of shyness.
●	Build confidence
●	Enhance English communication skills.
●	Encourage students' creative thinking to help them frame their own opinions,

Course Description

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. Post few trials the students are given same opportunity to do the same with the crowd.	The aim of the lesson is designed to teach the art of questioning. It 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 Outcomes: After the successful completion of the course, the student will be able to:	
CO1	Be more confident
CO2	Speak in front of a large audience without hesitation
CO3	Think creatively
CO4	Speak impromptu
CO5	Communicate in English

Reference Books(s) / Web links:
Kings Learning work sheets.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
GE23521.1	-	-	-	-	-	-	-	-	2	3	1	1	-	-	3
GE23521.2	-	-	-	-	-	-	-	-	2	3	2	-	-	-	2
GE23521.3	-	1	-	-	-	-	-	-	2	3	1	1	-	2	3
GE23521.4	-	-	-	-	-	-	-	-	2	3	-	-	-	-	1
GE23521.5	-	1	-	-	-	-	-	-	2	3	1	1	-	1	3
Average	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**3**	**1.25**	**1**	**0**	**1.50**	**2.40**

SEMESTER VI

MT23611	FUNDAMENTALS OF MACHINE DESIGN	Category	L	T	P	C
		PC	2	1	0	3

Objectives: The course shall	
●	Familiarize with various steps involved in the Design Process.
●	Understand the principles involved in evaluating the shape and dimensions of a component to satisfy functional and strength requirements.
●	Learn to use standard practices and standard data.
●	Use catalogues and standard machine components (Use of PSG Design Data Book is permitted).
●	Apply principles of machine design to practical problems and case studies.

UNIT-I	**Fundamental Concepts in Design**	10
Introduction to Robots - factors influencing robot design, selection of materials based on mechanical properties - Modes of failure -Factor of safety – stresses due to bending and torsion moment - Eccentric loading, Design against fluctuating loads - theories of failures.		
UNIT-II	**Design of flexible elements, Shafts, and Couplings**	09
Introduction to flexible elements, Design of belt drives – Flat, Vee, and Timing Belts. Design of solid and hollow shafts based on strength and rigidity, Rigid and flexible couplings.		
UNIT-III	**Joints**	08
Threaded fasteners - Bolted joints – Simple and eccentrically loaded bolted joints. Knuckle joints, Cotter joints, Theory of bonded joints		
UNIT-IV	**Gears**	09
Design of spur Gears - Geometric progression - Standard step ratio – Ray diagram, kinematic layout - Design of sliding mesh gear box - Design of multi speed gear box for machine tool applications.		
UNIT-V	**Bearings**	09
Sliding contact and rolling contact bearings, Hydrodynamic journal bearings, Selection of Rolling Contact bearings.		
	Total Contact Hours : 45	

Course Outcomes: At the end of this course students be able to:	
CO1	Design machine components for various types of loading.
CO2	Carry out shaft design for different applications.
CO3	Design threaded fasteners and joints based on the requirements.
CO4	Design spur gears based on strength and wear considerations.
CO5	Select suitable bearing based on application.

Textbooks:	
1	Bhandari V.B., “Design of Machine Elements”, 5th Edition, Tata McGraw-Hill Book Co, 2020.
2	Joseph Shigley, Charles Mischke, Richard Budynas, and Keith Nisbett, “Mechanical Engineering Design”, 11th Edition, Tata McGraw-Hill, 2019.

Reference Books(s) / Web links:	
1	Alfred Hall, Halowenko, A., and Laughlin, H., “Machine Design”, Tata McGraw-Hill Book Co. (Schaum’s Outline), 2010.
2	Ansel Ugural, “Mechanical Design – An Integral Approach", 1st Edition, Tata McGraw-Hill Book Co, 2003.
3	Merhyle F. Spotts, Terry E. Shoup, and Lee E. Hornberger, “Design of Machine Elements” 8th Edition, Prentice Hall, 2003.
4	Orthwein W., “Machine Component Design”, Jaico Publishing Co, 2003.
5	Robert C. Juvinall and Kurt M. Marshek, “Fundamentals of Machine Design”, 4th Edition, Wiley, 2005.
6	Sundararajamoorthy T.V., Shanmugam N., “Machine Design”, Anuradha Publications, Chennai, 2003.
7	Prabhu T.J., “Design of Transmission Elements”, Mani Offset, Chennai, 2000.

CO\ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT23611.1	3	3	2	2	2	-	-	-	-	-	-	1	3	2	1
MT23611.2	3	3	3	2	2	-	-	-	-	-	-	1	3	2	1
MT23611.3	3	3	3	2	2	-	-	-	-	-	-	1	3	2	1
MT23611.4	3	2	3	3	2	-	-	-	-	-	-	1	3	2	1
MT23611.5	3	2	3	3	2	-	-	-	-	-	-	1	3	2	1
Average	**3**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**	**2**	**1**

MT23612	ETHICS IN ROBOTICS AND ARTIFICIAL INTELLIGENCE	Category	L	T	P	C
		PC	3	0	0	3

Objectives: The course shall:	
●	Explore ethical theories and their applications to robotics and artificial intelligence.
●	Understand the social, legal, and ethical implications of AI and robotics in contemporary settings.
●	Develop critical skills for managing ethical decision-making in AI and robotics deployments.
●	Examine case studies and real-world scenarios to apply ethical considerations effectively.
●	Explore ethical theories and their applications to robotics and artificial intelligence.

UNIT-I	ETHICAL THEORIES AND FOUNDATIONS IN AI AND ROBOTICS	09
Introduction to Ethics: Historical and philosophical perspectives on ethics in technology; Major Ethical Theories: Utilitarianism, Deontology, Virtue Ethics, and their relevance to AI and robotics; Ethical Design: Principles for designing ethical AI systems, including transparency, accountability, and fairness.		
UNIT-II	**SOCIAL AND ETHICAL IMPLICATIONS OF ROBOTICS AND AI**	09
Social Impact: The effect of robotics and AI on employment, privacy, and societal norms; Legal Implications: Overview of laws and regulations that govern AI and robotics; Ethical AI Deployment: Strategies for ethical integration of AI in public and private sectors.		
UNIT-III	**GOVERNANCE AND POLICY IN AI ETHICS**	09
AI Governance: Frameworks for governing AI globally and nationally; Policy Making: Role of policy in shaping ethical AI development; International Guidelines: Discussion on global guidelines like the EU's AI regulations.		
UNIT-IV	**ETHICAL MANAGEMENT OF AI PROJECTS**	09
Project Management: Ethical considerations in project lifecycle from conception to deployment; Risk Assessment: Identifying ethical risks and mitigation strategies in AI projects; Stakeholder Engagement: Involving diverse stakeholders in ethical AI practices.		
UNIT-V	**CASE STUDIES AND FUTURE PERSPECTIVES**	09
Case Studies: Examination of key case studies highlighting ethical challenges and solutions in AI and robotics; Future Trends: Emerging issues and future directions in AI ethics; Leadership in AI Ethics: Developing skills for leading ethically in the technology domain.		
	Total Contact Hours : 45	

Course Outcomes: At the end of this course students be able to:	
CO1	Evaluate ethical frameworks and apply them to decision-making in robotics and AI.
CO2	Analyze the social and legal impacts of robotics and AI on society.
CO3	Develop and implement governance frameworks that ensure ethical compliance in AI projects.
CO4	Manage AI projects with a strong emphasis on ethical practices, transparency, and stakeholder engagement.
CO5	Lead discussions and initiatives on future ethical challenges in AI and robotics.

Textbooks:	
1	Bartneck, Christoph, Christoph Lütge, and Alan Wagner. *An Introduction to Ethics in Robotics and AI*. Springer, 2021.
2	Lin, Patrick, Keith Abney, and Ryan Jenkins, eds. *Robot Ethics 2.0: From Autonomous Cars to Artificial Intelligence*. Oxford University Press, 2017.

Reference Books(s) / Web links:	
1	Wallach, Wendell, and Colin Allen. *Moral Machines: Teaching Robots Right from Wrong*. Oxford University Press, 2009.
2	Chatila, Raja, et al. *Ethics and Robotics*. IOS Press, 2016.

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT23612.1	2	2	2	2	2	2	2	3	-	-	-	-	1	2	1
MT23612.2	2	3	2	3	2	3	2	3	-	-	-	-	2	3	2
MT23612.3	-	2	3	2	2	2	3	3	-	-	2	-	2	3	2
MT23612.4	-	2	3	3	2	2	2	3	2	2	3	-	1	2	3
MT23612.5	-	-	3	-	-	-	2	3	3	2	2	-	1	2	3
Average	**2.0**	**2.3**	**2.6**	**2.5**	**2.0**	**2.3**	**2.2**	**3.0**	**2.7**	**2.0**	**2.5**	**-**	**1.4**	**2.4**	**2.2**

MT23631	INDUSTRIAL ROBOTICS	Category	L	T	P	C
		PC	2	1	2	4

Objectives: The course shall	
●	Introduce the basics of Industrial Robotics and its components.
●	Explain the kinematics of Industrial Robots.
●	Discuss various robot programming languages and methods.
●	Explore the basics of Robot Operating System (ROS).
●	Examine the applications of robots in industry.

UNIT I	FUNDAMENTALS OF ROBOTICS	9
Introduction to robots, classification of robots, serial and parallel manipulators, robot anatomy, robot configurations, work volume, structure, performance, mechanical grippers (screw type, rotary actuators, cam type, magnetic, vacuum, air-operated), gripper force analysis, and design. open-loop study with stepper motor, Closed-loop study with servo motor.		
UNIT-II	**KINEMATICS OF INDUSTRIAL ROBOTS**	**10**
Coordinate frames, rotations, homogeneous coordinates, link coordinates, D-H representation, arm equation, multi-axis robot inverse kinematic problem, inverse kinematics of multi-axis robots. Path planning, Trajectory planning.		
UNIT-III	**ROBOT LANGUAGES AND PROGRAMMING**	**9**
Robot language structure, textual and generations of robot programming languages, constants, variables, data objects, motion commands, end effector and sensor commands, methods of robot programming, motion interpolation, program control, and subroutines. Python for Robots.		
UNIT-IV	**INTRODUCTION TO ROBOT OPERATING SYSTEMS (ROS)**	**08**
ROS concepts, writing ROS nodes, ROS tools, messages, classes, servers, simulation, and visualization in ROS. Industrial ROS, ROS examples, Programming for point to point/continuous.		
UNIT-V	**APPLICATIONS OF INDUSTRIAL ROBOTS**	**09**
Robot applications in welding, palletizing, material handling and processing, recent trends in industrial robots, building of grippers. Mobile robot locomotion: Types of locomotion, hopping robots, legged robots, wheeled robots Introduction to cobot and its applications in industries.		
	Theory Contact Hours :	**45**

List of Experiments

1. Study different types of robots based on configuration, links, joints, and applications.
2. Examine components of robots with drive systems and end effectors.
3. Determine the maximum and minimum positions of links.
4. Model forward and inverse kinematics for 3 and 4-axis robotic arms.
5. Perform the machine tending operation of a six-axis robot using a teach pendant.
6. Perform the palletizing operation of a six-axis robot using a teach pendant.
7. Offline programming of a six-axis robot using robotics simulation software.
8. Identify a simple part using machine vision technology.

Lab Contact Hours	:	**30**
Total Contact Hours	:	**75**

Course Outcomes: Upon completion of this course the students will be able to	
CO1	Understand the basic concepts and components of industrial robotics.
CO2	Apply kinematics to solve problems related to industrial robot motion.
CO3	Develop and implement robot programs using various programming languages.
CO4	Utilize ROS for robot simulation and control.
CO5	Analyze and apply industrial robots in real-world applications.

Text Book (s):	
1	Saeed B. Niku, Introduction to Robotics: Analysis, Control, Applications, Wiley Publications, 2020
2	Industrial Robotics, Groover, Tata McGraw-Hill, 2012

Reference Books(s) / Web links:	
1	Saha S K, ―Introduction to Robotics, Tata McGraw Hill Education Pvt. Ltd, 2010.
2	Wyatt Newman A Systematic Approach to Learning Robot Programming with ROS, CRC Press, 2018

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT23631.1	3	2	1	2	3	1	1	2	2	2	1	2	3	2	1
MT23631.2	3	3	2	3	2	1	1	2	2	1	2	2	3	2	2
MT23631.3	3	3	3	3	3	2	1	2	3	2	1	3	3	2	3
MT23631.4	2	3	3	3	3	2	2	2	3	2	1	3	3	3	3
MT23631.5	3	2	2	2	2	2	2	2	3	2	2	3	3	2	2
Average	**2.8**	**2.6**	**2.4**	**2.6**	**3.0**	**2.2**	**1.4**	**1.6**	**2.0**	**1.4**	**1.8**	**2.6**	**3.0**	**2.4**	**2.2**

MT23632	APPLIED HYDRAULICS AND PNEUMATICS	Category	L	T	P	C
		PC	2	1	2	4

Objectives:	
●	Demonstrate and provide an understanding of the principles and working of fluid power systems.
●	Provide basic knowledge about the various sources and properties of fluid power systems.
●	Educate and provide an understanding of the components and operation of hydraulic and pneumatic systems.
●	Enable students to design and implement pneumatic and hydraulic circuits for various applications.
●	Equip students with the skills to troubleshoot and maintain hydraulic and pneumatic systems in industrial applications.

UNIT I	**FLUID POWER BASICS**	**08**
Introduction to Fluid power, Advantages and Applications, Fluid power systems – Types of fluids, Properties of fluids, Basics of Hydraulics – Pascal's Law, Principles of flow – Laminar and Turbulent flow, Reynolds number, Darcy's equation, Losses in fluid power system, Problems. Properties of air, Perfect Gas Laws, Static head pressure, Vacuum-Problems. Machine plumbing, Sizing pneumatic lines – types of layout, pipe materials and sizes, O-rings, Sizing hydraulic lines, Suction line, Return lines, Working Pressure lines.		
UNIT-II	**SOURCE OF FLUID POWER**	**08**
Sources of Hydraulic power: Pumping Theory, Pump Classification, Construction, Working, Design, Advantages, and Disadvantages, Performance, Selection criterion of Linear, Rotary- Fixed and Variable displacement pumps - Problems. Types of compressor, Construction and working of compressor, Performance of compressor, Need for compressed air conditioning – pneumatic dryer, Filter, regulator and lubricator, Muffler – purpose and types.		
UNIT-III	**COMPONENTS OF HYDRAULIC AND PNEUMATIC SYSTEMS**	**10**
Hydraulic and Pneumatic actuators – Types – linear and rotary, Construction and working of double acting cylinder, special actuators – rod less, tandem, telescopic cylinders, flexible actuators. Cushioning mechanism. Types of actuating mechanism. Sensors – limit switches, reed switches and pressure switches. Direction control, Flow control and Pressure control valves, Quick Exhaust valve, sequencing and relief valve - Types, Construction and Operation, Power pack. Fluid Power ANSI Symbols.		
UNIT-IV	**HYDRAULIC AND PNEUMATIC CIRCUITS**	**10**
Design of hydraulic circuits, Speed and force calculation of linear actuator, Accumulators, Intensifiers, Regenerative, Pump Unloading, Double- pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail- safe, Speed control, Hydrostatic transmission. Design of pneumatic circuits - Cascade method - Sequencing Circuits Design - Combinational Logic Circuit Design. Introduction to Fluidics, Pneumatic logic circuits. Electrical control of pneumatic and hydraulic circuits: relays, timers, counters.		
UNIT-V	**SERVO MECHANISM AND TROUBLESHOOTING**	**09**
Servo systems - Hydro Mechanical servo systems, Electro hydraulic servo systems and proportional valves. Installation and maintenance of hydraulic and pneumatic systems - pressure compensation - temperature effects - fault finding - safety procedures. Low-cost Automation - Applications of fluid power systems – Case studies. Emerging trends and innovations in fluid power systems.		
	Theory Contact Hours : 45	

List of Experiments

1. Study of hydraulic and pneumatic components and standard symbols.
2. Design and execution of Logic circuits using pneumatic trainer kit.
3. Design and execution of speed control of pneumatic and hydraulic actuators.
4. Design and execution of flow control and pressure control of Pneumatic system.
5. Design and execution of flow and pressure of Hydraulic system.
6. Design and execution of electro pneumatic circuit with programmed logic sequence using a PLC.
7. Modeling and simulation of hydraulic system model using MATLAB/LabVIEW software.
8. Design and simulation of pneumatic circuit for the sequential operation.
9. Design and simulation of hydraulic circuit for the sequential operation.
10. Design and simulation of electro pneumatic circuit for the sequential operation.
11. Design and execution of electro pneumatic circuit using electro pneumatic trainer kit.
12. Design and simulation of Pneumatic Sequencing circuit by cascade method using pneumatic software.

	Lab Contact Hours	**:**	**30**
	Total Contact Hours	**:**	**75**

Course Outcomes: Upon completion of this course the students will be able to	
CO1	Design and analyze the performance of hydraulic and pneumatic actuators by recalling operating principles of fluid power systems
CO2	Exhibit the knowledge on selection and application of components of fluid power systems
CO3	Understand and clarify the specific functional operations of hydraulic and pneumatic systems
CO4	Identify problems and design suitable circuits using pneumatic and hydraulic software
CO5	Troubleshoot, maintain, and optimize the performance of hydraulic and pneumatic systems

Text Book (s):	
1	Anthony Esposito, “Fluid Power with Applications”, Prentice Hall, 2013.
2	Majumdar.S.R, “Oil Hydraulic System-Principle and Maintenance”, Tata McGraw Hill, 2012.

Reference Books(s) / Web links:	
1	Dudelyt, A Pease and John J Pippenger, “Basic Fluid Power”, Prentice Hall, 1987.
2	Joji.P, “Pneumatic Controls”, Wiley India, 2008.
3	Majumdar, S.R., “Pneumatic Systems – Principles and Maintenance”, Tata McGraw Hill, 2007.
4	Shanmugasundaram.K, “Hydraulic and Pneumatic Controls”, Chand & Co, 2006.
5	Srinivasan.R, “Hydraulic and Pneumatic Controls”, Vijay Nicole Imprints, 2008.

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT23632.1	3	3	3	2	3	2	1	-	2	1	2	3	2	2	3
MT23632.2	3	2	2	2	2	1	-	-	2	1	1	2	3	3	2
MT23632.3	3	2	3	1	2	1	-	-	1	1	1	2	3	2	2
MT23632.4	3	3	3	2	3	1	1	-	2	1	1	2	1	2	2
MT23632.5	3	3	3	3	2	2	1	-	2	1	1	2	3	2	1
Average	3	2.6	2.8	2.0	2.4	1.4	0.6	-	1.8	1	1.2	2.2	2.4	2.2	2

GE23621	PROBLEM SOLVING TECHNIQUES	Category	L	T	P	C
		EEC	0	0	2	1

Objectives: This laboratory course enables students

- To improve the numerical ability
- To improve problem-solving skills.

Topics covered	
1	Numbers system
2	Reading comprehension
3	Data arrangements and Blood relations
4	Time and Work
5	Sentence correction
6	Coding & Decoding, Series, Analogy, Odd man out and Visual reasoning
7	Percentages, Simple interest and Compound interest
8	Sentence completion and Para-jumbles
9	Profit and Loss, Partnerships and Averages
10	Permutation, Combination and Probability
11	Data interpretation and Data sufficiency
12	Logarithms, Progressions, Geometry and Quadratic equations.
13	Time, Speed and Distance
	Total Contact Hours : 30

Course Outcomes: On completion of the course, the student will be able to:	
●	Have mental alertness
●	Have numerical ability
●	Solve quantitative aptitude problems with more confident

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
GE23621.1	1	1	1	-	-	-	-	-	-	-	-	3	1	-	-
GE23621.2	1	1	1	-	-	-	-	-	-	-	-	3	1	-	-
GE23621.3	1	1	1	-	-	-	-	-	-	-	-	3	1	-	-
Average	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**1**	**-**	**-**

GE23627	DESIGN THINKING AND INNOVATION	EEC	L	T	P	C
			0	**0**	**4**	**2**

Objectives: The students will be able to

- To understand the design thinking concepts and deep understanding of user needs and experiences.
- To find the problem statement and To develop innovative design solutions that address identified user challenges
- To master the process of prototyping and iterating on designs.
- To conduct thorough market analysis and financial planning
- To effectively communicate design concepts and findings.

The mechatronics students are required to submit a mini project by implementing the concepts of design thinking, and the project shall be evaluated as per the norms of project work. The students can form a team of max. 3 students, and a mentor will be allotted for this purpose. The students will be encouraged to get teammates from other branches of study to promote inter disciplinary project. The assessment will be similar to that of project work.

Unit-I: Introduction to Design Thinking: The design thinking concepts - Different design thinking models - Details of Stanford Design thinking process: Empathize, Define, Ideate, Prototype, Test

Activities:

- Case studies of successful domain based Design Thinking and Innovative projects
- Group discussions on design thinking

Unit 2: Empathize and Define: User research methods (interviews, surveys, observation, contextual inquiry) - Persona development- Journey mapping – Brainstorming Defining the design problem statement

Activities:

- Conducting user interviews and surveys
- Creating user personas and journey maps
- Identifying key user needs and pain points
- Analyze the user needs and Brainstorming to define problem statement

Unit 3: Ideate and Create: Brainstorming techniques (e.g., mind mapping, SCAMPER) - Ideation tools (e.g., design thinking tools, concept sketching) - Concept generation and evaluation (e.g. Brainstorming)

Activities:

- Group brainstorming sessions to select the best idea
- Creating concept sketches and prototypes
- Evaluating ideas based on user needs and feasibility

Unit 4: Prototype and Test: Low, Medium and high level fidelity for prototyping-Usability testing -Iterative design

Activities:

- Building low-fidelity prototypes (e.g., paper prototypes)
- Conducting usability tests with users
- Iterating on designs based on feedback

Unit 5: Market Analysis and Implementation: Market research and analysis - Business model development- Financial planning-Implementation strategies

Activities:

- Conducting market research
- Developing a business model canvas
- Creating a financial projection
- Developing an implementation plan

Course Outcomes: Upon completion of this course the students will be able to	
CO1	Construct design challenge and reframe the design challenge into design opportunity.
CO2	Interview the user, and know the feelings of users to foster deep user understanding and be able to uncover the deep user insights and needs.
CO3	Develop ideas and prototypes by brainstorming.
CO4	Organize the user walkthrough experience to test prototype
CO5	Develop smart strategies and implementation plan that will deliver/achieve the idea/solution deduced from earlier phases.

Assessment:

- Encourage students to work on real-world design challenges based on the user needs
- Group presentations
- Quizzes and exams
- Evaluation of Project report and viva and also encourage the students for filing patent/ copyright / presenting in conference / publishing in journal

Text Book(s):	
1	Handbook of Design Thinking by Christian Müller-Roterberg, Kindle Direct Publishing, 2018**.**
2	Design Thinking – A Beginner's Perspective, by E Balagurusamy, Bindu Vijakumar, MC Graw Hill, 2024
Reference Books:	
1	Design Thinking for Entrepreneurs and Small Businesses: Putting the Power of Design to Work – by Beverly Rudkin Ingle, Apress; 1st ed. Edition, 2013
2	Design Thinking: Understanding How Designers Think and Work by Nigel Cross, Bloomsbury Visual Arts; 2 edition 2023
Web links	
1	Design thinking Guide https://www.rcsc.gov.bt/wp-content/uploads/2017/07/dt-guide-book-master-copy.pdf
2	NPTEL Course on Design Thinking and Innovation By Ravi Poovaiah ; https://onlinecourses.swayam2.ac.in/aic23_ge17/preview
3	IITB Design course tools and Resources https://www.dsource.in/

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
GE23627.1	3	2	3	3	3	2	2	3	3	3	3	3	2	2	3
GE23627.2	3	2	3	3	3	2	2	3	3	3	3	3	3	3	2
GE23627.3	3	2	3	3	3	2	2	3	3	3	3	3	3	2	2
GE23627.4	3	2	3	3	3	2	2	3	3	3	3	3	1	2	2
GE23627.5	3	2	3	3	3	2	2	3	3	3	3	3	3	2	1

SEMESTER VII

MT23711	INDUSTRIAL AUTOMATION	Category	L	T	P	C
		PC	2	1	0	3

Objectives: The course shall	
●	Abstract the importance of Automation and PLC Programming
●	Detail the architecture components of production plants using DCS
●	To understand the working of SCADA elements
●	Compare the working of SCADA, DCS and PLC
●	Teach the working of networking in industries

UNIT-I	**INDUSTRIAL AUTOMATION AND PLC PROGRAMMING**	**09**
Introduction to Industrial Process Automation-Definition, Necessity, Evolution, Types, Challenges of Automation Architecture of Industrial Automation Network- Process Automation with Smart and Intelligent Instruments- Industry 1.0 to Industry 4.0. PLC Program Structure and Execution - Programming Devices for PLC - PLC Programming Tools-Timer – Counters - Registers-Advanced PLC Functions - PLC Protocols- Selection and Commissioning of PLC		
UNIT-II	**DISTRIBUTED CONTROL SYSTEM (DCS)**	**09**
Computers in Process Automation-Architecture of Computer-Based Industrial Automation System-Hardware and Software Configuration-Process Automation Network-PC-Based Control Loop-Sampling of Process Data- Distributed Control System-Hardware Units of DCS-Communications in DCS Architecture-Software Packages of DCS-Operation, Monitoring, Control, and Data Acquisition in DCS-Integration of DCS with PLC and SCADA DCS based Process Control Simulations.		
UNIT-III	**SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA)**	**09**
Introduction-SCADA Basics-Different SCADA System Topologies-Evolution of SCADASCADA Architecture-Functions of SCADA-Elements of SCADA-SCADA, DCS, and PLC: A Comparison-SCADA Security: Threats, Vulnerabilities, and Consequences-SCADA Standards Organizations-Application Areas of SCADA-SCADA and IIoT SCADA Implementations for Automation Industries		
UNIT-IV	**INDUSTRIAL NETWORKING & M2M COMMUNICATION**	**09**
Introduction to industrial Networking-Network Devices- Fieldbus-Types- Topology-Benefits- Foundation Fieldbus-Comparison with OSI Model-Medium Access Control (MAC)- PROFIBUS-Communication via PROFIBUS,PROFINET,DP Bus Access-HART: Highway Addressable Remote Transducer-Wireless field bus-WHART-M2M Communication and Technologies-M2M Communication Protocols.		
UNIT-V	**INDUSTRIAL INTERNET OF THINGS (IIOT)**	**09**
Introduction: IoT and IIoT - Evolution of IIoT – Architecture of IoT and IIoT – IIoT Protocols – Layout of a Smart Factory – Benefits, Challenges, Technological components of IIOT – Difference between IoT and IIoT – Application areas of IIoT		
	Total Contact Hours : 45	

Course Outcomes: On completion of course students will be able to	
CO1	Discuss PLC programs for Industrial Automation Process
CO2	Explain the architecture layout for Automation Production Plant
CO3	Analyze the components and implementation of SCADA in process industries
CO4	Determine the types of Networking in Industries
CO5	Justify the difference in IoT and IIoT

Text Books:	
1	Dey, Chanchal, and Sunit Kumar Sen, Industrial automation technologies, 2020, CRC Press.
2	Gilchrist, Alasdair, Industrial Internet use-cases. Industry 4.0., 2016, Apress, Berkeley, CA.

