

PAAVAI ENGINEERING COLLEGE
 (AUTONOMOUS)
DEPARTMENT OF MECHATRONICS ENGINEERING
REGULATIONS – 2023
CHOICE BASED CREDIT SYSTEM
CURRICULUM
 (For the candidates admitted during the Academic Year 2023-2024 onwards)

SEMESTER V

S. No	Category	Course Code	Course Title	L	T	P	C
Theory							
1	PC	MT23501	Design of Machine Elements	3	1	0	4
2	PC	MT23502	MEMS and NEMS	3	0	0	3
3	PC	MT23503	Power Electronics	3	0	0	3
4	PC	MT23504	Control Systems	3	0	0	3
5	PC	MT23505	Maintenance and Condition Monitoring	3	0	0	3
6	PE	MT23***	Professional Elective - I	3	0	0	3
Practical							
7	PC	MT23506	Power Electronics Laboratory	0	0	4	2
8	PC	MT23507	Modelling and Simulation Laboratory	0	0	2	1
9	EE	MT23508	Industrial Training	0	0	2	1
10	EE	GE23501	Professional Development III	0	0	2	1
Total				18	1	10	24

PROFESSIONAL ELECTIVE COURSES (PE) – VERTICALS

VERTICAL I - SMART MOBILITY

S. No	Category	Course Code	Course Title	L	T	P	C
1	PE	MT23151	Electric and Hybrid Vehicles	3	0	0	3
2	PE	MT23152	Advanced Driver Assistance Systems	3	0	0	3
3	PE	MT23153	Automotive Mechatronics	3	0	0	3
4	PE	MT23154	Automotive System Modelling and Simulation	3	0	0	3
5	PE	MT23155	Vehicle Dynamics and Control	3	0	0	3
6	PE	MT23156	Battery Management System	3	0	0	3
7	PE	MT23157	Smart Mobility and Intelligent Vehicles	3	0	0	3

VERTICAL II - MANUFACTURING

S. No	Category	Course Code	Course Title	L	T	P	C
1	PE	MT23251	Computer Aided Inspection and Testing	3	0	0	3
2	PE	MT23252	CNC Technology and Programming	3	0	0	3
3	PE	MT23253	Design for Manufacturing	3	0	0	3
4	PE	MT23254	Digital Manufacturing	3	0	0	3
5	PE	MT23255	Advanced Manufacturing Technology	3	0	0	3
6	PE	MT23256	Additive Manufacturing Technologies	3	0	0	3
7	PE	MT23257	Introduction to Finite Element Analysis	3	0	0	3

VERTICAL III - ROBOTICS

S. No	Category	Course Code	Course Title	L	T	P	C
1	PE	MT23351	Mobile Robotics	3	0	0	3
2	PE	MT23352	Fundamental Design of Robot Elements	3	0	0	3
3	PE	MT23353	Robots in Manufacturing	3	0	0	3
4	PE	MT23354	Humanoid Robotics	3	0	0	3
5	PE	MT23355	Introduction to AI in Robotics	3	0	0	3
6	PE	MT23356	Robotics Technology and Flexible Automation	3	0	0	3
7	PE	MT23357	Micro Robotics	3	0	0	3

VERTICAL IV - AUTOMATION

S. No	Category	Course Code	Course Title	L	T	P	C
1	PE	MT23451	Factory Automation	3	0	0	3
2	PE	MT23452	Operation Research	3	0	0	3
3	PE	MT23453	Virtual Instrumentation	3	0	0	3
4	PE	MT23454	Advanced Machining Processes	3	0	0	3
5	PE	MT23455	Automated Material Handling Systems	3	0	0	3
6	PE	MT23456	Digital Twin and Industry 5.0	3	0	0	3
7	PE	MT23457	Total Integrated Automation	3	0	0	3

VERTICAL V - INTELLIGENCE

S. No	Category	Course Code	Course Title	L	T	P	C
1	PE	MT23551	Applied Signal Processing	3	0	0	3
2	PE	MT23552	Deep Learning	3	0	0	3
3	PE	MT23553	Introduction to Machine Learning	3	0	0	3
4	PE	MT23554	Applied Image Processing	3	0	0	3
5	PE	MT23555	Introduction to Internet of Things	3	0	0	3
6	PE	MT23556	Soft Computing	3	0	0	3
7	PE	MT23557	Artificial Intelligence for Mechatronics	3	0	0	3

VERTICAL VI - AVIONICS AND DRONE TECHNOLOGY

S. No	Category	Course Code	Course Title	L	T	P	C
1	PE	MT23651	Avionics	3	0	0	3
2	PE	MT23652	Drone Technology	3	0	0	3
3	PE	MT23653	Guidance and Control	3	0	0	3
4	PE	MT23654	Navigation and Communication System	3	0	0	3
5	PE	MT23655	Design of UAV	3	0	0	3
6	PE	MT23656	Aerodynamics of Drones	3	0	0	3
7	PE	MT23657	Aircraft Mechatronics	3	0	0	3

MINOR DEGREE IN AUTOMATION ENGINEERING

S. No	Category	Course Code	Course Title	L	T	P	C
1	MDC	MT23851	Basics of Automation Systems	3	0	0	3
2	MDC	MT23852	Sensors and Actuators	3	0	0	3
3	MDC	MT23853	Hydraulics and Pneumatics	3	0	0	3
4	MDC	MT23854	PLC and SCADA	3	0	0	3
5	MDC	MT23855	Low Cost Automation	3	0	0	3
6	MDC	MT23856	System Design Integration	3	0	0	3



SEMESTER V

MT23501	DESIGN OF MACHINE ELEMENTS	3	1	0	4
COURSE OBJECTIVES					
To enable the students to					
1	understand the various steps involved in the machine design process.				
2	analyze different loading conditions on shafts and couplings.				
3	design bolted joints for both in-plane and out-of-plane eccentric loading.				
4	identify and differentiate various mechanical drive systems including belt, chain, and gear drives based on their working principles and applications.				
5	understand the knowledge in springs and selection of bearings for different applications.				
UNIT I	DESIGN PROCESS AND DESIGN FOR STATIC LOAD				12
Introduction to the design process - Factors Influencing machine design, selection of materials based on mechanical properties - Direct, Bending and torsional stress equations - Impact and shock loading - Calculation of stresses for combinations; Theories of failure; Factor of safety; Design of curved beams - Crane hook and 'C'.					
UNIT II	DESIGN OF SHAFTS, KEYS AND COUPLINGS				12
Design of solid and hollow shafts based on strength, types of shafts, shaft materials, design of shaft for variable loading, rigidity and critical speed, Types of Couplings - Design of Muff Coupling, un projected flange coupling, projected flange coupling, Clamp coupling, Rigid flange coupling pin type flexible coupling, Applications.					
UNIT III	DESIGN OF JOINTS				12
Threaded fasteners Bolted joints including eccentric loading; Knuckle joints - Welding symbols, Stresses in butt and fillet welds, Design of Welded Joints for static loads, strength of transverse fillet welding joints, stress concentration factor for welded joints, Axis unsymmetrical welded joints, Eccentric load in the plane of welds.					
UNIT IV	GEARS AND MECHANICAL DRIVES				12
Classification, law of gearing, forms of tooth, interference, under cutting, minimum number of teeth pinion to avoid interference - Contact ratio. Drives classification Types of belt drives, velocity belting, length of the open and cross belts, power transmitted by a belt, tension ratio, centrifugal effect initial tension in belts.					
UNIT V	DESIGN OF SPRING AND BEARINGS				12
Design of helical and multi leaf under constant loads and varying loads, End conditions and length of springs, Stresses in Helical Springs of circular wire. Classification of bearing - Types of radial ball bearings, types of thrust ball bearings, standard dimensions and designation of bearings, bearing life, load rating, equivalent bearing load, load life relationship, selection of bearings, bearings for cyclic loads-cubic mean load.					
					TOTAL PERIODS 60

COURSE OUTCOMES		
At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	enquire knowledge about design process and the factors influencing it and design the simple components for static loading.	Understand (K2)
CO2	design the circular shafts based on strength and rigidity, keys and coupling for power transmission.	Apply (K3)
CO3	analyse the forces acting on bolts in eccentric loading, welded joints and design the elements.	Analyse (K4)
CO4	design and optimize the selection of gears and drives for automotive components and machine elements.	Apply (K3)
CO5	formulate the design procedure for springs and understand the rolling contact bearings for static and cyclic loads, select the lubricants and bearing dimensions for hydrodynamic lubrication.	Analyse (K4)

TEXT BOOKS

1. R.S.Khurmi, J.K.Gupta "A Textbook of Machine Design", Eurasia Publication House, New Delhi, 2005.
2. Bhandari V B, "Design of Machine Elements", 5th Edition, Tata McGraw-Hill Book Co, 2020.

REFERENCES

1. Sundarajamoorthy T.V. Shanmugam.N. "Machine Design", Anuradha Publications, Chennai, 2018.
2. Robert C.Juvinall and Kurt M. Marshek, "Fundamentals of Machine Component Design", 7th Edition, John Wesley & Sons, Inc, 2020.
3. Alfrd Hall, Halowenko, A and Laughlin, H., "Machine Design", McGraw Hill Education, 2017.
4. Ansel C Ugural "Mechanical Design of Machine Components Taylor & Francis, 2018.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2	1	1	-	-	-	-	-	-	2	3	2
CO2	3	2	3	1	2	-	-	-	-	-	-	2	3	2
CO3	3	3	3	2	2	-	-	-	-	-	-	2	3	2
CO4	3	2	3	1	3	-	-	-	-	-	-	2	3	3
CO5	3	2	3	2	2	-	-	-	-	-	-	2	3	2



MT23502	MEMS AND NEMS	3	0	0	3	
COURSE OBJECTIVES						
To enable the students to						
1	understand the structure and function of microsystems					
2	classify different micro sensors: acoustic, biomedical, chemical, optical, pressure, and thermal.					
3	learn photolithography steps and photoresist processing.					
4	interpret the periodic table and electronic configurations for nano materials.					
5	understand biomimetics and its role in NEMS/MEMS design.					
UNIT I	MICROSYSTEMS				9	
Overview - Microsystems, working principles of Micro Systems, Silicon based MEMS processes; MEMS - Semiconductor devices; Polymers in MEMS - Polyamide, SU-8, Liquid Crystal Polymer (LCP), PDMS, PMMA, Parylene and Fluorocarbon.						
UNIT II	MICRO SENSORS AND ACTUATORS				9	
Introduction - Micro sensors, acoustic wave sensors, biomedical sensors, chemical sensors, optical sensors, pressure sensors, thermal sensors; Micro actuation - Actuation using thermal, shape memory alloys, piezoelectric crystals, and electrostatic forces; Micro actuators - micro grippers, micro motors, micro valves, micro pumps, micro accelerometers, microfluidics.						
UNIT III	MATERIALS AND FABRICATION PROCESS FOR MEMS				9	
Ion implantation - diffusion, oxidation, thermal oxidation, silicon dioxide growth; Chemical Vapor Deposition (CVD) principles and techniques; Physical Vapor Deposition (PVD), Including deposition by epitaxy; Etching processes chemical and plasma etching.						
UNIT IV	INTRODUCTION AND OVERVIEW: NANO SCALE				9	
Sizing Features - From Micro to Nano scale, and Nano to String scale; Mendeleev's Periodic Table of Elements and Electronic Configurations; Nano engineering and Nano science - Smaller than Nano, Pico and Fem to scale; Introduction to Taxonomy of Nano Microsystems Synthesis and Design - Design and Optimization of Nano and Microsystems in the Behavioral Domain.						
UNIT V	NANO ELECTRO MECHANICAL SYSTEMS				9	
Biomimetics - Biological Analogies, Design of NEMS and MEMS, Biomimetics Fundamentals, Biomimetics for NEMS and MEMS; Biomimetics - Nano ICs, Nano computer Architectonics, Biomimetics and Nervous Systems.						
					TOTAL PERIODS	45
COURSE OUTCOMES						
At the end of this course, students will be able to					BT Mapped (Highest Level)	
CO1	understand the role of semiconductor devices in microsystem design.				Understand (K2)	
CO2	identify and describe applications of micro actuators like pumps, motors, and grippers.				Apply (K3)	

CO3	understand the role of substrates and wafers in MEMS fabrication.	Understand (K2)
CO4	understand taxonomy and behavioral design principles of nano/microsystems.	Understand (K2)
CO5	analyze and model mechanical, fluidic, thermal, and electromagnetic systems at the micro/nano scale.	Analyze (K4)

TEXT BOOKS

1. Chang liu, "Foundation of MEMS" Perason Education Inc, 2016.
2. Tai-Ran Hsu, "MEMS and Microsystems: Design and Manufacture", 2nd Edition, John Wiley and Sons, New York, 2018.

REFERENCES

1. James J. Allen, "Micro Electro Mechanical System Design", CRC Press Publisher, 2014.
2. Julian w. Gardner, Vijay K. Varadan, Osama O. Awadelkarim, "Micro Sensors MEMS and Smart Devices", John Wiley & Son LTD, 2012.
3. Mohamed Gad-el-Hak, editor, "The MEMS Handbook", CRC press Baco Raton, 2010.
4. Nadim Maluf, "An Introduction to Micro Electro Mechanical System Design", Artech House, 2009.

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(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	-	-	-	2	-	-	-	-	-	-	-	2	2
CO2	3	2	2	0	3	-	-	-	2	2	-	-	3	2
CO3	3	-	-	2	2	-	-	-	-	-	-	-	2	2
CO4	3	2	2	2	2	-	-	-	-	2	-	2	2	2
CO5	3	3	3	3	3	-	-	-	-	2	-	2	3	3



MT23503	POWER ELECTRONICS			3	0	0	3
COURSE OBJECTIVES							
To enable the students to							
1	understand the characteristics, triggering and protection of power semiconductor devices						
2	examine thyristor-based rectifier circuits for single-phase and three-phase systems.						
3	develop the single-phase and three-phase bridge inverters.						
4	explore the operation and control of DC-DC converters.						
5	understand the working of various AC voltage controllers.						
UNIT I	POWER SEMICONDUCTOR DEVICES						9
Introduction - Power diode, Power MOSFET, Power IGBT, SCR, TRIAC - Steady state characteristics; Gate triggering circuits - Firing circuits for the SCR - UJT; Protection circuits - Over current protection; Snubber circuits.							
UNIT II	AC - DC CONVERTERS						9
Phase Controlled Rectifiers - Single phase thyristor half wave circuit with R, RL load, Single phase thyristor full wave bridge converter, Three phase thyristor half converter circuits with R load, Three phase thyristor full converter circuits with R load, Effect of source inductance.							
UNIT III	INVERTERS						9
Single phase bridge inverters and three phase bridge (both 120 ° and 180 ° modes) Voltage Source Inverters; PWM Techniques - Single pulse modulation, Multiple pulse modulation, Sinusoidal PWM, Modified sinusoidal PWM and multiple PWM; Current Source Inverters.							
UNIT IV	DC - DC CONVERTERS						9
Choppers - Principle of chopper operation; Control strategies - Constant frequency system, Variable frequency system; DC chopper - Step down (Buck) chopper, Step up (Boost)chopper, Buck Boost chopper; Types of chopper circuits - Two quadrant chopper circuits, Four quadrant chopper circuits							
UNIT V	AC VOLTAGE CONTROLLERS						9
Single phase full wave controllers with resistive load; Three phase full wave controllers with resistive load; Sequence control of AC voltage controllers; Cycloconverters - Single phase cycloconverters, Three phase cycloconverters; Applications - AI driven fault diagnosis and prognosis in power electronics.							
						TOTAL PERIODS	45
COURSE OUTCOMES							
At the end of this course, students will be able to						BT Mapped (Highest Level)	
CO1	gain knowledge of various power semiconductor devices and firing circuits.					Understand (K2)	
CO2	understand the concept of controlled AC-DC converters.					Understand (K2)	
CO3	explain the concept of inverters.					Understand (K2)	
CO4	examine the performance of DC-DC converters (Choppers).					Understand (K2)	

CO5	explain the types of AC voltage controllers.	Understand (K2)												
TEXT BOOKS														
1. Bimbara B.S., "Power Electronics", 5th Edition, Kanna Publishers, New Delhi, 2014.														
2. Muhammad H. Rashid, "Power Electronics: Devices, Circuits & Applications", 4th Edition, Pearson, 2017.														
REFERENCES														
1. Singh M.D. & Kanchandhani K.B., "Power Electronics", McGraw Hill, New Delhi, 2013.														
2. Gobal K. Dubey, "Fundamentals of Electrical Drives", 2nd Edition, Narosal Publishing House, New Delhi, 2012.														
3. G. K. Dubey, Fundamentals of Electrical Drives, Wiley Eastern Ltd., New Delhi, 2007.														
4. L.Umanand, "Power Electronics Essentials and Applications", Wiley India Pvt Ltd, Reprint, 2015.														
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CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	2	2	2	-	-	-	-	-	-	2	3	3
CO2	3	2	3	2	3	-	-	-	-	-	-	2	3	3
CO3	3	3	3	2	2	-	-	-	-	-	-	2	3	3
CO4	3	3	3	2	2	-	-	-	-	-	-	2	3	3
CO5	3	3	2	3	3	-	-	-	-	-	-	3	3	3



MT23504		CONTROL SYSTEMS			3	0	0	3
COURSE OBJECTIVES								
To enable the students to								
1	understand the methods of representation of systems and to obtain system transfer function models.							
2	provide knowledge on time response of systems and steady state error analysis.							
3	acquaint basic knowledge in obtaining the closed-loop frequency responses of systems.							
4	impart the concept of stability of control system and methods of stability analysis.							
5	learn the various approach for the state variable analysis.							
UNIT I	SYSTEMS REPRESENTATION							9
Basic elements in control systems - open loop and closed loop with applications - Transfer functions of mechanical, electrical and analogous systems - Block diagram reduction - signal flow graphs.								
UNIT II	TIME RESPONSE ANALYSIS							9
Types of test input - Time response - Time domain specifications - Error coefficients - Steady state error, error constants. Design for PD, PI, and PID control systems.								
UNIT III	FREQUENCY RESPONSE AND SYSTEM ANALYSIS							9
Closed loop frequency response - Performance specification in frequency domain - Frequency response of standard second order system - Bode Plot - Polar Plot- Design of compensators using Bode plots for lead and lag compensation.								
UNIT IV	STABILITY OF CONTROL SYSTEMS							9
Concept of stability-Bounded - Input Bounded - Output stability - Characteristics equation - Routh Hurwitz criterion - Root locus construction - Nyquist stability criterion								
UNIT V	STATE VARIABLE METHODS							9
State variable Analysis - Concepts of state, state variable, state model, Conversion of state variable models to transfer functions - Conversion of transfer functions to state variable models - solution of state equations - concept of controllability and observability.								
							TOTAL PERIODS	45
COURSE OUTCOMES								
At the end of this course, students will be able to							BT Mapped (Highest Level)	
CO1	develop a mathematical model of a physical system and compute the transfer function using block diagram reduction technique and Signal flow graph.						Apply (K3)	
CO2	apply the transient response of control systems in using time domain.						Apply (K3)	
CO3	evaluate and analyze control systems using frequency domain methods.						Apply (K3)	
CO4	check the stability of systems.						Apply (K3)	
CO5	apply various transfer functions of digital control system using state variable models.						Apply (K3)	

TEXT BOOKS

1. I.J. Nagrath and M. Gopal, "Control Systems Engineering", New Age International Publishers, 2019.
2. A.Nagoorkani, "Control Systems", RBA Publications, 2018.