Reference Books / Web links:	
1	Johnson, David. Programmable Controllers for Factory Automation, 2020, CRC Press.
2	Sharma, K. L. S. Overview of industrial process automation, 2016, Elsevier.
3	Mikell P Groover, Automation, Production Systems and Computer Integrated Manufacturing, 2016, Pearson.
4	Frank D. Petruzella, Programmable Logic Controllers, 2019, Mc-Graw Hill.
5	Veena S. Chakravarthi, Internet of Things and M2M Communication Technologies Architecture and Practical Design Approach to IoT in Industry 4.0, Springer 2021.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT23711.1	1	2	3	1	2	1	-	-	1	2	-	-	2	2	2
MT23711.2	1	2	3	1	2	1	-	-	1	2	-	-	2	2	2
MT23711.3	1	2	3	1	2	1	-	-	1	2	-	-	2	2	2
MT23711.4	1	2	3	1	2	-	-	-	1	2	-	-	2	2	2
MT23711.5	1	2	3	1	2	-	-	-	1	2	-	-	2	2	2
Average	1.8	2	2.2	1	2	1	-	-	1	2	-	-	2	2	2

MT23712	MACHINE VISION	Category	L	T	P	C
		PC	3	1	0	4

Objectives: The course shall	
•	Enable students to understand the basics of vision systems.
•	Teach the algorithms of vision systems.
•	Instruct students on recognition techniques for objects.
•	Provide knowledge on the applications and software for vision systems.
•	Develop skills for implementing vision systems in robotic applications.

UNIT-I	VISION SYSTEMS	12
Basic Components – Elements of visual perception, Lenses: Pinhole cameras, Gaussian Optics – Cameras – Camera-Computer interfaces		
UNIT-II	**VISION ALGORITHMS**	**12**
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**	**12**
Object recognition, Approaches to Object Recognition, Recognition by combination of views – objects with sharp edges. Deep Learning Methods: Image classification, object detection and semantic segmentation		
UNIT-IV	**APPLICATIONS**	**12**
Face detection – Face recognition – foreground-background separation – particle filters – Chamfer matching, tracking, and occlusion – combining views from multiple cameras – human gait analysis-Application: Surveillance - In-vehicle vision system, Automotive Industries, Manufacturing, Electronics, Printing, Pharmaceutical, Biomedical, Robotics, Agricultural field.		
UNIT-V	**ROBOTS VISION**	**12**
Basic introduction to Robotic operating System (ROS) - Real and Simulated Robots - Introduction to OpenCV, Open NI and PCL, installing and testing ROS camera Drivers, ROS to OpenCV – The cv_bridge Package.		
	Total Contact Hours : 60	

Course Outcomes: After the successful completion of the course, the student will be able to:	
●	Understand the fundamentals of vision systems.
●	Determine appropriate vision algorithms for object prediction.
●	Design object recognition techniques for detecting objects.
●	Develop simple vision-based robot applications.
●	Apply various software tools in vision robots for different applications.

Text Book (s):	
1	Carsten Steger, Markus Ulrich, Christian Wiedemann, "Machine Vision Algorithms and Applications", WILEY-VCH, Weinheim,2008.
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, 2007.
2	Shimon Ullman, "High-Level Vision: Object recognition and Visual Cognition", A Bradford Book, USA, 2000
3	R.Patrick Goebel, " ROS by Example: A Do-It-Yourself Guide to Robot Operating System – Volume I", A Pi Robot Production, 2012.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT23712.1	3	3	3	2	1	-	-	-	-	-	-	-	2	2	1
MT23712.2	3	3	3	2	1	-	-	-	-	-	-	-	3	3	3
MT23712.3	3	3	3	3	2	2	-	-	-	-	-	1	3	2	3
MT23712.4	3	3	3	1	-	1	-	-	-	-	-	1	1	1	2
MT23712.5	3	2	2	1	-	1	-	-	-	-	-	2	3	1	3
Average	**3**	**2.8**	**2.8**	**1.8**	**1.3**	**1.3**	**-**	**-**	**-**	**-**	**-**	**1.3**	**2.4**	**1.8**	**2.4**

MT23721	COMPUTER AIDED ENGINEERING LABORATORY	Category	L	T	P	C
		PC	0	0	2	1

Objectives: The course shall	
●	Enable students to model parts using CAD software.
●	Teach students to assemble mechanical components using CAD software.
●	Provide experience in performing structural analysis using FEA software.

●	Demonstrate beam deflection analysis using FEA software.
●	Instruct students on tool path simulation for turning and milling using CAM software.

	List of Experiments			
1	Modelling of a part using any CAD package			
2	Modelling and assembling of the mechanical assembly using any CAD package			
3	Structural analysis using FEA software – any analysis package			
4	Beam deflection analysis using FEA software – any analysis package			
5	Modelling and tool path simulation – turning using any CAM package			
6	Modelling and tool path simulation – milling using any CAM package			
7	NC code generation for milling using any CAM package			
8	NC code generation for turning using any CAM package			
9	Mini project involving modeling and assembly of any real-time component.			
		Total Contact Hours	**:**	**30**

Course Outcomes: On completion of the course, the student will be able to:	
●	Model individual parts using CAD software.
●	Assemble mechanical components using CAD software.
●	Perform structural analysis and beam deflection analysis using FEA software.
●	Simulate tool paths for turning and milling using CAM software.
●	Generate NC codes for milling and turning operations using CAM software.

CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
MT23721.1	3	2	3	2	3	-	-	-	2	1	-	-	3	2	2
MT23721.2	3	2	3	2	3	-	-	-	2	1	-	-	3	2	2
MT23721.3	3	2	3	3	3	-	-	-	2	1	-	-	3	2	2
MT23721.4	3	2	3	3	3	-	-	-	2	1	-	-	3	2	2
MT23721.5	3	2	3	3	3	-	-	-	2	1	-	-	3	2	2
Average	**3**	**2**	**3**	**2.6**	**3**	**-**	**-**	**-**	**2**	**1**	**-**	**-**	**3**	**2**	**2**

MT23722	**INDUSTRIAL AUTOMATION LABORATORY**	**PC**	**L**	**T**	**P**	**C**
			0	0	2	1

Objectives:	
●	To understand the hardware and software components of PLC
●	To develop a Ladder logic program for Machine Control
●	To establish a ladder logic for conveyor-based sorting applications
●	To generate ladder logic program for domestic and industrial applications
●	To acquire the data logging process in Mindsphere

	List of Experiments			
1.	Design and Implementation of Timers and Counters using PLC Trainer Kit.			
2.	Wiring of Basic Field Devices to PLC.			
3.	Design and Implementation of Servo Motor Control using VFD Technique.			
4.	Design and Implementation of Machining Process using PLC.			
5.	Design and Implementation of Conveyor Control using HMI.			
6.	Design and Implementation of Material Sorting System using PLC.			
7.	Design and Implementation of Bottle Filling Process using PLC.			
8.	Design and Implementation of Washing Machine Control using PLC.			
9.	Design and execution of Wireless Data Logging using MindSphere			
10.	Design and execution of alarm control using SCADA			
		Total Contact Hours	**:**	**30**

Course Outcomes: On completion of the course, the student will be able to:	
●	Develop PLC programs for Industrial Automation Process
●	Design the architecture layout for Automation Production Plant
●	Analyze the components and implementation of SCADA in process industries
●	Determine the types of Networking in Industries
●	Justify the difference in IoT and IIoT

Web links for virtual lab (if any)	
1	https://plc-coep.vlabs.ac.in/

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT23722.1	3	2	2	1	3	-	-	-	2	1	-	-	3	2	2
MT23722.2	3	3	3	2	3	-	-	-	2	1	-	-	3	2	2
MT23722.3	3	3	3	2	3	-	-	-	2	1	-	-	3	2	2
MT23722.4	3	2	3	2	3	-	-	-	2	1	-	-	3	2	2
MT23722.5	3	2	3	2	3	-	-	-	2	1	-	-	3	2	2
Average	**3**	**2.4**	**2.8**	**1.8**	**3**	**-**	**-**	**-**	**2**	**1**	**-**	**-**	**3**	**2**	**2**

MT23723	MECHATRONICS PROBLEM SOLVING USING AI, ML AND DL	EEC	L	T	P	C
			-	-	4	2

Objectives: The course shall”	
●	Provide an understanding of the application of AI, ML, and DL in mechatronics.
●	Develop problem-solving skills through mini-projects.
●	Enable students to integrate AI, ML, and DL techniques into mechatronics systems.
●	Foster innovation and creativity in designing smart mechatronic solutions.
●	Promote teamwork and project management skills.

GUIDELINE FOR REVIEW AND EVALUATION	
	Students will work on various case studies provided by their respective mentors. These case studies will involve solving real-world mechatronics problems using AI, ML, and DL techniques. Each case study will be supervised by a faculty member, and students will be required to present their progress and final results. Assessment: 1. **Initial Proposal Presentation (10%):** Students will present their initial proposal for the case study, including objectives, methodology, and expected outcomes. 2. **Mid-term Progress Report (20%):** Students will submit a mid-term report detailing their progress, challenges faced, and solutions implemented. 3. **Final Project Report (30%):** A comprehensive report covering the entire case study, including problem statement, methodology, implementation, results, and conclusions. 4. **Final Presentation and Demonstration (30%):** Students will present their final results and demonstrate their solutions. This will include a Q&A session with the faculty and peers.

Course Outcomes: On completion of the course, the student will be able to:	
●	Apply AI, ML, and DL techniques to solve mechatronics problems.
●	Analyze and develop smart mechatronic solutions based on case studies.
●	Work effectively in teams to manage and execute case study projects.
●	Present case study findings and results clearly and concisely.
●	Demonstrate innovation and creativity in designing intelligent systems.

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT23723.1	3	3	3	2	3	1	2	-	2	2	1	3	3	3	2
MT23723.2	3	3	3	3	3	1	2	-	3	3	1	3	3	3	2
MT23723.3	3	3	3	2	3	1	2	-	3	3	1	3	3	3	2
MT23723.4	3	3	3	2	3	1	2	-	2	3	1	3	3	3	2
MT23723.5	3	3	3	2	3	1	2	-	3	3	1	3	3	3	2
Average	**3**	**3**	**3**	**2.2**	**3**	**1**	**2**	**-**	**2.6**	**2.8**	**1**	**3**	**3**	**3**	**2**

MT23724	PROJECT WORK PHASE 1	EEC	L	T	P	C
			-	-	4	2

Objectives: This laboratory course enables students to	
●	Facilitate the application of engineering knowledge to real-world problems.
●	Encourage innovation and creativity in project design and implementation.
●	Develop project management and teamwork skills.
●	Enhance research and analytical skills.
●	Promote effective communication and presentation of project work.

GUIDELINE FOR REVIEW AND EVALUATION	
	Students will work on their selected projects under the supervision of a faculty advisor. This phase will involve problem identification, literature review, project planning, and initial development work.

The assessment for this course will be based on continuous internal assessment and end-semester examinations as follows:

Assessment Component	Marks
Continuous Internal Assessment	
Review I	5
Review II	10
Review III	15
Supervisor Assessment	10
End Semester Examinations	
Report Evaluation by the Supervisor	10
Report Evaluation by the External Examiner	10
Viva-Voce	40
Total	100

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

- Identify and define a significant engineering problem.
- Conduct a thorough literature review and gather relevant information.
- Develop a detailed project plan and execute initial development work.
- Work effectively in teams and manage project tasks efficiently.
- Communicate project progress and findings effectively through written reports and presentations.

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT23724.1	3	3	3	2	2	1	2	-	3	2	2	3	3	3	2
MT23724.2	3	3	3	3	2	1	2	-	3	2	2	3	3	3	2
MT23724.3	3	3	3	2	2	1	2	-	3	2	2	3	3	3	2
MT23724.4	3	3	3	2	2	1	2	-	3	2	2	3	3	3	2
MT23724.5	3	3	3	3	2	1	2	-	3	2	2	3	3	3	2
Average	**3**	**3**	**3**	**2.4**	**2**	**1**	**2**	**-**	**3**	**2**	**2**	**3**	**3**	**3**	**2**

SEMESTER VIII

MT23821	PROJECT WORK PHASE II	EEC	L	T	P	C
			-	-	16	8

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

The project report shall carry a maximum of 30 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 50 marks. Marks are awarded to each student of the project group based on the individual performance in the viva-voce examination

The assessment for this course will be based on continuous internal assessment and end-semester examinations as follows:

Assessment Component	**Marks**
Continuous Internal Assessment	
Review I	5
Review II	10
Review III	15
Supervisor Assessment	10
End Semester Examinations	
Report Evaluation by the Supervisor	10
Report Evaluation by the External Examiner	10
Viva-Voce	40
Total	100

Course Outcomes: On completion of the course, the student will be able to:	
●	Identify and define a significant engineering problem.
●	Conduct a thorough literature review and gather relevant information.
●	Develop a detailed project plan and execute initial development work.
●	Work effectively in teams and manage project tasks efficiently.
●	Communicate project progress and findings effectively through written reports and presentations.

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT23821.1	3	3	3	2	2	1	2	-	3	2	2	3	3	3	2
MT23821.2	3	3	3	3	2	1	2	-	3	2	2	3	3	3	2
MT23821.3	3	3	3	2	2	1	2	-	3	2	2	3	3	3	2
MT23821.4	3	3	3	2	2	1	2	-	3	2	2	3	3	3	2
MT23821.5	3	3	3	3	2	1	2	-	3	2	2	3	3	3	2
Average	**3**	**3**	**3**	**2.4**	**2**	**1**	**2**	**-**	**3**	**2**	**2**	**3**	**3**	**3**	**2**

PROFESSIONAL ELECTIVE COURSES
VERTICAL A – COMPUTATIONAL ENGINEERING

ME23A11	MACHINE LEARNING FOR INTELLIGENT SYSTEMS	PE	L	T	P	C
			3	0	0	3

Objectives:	
●	To introduce basic machine learning techniques such as regression, classification
●	To learn about introduction of clustering, types and segmentation methods
●	To learn about introduction of clustering, types and segmentation methods
●	To learn about basics of neural networks and neuro fuzzy networks.
●	To learn about recurrent neural networks and Reinforcement learning

Unit – I	**Introduction To Machine Learning**	**9**
Philosophy of learning in computers, Overview of different forms of learning, Classifications vs. Regression, Evaluation metrics and loss functions in Classification, Evaluation metrics and loss Functions in Regression, Applications of AI in Robotics.		
Unit – II	**Clustering And Segmentation Methods**	**9**
Introduction to clustering, Types of Clustering, Agglomerative clustering, K-means clustering, Mean Shift clustering, K-means clustering application study, Introduction to recognition, K- nearest neighbor algorithm, KNN Application case study, Principal component analysis (PCA), PCA Application case study in Feature Selection for Robot Guidance.		
Unit – III	**Fuzzy Logic**	**9**
Introduction to Fuzzy Sets, Classical and Fuzzy Sets, Overview of Classical Sets, Membership Function, Fuzzy rule generation, Fuzzy rule generation, Operations on Fuzzy Sets, Numerical examples, Fuzzy Arithmetic, Numerical examples, Fuzzy Logic, Fuzzification, Fuzzy Sets, Defuzzification, Application Case Study of Fuzzy Logic for Robotics Application.		
Unit – IV	**Neural Networks**	**9**
Mathematical Models of Neurons, ANN architecture, Learning rules, Multi-layer Perceptron‘s, Back propagation, Introduction of Neuro-Fuzzy Systems, Architecture of Neuro Fuzzy Networks, Application Case Study of Neural Networks in Robotics.		
Unit – V	**RNN And Reinforcement Learning**	**9**
Unfolding Computational Graphs, Recurrent neural networks, Application Case Study of recurrent networks in Robotics, Reinforcement learning, Examples for reinforcement learning, Markov decision process, Major components of RL, Q-learning. Application Case Study of reinforcement learning in Robotics.		
	Total Contact Hours :	**45**

Course Outcomes: Upon completion of the course students should be able to:	
●	Understand basic machine learning techniques such as regression, classification
●	Understand about clustering and segmentation
●	Model a fuzzy logic system with Fuzzification and Defuzzification
●	Understand the concepts of neural networks and neuro fuzzy networks.
●	Gain knowledge on Reinforcement learning

S. No	**Text Books:**
1.	Micheal Negnevitsky, Artificial Intelligence: A Guide to Intelligent Systems, 3rd Edition, 2001.
2.	Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997
S. No	**Reference Books:**
1.	Bruno Siciliano, Oussama Khatib, ―Handbook of Robotics, 2016 2nd Edition, Springer.
2.	Simon Haykin, ―Neural Networks and Learning Machines: A Comprehensive Foundation Third Edition, Pearson, Delhi 2016.
3.	Timothy J Ross, ―Fuzzy Logic with Engineering Applications, 4th Edition, Chichester, 2010.
4.	https://nptel.ac.in/courses/106106202
5.	https://nptel.ac.in/courses/108104049

PO/PSO	**POs**												**PSOs**		
COs	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
ME23A11.1	3	2	3	2	1	-	-	-	-	-	1	3	2	-	1
ME23A11.2	3	2	3	2	1	-	-	-	-	-	1	3	-	-	2
ME23A11.3	3	2	3	2	1	-	-	-	-	-	1	3	2	2	3
ME23A11.4	2	2	3	2	1	-	-	-	-	-	1	3	2	2	3
ME23A11.5	3	2	3	2	1	-	-	-	-	-	1	3	1	2	3

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

ME23A12	CAD and CAE	Category	L	T	P	C
		PE	3	0	0	3

Objectives:	
·	Applying the fundamental concepts of computer graphics and its tools in a generic framework.
·	Creating and manipulating geometric models using curves, surfaces, and solids.
·	Applying concept of 3D modeling, visual realism, and CAD standard practices in engineering design
·	Developing mathematical models for Boundary Value Problems and their numerical solution.
·	Formulating solution techniques to solve non-linear problems

UNIT-I	FUNDAMENTALS OF COMPUTER GRAPHICS	9
Design process - Computer Aided Design – Computer graphics – co-ordinate systems- 2D and 3D transformations - Graphic primitives (point, line, circle drawing algorithms) - Clipping- viewing transformation. Standards for computer graphics		
UNIT-II	**GEOMETRIC MODELING**	**9**
Representation of curves - Hermite cubic spline curve, Bezier curve, B-spline curves, Surface Modeling – Surface Entities, Representation of Surface, Bezier Surface, B-Spline Surface and Coons Surface. Solid Modeling - Solid Entities, Solid Representation, Boundary Representation (B- Rep), Sweeps Representation, Constructive Solid Geometry (CSG).		
UNIT-III	**VISUAL REALISM and CAD STANDARDS**	**9**
Need for hidden surface removal, The Depth - Buffer Algorithm, Properties that help in reducing efforts, Scan Line coherence algorithm, Span - Coherence algorithm, Area-Coherence algorithms, Warnock's Algorithm, Priority Algorithms– shading – coloring – computer animation. Standards for computer graphics- Graphical Kernel System (GKS) - standards for exchange images Open Graphics Library (OpenGL) - Data exchange standards - IGES, STEP, CALS etc.		
UNIT-IV	**FINITE ELEMENT ANALYSIS**	**9**
Historical Background – Weighted Residual Methods - Basic Concept of FEM – Variational. Formulation of Boundary Value Problems – Ritz Method – Finite Element Modelling – Element Equations – Linear and Higher order Shape functions – Bar, Beam Elements – Applications to Heat Transfer problems.		
UNIT-V	**NON-LINEAR ANALYSIS**	**9**
Introduction to Non-linear problems - some solution techniques- computational procedure- material non-linearity-Plasticity and visco-plasticity, stress stiffening, contact interfaces- problems of gaps and contact - geometric non-linearity - modeling considerations - Free and Mapped meshing –Mesh quality- Error estimate- Introduction to Analysis Software.		
	Total Contact Hours :	**45**

Course Outcomes: At the end of the course, the students would be able to	
·	Discuss the fundamental concepts of computer graphics and its tools in a generic framework.
·	Create and manipulate geometric models using curves, surfaces and solids.
·	Discuss concept of 3D modeling, visual realism and standard CAD practices in engineering design.
·	Develop the mathematical models for one dimensional finite element problems and their numerical solutions.
·	Formulate solution techniques to solve non-linear problems.

Text Books:	
1	Ibrahim Zeid ―Mastering CAD CAM‖ Tata McGraw-Hill Publishing Co.2007
2	Seshu.P, ―Textbook of Finite Element Analysis‖, PHI Learning Pvt. Ltd., NewDelhi, 2012.

Reference Books(s) / Web links:	
1	William M Neumann and Robert F.Sproul ―Principles of Computer Graphics‖, McGraw Hill Book Co. Singapore, 1989.
2	Donald Hearn and M. Pauline Baker ―Computer Graphics‖'. Prentice Hall, Inc, 1992.
3	Foley, Wan Dam, Feiner and Hughes – ―Computer graphics principles & practice‖, Pearson Education - 2003
4	Reddy,J.N. ―Introduction to the Finite Element Method‖, 4thEdition, Tata McGrawHill,2018.

COs / PO/PSO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
ME23A12.1	1	1	1	1	1	2	1	3	2	2	1	2	2	1	1
ME23A12.2	2	1	1	1	1	2	1	3	2	2	1	2	2	1	1
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ME23A12.4	3	3	2	2	2	1	3	2	3	1	1	1	2	1	1
ME23A12.5	3	3	2	2	2	1	3	2	3	1	1	1	2	1	1

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

ME23A13	NUMERICAL HEAT TRANSFER	Category	L	T	P	C
		PE	3	0	0	3

Objectives:	
1	To analyse mathematical and computational methods for fluid flow and heat transfer simulations
2	To use the Nature of Numerical Methods and Methods of Deriving the Discretization Equations
3	To assess the Conduction flow analysis
4	To assess the flow of Convection and Diffusion flow analysis
5	To assess the flow parameters in internal and external flows

Unit – I	Mathematical Description of Physical Phenomena	9
Governing Differential Equation – Meaning of Differential Equation, Conservation of Chemical Species, The Energy Equation, A Momentum Equation, and The Time -Average Equation for Turbulent -Flow, The General Differential Equations. Nature of Coordinates – Independent variables, Proper choice of coordinates, one-way and two-way coordinates problem.		
Unit – II	**Discretization Methods**	**9**
The Nature of Numerical Methods – The Task, The Discretization concept, The structure of Discretization Equation. Methods of Deriving the Discretization Equations- Taylor Series Formulation, Variation Formulation , Method of Weighted Residuals, Control volume Formulation and examples		
Unit – III	**Heat Conduction**	**9**
Steady one-dimensional conductions, The Basic Equations, The Grid Spacing, The interface Conductivity, Nonlinearity, Source-term Linearization, Boundary Conditions. Unsteady oneDimensional Conduction- The General Discretization‘s Equation, Explicit, Crank-Nicolson and Fully Implicit Schemes. Two and Three Dimensional Situations, Geometric considerations.		
Unit – IV	**Convection and Diffusion**	**9**
Steady One-dimensional convection and Diffusion – Upwind scheme, The exact solution, The Exponential Scheme, Hybrid scheme. Discretization Equation for Two Dimensions, Discretization Equation for Three Dimensions, One way space coordinate and False Diffusion.		
Unit – V	**Calculation of the Flow Field**	**9**
Need for a special procedure, Representation of the Pressure-Gradient Term and Continuity Equation. The Momentum Equation, The Pressure and Velocity Corrections, The SIMPLE Algorithm, The SIMPLER Algorithm and PISO Algorithms, an open source software can be used for flow problems.		
	Total Contact Hours :	**45**

Course Outcomes: Upon completion of the course students should be able to:	
1	Derive and apply the governing equations and boundary conditions for Fluid dynamics
2	Analyse Discretization concept and Discretization Equations
3	Analyse Finite difference and Finite volume method for Conduction problems
4	Analyse Finite difference and Finite volume method for Convection and Diffusion problems
5	Analyse Flow field problems

Text Books:	
1	Patankar, S.V. ―Numerical Heat Transfer and Fluid Flow, Hemisphere Publishing Corporation, 2004.
2	P. S. Ghoshdastidar, Computer Simulation of Flow and heat transfer, Tata McGraw Hill Publications, New Delhi.
3	Suhas V. Patankar, Numerical Heat Transfer and Fluid Flow, Tata McGraw Hill Book Company 2018.
4	Varsteeg, Malalasekera, An introduction to Computational Fluid Dynamics The finite volume method, Pearson Prentice hall, 1995.
Reference Books:	
1	Chung, T.J. ―Computational Fluid Dynamics, Cambridge University, Press, 2002
2	Fletcher, C. A. J., ―Computational Techniques for Fluid Dynamics, Springer Verlag, 2011
3	Hyoung Woo Oh, ―Applied Computational Fluid Dynamics, InTech Publishers, 2012
4	John F Wendt ―Computational Fluid Dynamics‖ Springer, 2012.

COs	PO/PSO	POs												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
ME23A13.1		3	2	3	2	1	1	1	-	-	-	-	1	3	2	3
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ME23A13.4		3	2	3	2	2	1	1	-	-	-	-	1	3	2	3
ME23A13.5		3	2	3	2	2	1	1	-	-	-	-	1	3	2	3

ME23A14	THEORY ON COMPUTATION AND VISUALIZATION	Category	L	T	P	C
		PE	3	0	0	3

Objectives:	
●	To develop a comprehensive understanding of finite automata.
●	To Master the concept of regular expressions
●	To Understand the Chomsky hierarchy, explore context-free grammars and languages
●	To Acquire a foundational understanding of data visualization
●	To develop proficiency in visualizing spatial, geospatial, and multivariate data using various techniques.

Unit – I	Automata And Regular Expression	9
Need for automata theory - Introduction to formal proof – Finite Automata (FA) – Deterministic Finite Automata (DFA) – Non-deterministic Finite Automata (NFA) – Equivalence between NFA and DFA – Finite Automata with Epsilon transitions – Equivalence of NFA and DFA Equivalence of NFAs with and without ε-moves- Conversion of NFA into DFA – Minimization of DFAs		
Unit – II	**Regular Expressions And Languages**	**9**
Regular expression – Regular Languages- Equivalence of Finite Automata and regular expressions – Proving languages to be not regular (Pumping Lemma) – Closure properties of regular languages.		
Unit – III	**Context Free Grammar And Push Down Automata**	**9**
Types of Grammar - Chomsky hierarchy of languages -Context-Free Grammar (CFG) and Languages – Derivations and Parse trees – Ambiguity in grammars and languages – Push Down Automata (PDA): Definition – Moves - Instantaneous descriptions - Languages of pushdown automata – Equivalence of pushdown automata and CFG-CFG to PDA-PDA to CFG – Deterministic Pushdown Automata.		
Unit – IV	**Foundations For Visualization**	**9**
Visualization stages - Semiology of Graphical Symbols - The Eight Visual Variables – Historical Perspective - Taxonomies - Experimental Semiotics based on Perception Gibson's Affordance theory – A Model of Perceptual Processing.		
Unit – V	**Visualization Techniques**	**9**
Spatial Data: One-Dimensional Data - Two-Dimensional Data – Three Dimensional Data - Dynamic Data - Combining Techniques. Geospatial Data : Visualizing Spatial Data - Visualization of Point Data -Visualization of Line Data - Visualization of Area Data – Other Issues in Geospatial Data Visualization Multivariate Data : Point-Based Techniques – Line Based Techniques - Region-Based Techniques - Combinations of Techniques – Trees Displaying Hierarchical Structures – Graphics and Networks- Displaying Arbitrary Graphs/Networks.		
	Total Contact Hours :	**45**

Course Outcomes: Upon completion of the course students should be able to:	
●	Analyse a given language and design an appropriate finite automaton
●	Formulate regular expressions for specific languages and prove the equivalence between finite automata and regular expressions.
●	classify grammars based on Chomsky's hierarchy, generate languages using context-free grammars
●	Capable of designing effective visualizations and appreciating the historical development of visualization techniques.
●	Apply appropriate visualization techniques to represent different types of data effectively

S. No	Text Books:
1	Hopcroft J.E., Motwani R. & Ullman J.D., "Introduction to Automata Theory, Languages and Computations", 3rd Edition, Pearson Education, 2008.
2	John C Martin, "Introduction to Languages and the Theory of Computation", 4th Edition, Tata McGraw Hill, 2011.
S. No	**Reference Books:**
1	Harry R Lewis and Christos H Papadimitriou, "Elements of the Theory of Computation", 2nd Edition, Prentice Hall of India, 2015
2	Peter Linz, "An Introduction to Formal Language and Automata", 6th Edition, Jones & Bartlett, 2016.
3	Colin Ware, Information Visualization Perception for Design, 4th edition, Morgan Kaufmann Publishers, 2021.