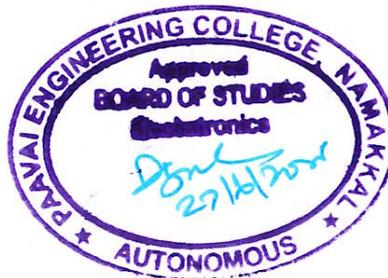
REFERENCES

1. B.C. Kuo, "Automatic Control Systems", Prentice Hall of India Ltd., 2017.
2. M. Gopal, "Control Systems, Principles & Design", Tata McGraw Hill, 2017.
3. K. Ogata, "Modern Control Engineering", Pearson Education, 2015.
4. S.K.Bhattacharya, "Control System Engineering", Pearson, 2018.

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CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	2	2	2	-	-	-	-	-	-	1	3	2
CO2	3	3	2	2	1	-	-	-	-	-	-	1	2	2
CO3	3	3	2	2	2	-	-	-	-	-	-	1	2	2
CO4	3	3	2	2	2	-	-	-	-	-	-	1	2	2
CO5	3	3	2	2	3	-	-	-	-	-	-	1	3	3



MT23505	MAINTENANCE AND CONDITION MONITORING			3	0	0	3
COURSE OBJECTIVES							
To enable the students to							
1	understand the various maintenance systems and strategies.						
2	familiarize with structured maintenance processes, documentation practices, and control systems.						
3	acquire knowledge of maintenance control techniques in order to improve equipment reliability.						
4	recognize the equipment failures and implement safety practices to minimize risks and enhance maintenance reliability.						
5	gain knowledge of condition monitoring techniques and troubleshooting methods to detect faults and optimize system performance.						
UNIT I	PRINCIPLES OF MAINTENANCE						9
Introduction to Maintenance - Objectives, functions and challenges in maintenance; Maintenance systems - Breakdown maintenance, Corrective maintenance, Opportunistic maintenance, Routine maintenance, Preventive maintenance, Predictive maintenance, Condition based maintenance system; Design out maintenance.							
UNIT II	SYSTEMATIC MAINTENANCE						9
Codification and Cataloguing; Instruction manual, operating manual, maintenance manual and departmental manual; Maintenance time standard; Maintenance work order and work permit; Job monitoring; Feedback and control system; Maintenance records and documentation; Maintenance of hydraulic, pneumatic and electrical equipments.							
UNIT III	MAINTENANCE CONTROL TECHNIQUES						9
Total Productive Maintenance (TPM) - Elements, factors and barriers; Reliability Centered Maintenance (RCM) - Methodology, features and benefits; Computerized Maintenance Management System (CMMS) - Objectives, factors, components and future; Equipment module - Material management module, Captive engineering module.							
UNIT IV	FAILURE ANALYSIS AND SAFETY IN MAINTENANCE						9
Failure definition, modes, types and rate; Failure reporting and collection; Failure analysis - Fault tree analysis (FTA), Event tree analysis (ETA), Root cause analysis (RCS), Failure modes and effect analysis (FMEA), Failure modes effect and criticality analysis (FMECA); Safety - Methods of enhancing safety, Modern industrial scenarios.							
UNIT V	CONDITION MONITORING AND TROUBLESHOOTING						9
Fundamentals and cost comparison in condition monitoring; On load and off load testing; Visual monitoring, Vibration monitoring, Temperature monitoring, Lubricant monitoring, Cracks monitoring, Noise and sound monitoring; Troubleshooting - Systematic Process in Fluid power system, CNC, and Automotives.							
						TOTAL PERIODS	45
COURSE OUTCOMES							
At the end of this course, students will be able to						BT Mapped (Highest Level)	
CO1	identify maintenance approaches and explain their applications in real					Understand (K2)	

	world engineering scenarios.	
CO2	categories the maintenance documentation process to support various industrial maintenance activities.	Understand (K2)
CO3	implement suitable maintenance strategies based on system requirements.	Apply (K3)
CO4	apply failure analysis techniques to identify root causes of equipment failures and recommend effective safety measures.	Analyze (K4)
CO5	apply appropriate condition monitoring techniques and structured troubleshooting processes in system.	Apply (K3)

TEXT BOOKS

1. Mohamed Ben-Daya, Salih O. Duffuaa., Abdul Raouf, Jezdimir Knezevic, Daoud Ait-Kadi, "Handbook of Maintenance Management and Engineering", Springer Verlag London Limited, 2014.
2. Sushil Kumar Srivastava, "Maintenance Engineering Principles, Practices & Management", S. Chand & Co, New Delhi, 2011.

REFERENCES

1. Keith Mobley R., "Maintenance Engineering Handbook", 8th Edition, McGraw Hill Professional, New Delhi, 2014.
2. Bhattacharya S.N., "Installation, Servicing and Maintenance", 2nd Edition, S.Chand & Co, New Delhi, 2013.
3. R. A. Collacott., "Mechanical Fault Diagnosis and condition monitoring", Chapman and Hall London a Halstead Press Book John Wiley & Sons, New York, 2011.
4. W.H. Tang, Q.H. Wu., "Condition Monitoring and Assessment of Power Transformers Using Computational intelligence", Springer London Ltd, 2013.

CO-PO MAPPING:

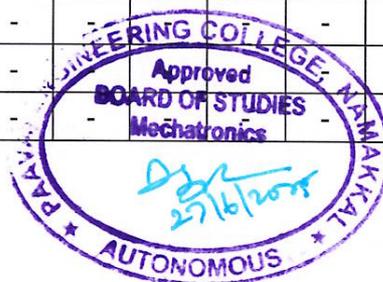
Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's

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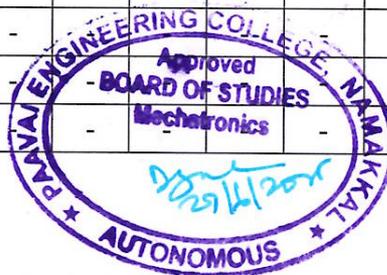
CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	2	-	-	-	-	-	-	-	1	-	-	2	2
CO2	2	3	2	1	1	-	-	-	1	2	-	-	2	2
CO3	3	2	3	2	2	-	-	-	2	2	-	1	3	3
CO4	2	2	2	3	2	-	-	2	-	2	-	1	2	2
CO5	2	2	3	2	2	-	-	2	-	2	-	1	3	3



MT23506	POWER ELECTRONICS LABORATORY												0	0	4	2
COURSE OBJECTIVES																
To enable the students to																
1	study the characteristics of switching devices.															
2	learn the applications of rectifiers.															
3	know performance of inverters and choppers.															
4	train with the design concepts of AC voltage controllers, and its's controlling techniques.															
LIST OF EXPERIMENTS																
CONTROL SYSTEMS																
1. Characteristics of SCR and TRIAC.																
2. Characteristics of MOSFET and IGBT.																
3. Gate Pulse Generation using R, RC and UJT.																
4. Voltage commutation.																
5. Current commutation.																
6. AC to DC half-controlled converter.																
7. AC to DC fully controlled converter.																
8. Step down and step up MOSFET based choppers.																
9. IGBT based single phase PWM inverter.																
10. IGBT based three phase PWM inverter.																
11. AC Voltage controller.																
12. Cycloconverter.																
														TOTAL PERIODS	60	
COURSE OUTCOMES																
At the end of this course, students will be able to														BT Mapped (Highest Level)		
CO1	compare and contrast the performance and applications of various power semi converter devices.													Analyze (K4)		
CO2	design the various phase-controlled rectifiers with different loads.													Apply (K3)		
CO3	analyze the chopper circuit using MOSFET, IGBT and PWM inverters.													Apply (K3)		
CO4	evaluate the performance of AC voltage converters.													Analyze (K4)		
CO-PO MAPPING :																
Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's																
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak																
CO's	PO's												PSO's			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2		
CO1	3	3	-	2	2	-	-	-	-	-	-	-	3	2		
CO2	3	3	3	2	2	-	-	-	-	-	-	-	3	3		
CO3	3	3	3	2	2	-	-	-	-	-	-	-	3	3		
CO4	3	3	2	2	2	-	-	-	-	-	-	-	3	3		



MT23507	MODELLING AND SIMULATION LABORATORY												0	0	2	1
COURSE OBJECTIVES																
To enable the students to																
1	model and simulate electromechanical and thermal systems using Simulink and Sims cape tools.															
2	design and implement control strategies (e.g., PID, feedback control) for dynamic system stabilization and performance.															
3	analyze real-world engineering systems such as motors, suspension, and robotics through simulation															
4	study the interaction between physical components and control logic in mechatronic and pneumatic systems.															
LIST OF EXPERIMENTS																
1. Model a DC Motor with PID controls in Simulink.																
2. Model a DC Motor with PID controls in Sims cape.																
3. Model a car suspension system using Sims cape.																
4. Model a basic heat transfer system with conduction, convection, and radiation.																
5. Model a pneumatic cylinder control pneumatic cylinder using a valve. a system to control extension and retraction of a valve.																
6. Model an inverted pendulum with feedback control.																
7. Model a simple robotic arm with two rotational joints.																
8. Model a pneumatic robot actuator.																
9. Create a simple model of a wheeled robot to study its motion.																
10. Model and simulate a two-wheeled robot that uses control system to balance itself dynamically.																
														TOTAL PERIODS	30	
COURSE OUTCOMES																
At the end of this course, students will be able to														BT Mapped (Highest Level)		
CO1	develop and simulate dynamic system models using Simulink and Sims cape.													Apply (K3)		
CO2	implement and tune control systems (e.g., PID, feedback) for real-time system response.													Apply (K3)		
CO3	analyze the performance and behavior of electromechanical, thermal, and pneumatic systems.													Analyze (K4)		
CO4	apply simulation tools to design and optimize robotic and automation components.													Apply (K3)		
CO-PO MAPPING :																
Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's																
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak																
CO's	PO's												PSO's			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2		
CO1	3	-	-	-	3	-	-	-	-	-	-	2	3	3		
CO2	3	2	3	-	3	-	-	-	-	-	-	2	3	3		
CO3	3	3	-	2	3	-	-	-	-	-	-	2	3	3		
CO4	3	-	3	-	3	-	-	-	-	-	-	2	3	3		



MT23508	INDUSTRIAL TRAINING			0	0	2	1
COURSE OBJECTIVES							
To enable the students to							
1	understand the application of classroom knowledge in solving industrial problems and processes.						
2	gain hands-on experience with modern tools, technologies, and practices.						
3	understand industrial workflow, safety standards, and professional ethics.						
4	develop problem-solving, analytical, and effective communication skills.						
DESCRIPTION							
<p>Industrial Training provides work experience relevant to their field of specialization, before graduation, and it is an essential component for the development of practical and professional skills required for an engineering graduate and supports for prospective employment.</p>							
<p>At the end of the industrial training, students should be able to improve their knowledge and skills relevant to their areas of specialization where they have been trained. The students should also be able to relate, apply, and adapt the relevant knowledge, concepts, and theories within an industrial organization, and also to practice the general workplace behavior and interpersonal skills.</p>							
<p>The student (either in group or single) should undergo industrial training for a minimum period of two weeks during the summer vacation after the completion of fourth semester as specified in the curriculum in any research organization/university/industry of State/National and International level industry relevant to their branch of specialization, after getting proper approval from the Head of the Institution.</p>							
<p>On the completion of the industrial training for the specified period, the student has to submit the industrial training report (at least 25-30 pages) containing the following details, along with the certificate obtained from the industry for the period of training undergone.</p>							
<ol style="list-style-type: none"> 1. Introduction of the industry. 2. Industry layout and its various operations with its infrastructure facilities. 3. Formulation of practical problems, data required to formulate the problems and its analysis. 4. Suggestions and recommendations for the above problems 							
<p>During the period of training, the student has to abide the rules and regulations enforced by the organization and to ensure FULL attendance during the period of industrial training and uphold the discipline and decorum of the institution.</p>							
<p>On the completion of the industrial training, the End Semester Examinations shall be conducted by the Office of the Controller of Examinations at the end of the fifth semester. A three-member committee</p>							

constituted by the Head of the Institution, consisting of (1) a senior faculty member at the Professor level, (2) senior faculty member at the Associate Professor and (3) faculty member from outside the department, will evaluate the industrial training undergone by the student. The evaluation shall be made based on the report submitted along with the presentation and a Viva voce Examination.

	TOTAL PERIODS	30
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COURSE OUTCOMES At the end of the course, the students will be able to	BT MAPPED (Highest level)
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CO1	explain industrial workflows, infrastructure, and organizational practices relevant to their specialization.	Understand (K2)
CO2	apply theoretical knowledge to perform tasks, operations, and problem-solving in an industrial environment.	Apply (K3)
CO3	demonstrate workplace discipline, safety practices, and professional ethics within an industrial setup.	Apply (K3)
CO4	analyze practical industrial problems, evaluate data, and propose feasible solutions with recommendations.	Analyze (K4)

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	1	2	1	-	1	1	-	2	2	2
CO2	3	2	2	2	2	2	1	1	2	2	1	2	3	3
CO3	1	1	2	1	1	3	2	3	2	2	1	2	2	2
CO4	3	3	3	3	2	2	2	2	2	3	2	3	3	3



GE23501	PROFESSIONAL DEVELOPMENT III	0	0	2	1
COURSE OBJECTIVES					
To enable students to					
1.	enhance their Resume writing skills and improving corporate vocabularies to survive in the corporate world.				
2.	evaluate their interview skills and improve their interview presentation.				
3.	solve the quantitative aptitude problems and improve their mental ability.				
4.	improve critical thinking and reasoning skills.				
UNIT I	RESUME WRITING SKILLS				6
Updated Resume Building III – Self Introduction III – Dressing Etiquette – JAM V – Corporate Vocabulary.					
UNIT II	INTERVIEW SKILLS				6
Interview skills – General guidelines - Work Ethics – Group Discussion III – JAM VI – Presentation Competence – Mock Interview.					
UNIT III	QUANTITATIVE APTITUDE				9
Cube Root and Square Root - Time and Work - Ages - Permutation and Combination - Probability – Calendar.					
UNIT IV	LOGICAL REASONING				9
Series Completion - Blood Relations - Coding and Decoding - Data Sufficiency - Statements and Assumptions.					
TOTAL PERIODS:					30
COURSE OUTCOMES Upon completion of the course, the students will be able to					BT MAPPED (Highest Level)
CO1	excel in drafting Resumes and speaking.				Applying (K3)
CO2	demonstrate the participative skills in group discussions and Interviews.				Applying (K3)
CO3	solve problems based on quantitative aptitude.				Applying (K3)
CO4	enhance their logical and verbal reasoning.				Analyzing (K4)
TEXTBOOKS					
1. Aggarwal, R. S. A Modern Approach to Verbal & Non-Verbal Reasoning. Revised ed., 2024–25, S. Chand & Company Ltd., 2024.					
2. Aggarwal, R. S. Objective General English: Fully Revised Video Edition. S. Chand & Company Ltd., 2022.					
REFERENCES					
1. Abhijit Guha, "Quantitative Aptitude ", Tata-Mcgraw Hill.2015.					
2. Word Power Made Easy By Norman Lewis, Wr.Goyal Publications.2016.					
3. Johnson, D.W. Reaching out — Interpersonal Effectiveness and self- actualisation. Boston: Allyn and Bacon.2019.					
4. Infosys Campus Connect Program — students' guide for soft skills.2015.					