COs	PO/PSO	POs												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
ME23A14.1		2	2	1	-	-	-	-	-	1	-	-	1	2	1	1
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ME23A14.3		2	2	1	-	-	-	-	-	1	-	-	1	2	1	1
ME23A14.4		2	2	1	-	-	-	-	-	1	-	-	1	2	1	1
ME23A14.5		2	2	1	-	-	-	-	-	1	-	-	1	2	1	1

VERTICAL B – LOGISTICS AND SUPPLY CHAIN MANAGEMENT

ME23B11	RELIABILITY AND MAINTENANCE ENGINEERING	Category	L	T	P	C
		PE	3	0	0	3

Objectives:		
⊘	To understand the fundamentals of reliability engineering.	
⊘	To apply reliability estimation techniques and design systems with improved reliability.	
⊘	To describe basic maintenance concepts and practices.	
⊘	To evaluate different maintenance policies.	
⊘	To explore the root cause for maintenance problems.	
UNIT-I	**RELIABILITY CONCEPTS**	**9**
Fundamentals of reliability engineering – Mortality curves concept of burn-in period, useful life and wear out phase of a system – Failure data analysis, mean failure rate, Mean Time To Failure (MTTF), Mean Time Between Failure (MTBF), hazard rate – Failure density and conditional reliability – Maintainability and availability – Simple problems.		
UNIT-II	**RELIABILITY ESTIMATION**	**9**
System reliability – Series, Parallel and Mixed configurations, Reliability improvement techniques, use of Pareto analysis – Design for reliability – Redundancy unit and standby redundancy – Fault tree analysis – Optimization in reliability – Product design – Product analysis – Product development – Product life cycles.		
UNIT-III	**MAINTENANCE CONCEPT**	**9**
Maintenance definition – Maintenance objectives and scope – Maintenance challenges and functions – Terotechnology – Maintenance costs – General introduction to maintenance Types		
UNIT-IV	**MAINTENANCE MODELS**	**9**
Proactive and reactive maintenance – Maintenance policies – Imperfect maintenance – Preventive and breakdown maintenance – Optimal preventive maintenance schedule – Product characteristics – Inspection decisions – Maximizing profit – Minimizing downtime – Replacement decisions.		
UNIT-V	**MAINTENANCE QUALITY**	**9**
Total Productive Maintenance fundamentals – Chronic and sporadic losses – TPM pillars – Five zero concept – Failure Modes and Effects Analysis (FMEA) – Failure Modes, Effects and Criticality Analysis (FMECA) – Root cause analysis – Repair time distribution – Analysis of downtime – Maintainability prediction – Design for maintainability – Reliability Centered Maintenance.		
	Total Contact Hours : 45	

Course Outcomes: Upon completion of this course, the students will be able to:	
⊘	Calculate and interpret different reliability concepts for engineering systems.
⊘	Develop and analyze reliability models for complex systems and implement reliability improvement techniques.
⊘	Identify and classify different types of maintenance practices and their applications in industrial scenarios.
⊘	Formulate optimal maintenance policies and apply decision-making techniques.
⊘	Perform root cause analysis of maintenance problems.

Text Book (s):	
1	Andrew K.S. Jardine& Albert H.C. Tsang, "Maintenance, Replacement and Reliability", Taylor and Francis, Third Edition 2021.
2	Srinath. L.S., "Reliability Engineering", 4th edition Affiliated East west press, 2011

Reference Books(s) / Web links:	
1	Balaguruswamy.E., "Reliability Engineering", McGraw Hill Education India, 2017
2	Bikas Badhury & S.K.Basu, "Terotechnology: Reliability Engineering and Maintenance Management", Asian Books, 2003.
3	Mishra R.C, "Reliability and Maintenance Engineering" New age International publisher, First Edition, 2006.
4	Venkataraman. K "Maintenance Engineering and Management", PHI Learning, Pvt. Ltd., Fourth Edition, 2010

PO-PSO / CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
ME23B11.1	2	3	1	-	2	2	2	-	2	-	-	2	-	-	1
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ME23B11.4	1	2	1	-	1	1	1	-	1	-	1	-	-	-	1
ME23B11.5	2	1	1	-	1	1	1	1	1	1	-	1	-	-	2

ME23B12	WAREHOUSING AUTOMATION	Category	L	T	P	C
		PE	3	0	0	3

Objectives:	
✓	To understand the concept of warehousing and its role in decision-making and operational strategies within the supply chain.
✓	To explore the various stages involved in receiving goods in a warehouse, including the use of advanced shipment notices (ASN) or invoice item lists for operational efficiency.
✓	To examine the significance of warehouse activities, including receiving, sorting, loading, unloading, picking, packing, and dispatch, and their role in optimizing warehouse operations.
✓	To introduce the principles of inventory management and the integration of inbound and outbound operations in warehouse management.
✓	To explain the importance of health, safety, and environmental practices, including the use of safety equipment and personal protective equipment (PPE) in warehouse operations.

UNIT-I	Introduction To Warehouse	9
Introduction to Warehousing Concept, Decision making, Operations, Need for warehousing, Issues affecting warehousing, Various warehousing facilities, Different types of ware houses, Characteristics of ideal ware houses - Broad functions in a warehouse - warehouse layouts and layout related to functions Warehouse Organization Structure -Benefits of Warehousing.		
UNIT-II	**Warehouse Inbound and Outbound Operations**	**9**
Receiving and Dispatch of Goods in warehouse Various stages involved in receiving goods – Stages involved receipt of goods-Advanced shipment notice (ASN) or invoice items list-Procedure for Arranging of goods on dock for counting and Visual inspection of goods unloaded-Formats for recording of goods unloaded from carriers-Generation of goods receipt note using computer- - put away of goods into storage locations -Storage location codes and its application- Automated Storage/ Retrieval System (AS/RS)-specialised equipment- Technical advancements.		
UNIT-III	**Warehouse Operations and Quality Control**	**9**
Receiving, sorting, loading, unloading, Picking Packing and dispatch, activities and their importance in a warehouse -quality parameters -Quality check-need for quality check-importance of quality check. Procedure to develop Packing list / Dispatch note-Cross docking method -Situations suited for application of cross docking -Information required for coordinating cross docking-Importance of proper packing-Packing materials -Packing machines -Reading labels.		
UNIT-IV	**Integrated Warehouse Management and Automation**	**9**
Warehouse Utilization Management -Study on emerging trends in warehousing sector -DG handling -use of Material Handling Equipment's in a warehouse -Inventory Management of a warehouse - Always Better Control (ABC) Inventory system- Inbound & Outbound operations of a warehouse and handling of Inbound & Outbound operations. Automation Systems: Over-view, Applications, Costs, Benefits. Receiving Automation: Pallet Inverter -Material Flow Automation: Conveyors -Lifts -Automated Guided Vehicles -Monorail - Picking/Outbound Automation: Pick / Put To Light -A Frame -Automated Order Selection – Pick-N-Go - Outbound Sorters -Automatic Truck Loading.		
UNIT-V	**Warehouse Safety Regulations and Operational Performance**	**9**
The safety rules and 'Procedures to be observed in a Warehouse - Hazardous cargo – Procedure for Identification of Hazardous Cargo -Safety data sheet-Instructions to handle hazardous cargo - Familiarization with the industry. Health, Safety & Environment - Safety Equipment's and their uses -5S Concept on shop floor. Personal protective Equipment's (PPE) and their uses. The Principles and Performance Measures of Material Handling Systems Introduction. Vehicle travel path(time), Handling time, vehicle utilization, no of loads completed, congestion, Effective performance systems.		
	Total Contact Hours : 45	

Course Outcomes:	
✓	Illustrate the need for warehousing, identifying the various factors and issues that affect warehousing decisions.
✓	Apply best practices in preparing and managing warehouse dispatches to maintain accurate and timely outbound logistics.
✓	Design efficient warehouse operations by integrating activities such as receiving, sorting, loading, unloading, picking, packing, and dispatch, ensuring each function contributes to the overall efficiency.
✓	Evaluate the effectiveness of warehouse utilization management strategies and assess their impact on operational efficiency in modern warehouses
✓	Develop protocols for the use of safety equipment and personal protective equipment (PPE) in warehouse operations, ensuring worker safety.
Text Book (s):	
1	Gwynne Richards, 'Warehouse Management: A Complete Guide to Improving Efficiency and Minimizing Costs in the Modern Warehouse', Kogan Page Publishers, ,2017
2	Frazelle, Edward H, 'World-Class Warehousing and Material Handling', Second Edition. New York: McGraw-Hill Education, 2016.
3	J P Saxena, Warehouse Management and Inventory Control- Vikas Publication House Pvt Ltd, First Edition, 2003.

Reference Books(s) / Web links:	
1	Martin Christopher, 'Stores Management and Logistics', S. Chand and Co., 2003.
2	J.R. Tony Arnold , 'Stephen N. Chapman and M. Clive Introduction to Materials Management', Pearson,2008

3	Raghuram G , ' Logistics and Supply Chain Management', Pearson Education, 2015
4	Nada R. Sanders, Big data driven supply chain management: A framework for implementing analytics and turning information into intelligence, Pearson Education,2014.
5	Michael Watson, Sara Lewis, Peter Cacioppi, Jay Jayaraman, Supply Chain Network Design: Applying Optimization and Analytics to the Global Supply Chain, Pearson Education,2013.

PO-PSO / CO	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
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ME23B12.2	-	3	-	2	3	-	-	-	-	-	-	-	-	1	-
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ME23B12.4	-	-	3	-	3	-	-	-	2	-	-	-	-	-	3
ME23B12.5	-	-	-	-	-	3	2	-	-	2	-	-	-	-	-

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

ME23B13	**OPERATIONS MANAGEMENT**	**Category**	**L**	**T**	**P**	**C**
		PE	**3**	**0**	**0**	**3**

Objectives:	
✓	To understand the basics of production and operations management and its role in product design and development.
✓	To analyze the various aspects of process planning and other controlling operations.
✓	To evaluate the different factors influencing plant location and layout.
✓	To apply the knowledge of materials and inventory management activities.
✓	To understand the concepts of quality and various quality control techniques.

UNIT-I	**INTRODUCTION TO OPERATIONS MANAGEMENT**	**9**
Operations Management – Introduction , nature, importance, historical development – Understanding similarities and difference among Products, Goods and Services and their interrelationships – Value Analysis – Production & Operations Strategy for Competitive Advantage , Types of Production System – Recent Trends in Production and Operations Management, Role of Operations in Strategic Management. Production and Operations strategy – Elements and Competitive Priorities, Nature of International Operations Management - Product Design – New Product Development, Make or Buy Decisions.		
UNIT-II	**PLANNING AND CONTROL OF OPERATIONS**	**9**
Process Planning – Process Redesigning, Procedure for designing a process – Production Planning and Control– Objectives, Elements, Stages of PPC – Demand Forecasting – Need, Types, Objectives and Steps. Overview of Qualitative and Quantitative methods. Capacity Planning – Long range, Types, Rough cut plan, Capacity Requirements Planning (CRP) - Aggregate Planning – Approaches, costs – Overview of MRP, MRP II and ERP		
UNIT-III	**PLANT LOCATION AND LAYOUT**	**9**
Facility Location – Factors influencing Plant Location, Break even Analysis. Plant Layout – Classification of Layout, Layout Design Procedures – CRAFT, ALDEP, CORELAP. Line Balancing – Objectives of Assembly Line Balancing, Ranked Positional Weight Method, COMSOAL		
UNIT-IV	**MATERIALS MANAGEMENT AND INVENTORY CONTROL**	**9**
Materials Management – Objectives, Planning, Budgeting and Control. Overview of Materials Management Information Systems (MMIS). Purchasing – Objectives, Functions, Policies, Vendor rating and Value Analysis. Stores Management – Nature, Layout, Classification and Coding - Overview of JIT. Inventory – Types of Inventory – Deterministic demand model – EOQ – Continuous and Periodic review Inventory models – Selective Inventory Control – ABC, VED, FSN Techniques		
UNIT-V	**QUALITY MANAGEMENT**	**9**
Definitions of quality, Quality revolution, quality gurus, TQM philosophies, Quality management tools – Quality Control – Objectives, importance, Quality Control Techniques – Control Charts – certification and awards. Lean Management – philosophy, elements of JIT manufacturing, continuous improvement. Six sigma – Human factors in job design – Ergonomics – Work Environment and workers Safety. Introduction to ERP and Optimisation software tools		
	Total Contact Hours : 45	

Course Outcomes: Upon Completion of this course, students will be able to	
✓	Gain a foundational understanding the concept of production and operations management, including its critical role in product design and development.
✓	Examine the various aspects of process planning and controlling operations.
✓	Investigate and understand the different factors influencing plant location and layout to make decisions
✓	Understand and explain the various key activities involved in materials and inventory management
✓	Formulate strategies to optimize production processes and enhance overall quality management using various quality control techniques

Text Book (s):	
1	Jay Heizer, Barry Render (2020), "Operations Management", 13th Edition, Pearson Education
2	Robert S.Russell, Bernard W.Taylor, (2019), " Operations and supply chain Management", 10th edition, Wiley.

Reference Books(s) / Web links:	
1	Mahadevan B, Operations management: Theory and practice. Pearson Education India; 2015
2	E.S. Buffa, (2007), Modern Production / Operation Management, 8th edition, Wiley
3	R. B. Kanna, Production and Operations Management, PHI Learning Private Ltd, 2nd edition, 2015.
4	S. N. Chary, Production and Operations Management, Tata McGraw Hill Education Private Limited, 4th edition, 2009
5	R. Panneerselvam, (2013), Production and Operations Management, 3rd edition, PHI
6	Norman Gaither and Gregory Frazier, Operations Management, South Western Cengage Learning,9 th edition, 2015
	https://onlinecourses.nptel.ac.in/noc20_me30/preview

PO-PSO Mapping

PO-PSO / CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
ME23B13.1	3	3	2	1	1	1	-	-	-	-	1	2	3	2	3
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ME23B13.4	3	3	2	1	1	1	-	-	-	-	1	2	3	2	3
ME23B13.5	3	3	2	1	1	1	-	-	-	-	1	2	3	2	3

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

ME23B14	MATERIAL HANDLING EQUIPMENT, REPAIR AND MAINTENANCE	Category	L	T	P	C
		PE	3	0	0	3

Objectives:	
✓	To provide knowledge of the classification and functional categories of material handling equipment.
✓	To familiarize with the design, features, and functions of various hand trucks and power trucks, including their advantages and limitations.
✓	To analyse conveyor systems and their role in enhancing automation and efficiency in material handling processes.
✓	To impart the knowledge on industrial applications and advancements Auxiliary Equipment and Hoisting Equipment.
✓	To study operational functions of Bulk Handling Equipment and Systems.

UNIT-I	INTRODUCTION TO MATERIALS HANDLING	9
Basic principles &objectives in material handling and its benefits - Classification of material handling equipment - selection of material handling equipments - guidelines for effective utilization of material handling equipments -unit load concept		
UNIT-II	**INDUSTRIAL VEHICLES**	9
Introduction and types - Hand trucks - Two wheel Hand Trucks - Multiple wheel Hand Trucks - Hand Lift Trucks - Power Trucks - Fixed Platform Truck - Platform Lift Truck - Pallet Lift Truck - Walkie Truck - Straddle Carrier - Fork Lift Trucks - Specifications of FLT - FLT Attachments - Tractors – Industrial Tractor-Trailer-Self-propelled trucks and fork trucks - Automated guided vehicles Theory		
UNIT-III	**CONVEYORS**	9
Classification of conveyors- Definition - Description - General Characteristics - types and uses of belt Conveyors - Roller conveyors - Haulage Conveyors - Screw Conveyors - Bucket Conveyors – Chain Conveyors - Cable Conveyors - Pneumatic and Hydraulic conveyors – Vibrating and actuating conveyors. Computer controlled conveyor system.		
UNIT-IV	**AUXILIARY EQUIPMENTAND HOISTING EQUIPMENT**	9
Hoppers - Gates- Feeders- Chutes-positioners- Ball Table- Weighing and Control Equipment- Pallet loaders and un loaders - applications and advancements. - Hoisting Equipment - parts of hoisting equipment - Description and uses of hoists - Description and uses of ropes - description and purpose of crane hooks - Elevators - Cranes - Derricks - and its types		
UNIT-V	**BULK HANDLING EQUIPMENT AND SYSTEMS**	**9**
Storage of bulk solids - bulk handling equipment - Robotic handling - Materials handling at the workplace - Robots and their classification - Major components of a robot - classification of Robotic manipulators - Robotic handling applications – Maintenance and safety of material handling equipment.		
	Total Contact Hours : 45	

Course Outcomes: At the end of the course the students would be able to	
✓	Evaluate and select suitable material handling equipment considering operational, financial, and safety factors.
✓	Recognize and describe various types of hand trucks, power trucks, and forklifts, including their functional differences and industrial applications.
✓	Develop material handling strategies by selecting the appropriate type of conveyor system.
✓	Elaborate the basic working principles of various Auxiliary Equipment and Hoisting Equipment.

✍	Explain the basic working principles of various Bulk Handling Equipment and Systems.

Text Books:	
1	Allegri (Sr.), T.H., Material Handling, Principles and Practices, CBS Publishers and Distributors, Delhi, 2019.
2	Siddharta Ray, Introduction to Materials Handling, New Age International Publishers, 2017.
Reference Books(s) / Web links:	
1	Bolz, H. A and Hagemann, G. E (ed.), ‘‘Materials Handling Handbook’’, Ronald Press 2011
2	8005:1976, Classification of Unit Loads, Bureau of Indian Standards.
3	Apple, J.A., ‘‘Material Handling System Design’’, John Wiley & Sons, 2021
4	Theodore H., Allegre Sr., Material Handling Principles and Practice, CBS Publishers and Distributors, 2019

PO / PSO	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
ME23B14.1	2	1	1	1	1	-	-	-	-	-	-	1	-	1	2
ME23B14.2	2	1	1	1	1	-	-	-	-	-	-	1	-	1	2
ME23B14.3	2	1	1	1	1	-	-	-	-	-	-	1	-	1	2
ME23B14.4	2	1	1	1	1	-	-	-	-	-	-	1	-	1	2
ME23B14.5	2	1	1	1	1	-	-	-	-	-	-	1	-	1	2

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

VERTICAL C – MECHANICAL AND INDUSTRIAL

AT23D11	ADVANCED AUTOMOTIVE MATERIALS	Category	L	T	P	C
		PE	3	0	0	3

Objectives:

The objective of this course is to provide the students with the knowledge on properties of engineering materials so as to enable them to select and apply for automotive applications

UNIT-I	ENGINEERING MATERIALS AND THEIR PROPERTIES	9

Classes of engineering materials - the evolution of engineering materials, Definition of materials properties, displaying material properties using materials selection charts, Forces for change in materials selection and design, Materials and the environment-selection of materials for automotive applications.

UNIT-II	BASIS OF MATERIAL SELECTION	9

Selection strategy, Attribute limits and Material indices, structural index Selection procedure: Design process - types of design, design requirements, Function, Material attributes, Shape and Manufacturing processes. Systematic process selection, Energy consumption for production, Material costs, Availability, Recyclability, Environmental consideration. Computer aided selection

UNIT-III	MATERIALS FOR ENGINES AND TRANSMISSION SYSTEMS	9

Materials selection for IC engines: Piston, piston rings, cylinder, Engine block, Connecting rod, Crank shaft, Fly wheels, Gear box, Gears, Splines, Clutches.

UNIT–IV	MATERIALS FOR AUTOMOTIVE STRUCTURES	9

Materials selection for bearings, leaf springs, chassis & frames, Bumper, shock absorbers, wind screens, panels, brake shoes, Disc, wheels, differentials, damping and antifriction fluids, Tires and tubes.

UNIT-V	ELECTRONIC MATERIALS FOR AUTOMOTIVE APPLICATIONS	9

Materials for sensors and electronic devices meant for Engine Speed and Crank Position, Throttle position sensor, Manifold Absolute Pressure, Temperature Sensor, Oxygen Sensor, Piezoelectric Sensor, Ultrasonic Sensor and Dew Sensor. Sensor Materials and Technologies

TOTAL	:	45 PERIODS

Course Outcomes

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

1	Develop knowledge on different class of materials and their applications
2	Understand the Selection criteria for various components and importance.
3	Comprehend different materials used for automotive engines and transmission
4	Select proper material for Automobile applications
5	Analyze different materials used for sensors in a vehicle

Text Books

1	Gladius Lewis, “Selection of Engineering Materials”, Prentice Hall Inc. New Jersey USA, 1995
2	Hiroshi Yamagata,” The Science and Technology of Materials in Automotive Engines”, Woodhead Publishing,2005

Reference Books

1	ASM Handbook. “Materials Selection and Design”, Vol. 20- ASM Metals Park Ohio.USA, 1997.
2	ASM Handbook, “Selection of Materials Vol. 1 and 2”, ASM Metals Park, Ohio. USA, 1991.
3	Cantor,“ Automotive Engineering: Lightweight, Functional, and Novel Materials”, Taylor & Francis Group, London, 2006
4	James A. Jacobs, Thomas F. Kilduff., “Engineering Materials Technology: Structure, Processing, Properties & Selection”, Prentice Hall, USA, 1996.
5	M F Ashby, “Materials Selection in Mechanical Design”, third edition, ButterworthHeineman, New York, 2005.

MT23C11	TECHNOLOGY MANAGEMENT	PC	L	T	P	C
			3	0	0	3

Objectives: The course shall:

●	Introduce the fundamentals of technology management and its applications.
●	Analyze the technological environment and its impact on organizational strategies.
●	Explore the dynamics of innovation and diffusion in a competitive context.
●	Discuss strategies for technology intelligence and intellectual property management.
●	Develop skills for leveraging technology for competitive advantage.

UNIT-I	INTRODUCTION TO TECHNOLOGY MANAGEMENT	09

Definition and characteristics of technology, Types of technology (Product, Process, and Service), Technology life cycle (Invention, Innovation, Diffusion, and Obsolescence), Management of technology – concept, scope, and objectives, Market and resource perspectives in technology management, Key principles and importance of technology management, Role of technology in competitive advantage, Historical evolution and future trends
in technology management.

UNIT-II	TECHNOLOGICAL ENVIRONMENT	09

Concept and definition of environment and technological environment, Dimensions of the technological environment (economic, social, political, and technological), Actors in the technological environment – firms, governments, and society, Induced and autonomous changes in technological environment, Major trends in technological environment – globalization, time compression, and technology integration, Analysis of technological opportunities and threats, Methods for scanning the technological environment.		
UNIT-III	**INNOVATION AND DIFFUSION**	**09**
Innovation – definition, components, and types (incremental, radical, disruptive), Innovation dynamics at the firm level, Role of organizational culture and leadership in innovation, Technology evolution – S-curve model and theories of technological change, Characteristics of innovative firms, Influence of environmental trends on innovation, Diffusion – definition, dynamics, and importance, Factors driving diffusion (market, technology, and adoption), Diffusion models (e.g., Bass Diffusion Model), Barriers to diffusion and strategies to overcome them.		
UNIT-IV	**TECHNOLOGY AND COMPETITION**	**09**
Introduction to competitive domains – cost leadership, differentiation, and focus, Competitive consequences of technological change, Technological characteristics of competitive domains (speed, complexity, uncertainty), Dynamics of change in competitive domains, Framework for analyzing technological emergence, Role of technology in building and sustaining competitive advantage, Case studies on the competitive impact of technology in global industries, Influence of environmental trends on competition, Strategies for leveraging technology in competitive environments.		
UNIT-V	**TECHNOLOGY INTELLIGENCE, STRATEGY, AND INTELLECTUAL PROPERTY**	**09**
Concept and definition of technology intelligence, Signals of new technology – identifying early indicators, Levels of technology intelligence (operational, tactical, strategic), Methods for gathering and analyzing technology intelligence, Definition and importance of technology strategy, Types of technology strategies (offensive, defensive, follower, niche), Principles for formulating technology strategies, Concept of intellectual property (IP) and its types (patents, copyrights, trademarks, trade secrets), Generic mechanisms for IP protection, Overview of IP systems in the US and India, Challenges of globalization in IP management, Emerging trends in IP management and strategy.		
	Total Contact Hours : 45	

Course Outcomes: After the successful completion of the course, the student will be able to:	
CO1	Explain the key concepts of technology management and their relevance in modern organizations.
CO2	Analyze the technological environment and its influence on organizational strategies.
CO3	Apply the principles of innovation and diffusion to foster technological advancements.
CO4	Evaluate the impact of technology on competition and formulate strategies to address technological changes.
CO5	Integrate technology intelligence and IP management into strategic decision-making processes.

Textbook (s):	
1	Narayanan, V.K., *Managing Technology and Innovation for Competitive Advantage*, Pearson Education, 2001.
2	Phaal, R. et al., *Technology Management: Activities and Tools*, Palgrave Macmillan, 2010.
Reference Books(s) / Web links:	
1	Rastogi, P.N., *Management of Technology and Innovation: Competing Through Technological Excellence*, SAGE Publications, 2009.
2	Ravikiran, U.A., *Textbook of Technology Management*, Laxmi Publications Pvt. Ltd., 2008.

CO\ PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	-	-	-	-	2	-	-	-	2	3	3	2	-
CO2	3	3	-	-	-	-	-	-	-	-	2	3	3	2	2
CO3	3	3	2	2	3	-	-	-	-	-	2	3	3	3	2
CO4	3	3	2	3	-	2	-	-	-	-	3	3	3	3	2
CO5	3	3	2	3	-	3	-	3	-	-	3	3	3	3	3
Avg	**3.0**	**2.8**	**2.0**	**2.7**	**3.0**	**2.5**	**2.0**	**3.0**	**-**	**-**	**2.4**	**3.0**	**3.0**	**2.6**	**2.3**

ME23611	**ADDITIVE MANUFACTURING TECHNOLOGIES**	**Category**	**L**	**T**	**P**	**C**
		PE	**3**	**0**	**0**	**3**

Objectives:	
	To familiarize the development of Additive Manufacturing,various business opportunities and applications.
	To understand various software tools, techniques and file formats to create 3D models that helps in product development / prototyping requirements using AM.
	To identify the technical aspects of liquid and solid based AM processes and their post processing requirements.
	To interpret with the powder based process, manufacturing techniques, bio additive manufacturing processes and organ printing.
	To relate with the basic of hybrid additive processes and rapid tooling techniques.