CO/PO MAPPING:														
Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
CO's	Programme Outcomes (PO's)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02
CO1	3	2	2	3	3	1	-	-	-	-	-	-	3	2
CO2	-	2	3	-	2	-	2	-	-	-	-	-	3	2
CO3	3	2	2	2	-	-	1	-	-	-	-	-	2	3
CO4	3	2	2	-	-	1	-	-	-	-	2	-	2	3



PROFESSIONAL ELECTIVE COURSES (PE) – VERTICALS

VERTICAL I - SMART MOBILITY

MT23151	ELECTRIC AND HYBRID VEHICLES	3	0	0	3
COURSE OBJECTIVES					
To enable the students to					
1	understand the fundamentals of vehicle propulsion and resistance forces.				
2	learn various transmission types and their role in vehicle performance.				
3	explore hybrid electric vehicle (HEV) architectures and energy requirements.				
4	understand energy storage systems like batteries, ultracapacitors, and flywheels.				
5	study regenerative braking systems and their integration in EVs and HEVs.				
UNIT I	FUNDAMENTALS OF VEHICLE PROPULSION				9
Vehicle Resistance-Rolling Resistance, Aerodynamic Drag, Grading Resistance; Dynamic Equation - Tire Ground Adhesion and Maximum Tractive Effort - Power Train Tractive Effort and Vehicle Speed - Vehicle Performance - Maximum Speed of a Vehicle, Grade ability, Brake Performance, Braking Force, Braking Distribution on Front and Rear Axles - Braking Regulation and Braking Performance Analysis.					
UNIT II	VEHICLE TRANSMISSION				9
Power Plant Characteristics-Transmission Characteristics-Manual Gear Transmission (MT) - Automatic Transmission-Conventional Automatic Transmission; Torque Converter Operation, Planetary or Epicycle Gear Train, Compound Epicycle Gear; Automated Manual and Dual - Clutch Transmission-Continuously Variable Transmission - Infinitely Variable Transmissions - Dedicated Hybrid Transmission (DHT).					
UNIT III	HYBRID ELECTRIC VEHICLES				9
Performance of Electric Vehicles -Traction Motor Characteristics; Tractive Effort and Transmission Requirement, Vehicle Performance - Energy Consumption; Architectures of Hybrid Electric Drivetrains - Series Hybrid Electric Drivetrains, Parallel Hybrid Electric Drivetrains, Parallel Hybrid Drivetrain with Torque Coupling and Speed Coupling, Hybrid Drivetrains with Both Torque and Speed Coupling.					
UNIT IV	PEAKING POWER SOURCES AND ENERGY STORAGE				9
Electrochemical Batteries - Electrochemical Reactions, Thermodynamic Voltage, Specific Energy, Specific Power, Energy Efficiency; Battery Technologies - Lead, Acid Battery, Nickel-Based Batteries, Lithium-Based Batteries; Ultra capacitors - Ultra-High-Speed Flywheels - Hybridization of Energy Storages.					
UNIT V	REGENERATIVE BRAKING				9
Braking Energy Consumed in Urban Driving - Braking Energy versus Vehicle Speed - Braking Energy versus Braking Power - Braking Power versus Vehicle Speed - Braking Energy versus Vehicle; Deceleration Rate - Braking Energy on Front and Rear Axles-Brake System of EV, HEV, and FCV-Parallel Hybrid Brake System - Fully Controllable Hybrid Brake System.					
TOTAL PERIODS					45

COURSE OUTCOMES														
At the end of this course, students will be able to		BT Mapped (Highest Level)												
CO1	analyze tractive effort, braking performance, and gradeability of vehicles.	Analyze (K4)												
CO2	compare different transmission types used in modern and hybrid vehicles.	Remember (K1)												
CO3	evaluate the architecture and performance of various hybrid electric drivetrains.	Understand (K2)												
CO4	identify and compare characteristics of energy storage devices in EVs.	Apply (K3)												
CO5	understand regenerative braking principles and braking energy distribution in hybrid systems.	Understand (K2)												
TEXT BOOKS														
1. Mehrdad Ehsani, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles", 3 rd Edition, CRC Press, 2018.														
2. Iqbal Husain, "Electric and Hybrid Vehicles-Design Fundamentals", CRC Press, 2003.														
REFERENCES														
1. James Larminie and John Lowry, "Electric Vehicle Technology Explained", John Wiley & Sons, 2003.														
2. Lino Guzzella, "Vehicle Propulsion System", Springer Publications, 2005.														
3. Ron HodKinson, "Light Weight Electric and Hybrid Vehicle Design", Butterworth Heinemann Publication, 2005.														
4. Abdullah Mahmoud "Electric Vehicle Technology Explained", USA: John Willey and Sons, 2003.														
CO-PO MAPPING:														
Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's														
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	2	2	2	-	1	-	-	-	-	2	3	2
CO2	2	2	3	-	2	-	-	-	-	-	-	2	3	2
CO3	3	2	3	2	2	-	1	-	-	-	-	2	3	2
CO4	2	2	2	1	3	-	2	-	-	-	-	2	3	2
CO5	2	2	2	1	2	-	2	-	-	-	-	2	3	2



MT23152	ADVANCED DRIVER ASSISTANCE SYSTEMS	3	0	0	3	
COURSE OBJECTIVES						
To enable the students to						
1	introduce basic systems of an automobile including engine, drivetrain, suspension, ABS, and steering.					
2	study various automotive sensors, their functions, types, and applications in vehicles.					
3	understand the integration and role of driver assistance systems and sensor fusion in modern vehicles.					
4	explore major ADAS features used in enhancing driving safety and automation.					
5	know the role of ADAS display technologies and systems for detecting driver impairment.					
UNIT I	AUTOMOTIVE FUNDAMENTALS				9	
Power System; Running System; Comfort System; Engine Components; Drive Train; Suspension System; ABS; Steering System.						
UNIT II	AUTOMOTIVE SENSORS				9	
Knock Sensors; Oxygen Sensors; Crankshaft Angular Position Sensor; Temperature Sensor; Speed Sensor; Pressure Sensor; Mass Air Flow Sensor; Manifold Absolute Pressure Sensors; Crash Sensor; Coolant Level Sensors; Brake Fluid Level Sensors - Operation, Types, Characteristics, Advantage and their Applications.						
UNIT III	OVERVIEW OF DRIVER ASSISTANCE TECHNOLOGY				9	
Basics of Theory of Operation; Applications; Integration of ADAS Technology into Vehicle Electronics; System Examples - Role of Sensor Data Fusion; Vehicle Prognostics Technology.						
UNIT IV	ADVANCED DRIVER ASSISTANCE SYSTEMS				9	
Advanced Driver Assistance Systems - Lane Departure (LDW), Active Cruise Control (ACC), Blind Spot Detection, Parking Assist, Autonomous Emergency Braking (AEB), Night Vision, Traffic Sign Recognition (TSR), Intelligent High beam Assistant (IHC), Tire Pressure Monitoring (TPMS), Front Collision Warning System (FCWS), Front Vehicle Departure Warning (FVDW), Adaptive Lighting, Driver Drowsiness Detection, Hill Decent Control, Rear Cross Traffic.						
UNIT V	ADAS DISPLAY & IMPAIRED DRIVER TECHNOLOGY				9	
Center Console Technology; Gauge Cluster Technology; Heads-Up Display Technology and Warning Technology - Driver Notification; Impaired Driver Technology - Driver Impairment Sensor Technology, Sensor Technology for Driver Impairment Detection, Transfer of Control Technology.						
					TOTAL PERIODS	45
COURSE OUTCOMES						
At the end of this course, students will be able to					BT Mapped (Highest Level)	
CO1	describe the fundamental components and functions of automotive systems.				Understand (K2)	
CO2	differentiate between various automotive sensors and their applications in vehicle electronics.				Analyze (K4)	

CO3	explain the working and integration of ADAS technologies and sensor data fusion.	Understand (K2)
CO4	examine ADAS features to determine their contribution to vehicle safety functions.	Apply (K3)
CO5	assess the effectiveness of driver display and impairment detection systems.	Analyze (K4)

TEXT BOOKS

1. Tom Denton, "Automobile Electrical and Electronic systems", Roulledge, 5th Edition, 2018.
2. William B Ribbens, "Understanding Automotive Electronic: An Engineering Perspective" Elsevier Science, 8th Edition, 2017.

REFERENCES

1. Lentin Joseph, Amit Kumar Mondal, "Autonomous Driving and Advanced Driver-Assistance Systems (ADAS): Applications, Development, Legal Issues, and Testing", CRC Press, 2022.
2. Radovan Miucic, "Connected Vehicles: Intelligent Transportation Systems", Springer, 2019.
3. Sreeraj Sreekumar, "Advanced Driver Assistance System at a Glance", LAP Lambert Academic Publishing, 2019.
4. Yan Li, Hualiang Shi, "Advanced Driver Assistance Systems and Autonomous Vehicles: From Fundamentals to Applications", Springer Verlag, Singapore, 2022.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	-	-	-	2	1	-	-	-	-	-	1	3	1
CO2	3	2	-	-	3	-	-	-	-	-	-	1	3	2
CO3	2	2	2	-	3	-	-	-	-	-	-	1	3	3
CO4	2	2	2	-	3	2	1	1	-	-	-	1	3	3
CO5	2	3	2	1	3	2	1	1	-	-	-	1	2	3



MT23153	AUTOMOTIVE MECHATRONICS			3	0	0	3
COURSE OBJECTIVES							
To enable the students to							
1	intention and purpose of this course is to study the basics of electronics, emission controls and its Importance in automobiles.						
2	understand the fundamentals of combustion and its role in engine performance and emission control.						
3	learn the various sensors and actuators used in automobiles for improving fuel economy and emission control.						
4	study the various blocks of mechatronics control units used for control of fuel, ignition and exhaust systems.						
5	learn about different types of chassis and mechatronics safety systems in automobile.						
UNIT I	INTRODUCTION						9
Evolution of electronics in automobiles; Emission laws - Introduction to Euro I, Euro II, Euro III, Euro IV, Euro V standards, Equivalent Bharat Standards; Charging systems - Working and design of charging circuit diagram, Alternators, Requirements of starting system, Starter motors and starter circuits.							
UNIT II	IGNITION AND INJECTION SYSTEMS						9
Ignition systems - Ignition fundamentals, Electronic ignition systems, Programmed Ignition, Distribution less ignition, Direct ignition, Spark Plugs; Electronic fuel Control - Basics of combustion, Engine fuelling and exhaust emissions, Electronic control of carburetion, Petrol fuel injection, Diesel fuel injection.							
UNIT III	SENSOR AND ACTUATORS IN AUTOMOTIVES						9
Working principle and characteristics of Airflow rate - Engine crankshaft angular position, Hall effect, Throttle angle, temperature, exhaust gas oxygen sensors; Study of fuel injector - Exhaust gas recirculation actuators, stepper motor actuator, and vacuum operated actuator.							
UNIT IV	ENGINE CONTROL SYSTEMS						9
Control modes for fuel control - Engine control subsystems, Ignition control methodologies, different ECU's used in the engine management, Block diagram of the engine management system. In vehicle networks - CAN standard, Format of CAN standard, Diagnostics systems in modern automobiles.							
UNIT V	CHASSIS AND SAFETY SYSTEMS						9
Traction control system - Cruise control system, Electronic control of automatic transmission, Antilock braking system, Electronic suspension system, Working of airbag and role of MEMS in airbag systems, Centralized door locking system, Climate control of cars.							
						TOTAL PERIODS	45
COURSE OUTCOMES							
At the end of this course, students will be able to						BT Mapped (Highest Level)	
CO1	understand the importance of emission standards in automobiles.					Understand (K2)	
CO2	understand the electronic fuel injection/ignition components and their function.					Understand (K2)	

CO3	choose and use sensors and equipment for measuring mechanical quantities.	Apply (K3)
CO4	diagnose electronic engine control systems problems with appropriate diagnostic tools.	Analyze (K4)
CO5	analyze the chassis and vehicle safety system.	Analyze (K4)

TEXT BOOKS

1. Ribbens, "Understanding Automotive Electronics", 8th Edition, Elsevier, Indian Reprint, 2017.
2. Sharma.P.C, "A Textbook of Production Technology", Vol I and II, S. Chand and Company Ltd., New Delhi, 2007.

REFERENCES

1. Barry Hollembeak, "Automotive Electricity, Electronics & Computer Controls", Delmar Publishers, 7th edition, 2019.
2. Richard K. Dupuy "Fuel System and Emission controls", Check Chart Publication, 4th edition, 2000.
3. Ronald. K. Jurgon, "Automotive Electronics Handbook", McGraw-Hill, 2001.
4. Tom Denton, "Automobile Electrical and Electronics Systems", Edward Arnold Publishers, 2000.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	2	1	1	1	3	3	1	-	-	-	2	2	1
CO2	3	2	1	1	2	2	2	1	-	-	-	2	3	2
CO3	3	2	2	2	3	1	1	-	-	1	-	2	3	3
CO4	3	3	2	3	3	2	2	1	-	1	1	2	3	3
CO5	3	3	2	2	2	3	2	2	1	2	-	2	3	2



MT23154	AUTOMOTIVE SYSTEM MODELLING AND SIMULATION	3	0	0	3	
COURSE OBJECTIVES						
To enable the students to						
1	understand the various steps involved in the design process.					
2	understand the principals involved in evaluating the shape and dimensions of a component and to satisfy functional and strength requirements.					
3	know the standard practices and standard data.					
4	know the types of clutches and coupling flywheel.					
5	understand the knowledge in selection of bearings and lubrications for different applications.					
UNIT I	INTRODUCTION TO MECHANICAL ENGINEERING DESIGN				9	
Mechanical Engineering Design - Phases and Interactions of the Design Process, Design Tools and Resources, The Design Engineer's Professional Responsibilities; Standards and Codes, Economics, Safety and Product Liability; Stress and Strength, Uncertainty, Design Factor and Factor of Safety, Reliability and Probability of Failure, Relating the Design Factor to Reliability; Dimensions and Tolerances; Calculations and Significant Figures, Design Topic Interdependencies; Power Transmission Case Study Specifications.						
UNIT II	SHAFTS AND SHAFT COMPONENTS				9	
Introduction - Shaft Materials, Shaft Layout, Shaft Design for Stress; Deflection Considerations; Critical Speeds for Shafts; Miscellaneous Shaft Components, Limits and Fits.						
UNIT III	SCREWS FASTENERS, AND THE DESIGN OF NON-PERMANENT JOINTS				9	
Thread Standards and Definitions - The Mechanics of Power Screws, Threaded Fasteners; Joints, Fastener Stiffness, Joints Member Stiffness, Bolt Strength, Tension Joints, The External Load Relating Bolt Torque to Bolt Tension, Statically Loaded Tension Joint with Preload, Gasketed Joints ; Fatigue Loading of Tension Joints - Bolted and Riveted Joints Loaded in Shear.						
UNIT IV	CLUTCHES BRAKES COUPLINGS AND FLYWHEELS				9	
Static Analysis of Clutches and Brakes - Internal Expanding Rim Clutches and Brakes, External Contracting Rim Clutches and Brakes, Type Clutches and Brakes, Frictional - Contact Axial Clutches; Disk Brakes - Cone Clutches and Brakes; Energy Considerations - Temperature Rise, Friction Materials, Miscellaneous Clutches and Couplings; Flywheels.						
UNIT V	DESIGN OF LUBRICATION AND JOURNAL BEARINGS				9	
Types of Lubrication - Viscosity; Petroff's Equation - Stable Lubrication, Thick Film Lubrication, Hydrodynamic Theory, Design Considerations, The Relations of the Variables, Steady State Conditions in Self-Contained Bearings - Clearance, Pressure, Fed Bearings Loads and Materials, Bearing Types, Thrust Bearings, Boundary, Lubricated Bearings.						
					TOTAL PERIODS	45
COURSE OUTCOMES						
At the end of this course, students will be able to					BT Mapped (Highest Level)	
CO1	develop the ability to comprehend and execute the steps of the design process effectively.				Understand (K2)	

CO2	comprehend the principles for evaluating the shape and dimensions of a component to meet functional and strength requirements.	Understand (K2)
CO3	acquire expertise in standard practices and the application of standard data.	Apply (K3)
CO4	analyze the design and operation of different types of clutches, couplings, and flywheels.	Analyze (K4)
CO5	analyze and choose suitable bearings and lubrication techniques for diverse applications.	Analyze (K4)

TEXT BOOKS

1. Bhandari V.B, "Design of Machine Elements", 5th Edition, Tata McGraw-Hill Book Co, 2020.
2. Joseph Shigley, Richard G. Budyna , J. Keith Nisbett and Kiatfa Tangchaichit, "Mechanical Engineering Design", 11th Edition, Tata McGraw-Hill , 2020.