UNIT-I	**INTRODUCTION**	9

Need, Fundamentals of Additive and digital Manufacturing, Advantages and Applications- Comparison of Additive Manufacturing with traditional Manufacturing- Generalized Additive Manufacturing (AM) process chain- Classification of AM process and Materials used - Need for AM in product development		
UNIT-II	**REVERSE ENGINEERING AND DESIGN FOR ADDITIVE MANUFACTURING (DFAM)**	9
Introduction to Reverse Engineering: Applications, Steps in reverse Engineering and software used. Design for additive manufacturing: Digitization Techniques and Devices, Model Reconstruction, CAD model preparation, Part orientation and support generation and removal, Model slicing and software –Demo using open source software– Tool path generation - Unique Capabilities, Exploring Design Freedoms and Design Tools for AM- File formats in AM. Data Processing and Controllers.		
UNIT-III	**LIQUID AND SOLID BASED ADDITIVE MANUFACTRING PROCESSES**	9
Liquid based AM process - Stereolithography apparatus, Polyjet printing, Digital Light Processing, Solid Ground Curing (SGC); Solid Based AM process - Fused Deposition Modeling (FDM), Laminated Object Manufacturing (LOM), Wax model printing: Support Structure Removal – Surface Texture Improvement – Surface Treatments		
UNIT-IV	**POWDER BASED AND BIO ADDITIVE MANUFACTURING PROCESSES**	9
Selective Laser Sintering (SLS), Selective Laser Melting (SLM) and Electron Beam Melting (EBM), Laser Engineered Net Shaping (LENS)-Cleaning & de-powdering – Machining – Surface Coating & Infiltration: Properties of metallic and non-metallic additive manufactured surfaces, Stress induced in additive manufacturing (AM) processes-Surface roughness problem in rapid prototyping ,Technologies of metal powder production; Bio-Additive Manufacturing, Computer Aided Tissue Engineering (CATE) – Processing Steps and Case Studies. Customized Implants and Prosthesis - Materials used in bio printing- Applications and limitations		
UNIT-V	**HYBRID ADDITIVE MANUFACTURING PROCESSES AND RAPID TOOLING**	9
Hybrid Processes-Wire Arc additive Manufacturing Process, Hot Wire Deposition, Laser Metal Deposition, Multi-laser metal deposition- Sustainability in AM – Introduction to 4D and 5D printing, Smart materials used in AM Processes; Rapid Tooling- Direct tooling & Indirect Tooling methods, Applications of Rapid Tooling in Reaction Injection Molding, Vacuum Casting, RTV Silicone Rubber Molds, Spin-Casting, Cast Resin Tooling, Hydroforming and Thermoforming.		
	Total Contact Hours : 45	

Course Outcomes: At the end of the course the students would be able	
	To familiarize the development of Additive Manufacturing, various business opportunities and applications.
	To Understand and evaluate various software tools, techniques and file formats to create 3D models that helps in product development / prototyping requirements using AM.
	To Interpret with Liquid and Solid based AM processes and its post processing requirements.
	To characterize the Powder based process and stress induced in powder based processes and Bio additive Manufacturing Processes.
	To ascertain the hybrid additive processes and rapid tooling techniques and their applications.

Text Books:	
1	Andreas Gebhardt and Jan-Steffen Hötter ―Rapid Prototyping - 3d Printing And Additive Manufacturing: Principles And Applications - Fifth Edition Of Rapid Prototyping‖, World Scientific Publishing Co Pvt Ltd, Singapore, 2019.
2	Ian Gibson, David W. Rosen and Brent Stucker ―Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing‖, 3rd edition, Springer., United States, 2021.
Reference Books(s) / Web links:	
1	Amit Bandyopadhyay and Susmita Bose, ―Additive Manufacturing‖, 2nd Edition, CRC Press.,United States, 2021.
2	Andreas Gebhardt, ―Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing‖, Hanser Gardner Publication, Cincinnati., Ohio, 2011
3	Kamrani A.K. and Nasr E.A., ―Engineering Design and Rapid Prototyping‖, Springer., United States, 2010.
4	Frank W. Liou ―Rapid Prototyping and Engineering applications: A tool box for prototype development‖, CRC Press., United States, 2011.
5.	Milan Brandt, ―Laser Additive Manufacturing: Materials, Design, Technologies, and Applications‖,Woodhead Publishing, United Kingdom, 2016.

CO-PO Mapping:

PO-PSO / CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
ME23611.1	3	-	-	-	-	1	-	-	1	1	-	2	-	1	2
ME23611.2	3	3	2	3	3	1	-	-	1	1	-	2	3	1	2
ME23611.3	3	-	-	-	-	1	-	-	1	1	-	2	-	1	2
ME23611.4	3	-	-	-	-	1	-	-	1	1	-	2	-	1	2
ME23611.5	3	-	2	2	-	1	3	-	1	1	-	2	-	1	2

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

MT23C12	**WORK SYSTEM DESIGN AND ERGONOMICS**	**L**	**T**	**P**	**C**

		3	0	0	3

Objectives:	
●	To introduce the principles of productivity, factors influencing it, and methods to measure and improve productivity.
●	To impart knowledge of work and method study techniques, enabling process optimization and efficiency improvement.
●	To explore principles of motion economy and advanced techniques such as Therbligs, SIMO charts, and cycle graphs for motion analysis.
●	To equip students with skills in time study, performance rating, and computation of standard time for effective work measurement.
●	To introduce the fundamentals of ergonomics, focusing on human factors and their role in optimizing man- machine systems.

UNIT – I	**WORK SYSTEM DESIGN**	9
Introduction and Concept of Productivity, Measurement of Productivity, Productivity Measures, Productivity Measurement Models. Factors Influencing Productivity, Causes of Low Productivity, Productivity Measurement Models, Productivity Improvement Techniques, and Numerical Problems on productivity, Case study on productivity.		
UNIT – II	**WORK STUDY AND METHOD STUDY**	9
Work Study - Basic Concept, Steps Involved in Work Study, Concept of Work Content, Techniques of Work Study, Human Aspects of Work Study. Method Study - Basic Concept, Steps Involved in Method Study, Recording Techniques, Operation Process Charts, Flow Process Charts, Two-Handed-Process Charts, Multiple Activity Charts, Flow Diagrams. String Diagrams.		
UNIT – III	**MOTION ECONOMY**	9
Principles of Motion Economy - Micro-Motion Study, Therbligs, SIMO Charts. Memo- Motion Study, Cycle graph and Chrono-Cycle Graph, Critical Examination Techniques, Development and Selection of New Method, Installation and Maintenance of Improved Methods.		
UNIT – IV	**WORK MEASUREMENT**	9
Basic Concept, Techniques of Work Measurement, Steps Involved in Time Study, Time Study Equipment, Performance Rating. Performance Rating: Examples, Allowances, Computation of Standard Time, Numerical on Computation of Standard Time. Work Sampling: Basics, Procedure of Work Sampling Study, Numerical Problems on work sampling, Introduction to Synthetic Data and PMTS, Introduction to MTM and MOST, Job evaluation and incentive schemes: Starlight line, Tailor, Merrick and Gantt incentive plans.		
UNIT – V	**ERGONOMICS**	9
Basic Concept, Industrial Ergonomics, Human factor engineering: Definition and history of development of human factors engineering, Types &characteristics of man-machine- system, Relative capabilities of human being and machines; development and use of human factor data; information input and processing, Introduction to information theory; factors effecting information reception and processing; coding and selecting of sensory inputs.		
	Total Contact Hours	**45**

Course Outcomes:	
CO1	Explain productivity concepts, identify influencing factors, and solve numerical problems to propose productivity improvement strategies.
CO2	Apply work and method study techniques to record, analyze, and improve operational processes.
CO3	Use principles of motion economy and motion study tools to analyze workflows and develop efficient work methods.
CO4	Conduct time studies, compute standard times, and evaluate the effectiveness of work measurement techniques.
CO5	Design ergonomic systems that enhance human-machine interaction and improve workplace safety and productivity.

Text Book(s):	
1	M. P. Goover, Work Systems and the Methods, Measurement and Management of Work, Pearson Prentice Hall
2	Industrial Engineering and Management, by Praveenkumar, Pearson

Reference Books(s) / Web links:	
1	Khan MI; Industrial Ergonomics; PHI Learning
2	B. Niebel and Freivalds, Methods standards and Work Design, McGraw-Hill, 2003
3	Manufacturing Organization and Management, Harold Amrine, John Ritchey, Moodie, Kmec, 6th ed, Pearson

CO\ PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	2	1	-	1	-	-	-	-	-	-	3	2	1
CO2	3	2	1	1	-	1	-	-	-	-	-	-	3	1	1
CO3	3	2	1	1	-	1	-	-	-	-	-	-	3	2	1
CO4	3	2	1	1	-	1	-	-	-	-	-	-	3	1	1
CO5	3	2	1	1	-	1	-	-	-	-	-	-	3	2	1
AVERAGE	**3**	2	**1.2**	**1.0**	**-**	**1.0**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**1.6**	**1.0**

MT23C13	**THEORY OF METAL CUTTING**	**L**	**T**	**P**	**C**

		3	0	0	3

Objectives:	
●	To make the students to familiar with the basic principles of metal cutting
●	To familiarise the students various cutting tool materials and its wear mechanisms during the machining operation.
●	Differentiate between single point and multi point cutting tools
●	To study the heat generation during machining and the necessity for cutting fluid
●	To study the effect of vibrations during machining

UNIT – I	**INTRODUCTION**	9
Need for rational approach to the problem of cutting materials-observation made in the cutting of metals-basic mechanism of chip formation-thin and thick zone modes-types of chips-chip breaker-orthogonal Vs oblique cutting- force velocity relationship for shear plane angle in orthogonal cutting-energy consideration in machining-review of Merchant, Lee and Shafter theories-critical comparison.		
UNIT – II	**SYSTEM OF TOOL NOMENCLATURE**	9
Nomenclature of single point cutting tool and nomenclature of multi point cutting tools – Twist Drill – milling cutter - System of tool nomenclature and conversion of rake angles-nomenclature of multi point tools like drills, milling- conventional Vs climb milling, mean cross sectional area of chip in milling-specific cutting pressure.		
UNIT – III	**THERMAL ASPECTS OF MACHINING**	9
Heat distribution in machining-effects of various parameters on temperature-methods of temperature measurement in machining-hot machining- Cutting fluid – properties – types of cutting fluids – Selection of cutting fluids.		
UNIT – IV	**TOOL MATERIALS, TOOL LIFE AND TOOL WEAR**	9
Essential requirements of tool materials-development of tool materials-ISO specification for inserts and tool holders- Tool geometry - Mechanisms of tool wear – Abrasion – Adhesion – Diffusion – Types of tool wear – flank wear – crater wear – Tool life – Tool life equations - factors affecting tool life – Illustrative problems- conventional and accelerated tool life tests-concept of machinability index-economics of machining.		
UNIT – V	**WEAR MECHANISMS AND CHATTER IN MACHINING**	9
Processing and Machining – Measuring Techniques – Reasons for failure of cutting tools and forms of wear- mechanisms of wear-chatter in machining-factors affecting chatter in machining-types of chatter-mechanism of chatter.		
	Total Contact Hours	**45**

Course Outcomes: After the successful completion of the course, the student will be able to:	
CO1	Explain the fundamental principles of metal cutting, chip formation mechanisms, and energy considerations in machining.
CO2	Apply tool nomenclature systems for single-point and multi-point cutting tools, including rake angle conversions and milling operations.
CO3	Evaluate the effects of machining parameters on heat generation and cutting fluid selection in machining processes.
CO4	Analyze tool materials, mechanisms of tool wear, and solve problems related to tool life and machining economics.
CO5	Identify wear mechanisms, reasons for tool failure, and factors influencing chatter in machining, and propose minimization strategies.

Text Book(s):	
1	David A. Stephenson and John S. Agapiou, Metal Cutting Theory and Practice, CRC Press, 2019
2	Boothroid D.G. & Knight W.A., Fundamentals of machining and machine tools, Marcel Dekker, Newyork, 2005.

Reference Books(s) / Web links:	
1	Bhattacharya.A., Metal Cutting Theory and practice, Central Book Publishers, India,2012.
2	A. B. Chattopadhyay, Machining and Machine Tools, Wiley, 2017
3	Shaw.M.C.Metal cutting principles, Oxford Clare don press, 2012.
4	B L Juneja and G S Sekhon., Fundamentals of Metal Cutting and Machine Tools, 2017.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	2	1	-	-	-	-	-	-	-	-	1	2	1
CO2	3	3	1	1	-	-	-	-	-	-	-	-	1	1	1
CO3	3	3	1	1	-	-	-	-	-	-	-	-	1	2	1
CO4	3	3	1	1	-	-	-	-	-	-	-	-	1	1	1
CO5	3	3	1	1	-	-	-	-	-	-	-	-	1	2	1
AVERAGE	**3**	**2.8**	**1.2**	**1.0**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1.0**	**1.6**	**1.0**

MT23C14	THEORY OF METAL FORMING	L	T	P	C
		3	0	0	3

Objectives:	
●	To study the basic concepts of metal forming techniques and to develop force calculation in metal forming process.
●	To study the thermo mechanical regimes and its requirements of metal forming
●	To learn the art of processing and making of powder metallurgy components
●	To learn the effect of friction and lubrication in Metal forming
●	To study the various surface treatment processes

UNIT – I	THEORY OF PLASTICITY	9
Theory of plastic deformation – Yield criteria – Tresca and Von-Mises – Distortion energy – Stress-strain relation – Mohr's circle representation of a state of stress – cylindrical and spherical co-ordinate system – upper and lower bound solution methods – Overview of FEM applications in Metal Forming analysis.		
UNIT – II	**THEORY AND PRACTICE OF BULK FORMING PROCESSES**	9
Analysis of plastic deformation in Forging, Rolling, Extrusion, rod/wire drawing and tube drawing – Effect of friction – calculation of forces, work done – Process parameters, equipment used – Defects – applications – Recent advances in Forging, Rolling, Extrusion and Drawing processes – Design consideration in forming – Equal Chanel Angular Pressing-High Pressure Torsion- Repetitive Corrugation and Straightening- Accumulative Roll bonding.		
UNIT – III	**SHEET METAL FORMING**	9
Formability studies – Conventional processes – H E R F techniques – Superplastic forming techniques – Hydro forming – Stretch forming – Water hammer forming – Principles and process parameters – Advantages, Limitations and applications.		
UNIT – IV	**POWDER METALLURGY AND SPECIAL FORMING PROCESSES**	9
Overview of P/M technique – Advantages – applications – Powder preform forging – powder rolling – Tooling, process parameters and applications. - Orbital forging – Isothermal forging – Hot and cold isostatic pressing – High speed extrusion – Rubber pad forming – Fine blanking – LASER beam forming.		
UNIT – V	**SURFACE TREATMENT AND METAL FORMING APPLICATIONS**	9
Experiment techniques of evaluation of friction in metal forming selection – influence of temperature and gliding velocity – Friction heat generation – Friction between metallic layers – Lubrication carrier layer – Surface treatment for drawing, sheet metal forming, Extrusion, hot and cold forging. Processing of thin Al tapes – Cladding of Al alloys – Duplex and triplex steel rolling – Thermo mechanical regimes of Ti and Al alloys during deformation – Formability of welded blank sheet – Laser structured steel sheet - Formability of laminated sheet.		
	Total Contact Hours	**45**

Course Outcomes:	
CO1	Apply the principles of plastic deformation and yield criteria to analyze metal forming problems.
CO2	Evaluate and optimize bulk forming processes by calculating forces, identifying defects, and integrating recent advancements.
CO3	Design and improve sheet metal forming processes using advanced techniques like superplastic forming and hydroforming.
CO4	Implement powder metallurgy and special forming techniques by selecting suitable tools and process parameters.
CO5	Analyze the impact of friction, lubrication, and surface treatments to enhance formability and optimize advanced material processing.

Text Book(s):	
1	William F. Hosford, Robert M. Caddell, Forming: Mechanics and Metallurgy, Cambridge University Press, 2011
2	Zainul Huda, Metal Forming Processes Fundamentals, Analysis, Calculations, Springer Cham, 2024
Reference Books(s) / Web links:	
1	Altan T., Metal forming – Fundamentals and applications – American Society of Metals, Metals park, 2003
2	ALTAN.T, SOO-IK-oh, GEGEL, HL – Metal forming, fundamentals and Applications, American Society of Metals, Metals Park, Ohio, 1995
3	Dieter G.E., Mechanical Metallurgy (Revised Edition II) McGraw Hill Co., 1988
4	Marciniak,Z., Duncan J.L., Hu S.J., 'Mechanics of Sheet Metal Forming', Butterworth-Heinemann An Imprint of Elsevier, 2006
5	Surender Kumar, Technology of Metal Forming Processes, Prentice Hall India Publishers, 2010

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	-	-	-	-	-	-	-	-	1	2	1
CO2	3	3	1	1	-	-	-	-	-	-	-	-	1	1	1
CO3	3	3	1	1	-	-	-	-	-	-	-	-	1	2	1
CO4	3	3	1	1	-	-	-	-	-	-	-	-	1	1	1
CO5	3	3	1	1	-	-	-	-	-	-	-	-	1	2	1
AVERAGE	**3**	**2.8**	**1.0**	**1.0**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1.0**	**1.6**	**1**

MT23C15	LEAN MANUFACTURING AND SIX SIGMA	PE	L	T	P	C

			3	**0**	**0**	**3**

Objectives: The course shall:	
●	Introduce the principles of Lean Manufacturing and Six Sigma to improve productivity and quality in industrial systems.
●	Equip students with the tools and techniques for identifying and eliminating process waste.
●	Provide an understanding of process mapping, value stream mapping, and the role of work cells in Lean systems.
●	Develop skills in applying Six Sigma methodologies, including DMAIC and DFSS, to real-world problems.
●	Enhance the ability to integrate Lean and Six Sigma concepts for continuous improvement and operational excellence.

UNIT-I	**LEAN MANUFACTURING, 5S, AND TPM**	**09**
Global competition, Need of customers and other stakeholders, Concept of change, Manufacturing activities, Basic elements of LM, Customer value, Value stream, Value flow, Customer pull, Continuous improvement, 5S workplace organization, Sort, Set-in-order, Shine, Standardize, Sustain, 5S implementation process, Total productive maintenance – introduction and significance, Pillars of TPM (Autonomous Maintenance, Planned Maintenance), Basic conditions applicable for TPM success, TPM implementation process.		
UNIT-II	**PROCESS MAPPING, VSM, AND WORK CELL**	**09**
Introduction to mapping, Process mapping – definition, need, and advantages, Types of process mapping, Steps in constructing a process map, Value stream mapping concept, Steps followed in VSM, Bottleneck analysis, Introduction to work cell concept, Work cell formation method – selecting part families, deciding process, deciding the machinery and equipment, selecting auxiliary tools and material handling equipment, designing the layout, Line balancing, Manpower – calculation and selection, Employee training, Preventive maintenance schedule, Quality standard formulation, Production control system and automated testing.		
UNIT-III	**SECONDARY TOOLS AND LEAN PLANNING**	**09**
Cause and effect diagram, Pareto chart, Spider/radar chart, Poka Yoke, Kanban, Autonomation, Single Minute Exchange of Dies (SMED), Standardized fixtures, Design for Manufacturing and Assembly (DFMA), Just-in- Time (JIT) concept, Visual workplace, Lean metrics (e.g., takt time, OEE), Customer focus, Hoshin planning – process, brainstorming vision, long-term strategies, annual planning, brainstorming annual plan, tree diagram, project and project team choice, project plan preparation.		
UNIT-IV	**SIX SIGMA FOUNDATION**	**09**
Evolution of Six Sigma, Six Sigma definition, Defects Per Million Opportunities (DPMO) and Sigma level, Practical meaning of Sigma level, Six Sigma as a business model, Stakeholders in Six Sigma, Six Sigma for business excellence, Six Sigma and Lean, Six Sigma and Kaizen, Six Sigma and quality certification, Six Sigma methodology (DMAIC, DMADV), Roles in Six Sigma (Green Belt, Black Belt, Master Black Belt), Design for Six Sigma road map, Organizing Six Sigma in organizations.		
UNIT-V	**PRODUCTIVITY IMPROVEMENT AND SIX SIGMA SETTING PRIORITIES**	**09**
Operator productivity improvement, Process improvement, Improving machinery and equipment use, Workplace organization, Avoidance of excess production and inventory, Voice of the customer, Identifying opportunities and selecting projects, Cost of Poor Quality (COPQ), Guidelines for selecting and defining Six Sigma projects, Project prioritization matrix, Risk management in Six Sigma projects.		
	Total Contact Hours :	**45**

Course Outcomes: After the successful completion of the course, the student will be able to:	
CO1	Analyze the principles of Lean Manufacturing and implement workplace organization practices like 5S and Total Productive Maintenance (TPM).
CO2	Construct and interpret process maps and value stream maps to identify opportunities for process optimization.
CO3	Apply Lean tools such as Kanban, SMED, and Just-In-Time (JIT) to enhance operational efficiency.
CO4	Evaluate Six Sigma methodologies and utilize tools like DMAIC for quality improvement projects.
CO5	Integrate Lean and Six Sigma techniques to prioritize and execute improvement projects in diverse industrial scenarios.

Textbook (s):	
1	Gopalakrishnan, N., Simplified Lean Manufacture. India, Prentice-Hall of India Pvt. Limited, 2010.
2	George, M. L., Lean Six Sigma: Combining Six Sigma Quality with Lean Production Speed, McGraw-Hill Education, 2002.
Reference Books(s) / Web links:	
1	Liker, J. K., The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer, McGraw- Hill Education, 2004.
2	Pyzdek, T., & Keller, P. A., The Six Sigma Handbook: A Complete Guide for Green Belts, Black Belts, and Managers at All Levels, McGraw-Hill Education, 2021.

CO\ PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	2	2	-	2	-	1	-	2	2	3	2	2
CO2	3	3	2	3	2	-	-	-	-	2	-	2	3	3	2
CO3	3	3	3	3	3	-	-	-	-	-	3	3	3	3	3
CO4	3	3	2	3	2	-	-	-	-	-	3	3	3	3	3
CO5	3	3	3	3	3	2	-	-	-	2	3	3	3	3	3
Avg	3.0	3.0	2.6	2.8	2.4	2.0	2.0	-	1.0	2.0	2.8	2.6	3.0	2.8	2.6

MT23C16	ADVANCED WELDING TECHNOLOGIES	PE	L	T	P	C
			3	0	0	3

Objectives: The course shall:	
●	To introduce the fundamental principles and applications of welding processes, focusing on automation and robotic welding systems.
●	To provide an understanding of solid-state and advanced welding techniques relevant to Mechatronics-based industries.
●	To explore welding metallurgy and material properties, focusing on their relevance to Mechatronics systems.
●	To impart knowledge on the design of weldments and residual stress management in automated and robotic welding systems.
●	To introduce defect analysis, quality control, and advanced inspection techniques used in welding processes.

UNIT-I	FUNDAMENTALS OF WELDING AND AUTOMATION IN WELDING	9
Introduction to welding processes – Overview of gas welding: Oxyacetylene Welding – Overview of arc welding: Shielded Metal Arc Welding (SMAW), TIG Welding, MIG Welding – Advantages, limitations, and applications – Introduction to automated welding systems – Robotic welding: Integration with industrial Mechatronics systems – Applications of robotic welding in precision manufacturing.		
UNIT-II	**SOLID STATE WELDING AND ADVANCED WELDING PROCESSES**	**9**
Overview of solid-state welding: Friction Welding, Friction Stir Welding, and Ultrasonic Welding – Principles, advantages, and applications in Mechatronics-based systems – Laser Beam Welding and Electron Beam Welding: Automation and control in advanced welding – Applications of advanced welding techniques in robotics, aerospace, and automotive industries.		
UNIT-III	**WELDING METALLURGY AND MATERIALS IN MECHATRONICS**	**9**
Heat flow and temperature distribution during welding – Influence of welding parameters on joint properties – Overview of weldability of materials commonly used in Mechatronics: Low alloy steels, aluminum alloys, and stainless steels – Welding of thin materials for sensors and actuators – Common defects in welded components used in Mechatronics and their remedies.		
UNIT-IV	**WELDING DESIGN AND RESIDUAL STRESS CONTROL**	**9**
Types of joints and joint efficiency – Basic weld design considerations for Mechatronics structures – Residual stresses: Causes, effects, and control techniques in robotic and automated welding systems – Importance of jigs, fixtures, and positioners for precision welding in automation – Distortion control methods for Mechatronics-based applications.		
UNIT-V	**INSPECTION TECHNIQUES AND QUALITY CONTROL**	**9**
Classification and sources of welding defects – Common defects in automated welding processes – Inspection techniques: Visual inspection, Liquid Penetrant Inspection, Magnetic Particle Inspection, Ultrasonic Testing (UT), and Radiographic Testing (RT) – Introduction to advanced techniques: Thermography and Acoustic Emission Testing – Quality assurance in robotic and automated welding systems for Mechatronics applications.		
	Total Contact Hours :	**45**

Course Outcomes: After the successful completion of the course, the student will be able to:	
CO1	Apply the principles of welding processes and automation to understand robotic welding systems.
CO2	Analyze and implement advanced welding processes, including friction and laser welding, in Mechatronics applications.
CO3	Evaluate the influence of heat flow, material properties, and welding parameters to optimize welding processes for Mechatronics components.
CO4	Design weldments for automated systems, considering residual stresses, distortion control, and Mechatronics- specific applications.
CO5	Identify and rectify welding defects using advanced inspection techniques and ensure quality control in automated welding systems

Textbook (s):	
1	Himanshu Vashishtha, Deepak Kumar, Ravindra V. Taiwade, Advanced Welding Techniques Current Trends and Future Perspectives, CRC Press, 2024
2	R.S. Parmar, Welding Engineering and Technology, Khanna Publishers, 2013
3	Tzyh-Jong Tarn, Shan-Ben Chen, and Changjiu Zhou, Robotic Welding, Intelligence and Automation, Springer, 2004
Reference Books(s) / Web links:	
1	Islam Nawaz Islam Nawaz, Advanced Welding Technology, Scitech Publications, 2018
2	Joao Pedro Oliveira, Zhi Zeng, Advanced Welding Technology in Metals, Mdpi, 2022
3	Howard Currant , Welding: Advanced Principles and Applications, Larsen and Keller Education, 2023

CO\ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	-	-	-	-	-	-	-	-	3	2	1
CO2	3	3	2	1	-	-	-	-	-	-	-	-	3	3	1
CO3	3	3	2	2	-	-	-	-	-	-	-	-	2	3	2
CO4	3	3	3	2	-	-	-	-	-	-	-	-	3	3	2
CO5	3	2	1	2	-	-	-	-	-	-	-	-	3	2	1
Avg	**3**	**2.6**	**1.8**	**1.6**	-	-	-	-	-	-	-	-	**2.8**	**2.6**	**1.4**

EE23D11	ANALYSIS OF ELECTRICAL MACHINES	Category	L	T	P	C
		PE	3	0	0	3

Objectives:

- To model and simulate different types of DC machines
- To develop reference frame equations for various elements like R, L and C
- To model an induction (three phase and 'n' phase) and synchronous machine
- To derive reference frame equations for induction and synchronous machines
- To study the need and working of multiphase induction and synchronous machines

UNIT-I MODELING AND SIMULATION OF BRUSHED-DC ELECTRIC MACHINERY **9**

Fundamentals of Operation – Introduction – Governing equations and modeling of Brushed DC-Motor – Shunt, Series and Compound – State model derivation – Construction of Model for a DC Machine using state equations- Simulation under no-load and loaded conditions-Simulation of soft starting for DC motor

UNIT-II REFERENCE FRAME THEORY **9**

Historical background –Three phase to two phase transformation – transformation of variables from stationary to arbitrary reference frame, Dynamic modeling-stator reference model, rotor reference model, Flux linkage equations, PU model

UNIT-III INDUCTION MACHINES **9**

Three phase induction machine – dq equivalent circuit– Ghani model - free acceleration characteristics – voltage and torque equations in machine variables and arbitrary reference frame variables – Simulation under no-load and load conditions- Machine variable form, arbitrary reference variable form

UNIT-IV SYNCHRONOUS MACHINES **9**

Three phase synchronous machine –Blondel's model, voltage and torque equations in machine variables and rotor reference frame variables (Park's equations) – Simulation under no-load and load conditions- Machine variable form, arbitrary reference variable form

UNIT-V MULTIPHASE (MORE THAN THREE-PHASE) MACHINE CONCEPTS **9**

Preliminary Remarks - Necessity of Multiphase Machines - Evolution of Multiphase Machines- Advantages of Multiphase Machines - Working Principle - Multiphase Induction Machine, Multiphase Synchronous Machine -Modeling of 'n' phase machine - Applications of Multiphase Machines

Total Contact Hours : 45

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

- Formulate the model for brushed DC-Motors (Shunt, Series, Compound and separately excited motor) and understand about simulation of DC motors using state model
- Apply reference frame theory for resistive and reactive elements (three phase)
- Compute the torque of three phase induction motor and synchronous motor in machine variable arbitrary reference frame variable
- Find the need and advantages of multiphase machines
- Demonstrate the working of multiphase induction and synchronous machine.

Text Book (s):

1. Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff, Steven D. Pekarek, "Analysis of Electric Machinery and Drive Systems", 3rd Edition, Wiley-IEEE Press, 2013.
2. Anderson and Foud, "Power system stability and control"IEEE Press, 2003
3. R. Ramanujam, Modeling and Analysis of Electrical Machines, I. k. International Publishing House Pvt.Ltd,2018

Reference Books(s) :

1. Stephen D. Umans, "Fitzgerald & Kingsley's Electric Machinery", Tata McGraw Hill, 7th Edition, 2020.
2. Bogdan M. Wilamowski, J. David Irwin, The Industrial Electronics Handbook, Second Edition, Power Electronics and Motor Drives, CRC Press, 2011
3. R. Krishnan, Electric Motor & Drives: Modeling, Analysis and Control, Pearson Education, 1st Imprint, 2015.
4. Chee Mun Ong ,Dynamic Simulation of Electric Machinery using MATLAB, , Prentice Hall, 1997
5. *Atif Iqbal,Shaikh Moinoddin, Bhimireddy Prathap Reddy,* Electrical Machine Fundamentals with Numerical Simulation using MATLAB/SIMULINK, *Wiley,2021*
6. P.S.*Bimbhra "Generalized theory of Electrical Machines, khanna Publications,2011*

Web links :

1. https://archive.nptel.ac.in/courses/108/106/108106023/
2. https://www.intechopen.com/chapters/71794

Suggested activities:

- To learn Magnet software
- To learn Matlab simulink software

Suggested Evaluation methods:

- To evaluate students based on Magnet assignments
- To evaluate students based on Matlab assignments

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

MT23D11	NEURAL NETWORKS AND FUZZY SYSTEMS	PE	L	T	P	C
			3	**0**	**0**	**3**

Objectives: The course shall:	
●	Explain with applications the basic concepts, models, and characteristics of artificial neural networks.
●	Analyze artificial neuron models, activation functions, and learning strategies for different ANN architectures.
●	Design and implement supervised learning networks, including perceptron, ADALINE, MADALINE, and backpropagation networks.
●	Apply associative memory networks like Hopfield and BAM to solve pattern recognition problems.
●	Distinguish between classical and fuzzy sets, understand fuzzy operations, and apply membership functions to handle uncertainty in real-world problems.

UNIT-I	**ARTIFICIAL NEURAL NETWORKS**	**9**
Introduction, Biological Neuron, Artificial Neuron, Basic concepts of Neural Networks, Basic Models of ANN Connections, McCulloch-Pitts Model, Characteristics of ANN, Applications of ANN		
UNIT-II	**ESSENTIALS OF ARTIFICIAL NEURAL NETWORKS**	**9**
Artificial Neuron Model, Operations of Artificial Neuron, Types of Neuron Activation Function, ANN Architectures, Classification Taxonomy of ANN Connectivity, Learning Strategies (Supervised, Unsupervised, Reinforcement), Learning Rules, Numerical problems, Types of Application		
UNIT-III	**SUPERVISED LEARNING NETWORKS**	**9**
Perceptron Network, Perceptron Learning Rule, Architecture, Perceptron Training Algorithm, ADALINE, MADALINE, Back Propagation Network, BP Learning Rule, Input Layer Computation, Hidden Layer Computation, Output Layer Computation, Radial Basis Function Demonstration through MATLAB		
UNIT-IV	**ASSOCIATIVE MEMORY NETWORK**	**9**
Training Algorithms for Pattern Association, Auto Associative Memory Network, Hetero Associative Memory Network, BAM, Hopfield Networks, Applications		
UNIT-V	**CLASSICAL & FUZZY SETS**	**9**
Introduction to classical sets- properties, Operations and relations; Fuzzy sets, Membership, Uncertainty, Operations, properties, fuzzy relations, cardinalities, membership functions.		
	Total Contact Hours : 45	

Course Outcomes: After the successful completion of the course, the student will be able to:	
CO1	Describe the basic concepts, models, and features of ANNs and their practical applications.
CO2	Analyze different neuron models, activation functions, and learning strategies to assess ANN architectures.
CO3	Design and implement supervised learning networks (perceptron, ADALINE, MADALINE, backpropagation) using MATLAB for numerical problem-solving.
CO4	Use associative memory networks to solve pattern recognition and associative learning tasks.
CO5	Differentiate classical and fuzzy sets, perform fuzzy operations, and apply membership functions to manage uncertainty in decision-making.

Textbook (s):	
1	Artificial Intelligence: A Modern Approach" by Stuart Russell and Peter Norvig, 2020.
2	Pattern Recognition and Machine Learning" by Christopher M. Bishop, 2006.

Reference Books(s) / Web links:	
1	Neural Networks and Deep Learning" by Michael Nielsen, 2015.
2	Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville, 2016.
3	Fuzzy Logic with Engineering Applications" by Timothy J. Ross, 2010.
4	Neural Networks for Pattern Recognition" by Christopher M. Bishop, 1995.
5	Fuzzy Systems Engineering: Theory and Practice" by Kazuo Tanaka, Hua O. Wang, 2005.

CO\ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	-	2	-	-	-	-	-	-	2	3	2	-
CO2	3	3	3	2	3	-	-	-	-	-	-	3	3	3	3
CO3	3	3	3	3	3	-	-	-	-	-	-	3	3	3	3
CO4	3	3	3	3	3	2	-	-	-	-	-	3	3	3	3
CO5	3	3	3	3	3	-	-	-	-	-	2	3	3	3	3
Avg	**3.0**	**2.8**	**3.0**	**2.8**	**2.8**	**2.0**	**-**	**-**	**-**	**-**	**2.0**	**2.8**	**3.0**	**2.8**	**3.0**

MT23D12	VIRTUAL INSTRUMENTATION	PE	L	T	P	C
			3	**0**	**0**	**3**

Objectives: The course shall:	
●	Understand the fundamentals of virtual instrumentation—its architecture, data flow, and advantages over conventional programming.
●	Develop VI programs with loops, arrays, clusters, graphs, and file I/O, including advanced features like sub-VIs and formula nodes.
●	Learn data acquisition basics, covering PC hardware, timing, counters, and timers.
●	Explore common interfaces (RS232C/RS485, GPIB, USB), basic networking, and motion control.
●	Apply Fourier transforms, power spectra, and filtering techniques to virtual instrumentation applications.

UNIT-I	**REVIEW OF VIRTUAL INSTRUMENTATION**	**10**
Historical perspectives, advantages, block diagram and architecture of a virtual instrument, data-flow techniques, graphical programming in the data flow, and comparison with conventional programming.		
UNIT-II	**VI PROGRAMMING TECHNIQUES**	**9**
VIS and sub-VIS loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, string and file I/O.		
UNIT-III	**DATA ACQUISTION BASICS**	**9**
AOC.OAC. 010. Counters & timers. PC Hardware structure, timing. Interrupts OMA, software and hardware installation.		
UNIT-IV	**COMMON INSTRUMENT INTERFACES**	**9**
Current loop, RS.232C/RS.485, GPIB, System buses, interface buses: USB, PCMCIA, VXI, SCXI, PXI, networking basics for office &. Industrial applications, Visa and IVI, image acquisition and processing, Motion control.		
UNIT-V	**USE OF ANALYSIS TOOLS**	**8**
Fourier transforms, power spectrum correlation methods, windowing & filtering, VI application in various fields.		
	Total Contact Hours : 45	

Course Outcomes: After the successful completion of the course, the student will be able to:	
CO1	Explain the advantages and architecture of virtual instrumentation, comparing it with conventional programming methods.
CO2	Develop virtual instruments using graphical programming elements like loops, charts, arrays, and sequence structures.
CO3	Analyze and implement data acquisition systems employing counters, timers, and PC hardware.
CO4	Integrate and interface protocols (RS-232C, USB, GPIB) within virtual instrumentation applications.
CO5	Utilize analysis tools, including Fourier transforms and correlation methods, for signal processing in virtual instrumentation.

Textbook (s):	
1	Gupta," Virtual Instrumentation Using Lab view" 2ndEdition, Tata McGraw-Hill Education, 2010.
2	LabVIEW: A Developer's Guide to Real-World Integration" by Jason W. H. M. 2017.
3	Virtual Instrumentation and LabVIEW" by Sanjay Gupta, Joseph John, 2012.

Reference Books(s) / Web links:	
1	R. H. Bishop, "Learning with LabVIEW", 1st edition, Pearson Publishing, 2014.
2	B. Mihura, "LabVIEW for Data Acquisition", Prentice Hall of India, 2013.
3	Gary Jonson, "Labview Graphical Programming", Second Edition, McGraw Hill, New York, 1997.
4	Gupta.S., Gupta.J.P., "PC interfacing for Data Acquisition & Process Control", Second Edition, Instrument Society of America, 1994.
5	Sokoloff; "Basic concepts of Labview 4", Prentice Hall Inc., New Jersey 1998.

CO\ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	-	2	-	-	-	-	-	-	2	3	2	-
CO2	3	3	3	2	3	-	-	-	-	-	-	3	3	3	3
CO3	3	3	3	3	3	-	-	-	-	-	-	3	3	3	3
CO4	3	3	3	3	3	2	-	-	-	-	-	3	3	3	3
CO5	3	3	3	3	3	-	-	-	-	-	2	3	3	3	3
Avg	**3.0**	**2.8**	**3.0**	**2.8**	**2.8**	**2.0**	**-**	**-**	**-**	**-**	**2.0**	**2.8**	**3.0**	**2.8**	**3.0**

EE23C11	HIGH VOLTAGE DIRECT CURRENT TRANSMISSION	Category	L	T	P	C
		PE	3	0	0	3

Objectives:	
●	To understand the concept, planning of DC power transmission and comparison with AC Power transmission.
●	To provide knowledge on the analysis of HVDC converters.
●	To study about the HVDC system control.
●	To impart knowledge on harmonics and design of filters.
●	To learn the model and analysis the DC system under study state.

UNIT-I	INTRODUCTION	
DC Power transmission technology – Comparison of AC and DC transmission – Planning and Application of DC transmission – Description of HVDC transmission system – Modern trends in HVDC technology – DC breakers – Types and applications of HVDC links and MTDC systems. Case study on HVDC systems in India.		9
UNIT-II	**ANALYSIS OF HVDC CONVERTERS**	
Voltage Source Converters (VSC) – Analysis of Graetz circuit with and without overlap – Pulse number – Choice of converter configuration – Converter bridge characteristics – Analysis of a 12 pulse converters – Analysis of VSC topologies and firing schemes.		9
UNIT-III	**CONVERTER AND HVDC SYSTEM CONTROL**	
Principles of DC link control and converter control characteristics – System control hierarchy – Firing angle control – Current and extinction angle control – Starting and stopping of DC link – Power control – Higher level controllers – Control of VSC based HVDC link - Converter malfunctioning.		9
UNIT-IV	**REACTIVE POWER AND HARMONICS CONTROL**	
Reactive power requirements in steady state – Sources of reactive power – SVC and STATCOM Harmonics in HVDC - characteristics and uncharacteristic harmonics, Calculation of voltage and current harmonics -harmonic filters – active and passive filters - Ratings of filter components and protection of Filters.		9
UNIT-V	**POWER FLOW ANALYSIS IN AC/DC SYSTEMS**	
Per unit system for DC quantities – DC system model – Inclusion of constraints – Power flow analysis – Solution of AC/DC power flow-Simultaneous method- Sequential method–Protection Systems in HVDC Substation-HVDC Simulator.		9

Total Contact Hours	**:**	**45**	

Course Outcomes:	
●	Realize the concept, planning of DC power transmission and comparison with Power transmission.
●	Formulate and Solve mathematical related to HVDC converters.
●	Develop models and concept of HVDC system control
●	Analyze the harmonics and design of filters.
●	Understand DC system under steady state

Suggested Activities	
●	Group discussion on applications
●	Exposure through industrial visit
Suggested Evaluation Methods	
●	Seminars
●	Group Assignments

Text Book(s):	
1	K.R. Padiyar, “HVDC Power Transmission System”, New Age Intl, third edition, 2015.
2	Edward Wilson Kimbark, “Direct Current Transmission”, Vol. I, Wiley interscience, New York, London, Sydney, 1971.
3	Rakosh Das Begamudre, “Extra High Voltage AC Transmission Engineering”, NewAge International (P) Ltd., New Delhi, 1990

Reference Books(s):	
1	Dragan Jovcic, Khaled Ahmed, “High Voltage Direct Current Transmission: Converters, Systems and DC Grids”, Wiley Publishers, first edition, 2015.
2	Colin Adamson and Hingorani N G, “High Voltage Direct Current Power Transmission”, Garraway Limited, London, 1960
3	S. Kamkshaiah, V Kamraju, “HVDC transmission”, Tata McGraw Hill, second edition, 2021.
4	S.Rao, “EHV-AC, HVDC Transmission and Distribution Engineering”, Khanna Publishers,3rd Edition, 2012
5	NPTEL: https://nptel.ac.in/courses/108106160.
Web links:	

	https://nptel.ac.in/courses/108104013

COs/POs&PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	2	-	3	1	-	-	-	2	2	3	3	1
CO 2	3	3	3	2	-	3	1	-	-	-	2	2	3	3	1
CO 3	3	3	3	2	-	3	1	-	-	-	2	2	3	3	1
CO 4	3	3	3	2	-	3	1	-	-	-	2	2	3	3	1
CO 5	3	3	3	2	-	3	1	-	-	-	2	2	3	3	1
Average	**3**	**3**	**3**	**2**	**-**	**3**	**1**	**-**	**-**	**-**	**2**	**2**	**3**	**3**	**1**

MT23D13	INTELLIGENT CONTROL SYSTEMS	PE	L	T	P	C
			3	**0**	**0**	**3**

Objectives: The course shall:	
●	Understand the basics of dynamic systems, robotic control, and System of Systems (SoS).
●	To learn state-space methods and observer design for practical applications like the inverted pendulum.
●	To explore fuzzy systems and neural networks for system identification and function approximation.
●	To study simulation frameworks for SoS with real-world examples.
●	To understand advanced control methods, such as hierarchical and decentralized control, for managing SoS.

UNIT-I	**INTRODUCTION**	**09**
Introduction – Model of Dynamic System – Control of Robot Manipulators – Stability – System of Systems – Challenging Problems in SoS – Theoretical Problems.		
UNIT-II	**OBSERVER DESIGN AND KALMAN FILTERING**	**09**
State Space Methods – Observing and Filtering based – Derivation – Inverted Pendulum.		
UNIT-III	**FUZZY SYSTEMS AND NEURAL NETWORK**	**09**
Introduction – Sets – Classical Set Operations – Properties of Classical Set – Predicate Logic – Introduction to Function Approximation – NN-Based Identification – Structure of NNs – Generating Training Data for an NN.		
UNIT-IV	**SYSTEM OF SYSTEMS SIMULATION**	**09**
Introduction – SoS in a Nutshell – SoS Simulation Framework – Case Studies.		
UNIT-V	**CONTROL OF SYSTEM OF SYSTEMS**	**09**
Introduction – Hierarchical Control of SoS – Decentralized Control of SoS – Other Control Approaches.		
	Total Contact Hours : 45	

Course Outcomes: After the successful completion of the course, the student will be able to:	
CO1	Explain dynamic systems, robotic control, and the basics of SoS.
CO2	Use state-space methods and design observers for applications like the inverted pendulum.
CO3	Apply fuzzy logic and neural networks for system identification and problem-solving.
CO4	Simulate System of Systems and analyze case studies.
CO5	Explain the advanced control methods for SoS.

Textbook (s):	
1	Thrishantha Nanayakkara, Ferat Sahin, Mo Jamshidi, "Intelligent Control Systems with an Introduction to System of Systems Engineering", CRC Press, 2018.
2	Ogata, K, "Modern Control Engineering" ,5th Edition, Pearson Education Inc, New Delhi, 2015.
3	Jamshidi, M. (Ed), "System of Systems Engineering, CRC Press, Boca Raton, FL, 2008.

Reference Books(s) / Web links:	
1	Laurene Fauseett, "Fundamentals of Neural Networks", Prentice Hall India, New Delhi, 2012.
2	Erdal Kayacan, Mojtaba Ahmadieh Khaneswar, "Fuzzy neural networks for Real time control applications", Elsevier, 2015.
3	J.S. R. Jang, C.T. Sun, and E. Mizutani, "Neuro-Fuzzy and Soft Computing - A computational approach to learning and machine intelligence", Prentice Hall, 2011.

CO\ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	-	-	-	-	-	-	-	-	2	3	2	-
CO2	3	3	3	3	3	-	-	-	-	-	-	3	3	3	3
CO3	3	3	3	3	3	-	-	-	-	-	-	3	3	3	3
CO4	3	3	3	3	3	-	-	-	-	-	2	3	3	3	3
CO5	3	3	2	3	3	2	-	-	-	-	3	3	3	3	3

Avg	**3.0**	**3.0**	**2.8**	**3.0**	**3.0**	**2.0**	**-**	**-**	**-**	**-**	**2.5**	**2.8**	**3.0**	**2.8**	**3.0**

MT23D14	**BATTERY MANAGEMENT SYSTEM**	**PE**	**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**

Objectives: The course shall:	
●	Introduce the fundamentals of battery management systems (BMS) and their significance in modern energy storage solutions.
●	Explain the requirements and functionalities of BMS, including sensing, control, and communication interfaces.
●	Provide an understanding of battery health and charge estimation methods.
●	Familiarize students with modeling and simulation techniques for battery systems.
●	Develop skills to design efficient and reliable battery management systems for various applications.

UNIT-I	**INTRODUCTION TO BMS**	**09**
Introduction to Battery Management System, Cells & Batteries, Nominal voltage and capacity, C rate, Energy and power, Cells connected in series, Cells connected in parallel, Electrochemical and lithium-ion cells, Rechargeable cell, Charging and Discharging Process, Overcharge and Undercharge, Modes of Charging		
UNIT-II	**BMS REQUIREMENT**	**10**
Introduction and BMS functionality, Battery pack topology, Voltage Sensing, Temperature Sensing, Current Sensing, BMS Functionality, High-voltage contactor control, Thermal control, Protection, Communication Interface, Range estimation, State-of-charge estimation, Cell total energy and cell total power,		
UNIT-III	**BATTERY SOC, SOH ESTIMATION AND CELL BALANCING**	**10**
Battery state of charge estimation (SOC), voltage-based methods to estimate SOC, Model-based state estimation, Battery Health Estimation, Lithium-ion aging: Negative electrode, Lithium ion aging: Positive electrode, Cell Balancing, Causes of imbalance, Circuits for balancing.		
UNIT-IV	**MODELING AND SIMULATION**	**09**
Equivalent-circuit models (ECMs), Physics-based models (PBMs), Empirical modeling approach, Physics-based modeling approach, Simulating an electric vehicle, Vehicle range calculations, Simulating constant power and voltage, Simulating battery packs,		
UNIT-V	**DESIGN OF BMS**	**07**
Design principles of battery management systems, Effect of load, distance, and force on battery life and BMS performance, Energy balancing in multi-battery systems, Strategies for BMS optimization, Design considerations for safety and reliability.		
	Total Contact Hours : 45	

Course Outcomes: After the successful completion of the course, the student will be able to:	
CO1	Understand the fundamental principles of battery systems and charging processes.
CO2	Identify the requirements and functionalities of battery management systems.
CO3	Apply techniques for SOC and SOH estimation and cell balancing.
CO4	Develop battery models and simulate their performance for various applications.
CO5	Design and optimize battery management systems for energy efficiency and safety.

Textbook (s):	
1	Plett, Gregory L. Battery management systems, Volume I: Battery modeling. Artech House, 2015.
2	Plett, Gregory L. Battery management systems, Volume II: Equivalent-circuit methods. Artech House, 2015.
3	Bergveld, H.J., Kruijt, W.S., Notten, P.H.L "Battery Management Systems -Design by Modelling" Philips Research Book Series 2002.

Reference Books(s) / Web links:	
1	Davide Andrea," Battery Management Systems for Large Lithium-ion Battery Packs" Artech House, 2010
2	Pop, Valer, et al. Battery management systems: Accurate state-of-charge indication for battery-powered applications. Vol. 9. Springer Science & Business Media, 2008.

CO\ PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	-	-	-	-	-	-	-	-	-	2	3	2	-
CO2	3	3	-	2	-	-	-	-	-	-	-	2	3	3	2
CO3	3	3	3	3	3	-	-	-	-	-	-	3	3	3	3
CO4	3	3	3	3	3	-	-	-	-	-	-	3	3	3	3
CO5	3	3	3	3	3	3	2	2	-	-	2	3	3	3	3
Avg	**3.0**	**2.8**	**3.0**	**2.8**	**3.0**	**3.0**	**2.0**	**2.0**	**-**	**-**	**2.0**	**2.6**	**3.0**	**2.8**	**2.8**

EE23A14	ENERGY STORAGE SYSTEMS	Category	L	T	P	C
		PE	3	0	0	3

Objectives:

- To understand the different types of energy storage technologies
- To analyze Battery energy storage system
- To analyze the Renewable energy storage system
- To comprehend the principle of Fuel Cell energy storage system
- To study the various applications of energy storage systems

UNIT-I INTRODUCTION **9**

Electricity - Role of energy storage systems and applications. Necessity of energy storage – types of energy storage – mechanical –chemical–electrical–electrochemical–electromagnetic–thermal – comparison of energy storage technologies.

UNIT-II BATTERY ENERGY STORAGE SYSTEM **9**

Fundamental concept of batteries – measuring of battery performance, charging and discharging, power density, energy density, and safety issues. Types of batteries – Lead Acid, Nickel -Cadmium, Zinc Manganese dioxide, Li-ion batteries. Battery critical parameters selection (voltage of cell –Specific energy–Charge (C-rate)–dis-Charge (C-rate),Cycle life–current density –Thermal runaway –Battery series parallel connection and String size–Battery mounting arrangement and installation. Safety of lithium-ion batteries. Types of lithium ion battery. Batteries for Electric Vehicles.

UNIT-III RENEWABLE ENERGY STORAGE SYSTEM **9**

Solar energy, Wind energy, Pumped hydro energy, fuel cells. Energy storage in Micro-grid and Smart grid. Energy Management with storage systems, Increase of energy conversion efficiencies by introducing energy storage.

UNIT-IV FUEL CELL ENERGY STORAGE SYSTEM **9**

Working Principle and Application of fuel cells: working principle of fuel cell, performance characteristics of fuel cells, efficiency of fuel cell, fuel cell stack, description of some commercially available fuel cell stacks.– Types Fuel Cell – Hydrogen oxygen cells– Hydrogen air cell–Hydrocarbon air cell–alkaline fuel cell–detailed analysis – advantages and disadvantages –Fuel Cell Electric Vehicles.

UNIT-V ALTERNATE ENERGY STORAGE TECHNOLOGIES **9**

Super capacitors– Principles & Methods – Applications–Compressed air Energy storage–Battery-Super capacitor Hybrid Energy Storage Systems–Pumped Hydro Storage. Double-layer capacitors (DLC), Super conducting magnetic energy storage (SMES)Flywheel energy storage (FES), Electrochemical storage systems, Secondary batteries, Flow batteries, Chemical energy storage, Hydrogen (H2), Synthetic natural gas (SNG).

Total Contact Hours : 45

Course Outcomes: On completion of the course, the students will

- Gain knowledge on different energy storage technologies
- Able to model the battery energy storage system
- Able to analyze a renewable energy storage system.
- Able to analyze the thermodynamics of fuel cell energy storage system
- Gain Knowledge on various applications of energy storage technologies and perform the selection

Text Book (s):

1. Energy Storage -Fundamentals, Materials and Applications, Robert Huggins, Springer, 2016
2. Energy Storage in Power Systems ,Francisco Díaz-González, Andreas Sumper, Oriol Gomis-Bellmunt 2016
3. Handbook on Battery Energy Storage System, Asian Development Bank
4. Handbook of lithium-ion battery pack design chemistry, components, types and terminology by Warner, John T, Elsevier.
5. Fundamentals and Application of Lithium-ion Battery Management in Electric Drive Vehicles by San Ping Jiang, Wiley.

Reference Books(s) :

1. Ibrahim Dincer and Mark A. Rosen, “Thermal Energy Storage Systems and Applications”, John Wiley & Sons 2002
2. James Larminie and Andrew Dicks, ”Fuel cell systems Explained”, Wiley publications, 2003.
3. Ru-shiliu, Leizhang and Xueliang sun, “Electrochemical technologies for energy storage and conversion”, Wiley publications, 2012.
4. A.G.Ter-Gazarian, “Energy Storage for Power Systems”, Second Edition, The Institution of Engineering and Technology (IET) Publication, UK, (ISBN – 978-1-84919-219-4), 2011.
5. Pistoia, Gianfranco, and Boryann Liaw. Behaviour of Lithium-Ion Batteries in Electric Vehicles: Battery Health, Performance, Safety, and Cost. Springer International Publishing AG, 2018.
6. Lithium-Ion Batteries Basics and Applications by Reiner Korthauer, Springer.

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	3	2	-	-	-	-	-	3	-	3	3	3	3
CO 2	3	3	3	2	3	-	-	-	-	3	-	3	3	3	3
CO 3	3	3	3	2	3	-	-	-	-	3	-	3	3	3	3
CO 4	3	3	3	2	3	-	-	-	-	3	-	3	3	3	3

CO 5	3	3	3	2	-	-	-	-	-	3	-	3	3	3	3
Average	3	3	3	2	3	-	-	-	-	3	-	3	3	3	3

MT23D15	**VLSI and FPGA**	**Category**	**L**	**T**	**P**	**C**
		PE	**3**	**0**	**0**	**3**

Objectives:

- To introduce the features of programmable logic devices
- To learn the features of various FPGAs and FPAA
- To understand the concepts of synchronous and asynchronous FSMs
- To provide the system design experience with FSMs using PLDs
- To introduce pulse mode approach to asynchronous FSM

UNIT-I	**PROGRAMMABLE LOGIC DEVICES**	**9**

Logic implementation options - Technology trends - Design with Field Programmable devices - ROM, PLA, PAL - CPLD - XC9500 family - Erasable Programmable Logic Devices - MAX5000, MAX7000 families.

UNIT - II	**FPGA AND FPAA**	**9**

Programming Technology, Logic blocks, routing architectures of SRAM-Programmable FPGA Architectures - XC2000, XC3000, XC4000 – Anti-fuse Programmed FPGAs - Routing Architecture of the Actel FPGAs - ProASIC plus - Design Applications - Current FPGA Technologies - FPAA
architecture and its reconfiguration.

UNIT-III	**SYNCHRONOUS FSM DESIGN**	**9**

Choice of Components to be Considered - Architecture Centered around Nonregistered PLDs - State Machine Designs - Centered around a Shift Register, Centered around a Parallel Loadable Up/Down Counter - One hot design method - Use of Algorithmic State Machine, Application of one hot design to serial 2's complementer, parallel to serial adder/subtractor controller- System-level design: controller, data path, and functional partition.