REFERENCES

1. Sundararajamoorthy T.V. Shanmugam. N, "Machine Design", Anuradha Publications, 2018.
2. Robell. C. Juvinall and KUII M. Marshek, "Fundamentals of Machine Component Design", 7th Edition, John Wiley & Sons Inc, 2020.
3. Alfred Hall, Halowenko, A and Laughlin, H, "Machine Design", McGraw Hill Education, 2017.
4. Ansel C. Ugural, "Mechanical Design of Machine Components", Tay lor & Francis, 2018.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	3	-	-	-	-	-	-	-	-	2	3	2
CO2	3	3	3	-	-	-	-	-	-	-	-	1	3	1
CO3	3	-	3	-	2	-	-	1	-	-	-	1	3	3
CO4	3	3	3	3	3	-	-	-	-	-	-	2	3	3
CO5	3	3	3	3	3	-	-	-	-	-	-	2	3	3



MT23155	VEHICLE DYNAMICS AND CONTROL	3	0	0	3	
COURSE OBJECTIVES						
To enable the students to						
1	understand the principles behind lateral dynamics.					
2	know the longitudinal dynamics and control mechanisms in an automobile.					
3	gain knowledge on the principles and functioning of electronic stability control systems.					
4	understand the design concepts and principles of automotive suspension system.					
5	learn the basics of dynamics and control in hybrid gas-electric vehicles.					
UNIT I	INTRODUCTION AND LATERAL VEHICLE DYNAMICS				9	
Driver Assistance Systems - Active Stability Control Systems, Ride Quality; Technologies for Addressing Traffic Congestion; Emissions and Fuel Economy; Lateral Systems Under Commercial Development - Kinematic Model of Lateral Vehicle Motion, Bicycle Model of Lateral Vehicle Dynamics, Dynamic Model in Terms of Error with Respect to Road, From Body Fixed to Global Coordinates.						
UNIT II	LONGITUDINAL VEHICLE DYNAMICS				9	
Longitudinal Vehicle Dynamics - Aerodynamic drag force, Longitudinal tire force, Rolling resistance, Calculation of normal tire forces; Driveline Dynamics- Adaptive cruise control, Benefits of Longitudinal Automation, Cruise Control and types; Anti-Lock Brake Systems and functions, Other logic based ABS control systems.						
UNIT III	ELECTRONIC STABILITY CONTROL				9	
Introduction-Functions, Types of stability control systems; Differential Braking Systems - Vehicle model, Control architecture and design; Steer By Wire Systems - Introduction and control design; Independent all-wheel drive torque distribution - Traditional four wheel drive systems						
UNIT IV	DESIGN AND ANALYSIS OF PASSIVE AND ACTIVE AUTOMOTIVE SUSPENSIONS				9	
Introduction to Automotive Suspensions - Modal Decoupling, Performance Variables for a Quarter Car Suspension, Analysis of Vibrations in the Sprung Mass Mode; Verification Using the Complete Quarter Car Mode, Half-Car and Full-Car Suspension Models; Active Control - Trade-Offs and Limitations, Active System Asymptotes, Analysis of Trade-Offs Using Invariant Points, Hydraulic Actuators for Active Suspensions.						
UNIT V	DYNAMICS AND CONTROL OF HYBRID GAS ELECTRIC VEHICLES				9	
Types of Hybrid Powertrains - Powertrain Dynamic Model and Simulation types, Background on Control Design Techniques for Energy Management; Driving Cycles - Performance Index, Constraints and System Model Details for Control Design and Parallel Hybrid Vehicle.						
					TOTAL PERIODS	45
COURSE OUTCOMES						
At the end of this course, students will be able to					BT Mapped (Highest Level)	
CO1	comprehend the principles underlying lateral dynamics.				Remember (K1)	

CO2	analyze the longitudinal dynamics and control mechanisms in automobiles.	Understand (K2)
CO3	provide knowledge on electronic stability control systems.	Apply (K3)
CO4	comprehend the design principles of automotive suspension systems.	Apply (K3)
CO5	gain an understanding of the fundamentals of dynamics and control in hybrid gas-electric vehicles.	Analyze (K4)

TEXT BOOKS

1. Rajesh Rajamani, "Vehicle Dynamics and Control", 2nd edition, Springer, 2021.
2. Singiresu S. Rao, "Mechanical Vibrations", 8th Edition, Prentice Hall, 2018.

REFERENCES

1. Wong. J. Y., "Theory of Ground Vehicles", 5th Edition, Wiley-Interscience, 2022.
2. Thomas D. Gillespie, "Fundamentals of Vehicle Dynamics", Society of Automotive Engineers Inc., 2021.
3. N.K. Giri, "Automotive Mechanics", Kanna Publishers, 2007.
4. J. Y. Woung - John Willey & Sons "Theory of Ground Vehicles ", Prentice Hall ,5th Edition, 2022.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	-	-	2	-	-	-	-	-	-	2	3	2
CO2	3	3	2	-	3	-	-	-	-	-	-	2	3	2
CO3	3	3	3	2	3	-	-	-	-	-	-	2	3	3
CO4	3	2	3	2	2	-	-	-	-	-	-	2	3	2
CO5	3	3	3	2	3	2	2	-	-	-	-	2	3	3



MT23156	BATTERY MANAGEMENT SYSTEM	3	0	0	3	
COURSE OBJECTIVES						
To enable the students to						
1	understand the working principles of battery cells and material choices.					
2	learn the conservation laws (charge and mass) to solid-phase battery modelling.					
3	understand the charge and mass conservation laws across solid and electrolyte phases.					
4	learn the model dynamic battery systems using state-space representations.					
5	know the thermal modeling techniques to optimize battery performance and safety in BMS.					
UNIT I	BATTERY BOOT CAMP				9	
Preliminaries; How Cells Work; Materials Choice; Insertion Electrode Cells - Lithium Ion Cell Preview, Manufacturing, Failure Modes; Equivalent - Circuit Models, Open Circuit Voltage (OCV), State of Charge Dependence, Equivalent Series Resistance, Diffusion Voltages, Rough Parameter Values, Warburg Impedance, Hysteresis Voltages.						
UNIT II	MICROSCALE CELL MODELS				9	
Charge Conservation in the Solid; Mass Conservation in the Solid; Thermodynamics; Physical Chemistry - Basic Characteristics of Binary Electrolytes; Electrolyte Mass Conservation; Electrolyte Charge Conservation; Butler; Volmer Equation; Implementing the Model; Cell-Level Quantities.						
UNIT III	CONTINUUM-SCALE CELL MODELS				9	
The Continuum-Scale Cell Model - Preliminaries, Volume Averaging Theorem 1, Volume-Averaging Theorem 2, Volume Averaging Theorem 3; Charge Conservation in the Solid - Mass Conservation in the Solid, Mass Conservation in the Electrolyte; Charge Conservation in the Electrolyte; Lithium Movement Between the Solid and Electrolyte Phases.						
UNIT IV	STATE-SPACE MODELS AND THE DISCRETE-TIME REALIZATION ALGORITHM				9	
A Quick Introduction to State-Space Models; Equations Describing the Solid Dynamics; State-Space Realization; Discrete Time Realization Algorithm (Dra); Step-By-Step Examples of the Dra; Eigen System Realization Algorithm (Era).						
UNIT V	THERMAL MODELING				9	
Preliminary Definitions; Microscale Thermal Model; Continuum Thermal Model; Parameter Temperature Variation; Reduced-Order Model; Gradient Transfer Functions - Heat Generation Terms, Heat Flux Terms; Uncoupled Model Results; Coupled Model Results.						
					TOTAL PERIODS	45
COURSE OUTCOMES						
At the end of this course, students will be able to					BT Mapped (Highest Level)	
CO1	gain a strong foundation in the principles of electrochemistry and how batteries work.				Understand (K2)	

CO2	design, analyse, and apply micro scale cell models.	Analyze (K4)
CO3	design and simulate continuum-scale models to predict battery behaviour under various operating conditions.	Apply (K3)
CO4	implement and use discrete-time realization algorithms for battery model discretization.	Apply (K3)
CO5	design effective thermal management systems for batteries in various applications.	Analyze (K4)

TEXT BOOKS

1. Bergveld, H.J., Kruijt, W.S., Notten, "Battery Management Systems Design by Modelling", Philips Research Book Series, New York, 2008.
2. C.C Chan, K.T Chau, "Modern Electric Vehicle Technology", Oxford University Press Inc., New York, 2001.

REFERENCES

1. Iqbal Hussein, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press, 2003.
2. Davide Andrea, "Battery Management Systems for Large Lithium Ion Battery Packs" ARTECH House, 2010.
3. Minami, T., Tatsumisago, M., Wakihara, M., Iwakura, C., Kohijiya, S., "Solid state ionics for batteries", Springer Publication, New York, 2009.
4. Jiuchun Jiang and Caiping Zhang, "Fundamentals and applications of Lithium Ion batteries in Electric Drive Vehicles", Wiley, 2015.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	-	-	-	-	-	-	-	-	-	2	2	2
CO2	3	3	2	2	2	-	-	-	-	-	-	2	3	2
CO3	3	3	3	3	2	-	-	-	-	-	-	2	3	3
CO4	3	2	3	2	3	-	-	-	-	-	-	2	3	3
CO5	3	3	3	3	2	2	2	-	-	-	-	2	3	3



MT23157	SMART MOBILITY AND INTELLIGENT VEHICLES	3	0	0	3	
COURSE OBJECTIVES						
To enable the students to						
1	introduce students to the various technologies and systems used to implement smart mobility and intelligent vehicles.					
2	learn the basics of radar technology and systems, ultrasonic sonar systems, LIDAR sensor technology and systems and other sensors for automobile vision system.					
3	learn basic control system theory applied to autonomous automobiles.					
4	produce overall impact of automating like various driving functions, connecting the automobile to sources of information that assist with a task.					
5	allow the automobile to make autonomous intelligent decisions concerning future actions of the vehicle that potentially impact the safety of the occupants through connected car & autonomous vehicle technology.					
UNIT I	INTRODUCTION TO AUTOMATED, CONNECTED, AND INTELLIGENT VEHICLES				9	
Concept of Automotive Electronics, Electronics Overview, History & Evolution, Infotainment, Body, Chassis, and Power train Electronics, Introduction to Automated, Connected, and Intelligent Vehicles. Case studies: Automated, Connected, and Intelligent Vehicles.						
UNIT II	SENSOR TECHNOLOGY FOR SMART MOBILITY				9	
Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, Lidar Sensor Technology and Systems, Camera Technology, Night Vision Technology, Other Sensors, Use of Sensor Data Fusion, Integration of Sensor Data to On-Board Control Systems.						
UNIT III	CONNECTED AUTONOMOUS VEHICLE				9	
Basic Control System Theory applied to Automobiles, Overview of the Operation of ECUs, Basic Cyber-Physical System Theory and Autonomous Vehicles, Role of Surroundings Sensing Systems and Autonomy, Role of Wireless Data Networks and Autonomy.						
UNIT IV	VEHICLE WIRELESS TECHNOLOGY & NETWORKING				9	
Wireless System Block Diagram and Overview of Components, Transmission Systems - Modulation and Encoding, Receiver System Concepts - Demodulation and Decoding, Wireless Networking and Applications to Vehicle Autonomy, Basics of Computer Networking - the Internet of Things, Wireless Networking Fundamentals, Integration of Wireless Networking and On-Board Vehicle Networks.						
UNIT V	CONNECTED CAR & AUTONOMOUS VEHICLE TECHNOLOGY				9	
Connectivity Fundamentals, Navigation and Other Applications, Vehicle-to-Vehicle Technology and Applications, Vehicle-to-Roadside and Vehicle-to-Infrastructure Applications, Autonomous Vehicles - Driverless Car Technology, Moral, Legal, Roadblock Issues, Technical Issues, Security Issues.						
					TOTAL PERIODS	45
COURSE OUTCOMES						
At the end of this course, students will be able to					BT Mapped (Highest Level)	
CO1	recognize the concept of cyber-physical control systems and their application to collision avoidance and autonomous vehicles.				Understand (K2)	

CO2	apply the concept of remote sensing and the types of sensor technology needed to implement remote sensing.	Apply (K3)
CO3	analyze the fully autonomous vehicles.	Analyse (K4)
CO4	apply the basic concepts of wireless communications and wireless data networks.	Apply (K3)
CO5	analyze the concept of the connected vehicle and its role in automated vehicles.	Analyse (K4)

TEXT BOOKS

1. Amir Taghavi pour, Mahyar Vajedi, Nasser L. Azad, "Intelligent Control of Connected Plug-in Hybrid Electric Vehicles", Springer Nature Switzerland AG, 2019.
2. Radovan Miucic, "Connected Vehicles: Intelligent Transportation Systems", Springer, 2019.

REFERENCES

1. Tom Denton, "Automobile Electrical and Electronic systems, Roulte edge", Taylor & Francis Group, 5th Edition, 2018.
2. T. Poongodi, & Balamurugan Balusamy, "Smart Mobility and Intelligent Transportation Systems for Commercial and Hazardous Vehicles", Naga Swetha Pasupuleti, 2021.
3. Petros Ioannou & Andreas A. Malikopoulos, "Transportation Mobility in Smart Cities, 2018.
4. Bob McQueen & Ammar Safi, "Smart Mobility using technology to improve transportation in smart cities", Kindle Edition, 2020.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	-	-	2	2	-	2	-	-	-	2	3	2
CO2	3	3	2	2	3	-	-	-	-	-	-	2	3	2
CO3	3	3	2	2	3	2	2	2	-	-	-	2	3	3
CO4	3	2	2	-	3	-	-	-	-	-	-	2	2	3
CO5	3	3	2	2	3	2	-	2	-	-	-	2	3	3



VERTICAL II – MANUFACTURING

MT23251	COMPUTER AIDED INSPECTION AND TESTING	3	0	0	3	
COURSE OBJECTIVES						
To enable the students to						
1	acquire the knowledge of metrology.					
2	impart knowledge on laser interferometer and recent advancements in metrology.					
3	understand the concept flow and temperature measurements.					
4	know the concept of Nano impact in metrology.					
5	utilize the advances in measurements for quality control in manufacturing industries.					
UNIT I	BASIC PRINCIPLES OF ENGINEERING METROLOGY				9	
Standards of Measurement - Analog and Digital Measuring Instruments; Comparators; Limits, Fits and Tolerances; Gauge Design - Surface Roughness, Form Errors and Measurements; Linear and angular measurements.						
UNIT II	OPTICAL METROLOGY				9	
Laser Metrology - LASER interferometer, Constructional features, Sources of error, Measurement of positional error, Straightness and flatness of machine tools; LASER Alignment Telescope; LASER Micrometer; LASER Triangulation technique - In process and on line measurement; White light interferometer.						
UNIT III	MEASUREMENTS OF FLOW, POWER AND TEMPERATURE				9	
Principles and analysis of measurement systems used for measurement of flow, Power, Pressure and Method of measuring temperature and applications.						
UNIT IV	NANO IMPACT ON METROLOGY				9	
Introduction - Nanotechnology, Importance of Nano dimension, Classification of Nanostructures, Applications, Importance of Nano metrology; Introduction to Microscopy - Transmission Electron Microscope, Scanning Electron Microscope, Scanning Tunneling Microscope, Atomic Force Microscope, X-Ray Diffraction System, Principles of XRD, Bragg Law, Two dimensional XRD System, Applications of XRD.						
UNIT V	QUALITY CONTROL AND ISO STANDARDS				9	
Introduction - Inspection , Gauge Control, Quality Control and Quality Assurance; Statistical Quality Control - Process Variability, Importance of Sampling, Statistical Quality Control by Attributes and Variables; Total Quality Management Continuous Improvement, Employee Empowerment, Use of Quality Tools; Product Design - Process Management, Managing Supplier Quality; Six Sigma - Six Sigma Approach, Quality Management Principles of ISO 9000, Implementation of ISO Standards.						
					TOTAL PERIODS	45
COURSE OUTCOMES						
At the end of this course, students will be able to					BT Mapped (Highest Level)	
CO1	gain knowledge and understanding of metrology principles and practices.				Remember (K1)	

CO2	provide knowledge on laser interferometry and recent advancements in metrology	Understand (K2)
CO3	comprehend the methodologies and technologies used in flow and temperature measurements	Apply (K3)
CO4	explore the influence of nanotechnology on modern metrology practices	Apply (K3)
CO5	implement advanced measurement methods for effective quality management in manufacturing industries	Analyze (K4)

TEXT BOOKS

1. Raghavendra N.V and Krishnamurthy.L, "Engineering Metrology and Measurements", Oxford University press published in india, 2017.
2. Jain R.K. "Engineering Metrology", Khanna Publishers, 2019.

REFERENCES

1. Gupta. I.C., "Engineering Metrology", Dhanpatrai Publications, 2005.
2. H.Doeblin.E.O, "Measurement System Applications and Designl", Tata McGraw Hill Publishing Company, New Delhi, 2008.
3. Connie Dotson, "Fundamentals of Dimensional Metrology", Thomas Asia, Singapore, 2006.
4. Groover M.P, "Automation, Production System and Computer Integrated Manufacturing", Prentice Hall, New Delhi, 2007.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	-	-	2	-	-	-	-	-	-	2	3	2
CO2	3	2	-	2	3	-	-	-	-	-	-	2	3	2
CO3	3	3	2	2	3	-	-	-	-	-	-	2	2	3
CO4	3	2	2	2	3	-	2	-	-	-	-	2	3	3
CO5	3	3	3	3	3	-	2	2	2	2	2	3	3	3



MT23252	CNC TECHNOLOGY AND PROGRAMMING	3	0	0	3	
COURSE OBJECTIVES						
To enable the students to						
1	know the fundamental concepts, types, and specifications of CNC systems.					
2	understand the structural components and mechanical elements of CNC machines.					
3	familiarize with the spindle and feed drive systems used in CNC machines.					
4	learn the syntax, logic, and structure of CNC part programming for turning and milling operations.					
5	understand the various CNC tooling systems, tool materials, and tool handling mechanisms.					
UNIT I	CNC SYSTEMS	9				
Introduction to NC, CNC, DNC; Principles, Specification and Features of CNC Systems; Machining Centers - Horizontal Machining Centre, Vertical Machining Centre; Factors influencing the selection of CNC machines; Practical aspects of introducing CNC machines in manufacturing industry; Safety aspects of CNC machines.						
UNIT II	STRUCTURE AND ELEMENTS OF CNC SYSTEM	9				
Machine physical architecture - Structural details, loads on CNC machine; Guide ways - Friction guide ways, Antifriction guide ways; Elements for rotary to linear motion - Recirculating ball screw, Rack and pinion; Torque transmission elements - Gears, Timing belt; Hydraulic and pneumatic systems in CNC.						
UNIT III	DRIVES AND CONTROL	9				
Spindle drive - Three phase induction motor - Construction, Characteristics, Speed control methods; Feed drive - AC Servo motor, Construction, Characteristics; Open and Closed loop position control; Feedback devices - Rotary encoder, linear encoder, proximity sensor, resolver.						
UNIT IV	CNC PROGRAMMING	9				
Structure of Part Program; Manual Part programming terminology - Preparatory, Miscellaneous, Interpolation functions, Fixed cycle and canned cycle for turning and milling operations; Programming of CNC Machining Centers; Procedure in CNC Program using CAM Software.						
UNIT V	TOOLING FOR CNC MACHINES	9				
Cutting tool materials - Carbides, Ceramics, Cubic Boron Nitride, Polycrystalline; Interchangeable tooling system - Preset and qualified tools, Coolant fed tooling system, Automatic head changers; Tooling requirements for Turning and Machining centers - Tool magazines, Automatic tool changer, Automatic pallet changer.						
					TOTAL PERIODS	45
COURSE OUTCOMES						
At the end of this course, students will be able to					BT Mapped (Highest Level)	
CO1	explain the principles, types, and selection criteria of CNC systems.				Understand (K2)	
CO2	describe the mechanical structure, motion elements, and support systems used in CNC machines.				Understand (K2)	

CO3	apply the drive systems and the role of feedback and control mechanisms in CNC motion accuracy.	Apply (K3)
CO4	develop manual CNC part programs for the machining operations.	Apply (K3)
CO5	analyze the tool handling systems for CNC machining centres.	Analyze (K4)

TEXT BOOKS

1. P. Radhakrishnan, "Computer Numerical Control Machines and Computer Aided Manufacture", New Age International Pvt Ltd, 2018.
2. Mahesh Dhotre, "CNC Machine Tool Technology", Sai Tech publication, 5th edition, 2018.