UNIT-IV	**ASYNCHRONOUS STATE MACHINE DESIGN**	**9**

Features and need for Asynchronous FSMs - Lumped path delay models for asynchronous FSMs - Excitation table, state diagrams, K-maps, and state tables - Design of the basic cells by using the LPD model - design examples - Hazards in Asynchronous FSMs - One-hot design of asynchronous state machines - Design of fundamental mode FSMs by using PLDs.

UNIT-V	**PULSE MODE APPROACH TO ASYNCHRONOUS FSM DESIGN**	**9**

Pulse Mode Models and System Requirements - Choice of Memory Elements - Other Characteristics of Pulse Mode FSMs - Design Examples - Analysis of Pulse Mode FSMs - One-Hot Programmable Asynchronous Sequencers.

Total Contact Hours	**:**	**45**

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

CO 1	Implement the digital designs with programmable logic devices
CO 2	Analyze the architectural features of FPGA and FPAA
CO 3	Make the system level designs using synchronous and asynchronous FSMs
CO 4	Design the fundamental mode FSMs using PLDs
CO 5	Apply pulse mode approach to FSM Design

Text Books:

1	Stephen M. Trimberger, Edr.,"Field Programmable Gate Array Technology",Springer Science Business media, LLC, 2012.
2	Richard F. Tinder, "Engineering Digital Design, Revised Second Edition", Academic Press, 2000.

Reference Books / Web links:

1	Roger Woods, John McAllister, Gaye Light body and Ying Yi, "FPGA-based implementation of Signal Processing Systems", A John Wiley and Sons, Ltd., Publication, 2017.
2	John V. Oldfield, Richard C.Dorf, "Field Programmable Gate Arrays - Reconfigurable logic for rapid prototyping and implementation of digital systems", John Wiley & Sons, Reprint, 2008
3	P. K .Chan& S. Mourad, "Digital Design Using Field Programmable Gate Array", Prentice Hall, 1994
4	Thomas L. Floyd, "Electronic Devices", Pearson Education Ltd., 8th Edition, 2013.

COs/POs&PSOs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1		3	2						2	3	2	
CO2	3	3	1		3							3	3	3	2
CO3	3	3	3		3							3	3	3	3
CO4	3	2	3		3							3	3	3	3
CO5	3	3	3		3							3	3	3	3
Average	3	2.6	2.2		3.0	2.0						2.8	3	2.8	2.8

VERTICAL E – ROBOTICS AND AUTOMATION

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

CO1	Recognize the fundamentals of Collaborative Robotics
CO2	Apply Swarm robot technology in real time applications
CO3	Analyze and select the suitable concept of Modular Robotics and its Mechanics formodelling a collaborative robot
CO4	Create various Natural models for robot collaboration
CO5	Develop collaborative robots for various requirement in industrial tasks.

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)

ME23C11	DRONE TECHNOLOGIES	Category	L	T	P	C
		PE	3	0	0	3

Objectives:

- To learn and understand the fundaments of design, fabrication and programming of drone
- To learn and understand the fundaments of design, fabrication and programming of drone
- To impart the knowledge on flying and operation of drone
- To know about the Drone Design Mechanism For Various applications
- To understand the safety risks and guidelines of fly safely

	INTRODUCTION TO DRONE TECHNOLOGY	**9**

History of Drone - Drone Concept - Vocabulary Terminology- Classifications of the UAV - UAV Materials, Launching system, attachment of UAV. Drone technology impact on the businesses- Drone business through entrepreneurship- Opportunities/applications for entrepreneurship and employability

UNIT-II	**DRONE DESIGN, FABRICATION AND PROGRAMMING**	**9**

Components of UAV – Battery of UAV - Function of the component parts - Aerodynamic forces, Viscosity, Stall speed, Compressibility, Earth‘s atmosphere -Assembling a drone- Payload - The energy sources- Level of autonomy- Drones configurations - Drone Programming and Simulation – Multi rotor stabilization.

UNIT-III	**DRONE FLYING AND OPERATION**	**9**

Flight modes- Flight control system –- Drone Controls Flight operations –Management tool - Operate a small drone in a controlled environment –Sensors- Lidar, sonar, IMU, Optical flow and other sensors –Auto pilot -Sense and avoid technique Onboard storage capacity - Removable storage devices Linked mobile devices and applications – Radio Communication – Ground control system – First person view – Data Fusion.

UNIT-IV	**DESIGN OF DRONE MECHANISM FOR COMMERCIAL APPLICATIONS**	**9**

Situational awareness – Flight operation – Decision making – analysis of weather factor – weather information - Choosing a drone based on the application -Drones in the insurance sector- Drones in delivering mail, parcels and other cargo- Drones in agriculture- Drones in defense – Drones in Healthcare - Drones in inspection of transmission lines and power distribution -Drones in filming and panoramic picturing

UNIT-V	**FUTURE DRONES AND SAFETY**	**9**

Drones - Safety risks- Maintenance -Risk analysis and prevention. -Guidelines to fly safely -Specific aviation regulation and standardization - Drone license- Miniaturization of drones- Increasing autonomy of drones -The use of drones in swarms.

	Total Contact Hours	**45**

Course Outcomes: At the end of the course the students would be able to

CO1	Know about a various type of drone technology
CO2	Drone fabrication and programming and execute the suitable operating procedures for functioning a drone
CO3	Select appropriate sensors and actuators for Drones
CO4	Develop a drone mechanism for specific applications
CO5	Create the programs for various drones

Text Books:

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

Reference Books(s) / Web links:

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

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	2	1	3	2	-	-	-	-	-	1	2	1	3
CO2	1	2	2	1	3	2	-	-	-	-	-	1	2	1	3
CO3	1	2	2	1	3	2	-	-	-	-	-	1	2	1	3
CO4	1	2	2	1	3	2	-	-	-	-	-	1	2	1	3
CO5	1	2	2	1	3	2	-	-	-	-	-	1	2	1	3
Impact	1	2	2	1	3	2	-	-	-	-	-	1	2	1	3

MT23E11	MEDICAL ROBOTICS	PE	L	T	P	C
			3	0	0	3

Objectives:

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

UNIT-I	**INTRODUCTION**	**9**
Types of medical robots - Navigation - Motion Replication - Imaging - Rehabilitation and Prosthetics – State of art of robotics in the field of healthcare-DICOM		
UNIT-II	**LOCALIZATION AND TRACKING**	**9**
Position sensors requirements - Tracking - Mechanical linkages - Optical – Sound based - Electromagnetic - Impedance-based - In-bore MRI tracking-Video matching - Fiber optic tracking systems - Hybrid systems.		
UNIT-III	**DESIGN OF MEDICAL ROBOTS**	**9**
Characterization of gestures to the design of robots - Design methodologies - Technological choices - Security		
UNIT-IV	**SURGICAL ROBOTICS**	**9**
Minimally invasive surgery and robotic integration -surgical robotic sub systems - synergistic control - Control Modes - Radiosurgery - Orthopedic Surgery - Urologic Surgery and Robotic Imaging -Cardiac Surgery – Neurosurgery - case studies		
UNIT-V	**ROBOTS I REHABILITATION AND MEDICAL CARE**	**9**
Rehabilitation for Limbs - Brain-Machine Interfaces - Steerable Needles - Assistive robots - Robotsin Physiotherapy - case studies.		
	Total Contact Hours : 45	

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

Text Books:	
1	Achim Ernst Floris Schweikard, Medical Robotics, Springer, 2016.
2	Paula Gomes, Medical robotics Minimally invasive surgery, Woodhead, 2013.
Reference Books / Web links:	
1	Jaydev P Desai, Rajni V Patel, Antoine Ferreira; Sunil Kumar Agrawal, The Encyclopedia of Medical Robotics, World Scientific Publishing Co. Pvt. Ltd, 2019
2	Jocelyne Troccaz , Medical Robotics, John Wiley & Sons Incorporated, 2013.
3	Vanja Bonzovic , Medical Robotics, I-tech Education publishing, Austria, 2008.
4	Farid Gharagozloo Robotic Surgery, Springer, 2022

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)

MT23E12	MECHATRONICS SYSTEM DESIGN	PE	L	T	P	C
			3	**0**	**0**	**3**

Objectives:	
●	To understand the principles and interdisciplinary nature of Mechatronic systems, integrating mechanical, electrical, and computational elements
●	To learn systematic approaches for modeling, simulation, and analysis of dynamic systems in Mechatronics.
●	To gain knowledge of sensors, actuators, and control strategies for designing efficient Mechatronic systems.
●	To explore embedded systems, communication protocols, and their integration into Mechatronic applications.
●	To develop the ability to design, optimize, and evaluate innovative Mechatronic systems for industrial and research applications.
UNIT-I	**Fundamentals of Mechatronic Systems** **9**
Definition, Scope, and Evolution of Mechatronics - Components of Mechatronic Systems: Mechanical, Electrical, Control, and Software Integration - Modeling and Simulation of Mechatronic Systems - Systematic Design Approach: V-Model and its Applications - Case Studies: Examples of Mechatronic Systems in Automotive and Consumer Electronics	
UNIT-II	**Mechatronic System Modeling and Analysis** **9**
Physical Modeling: Mechanical, Electrical, and Thermal Systems - System Dynamics and Differential Equations Bond Graphs and State-Space Representation - Linearization of Nonlinear Systems - Tools for Mechatronic System Modeling (e.g., MATLAB, Simulink) - Case Study: Dynamic Modeling of an Actuator	

UNIT-III	**Sensors and Actuators in Mechatronics**	**9**
Overview of Mechatronic Sensors: Position, Velocity, Force, Pressure, and Temperature Sensors - Sensor Signal Conditioning and Interfacing Techniques - Actuators: DC Motors, Stepper Motors, Servo Motors, Hydraulic and Pneumatic Actuators - Actuator Selection and Sizing Criteria - Mechatronic Systems Control: PID Controllers and Feedback Control Design - Case Study: Sensor and Actuator Integration in Robotics		
UNIT-IV	**Embedded Systems in Mechatronics**	**9**
Embedded Systems: Microcontrollers and DSPs in Mechatronics - Communication Protocols: CAN, LIN, and I2C Real- Time Operating Systems (RTOS) in Mechatronics - Integration of Embedded Systems with Sensors and Actuators - System-on-Chip (SoC) for Mechatronics Applications - Hands-on Example: Embedded Control of a DC Motor.		
UNIT-V	**Design and Optimization of Mechatronic Systems**	**9**
Concurrent Engineering and Design Optimization - Reliability and Fault Diagnosis in Mechatronic Systems Virtual Prototyping and Digital Twins - Application of Artificial Intelligence in Mechatronics Design - Case Study: Design of a Mechatronic System (e.g., Automated Guided Vehicle) - Future Trends and Emerging Applications in Mechatronics		
	Total Contact Hours : 45	

Course Outcomes:	
On completion of course students will be able to	
●	Demonstrate a thorough understanding of Mechatronic system fundamentals and interdisciplinary integration.
●	Apply modeling and simulation techniques to analyze the dynamics and performance of complex systems.
●	Select and integrate suitable sensors and actuators for effective Mechatronic system functionality.
●	Implement embedded systems and communication protocols for real-time Mechatronic applications.
●	Design and optimize reliable and innovative Mechatronic systems for industrial and research applications.

Text Books:	
1	Klaus Janschek, Mechatronic Systems Design: Methods, Models, Concepts, Springer, 2012.
2	W. Bolton, Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, Pearson, 2018.
Reference Books / Web links:	
1	Robert H. Bishop (Ed.), The Mechatronics Handbook, CRC Press, 2018.
2	David G. Alciatore and Michael B. Histand, Introduction to Mechatronics and Measurement Systems, McGraw Hill, 2020.
3	Devdas Shetty and Richard A. Kolk, Mechatronics System Design, Cengage Learning, 2017.

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	2	1	1	-	-	-	-	1	1	-	-	2	-	-
CO 2	3	2	1	-	-	-	-	-	-	1	-	-	-	-	-
CO 3	3	2	1	-	-	-	-	-	-	1	-	-	-	-	-
CO 4	3	2	1	1	1	-	-	-	1	1	-	-	2	1	1
CO 5	3	2	1	1	2	-	-	-	1	1	1	-	2	1	1
Average	3	2	1	1	1.5	-	-	-	1	1	1	-	2	1	1

MT23E14	**WIRELESS NETWORKS FOR INDUSTRIAL AUTOMATION**	**PE**	**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**

Objectives:	
●	To understand the technologies used in wireless networks
●	To study the standards of wireless networks
●	To understand the application of wireless networks in Automation
●	To study the usage of radio waves in wireless communication
●	To study the hacking methods of Industrial Networks
UNIT-I	**Wireless Network Technology** **9**
Standards – Proprietary or Non-Standard Wireless Networks – Wireless Versus Wired Networks – Antenna Technology – Wireless Network topologies	
UNIT-II	**Wireless Network Standards** **9**
Wireless Local Area Networks – Wireless Personal Area Networks – WMAN, WiMAX – Wireless Telephony – Convergence of Voice and Data Networks	
UNIT-III	**Application of Wireless Networks for Industrial Automation** **9**
Industrial Automation Requirements – Politics of Wireless – WiFi – Bluetooth – Zigbee – Wireless HART – 4G for Automation	
UNIT-IV	**Radio Frequency Tagging** **9**
Types of Tags – Tag Encoding – Alternative RFID Standards- RF Database Tag – RF Tag Recommendations	
UNIT-V	**Hacking Industrial Network** **9**
Cyber Security and Safety – Common Industrial Targets – Common Attack Methods – Weaponized Industrial Cyber Threats – Attack Trends – Dealing with Infection	
	Total Contact Hours : 45

Course Outcomes:	
On completion of course students will be able to	
●	Explain the standards of the Wireless Networks
●	Predict the technologies used for Wireless Networks
●	Select suitable wireless network for Industrial Automation
●	Predict the working of Radio waves in Industrial Networks
●	Identify the different types of hacking in Wireless Networks

Text Books:	
1	Dick Caro, "Wireless Networks for Industrial Automation", International Society of Automation, 2012
2	Eric D Knapp, Joel Thomas Langill "Industrial Network Security: Securing Critical Infrastructure Networks for Smart Grid, SCADA, and Other Industrial Control Systems", Syngress, 2010

Reference Books / Web links:	
1	Sudip K. Mazumder, "Wireless Networking Based Control", Springer, 2012
2	Danny Briere, Pat Hurley, "Wireless Network Hacks and Mods" John Wiley & Sons, 2014

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

MT23E16	**CNC TECHNOLOGY**	**PE**	**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**

Objectives: The course shall:	
●	To introduce students to the fundamental concepts of CNC (Computer Numerical Control) machines and their evolution.
●	To provide knowledge on the construction, working, and types of CNC machines.
●	To teach CNC programming for machine tool operations.
●	To explore applications of CNC machines in manufacturing and industry.
●	To introduce the latest advancements in CNC technologies and their integration with Mechatronics systems.

UNIT-I	**INTRODUCTION TO CNC MACHINES**	**9**
Evolution of CNC machines – Conventional vs. CNC systems – Basics of Numerical Control (NC) and Computer Numerical Control (CNC) – Advantages, disadvantages, and challenges of CNC systems – Structure and working principles of CNC machines – Coordinate systems: Cartesian and polar motion control –Types of CNC machines: Lathe, milling, turning, grinding, and drilling – Case study on CNC adoption in industries		
UNIT-II	**CONSTRUCTION AND WORKING OF CNC MACHINES**	**9**
Structural elements of CNC machines: Base, column, spindle, and tool turret – Open-loop and closed-loop CNC control systems – CNC drive mechanisms: Servo motors, stepper motors, and hydraulic drives – Feedback mechanisms: Linear and rotary encoders – Auxiliary components: Tool changers, tool magazines, and Automatic Tool Changers (ATC) – Coolant systems and chip management in CNC operations – Overview of machine tool types used in CNC systems.		
UNIT-III	**CNC PROGRAMMING**	**9**
Introduction to CNC programming – G-codes and M-codes: Functions and applications – Types of CNC programming: Manual (G-code) and CAM-based programming – Tool paths and cutting strategies: Facing, turning, drilling, milling, and contouring – Interpolation methods: Linear, circular, and helical – Practical examples of CNC program development for lathes and milling machines – Simulation and verification of CNC programs using software tools – Troubleshooting and debugging of CNC programs.		
UNIT-IV	**APPLICATIONS OF CNC MACHINES**	**9**
Industrial applications: Automotive, aerospace, electronics, and medical sectors – CNC machining centers and Flexible Manufacturing Systems (FMS) – Multi-axis CNC machines: 3-axis, 4-axis, and 5-axis systems – CNC- integrated robotic systems for automation – Case studies on successful CNC implementations in industries – Cost-benefit analysis of CNC machine adoption – Predictive and preventive maintenance strategies for CNC machines.		
UNIT-V	**LATEST DEVELOPMENTS IN CNC TECHNOLOGIES**	**9**
CNC integration with Industry 4.0 and IoT-enabled systems – Smart CNC systems: AI and machine learning applications – Adaptive control systems for real-time optimization – Hybrid machining processes: Laser-assisted and ultrasonic machining – CNC and additive manufacturing (3D printing) integration – Cloud-based CNC programming and data management – Virtual commissioning and simulation techniques for CNC systems – Future trends: CNC and		

Mechatronics integration in manufacturing			
		:	**45**

Course Outcomes: After the successful completion of the course, the student will be able to:	
CO1	Comprehend the fundamentals of CNC machines, including their benefits and challenges.
CO2	Analyze and explain the construction, working, and classification of CNC machines.
CO3	Develop CNC programs for various machining operations.
CO4	Assess and propose applications of CNC machines in modern manufacturing systems.
CO5	Demonstrate awareness of emerging trends in CNC technologies, including Industry 4.0 integration.

Textbook (s):	
1	Michael Fitzpatrick , Machining and CNC Technology, 5th edition, McGraw Hill, 2024
2	Peter Smid, CNC Programming Handbook, Industrial Press Inc.,U.S., 2003

Reference Books(s) / Web links:	
1	Alan Overby, CNC Machining Handbook: Building, Programming, and Implementation, McGraw-Hill, 2010
2	Hans Bernhard Kief and Helmut A. Roschiwal, The CNC Handbook: Digital Manufacturing and Automation from CNC to Industry 4.0, Industrial Press Inc, 2021
3	Khushdeep Goyal, CNC Machines and Automation, S.K. Kataria & Sons, 2014
4	Samer Najia, A Tinkerer's Guide to CNC Basics: Master the fundamentals of CNC machining, G-Code, 2D Laser machining and fabrication techniques, Packt Publishing, 2024

CO\ PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1	1	-	1	-	-	-	-	-	-	1	2	1
CO2	3	2	1	1	-	1	-	-	-	-	-	-	1	1	1
CO3	3	2	1	1	3	1	-	-	-	-	-	-	1	2	1
CO4	3	2	1	1	-	1	-	-	-	-	-	-	1	1	1
CO5	3	2	1	1	-	1	-	-	-	-	-	-	1	2	1
Avg	**3**	**2**	**1**	**1**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1.6**	**1**

MT23E17	**AUTOMOTIVE MECHATRONICS**	**PE**	**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**

Objectives: The course shall:	
●	To study about the basic Architecture and different systems in Automotive system
●	To observe the characteristics of the sensors used in Automotive Applications
●	To study about the working of different Control System in Automobiles
●	To find the fault occurrences and safety measures in Automobiles
●	To study about Hybrid Vehicles

UNIT-I	**INTRODUCTION**	**9**
Vehicle System Architecture - Electronic Control Unit: Operation, Design, Control Unit Software Motronic Engine Management System – Electronic Diesel Control.		
UNIT-II	**SENSORS AND ACTUATORS IN AUTOMOTIVE SYSTEMS**	**9**
Measuring Variables –Crank Shaft Sensor - Air Flow Rate Sensor – Throttle Angle Sensor – Coolant Sensor – Exhaust Gas Oxygen Sensor – Knock Sensor – Flex Fuel Sensor – Automotive Engine Control Actuators – Exhaust Gas Recirculation Actuator – Electric Motor Actuators.		
UNIT-III	**CONTROL AND COMMUNICATION SYSTEM**	**9**
Digital Engine Control and Features – Control Modes for Fuel Control – Discrete Time Idle Speed Control – EGR Control – Electronic Ignition Control – Digital Cruise Control – Antilock Braking System – Digital Braking System – Electronic Suspension Control System - Overview of automotive communication protocols, CAN, LIN, Flex Ray - TCP/IP for automotive - 802.11x communication protocols.		
UNIT-IV	**DIAGNOSTICS AND SAFETY IN AUTOMOTIVE SYSTEMS**	**9**
ISO 26262- Functional safety standard - Electronic Engine Control Diagnostics – Service Bay Diagnostic Tool – Onboard Diagnostics – Model Based Sensor Failure Detection – Misfire Detection – Expert systems in Automotive Diagnostics – Airbag Safety – Blind Spot Detection – Automatic Collision Avoidance System – Tire Pressure Monitoring System – Enhanced Vehicle Stability - AUTOSAR- standardized automotive software design.		
UNIT-V	**HYBRID DRIVES AND E-VEHICLES**	**9**
Drive Concepts: Introduction to Electric Motors, Power Electronics, Electric Drives, and Motor Control– Operating Strategies for Electric Hybrid Vehicle – Recuperative Brake System – Electrical Energy Accumulators – Tesla Roadster – Toyota Mirai - Volkswagen Golf GTE - Automotive energy storage systems: Batteries, ultracapacitors, flywheels and hydraulic accumulators - System design, integration and energy management.		
	Total Contact Hours	**: 45**

Course Outcomes: After the successful completion of the course, the student will be able to:	
CO1	Recognize the different system architecture of Automotive systems
CO2	Compare the sensor characteristics and Determine its suitability in Real time Environment
CO3	Determine the control system characteristics in Automotive Systems
CO4	Analyze the Fault Occurrences and Recognize the safety measures in Automobiles
CO5	Compare the system of the Hybrid Vehicles with other Vehicles

Textbook (s):	
1	Konrad Reif, "Automotive Mechatronics", Springer, 2016
2	Robert Bosch GmbH, "Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive, Springer, 2016.
3	Tom Denton , "Electric and Hybrid Vehicles", IMI, 2016.

Reference Books(s) / Web links:	
1	Mandy Concepcion, Automotive Electronic Diagnostics, Automotive Diagnostics and Publishing, 2009.
2	William Ribbens, "Understanding Automotive Electronics: An Engineering Perspective" Elsevier, 2017.
3	AK Babu, "Automotive Electrical and Electronics", Khanna Book Publishing; 2nd edition (1 January 2017)
4	Ronald. K. Jurgon, "Automotive Electronics Handbook", McGraw-Hill, 1999.
5	Barry Hollembeak, "Automotive Electricity, Electronics & Computer Controls", Delmar Publishers, 2001.

CO\ PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	2	-	2	-	-	-	-	-	-	2	3	-	3
CO2	3	2	2	2	3	3	2	-	-	-	-	3	2	2	2
CO3	3	1	1	2	-	1	-	-	-	-	-	1	-	3	2
CO4	3	3	3	3	3	3	3	-	-	-	-	2	2	3	2
CO5	3	-	2	-	-	-	-	-	-	-	-	2	2	2	1
Avg	3	2	2	2.3	2.6	2.3	2.5	-	-	-	-	2	2.2	2.5	2

VERTICAL F - DIVERSIFIED

CS23A31	BUSINESS ANALYTICS	Category	L	T	P	C
		PE	2	0	2	3

Objectives:

- Understand the Fundamentals of Business Analytics.
- Develop Spreadsheet Proficiency for Analytics.
- Master Data Visualization Techniques.
- Learn Descriptive Statistical Analysis.
- Explore Probability Distributions and Data Modeling.

UNIT-I	**Introduction to Business Analytics**	**6**

What Is Business Analytics? Evolution of Business Analytics, Scope of Business Analytics, Data for Business Analytics, Models in Business Analytics, Problem Solving with Analytics.

UNIT-II	**Analytics on Spreadsheets**	**6**

Basic Excel Skills, Excel Functions, Using Excel Lookup Functions for Database Queries, Spreadsheet Add-Ins for Business Analytics.

UNIT-III	**Visualizing and Exploring Data**	**6**

Data Visualization, Creating Charts in Microsoft Excel, Other Excel Data Visualization Tools, Data Queries: Tables, Sorting, and Filtering, Statistical Methods for Summarizing Data, Exploring Data Using PivotTables.

UNIT-IV	**Descriptive Statistical Measures**	**6**

Populations and Samples, Measures of Location, Measures of Dispersion, Measures of Shape, Excel Descriptive Statistics Tools, Descriptive Statistics for Grouped Data, Descriptive Statistics for Categorical Data: The Proportion, Statistics in PivotTables. Measures of Association, Outliers, Statistical Thinking in Business Decisions

UNIT-V	**Probability Distributions and Data Modeling**	**6**

Basic Concepts of Probability, Random Variables and Probability Distributions, Continuous Probability Distributions, Random Sampling from Probability Distributions, Data Modeling and Distribution Fitting.

	Contact Hours:	**30**

List of Experiments	
1.	**Excel essentials:** Introduction to the Interface an Source Data Formatting Navigation Shortcuts Format Painter Insert Delete Rows and Columns Autofill Data Sorting Filtering Custom Lists
2	**Excel Formulas** Logical Formulas IF & IFS Formulas Statistical Formulas Lookup Formulas Index and Match Switch Text Formulas Date and Time Formulas
3	**Excel Data Visualization** Inserting a Chart in Excel Changing Elements in a Chart Select Data Method Format Chart Elements Line Chart, Area Chart, Pie Chart, Donut Chart, Histogram & Pareto Chart, Waterfall Chart, Heat Maps, Combo Chart, Sparkline Dynamic Charts Funnel Chart, Slope Chart, Dumbbell Chart Highlight Points in Time Highlight Min and Max Actual vs Target
4	**Excel Pivot Table** Introduction to the Source Data Inserting a Pivot Table Understanding the Field List Clear, Select and Move Functions

	Refreshing Pivot Table Number Formatting in Pivot Table Conditional Formatting in Pivot Table Sorting in Pivot Table Filtering in Pivot Table Grouping in Pivot Table Pivot Table Layouts Table Styles and Other Important Options Summarize Values By Calculated Fields Pivot Charts Slicers	
5	**Mini Project**	
	Contact Hours:	**30**
	Total Contact Hours:	**60**

Course Outcomes: On completion of the course, the students will be able to
● Apply Business Analytics Techniques.
● Utilize Advanced Excel Functions.
● Create and Interpret Data Visualizations.
● Perform Descriptive Statistical Analysis.
● Model Business Scenarios Using Probability.

Text Book(s):	
1	R. Evans James, Business Analytics, 2nd Edition, Pearson, 2017.
2	R N Prasad, Seema Acharya, Fundamentals of Business Analytics, 2nd Edition, Wiley, 2016.
Reference Book(s) / Web link(s):	
1	Philip Kotler and Kevin Keller, Marketing Management, 15th edition, PHI, 2016.
2	VSP Rao, Human Resource Management, 3rd Edition, Excel Books, 2010.
3	Mahadevan B, "Operations Management -Theory and Practice", 3rd Edition, Pearson Education, 2018.