REFERENCES

1. E. Zimmer, M. Groover, "CAD/CAM Computer Aided Design and Manufacturing", Pearson Publications, 2017.
2. M. Adithan and B. S. Pabla, "CNC Machines", 3rd edition, New Age International Publishers, 2021.
3. Ahmad E Eladawi, "Computerized Numerical Control (CNC) Technology", LAP Lambert Academic Publishing, 2020.
4. Tilak Raj, "CNC Technology & Programming", Reprint, Dhanpat Rai Publishing Company (P) Ltd., New Delhi, 2015.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	1	-	2	-	-	-	-	-	-	1	2	1
CO2	3	2	1	-	2	-	-	-	-	-	-	1	3	1
CO3	3	3	2	2	3	-	-	-	-	-	-	1	3	2
CO4	2	2	3	-	3	-	-	-	-	1	-	2	2	3
CO5	2	2	2	-	3	-	-	-	-	1	-	1	3	2



MT23253	DESIGN FOR MANUFACTURING	3	0	0	3
COURSE OBJECTIVES					
To enable the students to					
1	introduce the development and design of products for various engineering applications.				
2	learn the design consideration principles of forming in the design of extruded, stamped, and forged products.				
3	learn design considerations specific to machined and cast components.				
4	study manufacturing methods for plastic, composite, and non-metal parts.				
5	know DFA principles for reducing cost, improving quality, and simplifying assembly.				
UNIT I	INTRODUCTION				9
General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, Process capability; Feature tolerances - Geometric Tolerances - Assembly limits - Datum features - Tolerance stacks - Quick References; The History of DFM, Managing DFM - Evaluating Design Proposals.					
UNIT II	FACTORS INFLUENCING FORM DESIGN				9
Working principle, Material, Manufacture Design - Possible solutions; Materials choice - Influence of materials on form design - form design of welded members, forgings and castings; Ferrous Metals. Nonferrous Metals, Nonmetallic Materials.					
UNIT III	MACHINED COMPONENTS				9
Designing for Machining; General Guidelines - Parts Cut to Length, Screw Machine Products, Other Turned Parts; Machined Round Holes, Parts Produced on Milling Machines, Parts Produced by Planning, Shaping, and Slotting-Screw Threads, Broached Parts, Contour-Sawed Parts, Flame-Cut Parts, Internally Ground Parts-Parts Cylindrically Ground on Center-Type Machines, Center less-Ground Parts, Flat-Ground Surfaces-Honed, Lapped, and Super finished Parts, Roller-Burnished Parts.					
UNIT IV	CASTING CONSIDERATION				9
Castings Made in Sand Moulds; Other Castings-Investment Castings, Die Castings; Thermosetting-Plastic Parts, Injection - Moulded Thermoplastic Parts, Structural-Foam-Molded Parts, Rotationally Molded Plastic Parts, Blow-Molded Plastic Parts-Reinforced-Plastic/Composite (RP/C) Parts, Plastic Profile Extrusions; Thermoformed-Plastic Parts-Welded Plastic Assemblies-Rubber Parts-Ceramic and Glass Parts, Plastic-Part Decorations.					
UNIT V	DESIGN FOR ASSEMBLY				9
Design for Assembly (DFA) - Arc Weldments and Other Weldments, Resistance Weldments; Soldered and Brazed Assemblies, Adhesively Bonded Assemblies - Designing for Cleaning, Polished and Plated Surfaces - Other Metallic Coatings; Designing for Heat Transfer - Organic Finishes - Designing for Marking - Shot Peened Surfaces - DFA and Cost Estimation.					
TOTAL PERIODS					45

COURSE OUTCOMES		
At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	elaborate the design principles for manufacturability.	Understand (K2)
CO2	discuss the factors influencing in form design.	Understand (K2)
CO3	apply the component design features of various machine.	Apply (K3)
CO4	design consideration principles of welding in the design of welded products.	Analyze (K4)
CO5	design consideration principles of additive manufacturing.	Analyze (K4)

TEXT BOOKS

1. James G. Bralla, "Design for Manufacturability Handbook", McGraw Hill Professional, 2021.
2. O. Molloy, E.A. Warman, S. Tilley, Design for Manufacturing and Assembly: Concepts, Architectures and Implementation, Springer, 2011.

REFERENCES

1. Coraopolis, Design for Manufacturing: A Structured Approach, Elsevier, 2001.
2. David M. Anderson, Design for Manufacturability & Concurrent Engineering, Design for Lean Manufacture, and Design Quickly for Fast Production, CIM Press, 2004.
3. Erik Tempelman, Hugh Shercliff, Bruno Ninaber van Eyben, Manufacturing and Design: Understanding the Principles of How Things Are Made, Elsevier, 2014.
4. Graedel T. Allen By. B, Design for the Environment Angle Wood Cliff, Prentice Hall Reason Publications, 2006.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	1	2	-	3	-	-	-	-	-	-	1	3	2
CO2	3	2	2	-	2	-	-	-	-	-	-	2	3	2
CO3	3	2	3	1	3	-	-	-	-	-	1	2	3	3
CO4	3	3	3	2	3	-	-	-	-	-	2	2	3	3
CO5	2	2	3	2	3	-	-	-	1	1	2	2	3	3



MT23254	DIGITAL MANUFACTURING	3	0	0	3
COURSE OBJECTIVES					
To enable the students to					
1	introduce the evolution, definition, features, and research methods of digital manufacturing science.				
2	understand modeling theories, virtual prototyping, reverse engineering, and computing models in digital manufacturing.				
3	explore the structure and functioning of manufacturing information systems and their integration mechanisms.				
4	learn about intelligent control systems in digital manufacturing and various intelligent manufacturing paradigms.				
5	study future advancements in digital manufacturing including MNEMS and technologies for extreme environments.				
UNIT I	INTRODUCTION TO DIGITAL MANUFACTURING				9
Development Course of Manufacturing and Manufacturing Science - Manufacturing as Craft and Technique, Manufacturing Becoming a Science; Concepts and Research and Development Status of Digital Manufacturing - Definition of Digital Manufacturing, Features and Development of Digital Manufacturing; Connotation and Research Method of Digital Manufacturing Science - Basic Concept and Connotation of Digital Manufacturing Science, Research Method of Digital Manufacturing Science.					
UNIT II	MODELLING IN DIGITAL MANUFACTURING				9
Modelling Theory and Method of Digital Manufacturing Science - Modelling Theory of Digital Manufacturing Science, Critical Modelling Theories and Technologies in Digital Manufacturing Science; C Space and Screw Space; Virtual Prototyping - Basic Theory and Applications of Virtual Prototyping; Basic Theory and Application of Reverse Engineering; Discrete Model of Manufacturing Computing; Information Model of Manufacturing Computing.					
UNIT III	MANUFACTURING INFORMATION SYSTEM				9
Information Characteristics of Manufacturing; Information Activities and Manufacturing Informatics; Measurement of Manufacturing Information; Mechanism of Synthesizing Manufacturing Information; Materialization of Manufacturing Information; Integration and Block Diagram Model for Manufacturing Information; Principle and Mechanism of Sharing Manufacturing Resources.					
UNIT IV	INTELLIGENT CONTROL IN MANUFACTURING				9
Introduction to Intelligent Control in Digital Manufacturing; Intelligent Multi Information Sensing; Intelligent Multi Information Fusing; Intelligent Manufacturing System – The Concepts and Features of Intelligent Manufacturing, Multi-Agent Manufacturing System, Holonic Manufacturing System.					
UNIT V	FUTURE DEVELOPMENTS				9
Digital Equipment; Digital Processing Technology; Basic Concept of MNEMS in Digital Manufacturing; Micro Nano - Equipment and Systems; Digital Manufacturing Technology in Micro Nano Manufacturing; Externalization of Digital Manufacturing - Complex Mechanical and Electrical System Modelling, Technology of Electrical and Mechanical Systems in Extreme Environments.					
TOTAL PERIODS					45

COURSE OUTCOMES		
At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	explain the fundamentals, features, and research methods related to digital manufacturing.	Understand (K2)
CO2	interpret and apply modeling techniques including virtual prototyping and reverse engineering in digital environments.	Apply (K3)
CO3	analyze the structure and operation of manufacturing information systems and their role in resource sharing.	Analyze (K4)
CO4	apply intelligent control concepts and evaluate intelligent sensing, fusion, and system frameworks.	Apply (K3)
CO5	identify and understand future trends such as MNEMS and technologies for extreme digital manufacturing environments.	Analyze (K4)

TEXT BOOKS

1. Zudezhou, Shanexie, Dejunchen, "Fundamentals of Digital Manufacturing Science", Springer, 2012.
2. Rene Wolf, Raffaello Lepratti, "Smart Digital Manufacturing: A Guide for Digital Transformation with Real Case Studies Across Industries", Wiley-VCH, 2020.

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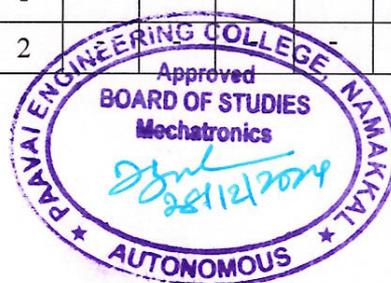
1. Kaushik Kumar, Divya Zindani, "Digital Manufacturing and Assembly Systems in Industry 4.0", CRC Press, 2021.
2. Agrawal Agrawal, Arijit Mitra, "SAP S/4HANA Supply Chain Planning and Manufacturing: Explore digital transformation using SAP IBP and SAP S/4HANA", BPB Publications, 2023.
3. Zhuming Bi, "Practical Guide to Digital Manufacturing: First-Time-Right for Design of Products, Machines, Processes and System Integration", Springer, 2021.
4. Vytautas Ostaševičius, "Digital Twins in Manufacturing: Virtual and Physical Twins for Advanced Manufacturing", Springer Nature Switzerland AG, 2022.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	-	2	-	-	-	-	-	-	-	3	2	2
CO2	3	-	3	-	3	-	-	-	-	-	-	-	3	3
CO3	-	3	3	-	3	-	-	-	-	-	-	-	3	3
CO4	3	-	3	-	3	-	-	-	-	-	-	3	3	3
CO5	3	3	-	-	3	-	2					3	3	3



MT23255	ADVANCED MANUFACTURING TECHNOLOGY	3	0	0	3	
COURSE OBJECTIVES						
To enable the students to						
1	impart the fundamental concepts in powder metallurgy.					
2	familiarize in various non-traditional machining processes and advanced inspection systems.					
3	introduce the surface treatments, coating and cleaning etc.					
4	know the advanced machining process technique.					
5	learn about the various quality assurance, testing and inspection.					
UNIT I	POWDER METAL PROCESS AND EQUIPMENT				9	
Introduction to Production of Metal Powders - Compaction of metal powders, Sintering, Secondary and finishing Operations, Design Considerations, Economics of Powder Metallurgy.						
UNIT II	NON TRADITIONAL MAHINING PROCESS				9	
Nonconventional machining processes - Comparison between traditional and nontraditional machining process, Abrasive Jet Machining, Ultrasonic micro machining, Abrasive water jet micro machining, Abrasive flow finishing, Chemo mechanical polishing, Electrochemical Machining, chemical and photochemical micro machining.						
UNIT III	SURFACE TREATMENTS, COATING AND CLEANING				9	
Introduction to Mechanical Surface Treatments - Mechanical Plating and Cladding, Case Hardening and Hard Facing, Thermal Spraying, Vapor Deposition, Ion Implementation and Diffusion Coating; Laser Treatments - Electroplating, Electro Less Plating and Electroforming; Conversion Coatings - Hot Dipping, Ceramic and Organic Coatings, Diamond Coating and Diamond Like Carbon; Surface Texturing - Painting, Cleaning of Surfaces.						
UNIT IV	ADVANCED MACHINING PROCESSES				9	
Introduction to Chemical Machining - Electrochemical Machining, Electrochemical Grinding; Electrical Discharge Machining - Laser Beam Machining, Electron Beam Machining, Water Jet Machining, Abrasive Jet Machining, Hybrid Machining Systems; Economics of Advanced Machining Processes.						
UNIT V	QUALITY ASSURANCE, TESTING AND INSPECTION				9	
Introduction to Product Quality - Quality Assurance, Total Quality Management, ISO and QS Standards; Statistical Methods of Quality Control - Statistical Process Control, Reliability of Products and Processes; Nondestructive Testing - Destructive Testing, Automated Inspection.						
					TOTAL PERIODS	45
COURSE OUTCOMES						
At the end of this course, students will be able to					BT Mapped (Highest Level)	
CO1	understand the need of powder metallurgy and the steps involved in				Understand (K2)	

	manufacturing a powder metallurgy component.													
CO2	apply the knowledge on various energy based non-traditional machining processes and suggest a suitable process based on the situations												Apply (K3)	
CO3	develop skills to generate surface treatments, coating and cleaning.												Analyze (K4)	
CO4	apply advanced machining process technique.												Apply (K3)	
CO5	analyze the various quality assurance, testing and inspection.												Analyze (K4)	
TEXT BOOKS														
1. Serope Kalpakjian and Steven Schmid, "Manufacturing Engineering and Technology", Pearson Education, 7th edition, 2014.														
2. Sharma.P.C, "A textbook of Production Technology", Vol I and II, S. Chand and Company Ltd., New Delhi, 2011.														
REFERENCES														
1. Serope Kalpakjian and Steven Schmid, "Manufacturing Engineering and Technology", 8th Edition, Pearson, 2020.														
2. Ibrahim Zeid and R Sivasubramanian, "CAD/CAM Theory and Practice", Tata McGraw Hill, 2010.														
3. Benedict. G.F., "Non-Traditional Manufacturing Processes", Marcel Dekker Inc., New York, 2007.														
4. Jagadeesha.T, "Non-Traditional Machining Processes", I K International Publishing, 2011.														
CO-PO MAPPING:														
Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's														
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	1	2	-	3	-	-	-	-	-	-	1	3	2
CO2	3	2	2	-	2	-	-	-	-	-	-	2	3	2
CO3	3	2	3	1	3	-	-	-	-	-	1	2	3	3
CO4	3	3	3	2	3	-	-	-	-	-	2	2	3	3
CO5	2	2	3	2	3	-	-	-	1	1	2	2	3	3



MT23256	ADDITIVE MANUFACTURING TECHNOLOGIES	3	0	0	3	
COURSE OBJECTIVES						
To enable the students to						
1	understand the need, history, growth and classification of additive manufacturing.					
2	learn the design process for additive manufacturing.					
3	know the principle, process parameters, and applications of SLA, SLS and EBM.					
4	learn the principle, process parameters, applications of FDM and LOM.					
5	understand the principle, process parameters, and applications of Three- Dimensional Printing.					
UNIT I	INTRODUCTION TO ADDITIVE MANUFACTURING				9	
Introduction to AM - AM evolution, Distinction between AM and CNC machining; Steps in AM, Classification of AM processes, Advantages of AM; Types of materials for AM.						
UNIT II	DESIGN FOR ADDITIVE MANUFACTURING				9	
Concepts and Objectives - AM Unique Capabilities; Part Consolidation - Topology Optimization, Lightweight Structure, DFAM for Part Quality Improvement; Data Processing - CAD Model Preparation, Part Orientation and Support Structure Generation, Model Slicing, Tool Path Generation; Customized Design and Fabrication for Medical Applications.						
UNIT III	PHOTO POLYMERIZATION AND POWDER BED FUSION PROCESSES				9	
Photo polymerization - SLA, Photo curable materials, Process, Advantages and Applications; Powder Bed Fusion- SLS, Process description, Powder fusion mechanism, Process Parameters, Typical Materials and Application; Selective Laser Melting (SLM) and Electron Beam Melting (EBM) - Materials, Process, Advantages and Applications.						
UNIT IV	EXTRUSION BASED AND SHEET LAMINATION PROCESSES				9	
Extrusion Based System - FDM, Introduction, Basic Principle, Materials, Applications and Limitations; Bio extrusion; Sheet Lamination Process - LOM, Gluing or Adhesive bonding, Thermal bonding, Materials, Application and Limitation.						
UNIT V	PRINTING PROCESSES AND BEAM DEPOSITION PROCESSES				9	
Droplet formation technologies - Continuous mode, Drop on Demand mode; Three-Dimensional Printing, Advantages - Bio plotter; Beam Deposition Process - LENS, Direct Metal Deposition (DMD), Electron Beam Based Metal Deposition - Process description, Material delivery, Process parameters, Materials, Benefits, Applications - Cost Components in Printing Processes.						
					TOTAL PERIODS	45
COURSE OUTCOMES						
At the end of this course, students will be able to					BT Mapped (Highest Level)	
CO1	explain the principles of printing and beam deposition in additive manufacturing.				Understand (K2)	
CO2	identify suitable materials and processes for each technique				Understand (K2)	
CO3	analyze key parameters affecting quality and performance				Analyze (K4)	