PO/PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CS23A31.1	2	2	3	1	1	-	-	-	1	2	1	1	3	2	1
CS23A31.2	3	3	3	2	3	-	-	-	1	2	2	2	3	1	2
CS23A31.3	2	2	3	3	2	-	-	-	3	1	1	3	3	1	2
CS23A31.4	2	1	1	2	2	-	-	-	3	3	2	1	1	3	1
CS23A31.5	2	3	2	3	2	-	-	-	3	3	1	3	3	1	1
Average	**2.2**	**2.2**	**2.4**	**2.2**	**2**	**-**	**-**	**-**	**2.2**	**2.2**	**1.4**	**2**	**2.8**	**1.6**	**1.4**

CD23C22	**DATA VISUALIZATION**	**Category**	**L**	**T**	**P**	**C**
		PE	**0**	**0**	**6**	**3**

Objectives:	
●	To introduce students to Excel's basic and advanced data visualization techniques.
●	To familiarize students with Tableau.
●	To develop skills in using Power BI.
●	To enable students to design comprehensive visual dashboards.
●	To apply knowledge through a capstone project.

List of Experiments	
Excel for Data Visualization	
1	**Data Manipulation and Cleaning** ● Using Functions and formulae for Data Cleaning. ● Sorting, Filtering and Data Validation techniques.
2	**Excel Charts and Tools** ● Getting started with charts (Bar, Line, Pie). ● Advanced charts (Histograms, Box plots, Area Chart, Bubble chart).
3	**Excel Advanced Features** ● Using PivotTables for data analysis. ● Dynamic Dashboards with Slicers and Timeline.
Data Visualization with Tableau	

4	**Getting Started with Tableau** ● Connecting to data and basic visualizations. ● Interactive Dashboards and Storytelling. ● Filters, Pages, Hierarchies, Sorting and Dates.
5	**Advanced Data Manipulation Techniques** ● Calculated fields and parameters. ● Calculations and Expressions -Total and Aggregations, Automatic and Custom split. ● Organizing Data and Visual Analytics – Reference lines and bands, Clusters, Forecasting, Trend lines, Summary Card.
Data Visualization with Power BI	
6	**Introduction to Power BI** ● Getting started with Data importing and transforming with Power Query. ● Report designing with basic visualizations and using the visualization pane. ● Measures, Filters. ● Features of Power BI- Drill through, Hierarchies.
7	**Advanced Power BI** ● DAX. ● Creating complex reports and dashboards.
8	**Capstone Project -** Students will select a real-world dataset and use any tools (Excel, Tableau, and Power BI) to create comprehensive dashboards.
	Total Contact Hours **90**

Course Outcomes: On completion of course, you will be able to	
CO1	Create basic and advanced visualizations in Excel for data analysis.
CO2	Develop interactive dashboards and perform data manipulations in Tableau.
CO3	Design reports and apply DAX for advanced reporting in Power BI.
CO4	Integrate and organize data to create comprehensive dashboards using various visualization tools.
CO5	Apply their learning to solve real-world data visualization problems using Excel, Tableau, and Power BI.

Textbooks:	
1	Kieran Healy, “Data Visualization: A Practical Introduction”, Princeton University Press, 1st Edition, 2022.
2	Claus Wilke, “Fundamentals of Data Visualization: A Primer on Making Informative and Compelling Figures”, O'Reilly Media, 2nd Edition, 2023.
3	Jon Schwabish, Better Data Visualizations: A Guide for Scholars, Researchers, and Wonks”, Columbia University Press, 1st Edition, 2023.
4	Sanjeev J. Wagh, Manisha S. Bhende, Anuradha D. Thakare, “Fundamentals of Data Science”, CRC Press, 2nd ,2022.

Reference Books (s):	
1.	Excel Visualizations Power BI Documentation
2.	https://learn.microsoft.com/en-us/training/browse/?products=power-bi https://www.tableau.com/learn/training
3.	Online Course: Coursera — Data Visualization with Tableau Excel Visualizations
4.	Power BI Documentation

PO/PSO / CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CD23C22.1	3	2	2	1	2	-	-	-	-	-	-	-	3	2	1
CD23C22.2	3	3	2	2	3	1	-	-	-	-	-	-	3	3	2
CD23C22.3	3	2	3	2	3	-	1	-	-	-	-	-	3	3	2
CD23C22.4	3	3	3	2	3	-	1	1	-	-	-	-	3	3	3
CD23C22.5	3	3	3	3	3	2	2	1	1	1	2	1	3	3	3
Average	**3**	**2.6**	**2.6**	**2**	**2.8**	**1.5**	**2**	**0.5**	**1**	**1**	**2**	**1**	**3**	**3**	**2.2**

MT23F11	ENTERPRISE RESOURCE PLANNING	PE	L	T	P	C
			3	0	0	3

Objectives: The course shall:	
●	Introduce the fundamentals of ERP systems and their role in organizations.
●	Provide an understanding of the implementation lifecycle of ERP solutions.
●	Explore the integration of business processes through ERP systems.
●	Analyze critical success factors for ERP implementation and management.
●	Examine the role of emerging technologies such as cloud computing and AI in ERP systems.

UNIT-I	**INTRODUCTION TO ERP SYSTEMS**	**09**
Definition and concept of ERP systems, Evolution of ERP from MRP and MRP II, Benefits and limitations of ERP, Components and architecture of ERP systems, ERP vendors and market trends, ERP modules overview – Finance, Manufacturing, HR, Supply Chain, CRM, ERP for small and medium enterprises (SMEs).		
UNIT-II	**ERP AND BUSINESS PROCESSES**	**09**
Integration of business processes using ERP, Business process reengineering (BPR) for ERP adoption, Role of ERP in automating business processes, ERP workflow and process automation, Examples of ERP-enabled processes in finance, sales, procurement, and inventory, ERP analytics and decision-making.		
UNIT-III	**ERP IMPLEMENTATION LIFECYCLE**	**09**
Phases of ERP implementation: Pre-implementation, Implementation, and Post-implementation, Steps in selecting an ERP package, Requirements analysis and gap analysis, ERP customization and configuration, Data migration and integration challenges, Training and change management, Critical success factors for ERP implementation, ERP failure case studies and lessons learned.		
UNIT-IV	**ERP AND EMERGING TECHNOLOGIES**	**09**
Cloud-based ERP systems, Advantages and challenges of SaaS ERP, Role of IoT in ERP integration, AI and machine learning for ERP analytics, Blockchain for secure transactions in ERP systems, Mobile ERP applications, Big data and ERP integration for advanced insights, Case studies on technology-driven ERP transformations.		
UNIT-V	**MANAGING ERP SYSTEMS**	**09**
Post-implementation challenges and maintenance, ERP performance monitoring and optimization, Upgrading and scaling ERP systems, ERP security and data protection, Managing ERP systems in a multi-vendor environment, Cost-benefit analysis of ERP investments, Future trends in ERP systems, Case studies on ERP system management in enterprises.		
	Total Contact Hours :	**45**

Course Outcomes: After the successful completion of the course, the student will be able to:	
CO1	Understand the fundamentals and architecture of ERP systems and their business applications.
CO2	Analyze business processes and identify integration opportunities through ERP systems.
CO3	Demonstrate knowledge of the ERP implementation lifecycle and associated challenges.
CO4	Evaluate the role of emerging technologies in enhancing ERP functionalities.
CO5	Develop strategies for managing, maintaining, and optimizing ERP systems in organizations.

Textbook (s):	
1	*Leon, A., Enterprise Resource Planning*, McGraw-Hill Education, 2019.
2	*Monk, E., & Wagner, B., Concepts in Enterprise Resource Planning*, Cengage Learning, 2013.

Reference Books(s) / Web links:	
1	*Sumner, M., Enterprise Resource Planning*, Pearson Education, 2014.
2	*Bradford, M., Modern ERP: Select, Implement, and Use Today's Advanced Business Systems*, Lulu.com, 2020.
3	*Dumas, M., et al., Fundamentals of Business Process Management*, Springer, 2018.

CO\ PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	-	-	2	-	-	-	-	-	-	2	2	2	2
CO2	3	3	2	3	3	-	-	-	-	-	2	3	3	3	3
CO3	3	3	-	2	3	-	-	-	-	-	2	3	2	3	2
CO4	3	2	2	3	3	2	-	-	-	-	-	3	3	3	3
CO5	3	3	2	3	3	2	-	-	-	-	3	3	3	3	3
Avg	**3.0**	**2.6**	**2.0**	**2.8**	**2.8**	**2.0**	**-**	**-**	**-**	**-**	**2.3**	**2.8**	**2.6**	**2.8**	**2.6**

ME23F14	HYBRID AND ELECTRIC VEHICLES	Category	L	T	P	C
		PE	3	0	0	3

Objectives:	
●	To understand upcoming technology of electric and hybrid electric vehicles
●	Analyse different aspects of drive train topologies
●	Learn different energy management strategies
●	To understand different communication systems used in electric and Hybrid electric vehicles
●	Explain the concept of vehicle to grid configurations

UNIT – I	INTRODUCTION OF HEV'S	9
Social and environmental importance of hybrid and electric vehicles, Impact of modern drivetrains on energy supplies, Basics of vehicle performance, vehicle power source characterization, Transmission characteristics, Mathematical models to describe vehicle performance.		
UNIT – II	**BASIC CONCEPT OF HYBRID TRACTION**	**9**
Introduction to various hybrid drive-train topologies, Power flow control in hybrid drive-train topologies, Fuel efficiency analysis, braking fundamentals and regenerative braking in EVs		
UNIT – III	**INTRODUCTION TO ELECTRIC COMPONENTS**	**9**
Configuration and control of DC Motor drives, Configuration and control of Introduction Motor drives, configuration and control of Permanent Magnet Motor Drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.		
UNIT – IV	**MATCHING THE ELECTRIC MACHINE AND THE INTERNAL COMBUSTION ENGINE (ICE)**	**9**
Sizing the propulsion motor, sizing the power electronics Selecting the energy storage technology, Communications, supporting subsystems		
UNIT – V	**INTRODUCTION TO ENERGY MANAGEMENT AND THEIR STRATEGIES**	**9**
Classification of different energy management strategies Comparison of different energy management strategies Implementation issues of energy strategies. Plug-in electric vehicles, Vehicle to grid (V2G) and G2V fundamentals, battery thermal management for electric vehicle.		
	Total Contact Hours :	**45**

Course Outcomes:	
CO1	Understand the Impact of conventional vehicles on the society and different types of drive train topologies.
CO2	Apply the load modelling based on the road profile and braking concepts.
CO3	Analyse the different types of motors used in electric and hybrid electric vehicles.
CO4	Analyse the different types of energy storage systems.
CO5	The concept vehicle to grid (V2G) and grid to vehicle (G2V).

Text Books:
1. Mehrdad Ehsani, Yimin Gao, Ali Emadi, ―Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals‖, CRC Press, 2010.
2. James Larminie, ―Electric Vehicle Technology Explained‖, John Wiley & Sons, 2003
3. Iqbal Hussain, ―Electric & Hybrid Vehicles – Design Fundamentals‖, Second Edition, CRC Press, 2011.
Reference Books:
1. Hybrid Vehicles and the future of personal transportation, Allen Fuhs, CRC Press, 2011.
2. Xi Zhang, Chris Mi, Vehicle Power Management: Modeling, Control and Optimization, Springer London Ltd; 2011th edition, 2013.

COs / PO/PSO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
ME23F14.1	2	2	2	-	-	-	-	-	-	-	2	-	1	2	2
ME23F14.2	2	2	2	-	-	-	-	-	-	-	2	-	1	2	-
ME23F14.3	2	2	2	-	-	-	-	-	-	-	2	-	-	2	2
ME23F14.4	2	2	2	-	-	-	-	-	-	-	2	-	-	2	--
ME23F14.5	2	2	2	-	-	-	-	-	-	-	2	-	-	2	2

MT23F12	SMART HOSPITALITY MANAGEMENT	PE	L	T	P	C
			3	0	0	3

Objectives: The course shall:	
●	Introduce the integration of Mechatronics technologies in core hospitality management operations.
●	Develop an understanding of automation in food production and service processes.
●	Equip students with the knowledge to utilize IoT, robotics, and AI in the front office and housekeeping tasks.
●	Provide insights into predictive maintenance and energy-efficient systems for sustainability in the hospitality industry.
●	Foster skills to design and implement smart solutions for enhancing guest experience and operational efficiency.

UNIT-I	SMART FOOD PRODUCTION	09

Introduction to automated food production systems, IoT-enabled smart kitchen equipment, Mechatronics in food preparation: robotics and automated cooking systems, Principles of automated menu planning, Sensor-based quality control in food production, Advanced packaging techniques with robotics, Data-driven inventory
management systems, Sustainability and waste reduction using automation.

UNIT-II	SMART FOOD AND BEVERAGE SERVICE	09

Automated food delivery systems: robots and conveyor systems, Smart ordering systems (e.g., touch-screen kiosks, AI-powered assistants), IoT-enabled inventory and supply chain systems, Automated beverage dispensing and preparation machines, Customer interaction with service robots, AI for predictive analytics in
demand forecasting, Energy-efficient systems in food and beverage service, Role of Mechatronics in waste management and sustainability practices.

UNIT-III	SMART FRONT OFFICE MANAGEMENT	09

Integration of Mechatronics systems in smart front desks (e.g., self-check-in kiosks), Biometric and facial recognition systems for guest identification, IoT-enabled guest monitoring and feedback systems, Data management systems and CRM platforms in hospitality, Robotics in concierge services, Cybersecurity in automated guest handling, Revenue management using AI-based tools, Predictive maintenance of front office
systems using IoT.

UNIT-IV	SMART HOUSEKEEPING	09

Automation in housekeeping operations: robotic cleaners and laundry systems, Sensor-based monitoring systems for room maintenance, IoT-enabled inventory control for housekeeping supplies, Energy-efficient lighting and HVAC systems controlled by smart sensors, AI-driven scheduling for housekeeping tasks, Employee training for managing Mechatronics systems, Sustainability through smart water and energy
management.

UNIT-V	SMART MAINTENANCE IN THE HOTEL INDUSTRY	09

Introduction to predictive and preventive maintenance using Mechatronics, IoT-based condition monitoring systems, Integration of Building Management Systems (BMS) in hotels, Smart HVAC and lighting systems for energy conservation, Mechatronics in waste management: automated sorting and recycling systems, AI and
sensors for fault detection and diagnostics, Compliance and safety management through automation, Future trends in smart maintenance systems.

	Total Contact Hours	:	45

Course Outcomes: After the successful completion of the course, the student will be able to:	
CO1	Apply Mechatronics-based automation systems in food production and quality control.
CO2	Design and implement smart technologies for efficient food and beverage service.
CO3	Integrate IoT and AI tools into front office operations for guest management.
CO4	Utilize robotic and sensor-based systems to improve housekeeping operations.
CO5	Develop and implement predictive maintenance strategies using Mechatronics systems.

Textbook (s):	
1	*Andrews, S., Food and Beverage Service*, Tata McGraw-Hill Education, 2013.
2	*Kasavana, M. L., Managing Front Office Operations*, AHLEI, 2012.
3	*Raghubalan, G., Hotel Housekeeping: Operations and Management*, Oxford University Press, 2011.
Reference Books(s) / Web links:	
1	*Groover, M. P., Automation, Production Systems, and Computer-Integrated Manufacturing*, Pearson, 2015.
2	*Jones, P., Handbook of Hospitality Operations and IT*, Routledge, 2008.
3	Bahga, A., & Madisetti, V., *Internet of Things: A Hands-On Approach*, Universities Press, 2014.
4	Pethuru Raj, R., & Anupama, C. R., *Internet of Things: Architectures, Protocols, and Standards*, CRC Press, 2017.

CO\ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	-	2	-	-	-	-	3	3	3	2
CO2	3	2	3	3	3	-	-	-	-	-	-	3	3	3	3
CO3	3	3	2	2	3	2	-	-	-	-	-	3	3	3	3
CO4	3	3	3	3	3	-	2	-	-	-	-	3	3	3	3

CO5	3	3	3	3	3	-	2	-	-	-	3	3	3	3	3
Avg	**3.0**	**2.8**	**2.8**	**2.6**	**2.8**	**2.0**	**2.0**	**-**	**-**	**-**	**3.0**	**3.0**	**3.0**	**3.0**	**2.8**

MT23F13	INTRODUCTION TO LARGE LANGUAGE MODELS	PE	L	T	P	C
			3	0	0	3

Objectives: The course shall:	
●	Provide an understanding of the foundational concepts of Natural Language Processing (NLP) and Deep Learning.
●	Explore statistical and neural language models for solving text processing tasks.
●	Introduce sequence models, attention mechanisms, and transformers with hands-on implementation.
●	Familiarize students with transfer learning techniques and advanced NLP tasks using pre-trained language models.
●	Highlight ethical considerations in NLP and retrieval-augmented generation for real-world applications.

UNIT-I	**FOUNDATIONS OF NATURAL LANGUAGE PROCESSING AND DEEP LEARNING**	**09**
Introduction to NLP: NLP pipeline and applications in Mechatronics (e.g., voice-controlled robots, natural language interfaces). Distributional semantics and its role in language understanding. Introduction to Deep Learning: Perceptron, Artificial Neural Networks (ANN), and backpropagation. Convolutional Neural Networks (CNN) and their applications. Word Vectors: Word2Vec, GloVe, and fast Text – Representation of words in vector space		
UNIT-II	**STATISTICAL AND NEURAL LANGUAGE MODELS**	**09**
Statistical Language Models: N-gram models, perplexity, and smoothing techniques. Neural Language Models: Language modeling using CNNs and RNNs. Introduction to PyTorch for deep learning. Implementation of RNNs and LSTMs using PyTorch.		
UNIT-III	**SEQUENCE MODELS, ATTENTION MECHANISMS, AND TRANSFORMERS**	**09**
Sequence-to-Sequence Models: Sequence-to-sequence modeling and beam search. Attention and self-attention mechanisms. Transformers: Introduction to Transformers, positional embeddings, and tokenization strategies. Implementation of Transformers using PyTorch.		
UNIT-IV	**TRANSFER LEARNING AND ADAPTATION IN NLP**	**09**
Transfer Learning: Encoder-only models (ELMo, BERT), Decoder-only models (GPT), Encoder-decoder models (T5). Prompting and Fine-tuning: Hard and soft prompting, instruction fine-tuning (FLAN). Advanced Prompting Techniques: Chain of Thoughts, Prompt Chaining, etc. Introduction to the Hugging Face library for NLP tasks.		
UNIT-V	**ADVANCED TOPICS AND ETHICAL CONSIDERATIONS**	**09**
Knowledge Graphs (KGs): Representation, completion, and alignment tasks. Differences between graph neural networks and neural KG inference. Retrieval-Augmented Generation: Techniques for retrieving information from structured and unstructured sources. Retrieval-augmented models: REALM, RAG, KGQA (Embed KGQA, Grail QA). Recent Trends and Ethical NLP: Overview of popular models (GPT-4, Llama 3, Claude 3, Mistral, Gemini). Ethical considerations in NLP: Bias, toxicity, and responsible AI.		
	Total Contact Hours :	**45**

Course Outcomes: After the successful completion of the course, the student will be able to:	
CO1	Understand the foundational concepts of NLP and its relevance to Mechatronics systems.
CO2	Implement statistical and neural language models for text processing tasks.
CO3	Develop and fine-tune sequence models, attention mechanisms, and transformers.
CO4	Explore transfer learning techniques for large language models and their applications.
CO5	Analyze ethical considerations in NLP and utilize retrieval-augmented generation for advanced tasks

Textbook (s):	
1	Tanmoy Chakraborty, *Introduction to Large Language Models*, Wiley India, 1st Edition, 2025. ISBN: 9789363864740.
2	Dan Jurafsky and James H. Martin, *Speech and Language Processing*, 2nd Edition, Pearson Press, 2008.
3	Jacob Eisenstein, *Natural Language Processing*, First Edition, The MIT Press, 2019.

Reference Books(s) / Web links:	
1	Christopher D. Manning et al., *Foundations of Statistical NLP*, MIT Press.
2	Ian Goodfellow et al., *Deep Learning*, MIT Press.
3	PyTorch Documentation: https://pytorch.org/docs/.
4	Hugging Face Tutorials: https://huggingface.co/.
5	Recent Trends in NLP: Papers and resources from *arXiv*.

CO\ PO	**PO1**	**PO2**	**PO 3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	-	-	-	-	2	-	-	-	2	3	3	2	-
CO2	3	3	-	-	-	-	-	-	-	-	2	3	3	2	2
CO3	3	3	2	2	3	-	-	-	-	-	2	3	3	3	2
CO4	3	3	2	3	-	2	-	-	-	-	3	3	3	3	2
CO5	3	3	2	3	-	2	-	-	-	-	3	3	3	3	2
Avg	**3.0**	**2.8**	**2.0**	**2.7**	**3.0**	**2.5**	**2.0**	**3.0**	**-**	**-**	**2.4**	**3.0**	**3.0**	**2.6**	**2.3**

MT23F14	COMPUTER VISION AND DEEP LEARNING	PC	L	T	P	C
			3	0	0	3

Objectives: The course shall:	
●	Introduce the fundamentals of computer vision and its relevance to Mechatronics systems.
●	Develop an understanding of deep learning concepts and their application in image processing.
●	Explore advanced computer vision techniques for object detection, recognition, and segmentation.
●	Integrate RNNs and attention models for video analysis and intelligent systems.
●	Examine generative models and recent trends in vision for innovative solutions.

UNIT-I	FUNDAMENTALS OF COMPUTER VISION	09
Introduction and Overview: Course motivation and relevance to Mechatronics. Image formation, capture, and representation. Basics of linear filtering, correlation, and convolution. Visual Features and Representations: Edge, blob, and corner detection. Scale space and scale selection. Feature descriptors: SIFT, SURF, HoG, LBP. Practical Applications**:** Object detection in mechanical systems. Edge detection for robotic vision.		
UNIT-II	**DEEP LEARNING BASICS AND CONVOLUTIONAL NEURAL NETWORKS**	**09**
Deep Learning Review: Overview of deep learning.Multi-layer perceptrons and backpropagation.Introduction to CNNs: Basics of convolutional neural networks. Evolution of architectures: AlexNet, VGG, ResNet. Visualization and Understanding CNNs: Kernel visualization. Neural style transfer, Grad-CAM. Practical Applications: Feature extraction for robotic components. Real-time image processing for automation.		
UNIT-III	**ADVANCED COMPUTER VISION TECHNIQUES**	**09**
Visual Matching**:** Bag-of-words, VLAD. RANSAC, Hough transform. Optical flow for motion analysis. CNNs for Recognition, Detection, and Segmentation: Recognition and verification (Siamese networks, triplet loss). Object detection (R-CNN, YOLO, SSD). Image segmentation (U-Net, Mask-RCNN). Practical Applications: Object detection for assembly line automation. Motion tracking in robotic arms.		
UNIT-IV	**RECURRENT NEURAL NETWORKS AND ATTENTION MODELS**	**09**
Recurrent Neural Networks (RNNs)**:** Basics of RNNs. CNN + RNN for video understanding and activity recognition. Attention Models: Introduction to attention mechanisms. Applications in vision and language (image captioning, visual QA). Spatial transformers and transformer networks. Practical Applications: Action recognition for robotic behavior analysis. Visual QA for intelligent inspection systems.		
UNIT-V	**GENERATIVE MODELS AND RECENT TRENDS**	**09**
Deep Generative Models: GANs, VAEs, and other generative models (PixelRNNs, Normalizing Flows). Applications: Image editing, inpainting, super-resolution. Variants and Applications: CycleGANs, Progressive GANs, Pix2Pix. Applications in 3D object generation and security. Recent Trends in Vision: Few-shot and self-supervised learning. Reinforcement learning in vision. Practical Applications: Generating synthetic datasets for Mechatronics. Predictive maintenance using vision systems.		
	Total Contact Hours :	**45**

Course Outcomes: After the successful completion of the course, the student will be able to:	
CO1	Understand the fundamentals of computer vision concepts, including image formation, visual features, and their practical applications in Mechatronics systems.
CO2	Design and implement convolutional neural networks (CNNs) for real-time image processing and feature extraction in automation systems.
CO3	Apply advanced computer vision techniques such as object detection, recognition, segmentation, and motion analysis to solve Mechatronics-related challenges.
CO4	Integrate Recurrent Neural Networks (RNNs) and attention mechanisms for video understanding, action recognition, and intelligent inspection systems.
CO5	Explore and utilize deep generative models and recent trends in computer vision to innovate solutions for predictive maintenance, 3D object generation, and other Mechatronics applications.

Textbook (s):	
1	Ian Goodfellow, Yoshua Bengio, and Aaron Courville, *Deep Learning*, MIT Press, 2016. ISBN: 978-0262035613.
2	Richard Szeliski, *Computer Vision: Algorithms and Applications*, Springer, 2nd Edition, 2022. ISBN: 978- 3030343714.
3	Simon Haykin, *Neural Networks and Learning Machines*, Pearson, 3rd Edition, 2008. ISBN: 978-0131471399.

Reference Books(s) / Web links:	
1	Christopher M. Bishop, *Pattern Recognition and Machine Learning*, Springer, 2006. ISBN: 978-0387310732.
2	David A. Forsyth and Jean Ponce, *Computer Vision: A Modern Approach*, Pearson, 2nd Edition, 2012. ISBN: 978-0136085928.
3	Sebastian Raschka and Vahid Mirjalili, *Python Machine Learning*, Packt Publishing, 3rd Edition, 2019. ISBN: 978-1789955750.
4	Francois Chollet, *Deep Learning with Python*, Manning Publications, 2nd Edition, 2021. ISBN: 978-1617296864.
5	John C. Russ and J. Christian Russ, *The Image Processing Handbook*, CRC Press, 7th Edition, 2016. ISBN: 978- 1498740265.

CO\ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	-	-	-	-	-	2	3	3	2	-
CO2	3	3	3	2	3	-	-	-	-	-	2	3	3	3	2
CO3	3	3	3	3	3	-	-	-	-	-	3	3	3	3	3
CO4	3	3	3	3	3	2	-	-	-	-	3	3	3	3	3
CO5	3	3	3	3	3	2	2	-	-	-	3	3	3	3	3
Avg	3.0	3.0	2.8	2.6	2.8	2.0	2.0	-	-	-	2.6	3.0	3.0	2.8	2.6

MT23F15	INTERNET TOOLS AND JAVA PROGRAMMING	PE	L	T	P	C
			3	**0**	**0**	**3**

Objectives: The course shall:	
●	Understand the fundamental concepts of Java programming and its application in solving real-world problems.
●	Develop object-oriented programming skills to design robust and reusable software solutions.
●	Build graphical user interfaces (GUI) and implement event-driven programming for interactive applications.
●	Explore advanced Java programming techniques, including multithreading, exception handling, and file I/O, to manage complex systems.
●	Apply Java-based networking and Internet tools for communication and control in mechatronic and robotic systems.

UNIT-I	**CORE JAVA FUNDAMENTALS AND PROGRAMMING BASICS**	**09**
Introduction to Java: History and evolution of Java-Java environment setup-Installation and usage of Java Development Kit (JDK). Basic Programming Constructs: Data types and variables-Operators: Arithmetic, relational, and logical-Type conversion and casting. Control Statements: Conditional statements: if-else, switch-Looping statements: for, while, do-while. Arrays and Array Manipulation: Single and multi-dimensional arrays-Array operations and basic algorithms.		
UNIT-II	**OBJECT-ORIENTED PROGRAMMING CONCEPTS**	**09**
Classes and Objects: Class definition, object creation-Constructors and method overloading. Inheritance: Concept of inheritance-Types of inheritance (single, multilevel, hierarchical)-Superclass and subclass relationships. Packages and Access Modifiers: Package creation and usage-Access specifiers: public, private, protected. Interfaces and Abstract Classes: Interface definition and implementation-Abstract class concepts and applications		
UNIT-III	**ADVANCED JAVA PROGRAMMING TECHNIQUES**	**09**
Exception Handling: try-catch blocks- Throwing and handling exceptions- Custom exception creation. Multithreading Programming: Thread lifecycle and management- Synchronization and inter-thread communication-String Handling-String manipulation methods-StringBuilder and String Buffer usage. File I/O Operations: File reading and writing-Handling text and binary file formats.		
UNIT-IV	**JAVA GUI DEVELOPMENT AND EVENT HANDLING**	**09**
Introduction to AWT: Basic GUI components-Window and frame creation. Event Handling: Event listeners- Handling mouse and keyboard events. Layout Managers: Flow, border, and grid layouts-Creating responsive interfaces. Java Swing Introduction: Advanced GUI components-Building interactive user interfaces.		
UNIT-V	**INTERNET TOOLS AND NETWORKING IN JAVA**	**09**
Java Networking: Socket programming basics-Client-server communication. Java Applets: Applet lifecycle- Simple applet-based programs. Introduction to Internet Tools: Overview of web technologies-Basic communication protocols (HTTP, FTP, etc.). Networking in Mechatronics Systems: Remote control of robotic systems-Data exchange between mechanical systems		
	Total Contact Hours :	**45**

Course Outcomes: After the successful completion of the course, the student will be able to:	
CO1	Understand and apply fundamental Java programming concepts, including data types, control structures, and object-oriented programming.
CO2	Design and implement object-oriented solutions for mechatronic system components and simulations.
CO3	Develop graphical user interfaces (GUI) and event-driven applications for robotic and mechanical system control.
CO4	Utilize multithreading and exception handling to manage complex processes in mechatronic systems.
CO5	Implement networking and Internet tools for remote control and data communication in mechatronic applications.

Textbook (s):	
1	Herbert Schildt**,** *Java: The Complete Reference,* McGraw Hill.
2	Kathy Sierra and Bert Bates**,** *Head First Java,* O'Reilly Media.
3	Paul Deitel and Harvey Deitel**,** *Java How to Program,* Pearson.

Reference Books(s) / Web links:	
1	Bruce Eckel**,** *Thinking in Java,* Prentice Hall.
2	John Hubbard, *Schaum's Outline of Programming with Java,* McGraw Hill.
3	E. Balagurusamy, *Programming with Java: A Primer,* McGraw Hill.
4	David Flanagan, *Java in a Nutshell,* O'Reilly Media.

5	*Mechatronics-specific Java programming resources* (e.g., research articles, online documentation).

CO\ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	-	-	-	-	-	2	3	3	2	-
CO2	3	3	3	2	3	-	-	-	-	-	2	3	3	3	2
CO3	3	3	3	3	3	-	-	-	-	-	3	3	3	3	3
CO4	3	3	3	3	3	2	-	-	-	-	3	3	3	3	3
CO5	3	3	3	3	3	2	2	-	-	-	3	3	3	3	3
Avg	3.0	3.0	2.8	2.6	2.8	2.0	2.0	-	-	-	2.6	3.0	3.0	2.8	2.6

MT23F16	INTRODUCTION TO DATABASE SYSTEMS	PE	L	T	P	C
			3	**0**	**0**	**3**

Objectives: The course shall:	
●	Introduce students to the fundamentals of database systems and their applications in Mechatronics.
●	Enable students to model real-world problems using Entity-Relationship (ER) diagrams.
●	Provide a strong foundation in relational algebra, Structured Query Language (SQL), and query optimization.
●	Equip students with skills to design normalized databases for efficient storage and retrieval.
●	Familiarize students with advanced topics like distributed databases and NoSQL for IoT-based Mechatronics applications.

UNIT-I	**INTRODUCTION TO DATABASE SYSTEMS AND ER MODEL**	**09**
Introduction to Databases: Importance of databases in Mechatronics systems -Database applications in real-world automation and control-Database architecture and components. Entity-Relationship (ER) Model: Basics of ER modeling- Entities, attributes, relationships, and cardinality- ER diagrams for mechanical and robotic systems. Practical Applications: Designing ER diagrams for sensor data management in Mechatronics.		
UNIT-II	**RELATIONAL MODEL AND QUERY LANGUAGES**	**09**
Relational Model: Introduction to the relational model- Keys: Primary, foreign, and candidate keys- Relational algebra operations. Tuple Relational Calculus (TRC): Introduction to TRC- Expressing queries in TRC. Structured Query Language (SQL): Basics of SQL: Data definition and manipulation- Simple queries, aggregate functions, and joins. Practical Applications: Writing SQL queries for data acquisition and analysis in Mechatronics systems.		
UNIT-III	**INDEXING AND QUERY PROCESSING**	**09**
Indexes: Introduction to indexing- Types of indexes: B-trees and hash-based indexes- Role of indexes in improving query performance. Query Processing: Query optimization techniques- Cost-based query evaluation. Practical Applications: Optimizing queries for real-time robotic system data.		
UNIT-IV	**NORMALIZATION AND DATABASE DESIGN**	**09**
Normalization: Functional dependencies-Normal forms: 1NF, 2NF, 3NF, BCNF-Decomposition and lossless join. Database Design: Principles of good database design-Designing databases for Mechatronics applications. Practical Applications: Normalizing data for efficient storage in Mechatronics systems.		
UNIT-V	**TRANSACTION PROCESSING AND ADVANCED TOPICS**	**09**
Transaction Processing: ACID properties-Concurrency control: Locking, deadlocks, and timestamp ordering-Recovery mechanisms. Advanced Topics: Distributed databases- Introduction to NoSQL databases for IoT-based Mechatronics systems. Practical Applications: Managing concurrent operations in automated systems.		
	Total Contact Hours : 45	

Course Outcomes: After the successful completion of the course, the student will be able to:	
CO1	Understand the basics of database systems and their role in Mechatronics applications.
CO2	Apply ER modeling and relational algebra to represent and manipulate real-world data.
CO3	Develop and optimize SQL queries for data management in Mechatronics systems.
CO4	Design normalized databases and implement efficient storage solutions for Mechatronics applications.
CO5	Analyze advanced database concepts like transaction processing and NoSQL for IoT-based systems.

Textbook (s):	
1	Ramez Elmasri and Shamkant B. Navathe, *Fundamentals of Database Systems*, Pearson Education.
2	Silberschatz, Korth, and Sudarshan, *Database System Concepts*, McGraw-Hill.
3	Raghu Ramakrishnan and Johannes Gehrke, *Database Management Systems*, McGraw-Hill.

Reference Books(s) / Web links:	
1	C.J. Date, *An Introduction to Database Systems*, Pearson Education.
2	Hector Garcia-Molina, Jeffrey D. Ullman, and Jennifer Widom, *Database Systems: The Complete Book*, Pearson Education.
3	*SQL for Data Science*, John Wiley & Sons.
4	Online Resources: TutorialsPoint, GeeksforGeeks, W3Schools.
5	Research Papers on NoSQL and IoT in Mechatronics.

CO\ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	-	-	-	-	-	2	2	3	2	-
CO2	3	3	3	2	2	-	-	-	-	-	2	3	3	3	2
CO3	3	3	3	3	3	-	-	-	-	-	3	3	3	3	3
CO4	3	3	3	3	3	2	-	-	-	-	3	3	3	3	3
CO5	3	3	3	3	3	3	2	-	-	-	3	3	3	3	3
Avg	**3.0**	**2.8**	**2.8**	**2.6**	**2.6**	**2.0**	**2.0**	**-**	**-**	**-**	**2.6**	**2.8**	**3.0**	**2.8**	**2.6**

AI23632	**NATURAL LANGUAGE PROCESSING**	**Category**	**L**	**T**	**P**	**C**
		PE	**2**	**0**	**2**	**3**

Objectives:	
•	To introduce the fundamental concepts of Natural Language Processing (NLP for analysing words based on statistical measures and CORPUS.
•	To understand the principles of morphological analysis and language modelling using finite state machines and n-gram models.
•	To explore vector semantics and learn how to represent words and their relationships through embeddings and similarity measures.
•	To analyse and implement Hidden Markov Models (HMMs) and their applications in Part-Of-Speech (POS) tagging
•	To study the architecture of transformers and large language models, including pre-training and evaluation techniques.

UNIT-I	**INTRODUCTION TO NATURAL LANGUAGE PROCESSING**	**6**
Introduction to NLP - Various stages of NLP –NLP Pipeline, The Ambiguity of Language: Parts of Speech, Phrase Structure. Statistics Essential Information Theory: Entropy, perplexity, The relation to language: Cross entropy, Text Prepossessing: Character Encoding, Word Segmentation, Sentence Segmentation, Introduction to Corpora, Corpora Analysis		
UNIT-II	**MORPHOLOGY AND LANGUAGE MODELLING**	**6**
Inflectional and Derivation Morphology, Morphological analysis and generation using Finite State Automata and Finite State transducer. Bag of words, skip-gram, Continuous Bag-Of-Words, N gram model, n -gram Models over Sparse Data: Bins: Forming Equivalence Classes- - Statistical Estimators- Combining Estimators		
UNIT-III	**VECTOR SEMANTICS AND EMBEDDINGS**	**6**
Lexical Semantics-Vector Semantics-Words and Vectors-Cosine for measuring similarity- TF-IDF: Weighing terms in the vector-Pointwise Mutual Information (PMI) -Applications of the TF-IDF or PPMI vector models- Word2vec -Visualizing Embeddings-Semantic properties of embeddings-Bias and Embeddings-Evaluating Vector Models		
UNIT-IV	**MARKOV MODEL AND POS TAGGING**	**6**
Markov Model: Hidden Markov model, Three Fundamental questions of HMM, Implementation properties, and Variants of HMMs, Multiple input observation. **POS**: The Information Sources in Tagging: Markov model taggers, Viterbi algorithm, Applying HMMs to POS tagging, Applications of Tagging.		
UNIT-V	**TRANSFORMERS AND LARGE LANGUAGE MODELS**	**6**
The Transformer - Attention-Transformer Blocks- Parallelizing computation using a single matrix X , The input: embeddings for token and position-The Language Modelling Head - Large Language Models : Large Language Models with Transformers - Sampling for LLM Generation -Pretraining Large Language Models -Evaluating Large Language Models		
	Contact Hours : 30	

List of Experiments	
1.	Develop a morphological analyser to process and analyse various sentence structures, including interrogative, declarative, and complex sentences with conjunctions. Perform word segmentation and sentence segmentation as part of the analysis. **Suggested Dataset/Corpus: Universal Dependencies (UD) English Treebank**
2.	Design a basic NLP pipeline to preprocess raw text data by performing tokenization, sentence segmentation, and part-of-speech (POS) tagging. Automate the pipeline to process large-scale text efficiently. **Suggested Dataset/Corpus: Universal Dependencies (UD) English Treebank**
3.	Implement a Named Entity Recognition (NER) system using Python libraries such as spaCy or NLTK. Utilize a pre-trained model to extract named entities, including people, organizations, and locations, from a text corpus. **Suggested Dataset/Corpus**: **CoNLL-2003 NER Dataset**
4.	Construct unigram, bigram, and trigram models to analyze their performance on sparse data. Compare the language models based on perplexity and their effectiveness in predicting word sequences. **Suggested Dataset/Corpus**: **The Brown Corpus**
5.	Implement n-gram language models (unigram, bigram, trigram, etc.) and apply smoothing techniques like Laplace smoothing to address data sparsity. Evaluate the models on a large text corpus for accuracy and perplexity. **Suggested Dataset/Corpus**: **Google Ngram Dataset**

6.	Design a spelling correction model using a combination of morphological rules and n-gram probabilities. Test the model on a dataset containing deliberately misspelled words and compare it to established spell-check systems. **Suggested Dataset/Corpus**: **Birkbeck Spelling Error Corpus**
7.	Implement the Term Frequency-Inverse Document Frequency (TF-IDF) model and use cosine similarity to compare the similarity between documents in a given corpus. Visualize the similarity matrix for better insight. **Suggested Dataset/Corpus**: **20 Newsgroups Dataset**
8.	Train a Word2Vec model on a given text corpus and visualize the resulting word embeddings using dimensionality reduction techniques like t-SNE or PCA. Analyze the semantic relationships between words in the embeddings. **Suggested Dataset/Corpus**: **Text8 Dataset**
9.	Build a Hidden Markov Model (HMM) for part-of-speech (POS) tagging. Train the model on a tagged corpus and evaluate its accuracy on a test dataset. **Suggested Dataset/Corpus**: **Universal Dependencies (UD) Treebank**
10.	Use a pre-trained Transformer model (e.g., BERT) to build a sentiment analysis model. Fine-tune the model on a dataset of tweets, classify sentiment (positive, neutral, negative), and evaluate its performance using accuracy and F1-score. **Suggested Dataset/Corpus**: **Sentiment140 Dataset**
11	Use a pre-trained language model to perform sentiment analysis or keyword extraction on a dataset of WhatsApp chat data. Analyze the conversational patterns, emotions, and key topics discussed in the chats. **Suggested Dataset/Corpus**: **WhatsApp Chat Export (User-Generated Data)**
12	Implement a question-answering system using a pre-trained BERT model. Input a passage and a question, and use the model to extract the correct answer from the passage. Evaluate the system on accuracy and relevance of the answers. **Suggested Dataset/Corpus**: **SQuAD (Stanford Question Answering Dataset)**
13	**Mini Project** ● Choose a Topic: Identify a deep learning problem of interest, such as image classification, text generation, or anomaly detection. ● Research related works using platforms like Google Scholar. ● Dataset Selection: Find or collect a suitable dataset from sources like Kaggle or UCI. Ensure it is relevant, well-sized, and consider preprocessing requirements. ● Develop Methodology: Start with baseline models, then experiment with advanced architectures (e.g., CNNs, Transformers). Use frameworks like TensorFlow or PyTorch. ● Implementation & Evaluation: Train models and evaluate performance using appropriate metrics (e.g., accuracy, F1-score). Document findings systematically. ● Discuss & Present: Analyze results, highlight challenges, and present your work with clear insights and future directions.

	Contact Hours	**:**	**30**
	Total Contact Hours	**:**	**60**

Course Outcomes: On completion of the course, the students will be able to	
●	Analyse the different stages in the NLP pipeline and perform statistical analysis on the data.
●	Apply morphological analysis techniques and construct n-gram models for language processing.
●	Evaluate the effectiveness of word embeddings and semantic vector models
●	Implement and analyse Hidden Markov Models (HMMs) for Part-Of-Speech (POS) tagging and compare their effectiveness.
●	Design and evaluate transformer-based large language models for text generation and other NLP applications

Textbooks:	
1	Daniel Jurafsky and James H. Martin “Speech and Language Processing”, 3rd edition, Prentice Hall, 2024
2	T V Geetha,” Understanding Natural Language Processing” (Machine Learning and Deep Learning Perspectives),1st edition, Pearson,2024

Reference Books:	
1	Christopher D. Manning and HinrichSchutze, “Foundations of Natural Language Processing”, 6th Edition, The MIT Press Cambridge, Massachusetts London, England, 2003 2009.
2	NitinIndurkhya, Fred J. Damerau “Handbook of Natural Language Processing”, Second Edition, CRC Press, 2010.
3	James Allen “Natural Language Understanding”, Pearson Publication, 8th Edition. 2012
4	Hobson lane, Cole Howard, Hannes Hapke, “Natural language processing in action” MANNING Publications, 2nd edition, 2019.
5	Alexander Clark, Chris Fox, Shalom Lappin, “The Handbook of Computational Linguistics and Natural Language Processing”, Wiley-Blackwell, 2016
6	Rajesh Arumugam, Rajalingappa Shanmugamani “Hands-on natural language processing with python: A practical guide to applying deep learning architectures to your NLP application”. PACKT publisher, 2018.

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
AI23632.1	3	3	2	2	3	2	1	2	2	2	2	3	3	2	2
AI23632.2	3	3	2	2	3	2	1	1	2	2	2	3	3	2	3
AI23632.3	3	3	3	2	3	2	1	2	2	2	2	3	3	3	3
AI23632.4	3	3	3	2	3	2	1	2	2	2	2	3	3	3	2
AI23632.5	3	3	3	3	3	2	1	2	3	3	3	3	3	3	3
Average	**3**	**3**	**2.6**	**2**	**2.2**	**1**	**1**	**1.8**	**1**	**1**	**-**	**1**	**3**	**3**	**2**

VERTICAL G DIVERSIFIED

MT23G11	SOCIAL INNOVATION IN INDUSTRY 4.0	PE	L	T	P	C
			3	0	0	3

Objectives: The course shall:

- To introduce the concept of social innovation and its relevance to modern society.
- To provide a comprehensive understanding of Industry 4.0 technologies and their integration with social innovation.
- To equip students with tools and techniques for designing, prototyping, and implementing innovative solutions.
- To explore case studies demonstrating the societal impact of innovation in various sectors, including medical devices and agriculture.
- To assess the environmental, economic, and social implications of social innovation and Industry 4.0 initiatives.

UNIT-I	INTRODUCTION TO SOCIAL INNOVATION AND INDUSTRY 4.0	09

Definition and significance of social innovation – Evolution of Industry 4.0 – Technologies driving Industry 4.0: IoT, AI, Robotics, Big Data, and Additive Manufacturing – Interplay between social innovation and Industry 4.0 – Opportunities and challenges in implementing social innovation – Importance of sustainability and societal impact in innovation

UNIT-II	TYPES OF SOCIAL INNOVATION AND VALUE CREATION	09

Overview of social innovation types – Incremental vs. radical innovations – Process, product, and system innovations – Value creation models – Role of entrepreneurship in driving social innovation – Economic, societal, and environmental value creation – Sustainable entrepreneurship and innovation strategies.

UNIT-III	DESIGN AND PROTOTYPING FOR SOCIAL INNOVATION AND INDUSTRY 4.0	09

Introduction to design thinking for Industry 4.0 – Methods and tools for innovation design – Prototyping techniques: 3D printing, rapid prototyping, and iterative design – Prototyping for medical devices and agricultural implements – Design principles for creating user-centric solutions – Importance of feedback loops in innovation design.

UNIT-IV	COSTING, IPR, AND INNOVATION MANAGEMENT	09

Costing methodologies for innovative solutions – Financial planning for social innovation projects – Introduction to Intellectual Property Rights (IPR): Patents, trademarks, and copyrights – Importance of IPR in fostering innovation – Types of innovation and their relevance to Industry 4.0 – Managing innovation in collaborative environments.

UNIT-V	CASE STUDIES AND SOCIETAL IMPACT ANALYSIS	09

Case studies on social innovation in healthcare, agriculture, and education – Prototyping and deployment of medical devices – Design and development of agricultural implements – Societal impact analysis methods – Measuring the success of social innovation projects – Long-term sustainability and scalability of innovative solutions – Ethical considerations in social innovation.

Total Contact Hours	:	45

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

CO1	Understand and explain the principles of social innovation and Industry 4.0.
CO2	Identify and categorize various types of social innovations and their applications.
CO3	Design and prototype innovative solutions for societal challenges using Industry 4.0 technologies.
CO4	Evaluate the economic and environmental feasibility of innovative solutions, including IPR and costing considerations.
CO5	Analyze real-world case studies to measure the societal impact of social innovations.

Textbook (s):

1	Murray, R., Caulier-Grice, J., and Mulgan, G., The Open Book of Social Innovation, London: National Endowment for Science, Technology, and the Arts, 2010.
2	Hopkinson, N., Hague, R., and Dickens, P. (Eds.), Rapid Manufacturing: An Industrial Revolution for the Digital Age, John Wiley & Sons, 2006.
3	Nicolopoulou, K., Karataş-Özkan, M., Janssen, F., and Jermier, J. (Eds.), Sustainable Entrepreneurship and Social Innovation, Taylor & Francis, 2016.

Reference Books(s) / Web links:

1	Brown, T., Design Thinking for Social Innovation, Harvard Business Review Press, 2009.
2	Schwab, K., The Fourth Industrial Revolution, World Economic Forum, 2016

CO\ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	3	2	-	2	-	3	1	-	-	-	2	3	1
CO2	2	2	3	2	-	-	-	2	2	3	-	3	-	3	1
CO3	2	2	3	2	-	-	-	-	3	3	-	2	-	2	1
CO4	2	2	3	2	-	-	-	-	1	2	3	3	-	2	3
CO5	2	2	3	2	-	2	3	3	1	-	2	3	3	3	2
Avg	2	2	3	2	**-**	**2.0**	**3.0**	**2.6**	**1.6**	**2.6**	**2.5**	**2.7**	**2.5**	**2.6**	**1.6**

MT23G12	NEW SPINNING TECHNOLOGIES	PE	L	T	P	C
			3	0	0	3

Objectives: The course shall:	
●	Introduce advanced spinning technologies and their principles.
●	Analyze the limitations of conventional spinning systems and explore innovative alternatives.
●	Explain the working mechanisms and design aspects of modern spinning machines.
●	Evaluate the properties of yarns produced by various new spinning technologies.
●	Investigate process parameters and their influence on spinning efficiency and yarn quality.

UNIT-I	OVERVIEW OF SPINNING TECHNOLOGIES	09
Introduction to spinning systems, Limitations of ring spinning, Principle of open-end spinning, Comparison of ring spinning and open-end spinning systems, General description of the open-end spinning machine, Parts and their functions, Working mechanism of open-end spinning, Sliver feed, fibre separation, and transport mechanisms.		
UNIT-II	**ROTOR SPINNING**	**09**
Principle of rotor spinning, Rotor design and groove geometry, Role of the navel in yarn twisting, Mechanics of twisting and yarn formation, Process parameters and their significance in rotor spinning, Rotor yarn structure and properties, Technological innovations in rotor spinning, Comparison of rotor-spun yarns with ring-spun yarns, Applications of rotor spinning in industry.		
UNIT-III	**AIR-JET AND VORTEX-SPINNING**	**09**
Principle of air-jet spinning, Sliver feed: high draft and high speed, Twin-jet design and twisting principle, Air-jet yarn structure and properties, Applications of air-jet spinning, Principle of vortex spinning, Mechanism of yarn formation in vortex spinning, Structural characteristics of vortex-spun yarns, Comparison of air-jet and vortex spinning technologies.		
UNIT-IV	**FRICTION SPINNING**	**09**
Principle of yarn formation in friction spinning, Operational stages in friction spinning and their significance, Friction drum design aspects, Mechanics of yarn formation in friction spinning, Structural characteristics of friction-spun yarns, Applications of friction spinning in technical textiles, Comparison of friction spinning with other spinning technologies, Innovations in friction spinning systems, Challenges and limitations of friction spinning systems.		
UNIT-V	**WRAP SPINNING AND COMPARATIVE ANALYSIS OF SPINNING SYSTEMS**	**09**
Principle of wrap spinning, Mechanics of yarn formation in wrap spinning, Yarn structure and properties in wrap spinning, Applications and limitations of wrap spinning systems, Comparative analysis of spinning systems (ring, rotor, air-jet, vortex, friction, and wrap), Process optimization in modern spinning technologies, Future trends in spinning systems.		
	Total Contact Hours :	**45**

Course Outcomes: After the successful completion of the course, the student will be able to:	
CO1	Identify the limitations of conventional spinning systems and evaluate alternatives.
CO2	Explain the principles and mechanisms of advanced spinning technologies.
CO3	Analyze the process parameters influencing yarn formation and properties.
CO4	Compare yarn structures and properties across various spinning systems.
CO5	Investigate the applications, innovations, and future trends in spinning technologies.

Textbook (s):	
1	*Kothari, C. R., Research Methodology: Methods and Techniques*, New Age International Publishers, 2004.
2	*Day, R. A., How to Write and Publish a Scientific Paper*, Cambridge University Press, 2011.

Reference Books(s) / Web links:	
1	*Highman, N., Handbook of Writing for the Mathematical Sciences*, SIAM, 1998.
2	*Singh, A., Research Methodology: Techniques and Trends*, Gyan Publishing House, 2018.

CO\ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	2	2	-	-	-	-	-	-	2	3	3	2
CO2	3	3	-	3	-	-	-	-	-	-	-	2	3	3	-
CO3	3	3	3	3	-	-	-	-	-	-	-	3	3	3	2
CO4	3	3	2	3	-	-	-	-	-	-	-	2	3	3	2
CO5	3	3	-	3	-	-	2	2	-	-	3	3	3	3	3
Avg	3.0	3.0	2.5	2.8	2.0	-	2.0	2.0	-	-	3.0	2.4	3.0	3.0	2.3

AT23D18	VEHICLE CONTROL SYSTEMS	Category	L	T	P	C
		PE	3	0	0	3

Objectives:

- The objective of this course is to make the students to understand the basics of control system used in automobiles

UNIT-I	INTRODUCTION TO VEHICLE CONTROL SYSTEM	9

Trends, overview and examples of vehicle control system- Sensors, actuators and controller modules-Vehicle communication Network-System Engineering V-diagram- Algorithm Development - Steps in vehicle control system design- Degree of freedom for vehicle control- selection of controlled, manipulated, measured disturbance variables- classification of the variables in various automotive systems like engines, suspension, braking, air conditioning – General types of vehicle controller configurations- Feedback, Inferential, Feed-Forward, Ratio control.

UNIT-II	CONTROL SCHEMES, CRUISE AND HEADWAY CONTROL	9

Feed - Forward control - Cascade control- Design considerations for cascade control, Time delay compensation, Inferential control- Nonlinear control- Adaptive control etc. Cruise control design- Autonomous cruise control- Anti locking brakes- Traction control system- Vehicle stability control linear and non-linear vehicle model- VSC Design Principles – four-wheel steering – Goals of 4WS Algorithms – active suspensions.

UNIT-III	DRIVER MODELING AND POWERTRAIN CONTROL SYSTEMS	9

Driving simulators- percentage of road departure- Driver modeling- Transfer function models- Preview/ Predictive models- longitudinal driver models Control oriented engine modeling- Air intake model- Fuel dynamics model- Air Fuel ratio dynamics- Engine Control Loops- Air Fuel Ratio control- EGR Control- Spark Timing control- Idle speed control- Knock control-Adaptive knock control- Combustion torque estimation- Transmission control

UNIT–IV	CONTROL OF HYBRID AND FUEL CELL VEHICLES	9

Series-Parallel- Split Hybrid Configurations- Hybrid Vehicle Control Hierarchy- Control Concepts of Series Hybrids- Equivalent Consumption minimization strategy- control concepts for split hybrid modelling of fuel cell systems- fuel stack model- control of fuel cell system.

UNIT-V	HUMAN FACTORS AND INTELLIGENT TRANSPORT SYSTEM	9

Human factors in vehicle automation- cross over model principle- Risk- Homeostatic Theory- Driving simulators- percentage of road departure Advanced traffic management system- Advanced traveller information system- commercial vehicle operation- Advanced vehicle control system- Preventing collisions- Longitudinal motion control and platoons- Site specific information comparison of longitudinal control approaches- String stability- Automated steering and lateral control – Lane sensing- automated lane change and follow control.

TOTAL	:	45 PERIODS

Course Outcomes

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

1	Understand the basics of control system used in automobiles
2	Recognize the electronically controlled system used in driving mechanics
3	Understand the working principle of driver modelling and power train control systems.
4	Identify the control system used in hybrid and electrical vehicles.
5	Illustrate the need of automated transport systems.

Text Books

1	Galip Ulsoy , Automotive Control System, Cambridge University Press, 2012.
2	Uwe Kiencke and Lars Nielson, Automotive Control System, SAE Publications, 2006

Reference Books

1	Bosch Automotive Handbook, Sixth Edition,2004
2	Benjamin C.Kuo and Farid Golnaraghi, Automatic Control System, John Wiley & Sons, Eight edition, 2003
3	Katsuhiko Ogata, System Dynamics, Prentice Hall International, Inc. Third Edition,1998
4	Richard C.Dorf and Robert H.Bishop, Modern Control Systems, Pearson Prentice Hall,2008