CO4	compare advantages, limitations, and applications of each method.	Understand (K2)												
CO5	analyze real-world use cases in industries like aerospace and healthcare.	Analyze (K4)												
TEXT BOOKS														
1. Ian Gibson, David Rosen, Brent Stucker, Mahyar Khorasani “Additive Manufacturing Technologies”. 3rd edition Springer Cham, Switzerland, 2021.														
2. Andreas Gebhardt and Jan-Steffen Hötter “Additive Manufacturing: 3D Printing for Prototyping and Manufacturing”, Hanser publications, United States, 2015.														
REFERENCES														
1. Andreas Gebhardt, “Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing”, Hanser Gardner Publication, Cincinnati., Ohio, 2011.														
2. Milan Brandt, “Laser Additive Manufacturing: Materials, Design, Technologies, and Applications”, Woodhead Publishing., United Kingdom, 2016.														
3. Amit Bandyopadhyay and Susmita Bose, “Additive Manufacturing”, 1st Edition, CRC Press., United States, 2015.														
4. Kamrani A.K. and Nasr E.A., “Rapid Prototyping: Theory and practice”, Springer., United States, 2006.														
CO-PO MAPPING:														
Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	1	1	3	1	1	-	-	2	-	2	3	2
CO2	3	2	2	1	3	-	2	-	-	1	-	2	3	2
CO3	3	3	2	3	3	-	2	-	-	2	-	2	3	2
CO4	3	2	2	2	2	2	3	-	-	2	-	2	3	2
CO5	3	3	3	3	2	3	3	1	1	3	2	3	3	2



MT23257	INTRODUCTION TO FINITE ELEMENT ANALYSIS	3	0	0	3
COURSE OBJECTIVES					
To enable the students to					
1	acquire the basic concepts of finite element analysis.				
2	impart knowledge on one dimensional finite element analysis.				
3	understand the concept of two dimensional finite element analysis.				
4	know the concept of isoparametric elements in two dimensional problems				
5	learn about basics of beams and frames, trusses.				
UNIT I	INTRODUCTION				9
Introduction-Stress and equilibrium, Boundary conditions, Stress and Strain relationship; Rayleigh-Ritz method; Galerkin's method, Saint venant's Principle, Von Mises stress; Matrix Algebra; Gaussian Elimination, Conjugate Gradient Method.					
UNIT II	ONE DIMENSIONAL FINITE ELEMENTS ANALYSIS				9
Introduction - Finite element modelling, Coordinate and shape functions, Potential energy approach, Galerkin approach, Assembly of the global stiffness matrix and load vector, Finite element equations and boundary conditions, Quadratic shape function and temperature effect.					
UNIT III	TWO DIMENSIONAL FINITE ELEMENT ANALYSIS				9
Introduction - Finite element modelling, Constant strain triangle, Problem modelling and boundary condition, Orthotropic materials and temperature effect.					
UNIT IV	ISOPARAMETRIC ELEMENTS IN TWO DIMENSIONAL PROBLEMS				9
Introduction - Four node quadrilateral, Shape function, element force vector; Numerical integration - Two dimension integral and stiffness integration; Higher order elements - Four node quadrilateral for axisymmetric problems; Conjugate Grade Implementation; Axis symmetric formulation and finite element modelling for triangle element.					
UNIT V	TRUSSES BEAMS AND FRAMES				9
Introduction - Plane trusses, Three dimensional trusses and assemble of global stiffness matrix; Beam introduction - Potential and Galerkin approach, Load vector, Boundary condition; Plane frame and three dimensional frame.					
				TOTAL PERIODS	45
COURSE OUTCOMES					
At the end of this course, students will be able to				BT Mapped (Highest Level)	
CO1	gain foundational knowledge and understanding of finite element analysis concepts.			Remember (K1)	
CO2	provide knowledge on one-dimensional finite element analysis.			Understand (K2)	
CO3	comprehend the principles of two-dimensional finite element analysis.			Apply (K3)	

CO4	develop an understanding of the fundamentals of isometric elements in two dimension.	Apply (K3)												
CO5	calculate the fundamentals of trusses, beams and frames using finite elements methods.	Analyze (K4)												
TEXT BOOKS														
1. T. R. Chandrupatla and A. D. Belegundu, "Introduction to Finite Elements Engineering", Pearson Education, New Delhi, 2018.														
2. Daryl L. Logan, "First Course in the Finite Element Method", Cengage Learning, 2012.														
REFERENCES														
1. Singiresu S.Rao, "The Finite Element Methods in Engineering", Pearson Education, 2019.														
2. K.J. Bathe, "Finite Element Procedures", Klaus-Jurgen Bathe, 2011.														
3. P.Seshu, "Finite Element Analysis", 11 th edition PHI Learning Private limited. 2013.														
4. Reddy, JN., and Gartling DK., "The Finite Element Method in Heat Transfer and Fluid Dynamics", CRC Press; 3rd edition, 2010.														
CO-PO MAPPING:														
Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	-	-	-	-	-	-	-	-	-	1	2	2
CO2	3	3	-	-	2	-	-	-	-	-	-	1	2	2
CO3	3	3	2	2	3	-	-	-	-	-	-	2	2	2
CO4	3	2	2	2	3	-	-	-	-	-	-	2	2	2
CO5	3	3	3	2	3	-	-	-	1	1	1	2	2	2



VERTICAL III – ROBOTICS

MT23351	MOBILE ROBOTICS	3	0	0	3	
COURSE OBJECTIVES						
To enable the students to						
1	know the mobile robotic technology and its types in detail.					
2	learn the kinematics of wheeled and legged robot.					
3	familiarize the intelligence into the mobile robots using various sensors.					
4	know the localization strategies and mapping technique for mobile robot.					
5	aware the collaborative mobile robotics in task planning, navigation and intelligence.					
UNIT I	INTRODUCTION TO MOBILE ROBOTICS				9	
Introduction; Locomotion of the Robots - Key Issues on Locomotion; Legged Mobile Robots - Configurations and Stability; Wheeled Mobile Robots - Design Space and Mobility Issues; Unmanned Aerial and Underwater Vehicles.						
UNIT II	KINEMATICS				9	
Kinematic Models - Representation of Robot, Forward Kinematics; Wheel and Robot Constraints - Degree of Mobility and Steerability, Manoeuvrability, Workspace, Degrees of Freedom; Path and Trajectory Considerations - Motion Controls, Holonomic Robots.						
UNIT III	PERCEPTION				9	
Sensor for Mobile Robots - Classification and Performance Characterization, Wheel/Motor Sensors, Heading Sensors, Ground Based Beacons, Active Ranging, Motion/Speed Sensors; Camera - Visual Appearance based Feature Extraction.						
UNIT IV	LOCALIZATION				9	
Localization Based Navigation Versus Programmed Solutions - Map Representation, Continuous Representations, Decomposition Strategies; Probabilistic Map Based Localization; Landmark Based Navigation - Globally Unique Localization, Positioning Beacon Systems, Route Based Localization, Autonomous Map Building, Simultaneous Localization and Mapping (SLAM).						
UNIT V	PLANNING, NAVIGATION AND COLLABORATIVE ROBOTS				9	
Introduction; Competences for Navigation - Planning and Reacting; Path Planning - Obstacle Avoidance, Navigation Architectures, Control Localization, Techniques for Decomposition; Case studies - Collaborative Robots, Swarm Robots.						
					TOTAL PERIODS	45
COURSE OUTCOMES						
At the end of this course, students will be able to					BT Mapped (Highest Level)	
CO1	evaluate the appropriate mobile robots for the desired application.				Understand (K2)	
CO2	create the kinematics for given wheeled and legged robot.				Understand (K2)	
CO3	analyse the sensors for the intelligence of mobile robotics.				Analyze (K4)	

CO4	apply the localization strategies and mapping technique for mobile robot.	Apply (K3)
CO5	create the collaborative mobile robotics for planning, navigation and intelligence for desired applications.	Analyze (K4)

TEXT BOOKS

1. Roland Siegwart and Illah R.Nourbakish, "Introduction to Autonomous Mobile Robots", MIT Press, Cambridge, 2004.
2. Mohanta Jagadish Chandra, "Introduction to Mobile Robots Navigation", LAP Lambert Academic Publishing, 2015.

REFERENCES

1. Dragomir N. Nenchev, Atsushi Konno, Teppei Tsujita, "Humanoid Robots: Modelling and Control", Butterworth-Heinemann, 2018.
2. Peter Corke, "Robotics, Vision and Control", Springer, 2017.
3. Ulrich Nehmzow, "Mobile Robotics: A Practical Introduction", Springer, 2003.
4. Xiao Qi Chen, Y.Q. Chen and J.G. Chase, "Mobile Robots - State of the Art in Land, Sea, Air, and Collaborative Missions", Intec Press, 2009.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
 (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	2	2	1	2	-	-	-	-	1	-	2	2	1
CO2	3	2	2	2	2	-	-	-	-	-	-	2	2	2
CO3	3	3	2	2	3	-	-	-	-	-	-	2	3	2
CO4	3	2	2	2	2	-	-	-	-	-	-	2	3	2
CO5	3	3	3	2	3	-	-	-	2	2	1	2	3	3



MT23352	FUNDAMENTAL DESIGN OF ROBOT ELEMENTS	3	0	0	3	
COURSE OBJECTIVES						
To enable the students to						
1	know the machine members subjected to static and variable loads.					
2	understand the flexible elements like belts, ropes, and chain drives for engineering applications.					
3	know the shafts and threaded fasteners for various applications.					
4	understand the selection of bearings and robot grippers.					
5	understand the gears and gearbox for machine tools and applications.					
UNIT I	FUNDAMENTAL CONCEPTS IN DESIGN				9	
Introduction to Robots - factors influencing robot design, selection of materials based on mechanical properties - Modes of failure -Factor of safety – stresses due to bending and torsion moment - Eccentric loading, Design against fluctuating loads - theories of failures.						
UNIT II	DESIGN OF FLEXIBLE ELEMENTS AND BEARINGS				9	
Introduction to flexible elements, Design of belt drives – Flat, Vee, and Timing Belts, Design of chain drives - Sliding contact and rolling contact bearings - Hydrodynamic journal bearings, Somerfield Number, Raimondi & Boyd graphs - Selection of Rolling Contact bearings.						
UNIT III	DESIGN OF SHAFTS AND THREADED FASTENERS				9	
Shafts and Axles - Design of solid and hollow shafts based on strength, rigidity, and critical speed - Keys and splines, Threaded fasteners - Bolted joints – Simple and eccentrically loaded bolted joints.						
UNIT IV	DESIGN OF GEARS AND GEAR BOXES				9	
Design of Gears (Spur, Helical and Bevel) - Geometric progression - Standard step ratio - Ray diagram, kinematic layout - Design of sliding mesh gear box - Design of multi speed gear box for machine tool applications.						
UNIT V	DESIGN OF GEARS AND GEAR BOXES				9	
Design of Gears (Spur, Helical and Bevel) - Geometric progression - Standard step ratio - Ray diagram, kinematic layout - Design of sliding mesh gear box - Design of multi speed gear box for machine tool applications.						
					TOTAL PERIODS	45
COURSE OUTCOMES						
At the end of this course, students will be able to					BT Mapped (Highest Level)	
CO1	recognize various parameters for belt, ropes, shafts, fasteners and chain drives and other machine members.				Understand (K2)	
CO2	apply the belt, ropes, shafts, fasteners and chain drives and other machine members subjected to static and dynamic loads.				Apply (K3)	
CO3	apply the belt, ropes, shafts, fasteners and chain drives and other machine members for various applications.				Apply (K3)	

CO4	analyse the parameters for designing belt, ropes, shafts, fasteners and chain drives and other machine members in manufacturing a robot.	Analyse (K4)												
CO5	design the gears and its elements for various robot.	Analyse (K4)												
TEXT BOOKS														
1. Bhandari. V.B, "Design of Machine Elements", Tata McGraw-Hill Education, 5th edition, 2020.														
2. Gareth J.Monkman, Stefan Hesse, Ralf Steinmann, Henrik Schunk, "Robot Grippers", Wiley, 2017.														
REFERENCES														
1. Robert L.Norton, "Machine Design – An Integrated Approach", Prentice Hall International Edition, 5th edition, 2018.														
2. Adam Morecki, JozeKnapczyk, "Basics of Robotics: Theory and Components of Manipulators and Robots", Springer, 2019.														
3. Shimon Y. Nof, "Handbook of Industrial Robotics", John Wiley & Sons, 2019.														
4. Mikell P. Groover, "Industrial Robotics", McGraw Hill, 2nd edition, 2017.														
CO-PO MAPPING:														
Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	2	1	1	1	2	-	-	-	-	-	1	2	3
CO2	2	2	1	1	1	2	-	-	-	-	-	1	2	3
CO3	2	2	1	1	1	2	-	-	-	-	-	1	2	3
CO4	2	2	1	1	1	2	-	-	-	-	-	1	2	3
CO5	2	2	1	1	1	2	-	-	-	-	-	1	2	3



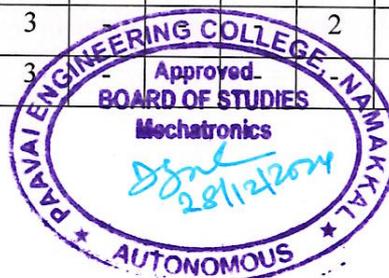
MT23353	ROBOTS IN MANUFACTURING			3	0	0	3
COURSE OBJECTIVES							
To enable the students to							
1	get a knowledge of working on Industrial robots and their load handling capacity.						
2	enlist with an application of robots in various operation.						
3	familiar with a material handling system.						
4	impart the knowledge on robotic welding.						
5	obtain the knowledge on various type of robot welding operation.						
UNIT I	INTRODUCTION						9
Types of industrial robots - Load handling capacity, General considerations in Robotic material handling, Material transfer, Machine loading and unloading, CNC machine tool loading, Robot centered cell.							
UNIT II	SELECTION OF ROBOTS AND OTHER APPLICATIONS						9
Factors influencing the choice of a robot - Robot performance testing, Economics of robotization, Impact of robot on industry and society; Application of Robots in continuous arc welding, Spot welding, Spray painting, Assembly operation, Cleaning, Robot for underwater applications.							
UNIT III	MATERIAL HANDLING						9
Concepts of material handling - Principles and considerations in material handling systems design, Conventional material handling systems, Industrial trucks, Monorails, Rail guided vehicles, Conveyor systems, Cranes and hoists, advanced material handling systems; Automated guided vehicle systems - automated storage and retrieval systems(ASRS), Bar code technology, Radio frequency identification technology; Introduction to Automation Plant design software.							
UNIT IV	ROBOTIC WELDING						9
Robotic welding system, Programmable and flexible control facility; Introduction, Types, Flex Pendant, Lead through programming, Operating mode of robot, Jogging, Types, programming for robotic welding, Welding simulation, Welding sequences, Profile welding.							
UNIT V	APPLICATIONS OF ROBOTS IN WELDING AND ALLIED PROCESSES						9
Application of robot in manufacturing - Exploration of practical application of robots in welding, Robots for car body's welding, Robots for box fabrication, Robots for microelectronic welding and soldering; Applications in Nuclear, Aerospace and ship building; Case studies for simple and complex applications.							
						TOTAL PERIODS	45
COURSE OUTCOMES							
At the end of this course, students will be able to						BT Mapped (Highest Level)	
CO1	recognize various concepts of industrial robot.					Understand (K2)	
CO2	select the appropriate manufacturing procedure for robots.					Understand (K2)	
CO3	apply various manufacturing process in robot manufacturing.					Analyze (K4)	
CO4	learn about the welding operation and also related to programming.					Understand (K2)	

CO5	produce a manufacturing plan for developing a robot.	Analyze (K4)												
TEXT BOOKS														
1. Richard D Klafter, Thomas Achmielewski, MickaelNegin , “Robotic Engineering - An integrated Approach”, Prentice Hall India, New Delhi, 2018.														
2. Mikell.P.Groover, “Automation, Production Systems, and Computer Integrated Manufacturing”, Pearson Education, New York, 2016.														
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1. Pires J N, Loureiro A, Bolmsjo G, “Welding Robots: Technology, System Issues and Application”, Springer, London, 2010.														
2. Parmar R S , “Welding Processes and Technology”, Khanna Publishers, New Delhi, 2nd Edition, 2013.														
3. John A. piotrowski, William T. Randolph, “Robotic welding: A Guide to Selection and Application, Welding Division, Robotics International of SME”, Publications Development Dept., Marketing Division, 2011.														
4. Mikell P Groover, Mitchel Weiss, Roger N Nagel, N.G.Odrey, AshishDutta , “Industrial Robotics (SIE): Technology, Programming and Applications”, 2nd Edition, McGraw Hill Education India Pvt Ltd, 2012.														
CO-PO MAPPING:														
Mapping of Course Outcome (CO’s) with Programme Outcomes (PO’s) and Programme Specific Outcomes PSO’s														
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
	Programme Outcomes PO’s												PSO’s	
CO’s	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	-	-	-	-	-	-	-	-	-	1	3	-
CO2	3	2	-	-	2	-	-	-	-	-	-	2	2	1
CO3	3	2	2	-	2	-	-	-	-	-	-	2	3	2
CO4	2	-	2	-	3	-	-	-	-	-	-	2	3	2
CO5	3	3	3	2	3	-	-	-	2	2	2	3	3	2



MT23354	HUMANOID ROBOTICS	3	0	0	3
COURSE OBJECTIVES					
To enable the students to					
1	define the basic concepts of coordinate transformations and robot kinematics.				
2	recognize the fundamentals of Zero Moment Point (ZMP) and robot dynamics.				
3	list the elements involved in biped walking pattern generation.				
4	identify techniques used for generating whole-body motion in humanoid robots.				
5	recall key equations and concepts in rigid body and link system dynamics.				
UNIT I	KINEMATICS				9
Coordinate Transformations – World Coordinates, Local Coordinates and Homogeneous Transformations, Local Coordinate Systems Local to Local Coordinate Systems, Homogeneous Transformations and Chain Rules; Characteristics of Rotational Motion - Roll, Pitch and Yaw Notation, Rotation Matrices; Robot Data Structure; Kinematics of a Humanoid Robot – Creating the Model, Forward Kinematics: Calculating the Position of the Links from Joint Angles, Inverse Kinematics: Calculating the Joint Angles from a Link's Position and Attitude.					
UNIT II	ZMP AND DYNAMICS				9
ZMP and Ground Reaction Forces – ZMP Overview, 2D Analysis, 3D Analysis; Measurement of ZMP - General Discussion, ZMP of Each Foot, ZMP for Both Feet Contact; Dynamics of Humanoid Robots – Humanoid Robot Motion and Ground Reaction Force, Momentum, Angular Momentum, Angular Momentum and Inertia Tensor of Rigid Body.					
UNIT III	BIPED WALKING				9
Two Dimensional Walking Pattern Generation – Two Dimensional Inverted Pendulum, Behavior of Linear Inverted Pendulum, Orbital Energy, Support Leg Exchange, Planning a Simple Biped Gait, Extension to a Walk on Uneven Terrain; 3D Walking Pattern Generation - 3D Linear Inverted Pendulum, Natures of the 3D Linear Inverted Pendulum, 3D Walking Pattern Generation, Introducing Double Support Phase, From Linear Inverted Pendulum to Multi-body Model.					
UNIT IV	GENERATION OF WHOLE BODY MOTION PATTERNS				9
Generating Rough Whole Body Motion – Using Motion Capture, Using a Graphical User Interface, Using High Speed Multi variate Search Methods; Converting Whole Body Motion Patterns to Dynamically Stable Motion - Dynamics Filter, Auto Balancer, Strict Trunk Motion Computation Algorithm; Remote Operation of Humanoid Robots with Whole Body Motion Generation – Remote Generation of Whole Body Motion Using the Operation Point Switching Method, Full Body Motion Generation of Stable Motion Using Split Momentum Control, Application and Experiments with the Humanoid Robot HRP-2.					
UNIT V	DYNAMIC SIMULATION				9
Dynamics of Rotating Rigid Body - Euler's Equation of Motion; Dynamics of Rigid Body - Newton-Euler Equations, Dynamics by Spatial Velocity, Rigid Body Simulation Based on Spatial Velocity,					

Simulation of a Spinning Top; Dynamics of Link System – Forward Kinematics with Acceleration, Inverse Dynamics of Link System, Forward Dynamics of Link System, Featherstone’s Method.														
												TOTAL PERIODS	45	
COURSE OUTCOMES														
At the end of this course, students will be able to												BT Mapped (Highest Level)		
CO1	explain and apply kinematic principles and transformations in humanoid robot modeling.											Apply (K3)		
CO2	analyze Zero Moment Point (ZMP) and dynamic parameters affecting humanoid stability.											Analyze (K4)		
CO3	develop bipedal walking patterns using inverted pendulum models in 2D and 3D.											Apply (K3)		
CO4	identify various whole-body motion generation methods used in humanoid robots.											Apply (K3)		
CO5	analyze the fundamental equations governing the dynamics of rigid bodies and link systems.											Analyze (K4)		
TEXT BOOKS														
1. Shuuji K, Hirohisa H, Kensuke H, Kazuhito, Springer-Verlag GmbH, “Introduction to Humanoid Robotics”, Springer, London, 2019.														
2. Goswami Ambarish, Vadakkepat Prahlad, “Humanoid Robotics: A Reference”, Springer, 2019.														
REFERENCES														
1. J. Craig, “Introduction to Robotics: Mechanics and Control”, Fourth Edition, Pearson, 2020.														
2. A. Goswami, P. Vadakkepat (Eds.), “Humanoid Robotics: A Reference”, Springer, Netherlands, Dordrecht, 2018.														
3. J K. Harada, E. Yoshida, K. Yokoi (Eds.), “Motion Planning for Humanoid Robots”, Springer, London, 2012.														
4. Jean-Claude Latombe, “Robot Motion Planning”, Kluwer Academy Publishers, 2014.														
CO-PO MAPPING:														
Mapping of Course Outcome (CO’s) with Programme Outcomes (PO’s) and Programme Specific Outcomes PSO’s														
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
CO’s	Programme Outcomes PO’s												PSO’s	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2	-	3	-	-	-	-	-	-	2	3	3
CO2	3	3	-	2	3	-	-	-	-	-	-	2	2	3
CO3	3	2	3	1	3	-	-	-	-	-	-	1	3	3
CO4	3	2	3	-	3	-	-	-	2	1	1	1	3	3
CO5	3	3	-	2	3	-	-	-	-	-	-	2	3	2



MT23355	INTRODUCTION TO AI IN ROBOTICS	3	0	0	3	
COURSE OBJECTIVES						
To enable the students to						
1	acquire the basic concepts of robotics paradigms.					
2	understand the fundamentals of biological foundation and reactive architecture.					
3	impart knowledge on design a reactive case study and sensors.					
4	understand the concept of robot hybrid paradigm.					
5	learn about basics of topological navigation with a hybrid architecture.					
UNIT I	ROBOTIC PARADIGMS				9	
Tele operation to Autonomy - Social implication of robotics; A Brief History of robotics - Tele operation, Tele presence; Semi - Autonomous control; The seven area of AI; Attributes of the Hierarchical Paradigm - Representative Architectures, Evaluation of Hierarchical, Advantages and disadvantages; Programming consideration; Artificial intelligence basics - Principle AI applications areas, rise, fall, rebirth of AI.						
UNIT II	BIOLOGICAL FOUNDATION OF THE REACTIVE PARADIGM				9	
Introduction - Reflexive behaviors, Coordination & Control of Behaviors, Perception in Behaviors; Schema Theory - Principles and issues in Transferring Insights to Robots; Attributes of Reactive Paradigm - Sub assumption Architecture; Potential Fields Methodologies - Advantages and disadvantages; Evaluation of Reactive Architectures.						
UNIT III	DESIGNING A REACTIVE IMPLEMENTATION				9	
Behaviors as objects in OOP; Steps in Designing a Reactive Behavioral system; Case Study; Assemble ages of Behaviors; Logical sensors-Behavioral Sensor fusion, Designing a sensor Suite, Proprioceptive Sensors, Proximity Sensors; Computer Vision- Range from vision.						
UNIT IV	HYBRIDE DELIBERATIVE AND REACTIVE PARADIGM				9	
Attributes of the Hybrid paradigm, Architectural Aspects, Managerial Architectures; State - Hierarchy Architectures, Model oriented Architectures, Other Robots in the Hybrid Paradigm; Evaluation of Hybrid Architecture-Interleaving Deliberation and Reactive control; Multi-agents - Heterogeneity, Control, cooperation, Goals, Emergent Social Behavior.						
UNIT V	NAVIGATION				9	
Topological path planning - Landmarks and Gateways, Relational Methods, Associative Methods; Case study of Topological Navigation with a Hybrid Architecture; Metric Path Planning - Configuration space, CS pace Representations; Graph Based planners - Wave front Based Planners, Interleaving Path Planning and Reactive Execution; Case Study - Unmanned Ground Robotics Competition, Topological Navigation with a Hybrid Architecture.						
					TOTAL PERIODS	45
COURSE OUTCOMES						
At the end of this course, students will be able to					BT Mapped (Highest Level)	

CO1	gain foundational knowledge of robotics paradigms.	Remember (K1)
CO2	comprehend the core principles of biological foundations and reactive architecture	Understand (K2)
CO3	provide knowledge on designing reactive case studies and utilizing sensors.	Apply (K3)
CO4	grasp the concept of the robot hybrid paradigm	Apply (K3)
CO5	gain knowledge of the fundamentals of topological navigation within a hybrid architecture.	Analyze (K4)

TEXT BOOKS

1. Robin.R.Murphy, "Introduction to AI Robotics", 5th edition PHI Learning Private limited, 2010.
2. Guilin Yang, I-Ming Chen, "Modular Robots: Theory and Practice", Springer, 2022.

REFERENCES

1. Giandomenico Spezzano, "Swarm Robotics", Applied Sciences, MDPI, 2019.
2. Heiko Hamann, "Collective Decision-Making in Swarm Robotics: A Formal Approach", Springer, 2019.
3. Mair, G.M., "Industrial Robotics", Prentice-Hall, 1988.
4. Groover, M.P., Weiss, M., Nagel, R.N., and Odrey, N.G., "Industrial Robotics, Technology, Programming, and Applications", McGraw-Hill, 1995.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	-	-	1	-	-	-	-	-	-	2	3	2
CO2	3	3	-	-	2	-	-	-	-	-	-	2	3	3
CO3	3	3	2	1	3	-	-	-	-	1	-	2	3	3
CO4	3	2	2	1	3	-	-	-	-	-	-	2	3	3
CO5	3	3	2	2	3	-	-	-	-	1	-	2	3	3



MT23356	ROBOTICS TECHNOLOGY AND FLEXIBLE AUTOMATION	3	0	0	3	
COURSE OBJECTIVES						
To enable the students to						
1	understand the principles of robot kinematics, dynamics, and transformations.					
2	learn about intelligent robotic systems using sensors, AI, and vision technologies.					
3	know the mechatronics system and their integration with computer-based control.					
4	study the fundamentals and benefits of flexible automation in industry.					
5	identify real-world robotic applications and future trends in robotics.					
UNIT I	ROBOT KINEMATICS & DYNAMICS				9	
Introduction-forward and reverse kinematics, three degree of freedom- forward and reverse transformation of a four degree of freedom; homogeneous transformation - kinetic equation using homogenous transformation - reverse kinematic of robots - robot arm dynamics.						
UNIT II	SENSORS AND INTELLIGENT ROBOTS				9	
AI and Automated Manufacturing-AI and Robotics; Need for sensing systems-Sensory device and types-Robot vision system-Design and control of sensor integrated dexterous-Soft computing.						
UNIT III	MECHATRONICS AND COMPUTER INTERFACING				9	
Mechatronics- leading edge technology - Automation and Mechatronic applications-Basic Electronic component; Digital Circuits and design – PLC - Computers and microprocessors; Common IP/OP devices - PC Microprocessor.						
UNIT IV	FLEXIBLE AUTOMATION TECHNOLOGY				9	
Introduction - Flexible automation; A new tool - feasibility of the robots - data acquisition - investment and evaluation strategies-planning for robot installation.						
UNIT V	APPLICATION OF ROBOTS				9	
Introduction-Capabilities of robot-Robotics applications-Obstacle avoidance-Robotic application under CIM-Robotics in India-The future of robotics.						
					TOTAL PERIODS	45
COURSE OUTCOMES						
At the end of this course, students will be able to					BT Mapped (Highest Level)	
CO1	describe kinematic and dynamic models for robot motion analysis.				Understand (K2)	
CO2	integrate sensor technologies and AI techniques in robotic systems.				Apply (K3)	
CO3	apply basic electronics, PLCs, and microprocessors for automation tasks.				Apply (K3)	
CO4	analyse flexible automation setups and plan robot installations.				Apply (K3)	

CO5	analyse industrial applications and limitations of robotics in automation.	Analyse (K4)												
TEXT BOOKS														
1. S.R.DEB & S.DEB Robotics Technology & Flexible automation 2nd Edition, McGraw-Hill Education, 2020.														
2. Mikell P. Groover, Mitchell Weiss, Roger N. Nagel, and Nicholas G. Odrey “Industrial Robotics: Programming and Applications” Publisher: McGraw Hill Education, 2019.														
REFERENCES														
1. Illah Reza Nourbakhsh is K&L Gates “Introduction to Autonomous Mobile Robots” MIT Press, 2011.														
2. K&L Gates “Introduction to Autonomous Mobile Robots”, MIT Press, 2010.														
3. Stuart Russell and Peter Norvig “Artificial Intelligence: A Modern Approach”, 3 rd edition Pearson Education, 2020.														
4. W. Bolton, “Principles and Applications”, Published by Elsevier Newness, 2019.														
CO-PO MAPPING:														
Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's														
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	3	2	2	-	-	-	-	-	-	1	3	2
CO2	2	2	3	2	3	-	-	-	-	-	-	1	3	3
CO3	2	-	2	2	3	-	-	-	-	-	-	1	3	2
CO4	2	2	3	2	2	-	-	-	-	-	2	2	3	3
CO5	2	2	2	2	2	2	-	-	1	1	1	2	3	2



MT23357	MICRO ROBOTICS			3	0	0	3
COURSE OBJECTIVES							
To enable the students to							
1	know the fundamental aspects of the emerging field of micro robotics.						
2	learn the micro scale, technologies for fabricating small devices, bio-inspired design, and applications of the field.						
3	understand various Mathematical formalism for flexures, Electrostatic actuators, Piezo-electric actuators, Magneto-strictive actuator and other sensors.						
4	know various applications micro robotics.						
5	aware the implementation of micro robotics.						
UNIT I	INTRODUCTION TO MICROROBOTICS						9
Introduction to Micro robotics; MST (Micro System Technology); Micromachining - Working principles of Microsystems Applications of Microsystems, Micro-fabrication principles, Design selection criteria for micromachining; Packaging and Integration aspects; Micro-assembly platforms and manipulators.							
UNIT II	SCALING LAWS AND MATERIALS FOR MEMS						9
Introduction; Scaling laws - Scaling effect on physical properties scaling effects on Electrical properties, scaling effect on physical forces; Physics of Adhesion – Silicon; compatible material system; Shape memory alloys; Material properties - Piezoresistivity, Piezoelectricity and Thermoelectricity.							
UNIT III	FLEXURES, ACTUATORS AND SENSORS						9
Elemental flexures - Flexure systems, Mathematical formalism for flexures; Electrostatic actuators; Piezo-electric actuators; Magneto-strictive actuators; Electromagnetic sensors; Optical-based displacement sensors; Motion tracking with microscopes.							
UNIT IV	MOBILITY OF MICROROBOTS						9
Introduction; Task specific definition of micro-robots; Size and Fabrication Technology based definition of micro- robots; Mobility and Functional-based definition of micro-robots; Applications for MEMS based micro-robots.							
UNIT V	IMPLEMENTATION OF MICROROBOTS						9
Arrayed actuator principles for micro-robotic applications; Micro-robotic actuators; Design of locomotive micro-robot devices based on arrayed actuators; Micro-robotics devices; Micro- grippers and other micro-tools; Micro-conveyors; Walking MEMS Micro-robots; Multi-robot system - Micro-robot powering, Micro-robot communication.							
						TOTAL PERIODS	45
COURSE OUTCOMES							
At the end of this course, students will be able to						BT Mapped (Highest Level)	
CO1	explain and apply the concepts of mass, energy, and momentum					Understand (K2)	

	balance in micro robotics.													
CO2	apply adapt, and synthesize learned engineering skills to create micro robot.	Understand (K2)												
CO3	model micro robots for different robotics applications.	Analyze (K4)												
CO4	formulate the specifications and design of mechatronic systems.	Apply (K3)												
CO5	implement the micro robot for different robotics applications.	Analyze (K4)												
TEXT BOOKS														
1. Mohamed Gad-el-Hak , “The MEMS Handbook”, 2nd Edition, CRC Press, New York, 2017.														
2. Yves Bellouard, "Micro robotics Methods and Applications", CRC Press, Massachusetts, 2019.														
REFERENCES														
1. NadimMaluf and KirtWilliams, “An Introduction to Micro electro mechanical systems Engineering”, 2nd edition, Artech House, 2004.														
2. Julian W Gardner, “Micro sensors: Principles and Applications”, 2nd edition, Wiley, 2007.														
3. MetinSitti, “Mobile Micro robotics”, MIT Press, 2017.														
4. Nicolas Chaillet, Stephane Rangier “Micro robotics for Micromanipulation”, John Wiley & Sons, 2013.														
CO-PO MAPPING:														
Mapping of Course Outcome (CO’s) with Programme Outcomes (PO’s) and Programme Specific Outcomes PSO’s														
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
CO’s	Programme Outcomes PO’s												PSO’s	
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CO1	3	2	-	-	-	-	-	-	-	-	-	1	3	2
CO2	3	2	3	-	2	-	-	-	1	1	-	2	3	3
CO3	3	3	2	2	3	-	-	-	-	-	-	2	3	3
CO4	3	2	3	-	2	-	-	-	-	1	1	2	3	2
CO5	3	2	3	-	3	-	-	-	1	1	1	2	3	3



VERTICAL IV - AUTOMATION

MT23451	FACTORY AUTOMATION	3	0	0	3
COURSE OBJECTIVES					
To enable the students to					
1	understand the fundamental concepts and components of factory automation and production systems.				
2	explore various material handling equipment and systems, and analyze design considerations for efficient material transport and storage				
3	learn the classification, components, and operational principles of automated manufacturing systems including flexible manufacturing systems.				
4	gain knowledge of control technologies, process capability, and statistical process control tools used in automation.				
5	understand computer-based industrial control systems including cad/cam, process planning, and production scheduling techniques.				
UNIT I	OVERVIEW OF FACTORY AUTOMATION				9
Introduction to Production System Facilities - Manufacturing Support Systems, Automation in Production Systems, Manual Labor in Production Systems; Automation Principles and Strategies; Manufacturing Industries and Products - Manufacturing Operations, Product/Production Relationships, Production Concepts and Mathematical Models, Costs of Manufacturing Operations.					
UNIT II	MATERIAL HANDLING AND IDENTIFICATION TECHNOLOGIES				9
Material Handling Equipment - Considerations in Material Handling System Design; Material transport systems - Industrial Trucks, Automated Guided Vehicle Systems, Monorails and Other Rail Guided Vehicles, Conveyor Systems, Crane and Hoists; Analysis of Material Transport Systems - Storage System Performance, Storage Location Strategies, Conventional Storage Methods and Equipment.					
UNIT III	AUTOMATED MANUFACTURING SYSTEMS				9
Components of a Manufacturing System - Classification of Manufacturing Systems, Overview of the Classification Scheme, Manufacturing Progress Functions (Learning Curves); Part Families - Parts Classification and Coding, Production Flow Analysis, Cellular Manufacturing; Application Considerations in Group Technology; Quantitative Analysis in Cellular Manufacturing FMS Applications and Benefits - FMS Planning and Implementation, Issues and Quantitative Analysis of Flexible Manufacturing System.					
UNIT IV	CONTROL TECHNOLOGIES IN AUTOMATION				9
Process Variability and Process Capability - Control Charts, Other SPC Tools; Implementing Statistical Process Inspection Metrology - Contact versus Noncontact Inspection Techniques, Conventional Measuring and Gaging Techniques; Coordinate Measuring Machines - Surface Measurement, Machine Vision, Other Optical Inspection Techniques, Noncontact Non optical inspection Technologies.					
UNIT V	COMPUTER BASED INDUSTRIAL CONTROL				9
Product Design and CAD - CAD System Hardware, CAM, and CIM, Quality Function Deployment; Process Planning - Computer Aided Process Planning (CAPP), Concurrent Engineering and Design for Manufacturing, Advanced Manufacturing Planning, Aggregate Production Planning and the Master Production Schedule, Material Requirements Planning (MRP), Capacity Planning, Shop Floor Control, Inventory Control,					

Manufacturing Resource Planning (MRP II), Just In Time (JIT) Production Systems.														
												TOTAL PERIODS	45	
COURSE OUTCOMES														
At the end of this course, students will be able to												BT Mapped (Highest Level)		
CO1	understand key concepts and strategies in factory automation and production systems.											Understand (K2)		
CO2	recognize and assess material handling equipment and design effective transport and storage solutions.											Understand (K2)		
CO3	classify and analyze automated manufacturing systems, including flexible manufacturing systems.											Analyse (K4)		
CO4	apply control technologies and spc tools to enhance manufacturing process quality.											Apply (K3)		
CO5	use computer-based industrial controls like cad/cam and process planning to improve production efficiency.											Apply (K3)		
TEXT BOOKS														
1. M.P. Groover, "Automation, Production Systems and Computer Integrated Manufacturing", 4th Edition, Pearson Education, 2016.														
2. Bolton W., "Mechatronics", 6th Edition, Pearson Education, New Delhi, 2019.														
REFERENCES														
1. Krishna Kant, "Computer Based Industrial Control", 2nd Edition, EEE-PHI, 2010.														
2. Tiess Chiu Chang & Richard A.Wysk. "An Introduction to Automated Process Planning Systems", Prentice Hall International, 2006.														
3. Viswanandham, "Performance Modeling of Automated Manufacturing Systems", Prentice Hall India Learning Pvt. Ltd., 2009.														
4. Petruzella Frank D., "Programmable Logic Controllers", 5th Edition, McGraw-Hill, New York, 2019.														
CO-PO MAPPING:														
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CO1	3	2	2	1	2	1	-	-	-	1	-	2	2	1
CO2	3	2	3	2	2	-	-	-	-	1	1	2	3	2
CO3	3	3	3	2	2	-	1	-	-	-	1	2	3	2
CO4	2	2	2	3	3	-	1	-	-	-	1	2	2	3
CO5	3	2	3	2	3	-	1	-	-	1	2	3	3	3



MT23452	OPERATION RESEARCH	3	0	0	3	
COURSE OBJECTIVES						
To enable the students to						
1	understand the optimum solution for linear programming problems.					
2	study the Transportation and assignment models and various techniques to solve them.					
3	understand the optimum solution for project management.					
4	know the optimality, formulation and computation of integer programming problems.					
5	acquire the knowledge of optimality, formulation and computation of dynamic programming problems.					
UNIT I	LINEAR PROGRAMMING	9				
Operation Research model - OR model, Queuing and simulation model, Art of modelling, Phases of an OR study; Two variable LP model - Graphical LP solution, Selected LP application, Computer solution with excel solver and AMPL, LP Modelling in equation form.						
UNIT II	TRANSPORTATION AND ASSIGNMENT PROBLEMS	9				
Transition and graphical to algebraic solution - Simplex method, Artificial starting solution, Artificial starting solution, special cases in the simplex method , Sensitivity analysis; Duality and post optimal analysis: Nontraditional transportation model, Assignment model.						
UNIT III	PROJECT MANAGEMENT BY PERT & CPM	9				
Network models - Minimal spanning tree algorithm, Maximum flow model: CPM and PERT; Linear programme simplex method, Bounded variable algorithm, Duality, Parametric linear programming.						
UNIT IV	INTEGER PROGRAMMING	9				
Goal programming formulation and algorithms; Integer linear programming application and algorithm - Branch and Bound algorithm, Cutting plane algorithm and computational consideration.						
UNIT V	DYNAMIC PROGRAMMING PROBLEMS	9				
Nature of computation in DP and selected DP application - Cargo loading model, work force size model, Equipment replacement model, Investment model; Role of Inventory model - EOQ model, Dynamic EOQ models.						
					TOTAL PERIODS	45
COURSE OUTCOMES						
At the end of this course, students will be able to					BT Mapped (Highest Level)	
CO1	develop a fundamental understanding of linear programming models, able to develop a linear programming model from problem description, apply the simplex method for solving linear programming problems.				Remember (K1)	
CO2	analyze the concept of developing, formulating, modeling and solving transportation and assignment problems.				Understand (K2)	

CO3	determine the optimum solution for linear programming problems.	Apply (K3)
CO4	solve the integer programming problems using various methods.	Apply (K3)
CO5	conceptualize the principle of optimality and sub-optimization, formulation and computational procedure of dynamic programming.	Analyze (K4)

TEXT BOOKS

1. Taha. H.A, "Operations Research - An Introduction, Pearson Education, Ninth Edition, New Delhi, 2017.
2. Kanti Swarup, P.K.Gupta and Man Mohan, " Operations Research " , Sultan Chand & Sons, New Delhi, Fifth Edition , 2010.

REFERENCES

1. Pradeep Prabhakar Pai , "Operations Research and Practice", Oxford University Press, New Delhi , 2012.
2. J.P.Singh and N.P.Singh , " Operations Research" , Ane Books Pvt.Ltd, New Delhi , 2014.
3. F.S.Hillier and G.J. Lieberman, "Introduction to Operations Research", Tata McGraw Hill, Eighth Edition, New Delhi, 2020.
4. Richard Bronson & Govindasami Naadimuthu , "Operations Research" Tata McGraw Hill, Second Edition, New Delhi, 2014.

CO-PO MAPPING:

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CO's	Programme Outcomes PO's												PSO's	
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CO1	3	2	-	-	3	-	-	-	-	-	-	2	2	2
CO2	3	3	-	-	2	-	-	-	-	-	-	2	2	3
CO3	3	3	2	-	3	-	-	-	-	-	-	2	2	3
CO4	3	3	2	2	3	-	-	-	-	-	-	2	2	3
CO5	3	3	2	2	3	-	-	-	-	-	-	3	3	3



MT23453	VIRTUAL INSTRUMENTATION	3	0	0	3
COURSE OBJECTIVES					
To enable the students to					
1	understand the basics of Virtual Instrumentation and LabVIEW.				
2	familiarize with basic programming tools, control structures, and graphical user interface components.				
3	explain the use of programming structures such as loops, case logic, sequences, and scripting nodes.				
4	understand data acquisition hardware, communication interfaces, and configure DAQ systems.				
5	explore the application of software toolkits for signal analysis, control system design, and industrial automation.				
UNIT I	INTRODUCTION TO VIRTUAL INSTRUMENTATION				9
Virtual Instrumentation; Programming Requirements; Drawbacks of Recent Approaches; Virtual Instruments Versus Traditional Instruments; Advantages of VI; Creating Virtual Instruments Using LabVIEW; Virtual Instrumentation in the Engineering Process; Advantages of LabVIEW; LabVIEW Environment; Dataflow Programming; G Programming.					
UNIT II	BASIC TOOLS, LOOPS AND GRAPHS				9
Virtual Instruments - Front Panel, Block Diagram; Control Structures - FOR Loop, While Loop, Shift Registers, Feedback Nodes; Arrays; Clusters; Waveform Charts; Waveform Graphs; XY Graphs; Tables.					
UNIT III	PROGRAMMING WITH STRUCTURES, STRINGS, FILE I/O				9
Structures - Case Structure, Sequence Structures, Customizing Structures, Timed Structures, Formula Nodes, Event Structure, LabVIEW MathScript; Strings - Creating String Control and Indicators, String Functions, Formatting Strings, Configuring String Controls and Indicators; File I/O - Basics of File I/O, Choosing a File I/O Format, LabVIEW Data Directory, File I/O VIs.					
UNIT IV	DATA ACQUISITION				9
Interface Buses - RS 232, RS422, RS485, GPIB and USB; Hardware Aspects - Signal Grounding, Digital I/O Techniques, Data Acquisition in LabVIEW, Hardware Installation and Configuration, Components of DAQ, DAQ Signal Accessory, DAQ Assistant, DAQ Hardware, DAQ Software.					
UNIT V	TOOLS AND APPLICATIONS				9
Tools - Signal processing and Analysis, Control System Design and Simulation Tools, Digital Filter Design Toolkit, Sound And Vibration Toolkit, Spectral Measurements Toolkit; Applications – Fiber Optic Component Inspection Using Integrated Vision and Motion Components, Data Acquisition and User Interface of Beam Instrumentation System at SRRC, VISCP; Virtual Instrumentation and CAD Tool for Electronic Engineering Learning, Distributed Multiplatform Control System with LabVIEW, The Virtual Instrument Control System, Controller Design Using the Maple Professional Math Toolbox for LabVIEW.					
TOTAL PERIODS					45

COURSE OUTCOMES		
At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	explain the Virtual Instrumentation concepts.	Understand (K2)
CO2	apply structured programming concepts in developing LabVIEW programs.	Apply (K3)
CO3	build LabVIEW programs using structures, nodes and state machine concepts.	Apply (K3)
CO4	utilize DAQ System to solve real time problems.	Apply (K3)
CO5	apply knowledge on various tools in practical works.	Apply (K3)

TEXT BOOKS

1. S,Sumathi, P,Surekha, "LabVIEW based Advanced Instrumentation Systems", 1st Edition, Springer Berlin, Heidelberg, 2017.
2. Jovitha Jerome, "Virtual Instrumentation Using LabVIEW", 3rd Edition, PHI Learning Pvt. Ltd., New Delhi, 2012.

REFERENCES

1. Nadovich, C., "Synthetic Instruments Concepts and Applications", Elsevier, 2005.
2. Bitter, R., Mohiuddin, T. and Nawrocki, M., "Labview Advanced Programming Techniques", CRC Press, 2nd Edition, 2007.
3. Gupta, S. and Gupta, J. P., "PC Interfacing for Data Acquisition and Process Control", 2nd Edition, Instrument Society of America, 2004.
4. Jamal, R. and Picklik, H., "Labview - Applications and Solutions", National Instruments Release, 2008.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	-	-	-	2	-	-	-	-	-	-	2	2	2
CO2	2	2	2	-	3	-	-	-	-	-	-	2	2	3
CO3	2	-	3	-	3	-	-	-	-	-	-	2	3	3
CO4	3	-	2	3	3	-	-	-	-	-	-	2	3	3
CO5	3	-	2	2	3	-	-	-	-	-	-	2	3	3



MT23454	ADVANCED MACHINING PROCESSES	3	0	0	3
COURSE OBJECTIVES					
To enable the students to					
1	impart knowledge on the principles, equipment, and applications of mechanical energy-based advanced machining processes.				
2	differentiate chemical and electro chemical energy-based processes.				
3	describe thermo-electric energy-based processes.				
4	gain knowledge on advanced finishing processes.				
5	understand the various hybrid electrochemical processes.				
UNIT I	INTRODUCTION AND MECHANICAL ENERGY BASED PROCESSES				9
Introduction, history of machining, traditional machining processes, non-traditional machining processes, comparison of traditional and non-traditional machining processes, need for advanced machining processes; Abrasive jet machining (AJM) - machining system, material removal rate, applications, advantages and limitations of AJM; Water jet machining (WJM) - machining system, process parameters, applications, advantages and disadvantages of WJM; Ultrasonic machining (USM) - machining system, material removal process, factors affecting material removal rate, dimensional accuracy and surface quality, applications.					
UNIT II	CHEMICAL AND ELECTRO CHEMICAL ENERGY BASED PROCESSES				9
Chemical Milling (CHM) - tooling for CHM, process parameters, material removal rate, accuracy and surface finish, advantages, limitations, applications; Photochemical milling - process description, applications, advantages; Electro polishing - process parameters, applications, process limitations; Electro chemical machining (ECM) - principles, ECM equipment, basic working principles, process characteristics, process control, applications; Basics of electrochemical drilling and electrostream drilling.					
UNIT III	THERMO-ELECTRIC ENERGY BASED PROCESSES				9
Electric discharge machining (EDM) - mechanism of material removal, machining system, material removal rates, applications, advantages and limitations; Wire Electric Discharge Machining (W-EDM) - mechanism of material removal, applications, advantages and limitations; Laser beam machining (LBM) - material removal mechanism, applications, advantages and limitations; Electron beam machining (EBM) - basic equipment and removal mechanism, applications, advantages and disadvantages; Plasma beam machining (PBM) - machining systems, material removal rate, applications, advantages and disadvantages.					
UNIT IV	ADVANCED FINISHING PROCESSES				9
Principles, equipment's, effect of process parameters, applications, advantages and limitations - Abrasive Flow Machining (AFM), Magnetic Abrasive Finishing (MAF), Magnetorheological Finishing (MRF), Magneto Rheological Abrasive Finishing (MRAF).					
UNIT V	HYBRID ELECTROCHEMICAL PROCESSES				9
Electro chemical grinding (ECG) - mechanism of material removal, accuracy and surface quality, applications, advantages and limitations; Electrochemical honing - process characteristics, applications; Electro chemical deburring - material removal process, advantages; Ultrasonic-Assisted ECM - material removal process; Laser-Assisted ECM - material removal process.					
TOTAL PERIODS					45

COURSE OUTCOMES		
At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	understand mechanical energy-based processes like AJM, WJM, and USM.	Understand(K2)
CO2	explain chemical and electrochemical processes such as CHM, ECM, photochemical milling and electropolishing.	Understand(K2)
CO3	apply thermo-electric processes like EDM, WEDM, LBM, EBM, and PBM to machining scenarios.	Apply(K3)
CO4	analyze advanced finishing processes (AFM, MAF, MRF, MRAF) for performance and surface outcomes.	Analyze(K4)
CO5	analyze hybrid electrochemical processes for precision and suitability in automation-based applications.	Analyze(K4)

TEXT BOOKS

- Hassan Abdel-Gawad El-Hofy, "Advance Machining Processes", McGraw-Hill Publication, United States, 2005.
- V. K. Jain, "Advanced Machining Processes", Allied Publishers; 1st edition, 2009.

REFERENCES

- M.Adithan, "Unconventional Machining Processes", Atlantic, New Delhi, India, 2018.
- Anand Pandey, "Modern Machining Processes", Ane Books Pvt. Ltd., New Delhi, India, 2023.
- Jagadeesha T, "Non-Traditional Machining Processes", I.K. International Publishing House Pvt. Ltd., New Delhi, India, 2016.
- Benedict, G.F, "Non-traditional Manufacturing Processes", CRC Press, 2019.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	2	-	-	1	-	-	-	-	-	-	2	2	1
CO2	2	2	-	-	2	-	-	-	-	-	-	2	2	1
CO3	3	2	2	1	3	-	-	-	-	-	-	2	3	2
CO4	3	3	2	2	3	-	-	-	-	1	-	2	3	3
CO5	3	3	2	2	3	1	1	1	-	1	-	3	3	3



MT23455	AUTOMATED MATERIAL HANDLING SYSTEMS			3	0	0	3
COURSE OBJECTIVES							
To enable the students to							
1	understand the concepts and functions of material handling and storage systems.						
2	learn various methods and equipment used for storing and moving materials.						
3	explore the integration of handling and storage for efficient workflow.						
4	identify key design considerations for safe and effective systems.						
5	understand automation and modern technologies in storage and handling.						
UNIT I	INTRODUCTION TO MATERIAL HANDLING						9
Definition and Scope of Materials Handling - Importance of Materials Handling, Systems Concept in Characteristics and Classification of Materials; Definition of Unit Load - Advantages and Disadvantages, Load Unitization Process and Handling Methods Pallets, Skids and Containers; Alternative Methods of Handling - Packaging for Materials Handling, Basic Equipment Types, Classification of Handling Equipment.							
UNIT II	CONVEYORS						9
Conveyors - Belt Conveyors, Chain Conveyors, Haulage Conveyors, Cable Conveyors, Bucket Conveyors, Roller Conveyors, Screw Conveyors, Pneumatic Conveyors, Hydraulic Conveyors.							
UNIT III	HOISTING EQUIPMENT						9
Parts of Hoisting Equipment - Hoists, Winches, Elevators, Cranes, Derricks, Storage of Bulk Solids, Bulk Handling Equipment.							
UNIT IV	ROBOTIC HANDLING						9
Materials Handling at the Workplace - Robots and their Classification; Robotic Handling Applications - Gates, Feeders, Chutes, Positioners, Ball Table, Weighing and Control Equipment, Pallet Loader and Unloader.							
UNIT V	STORAGE SYSTEMS						9
Organization, Maintenance and Safety in Materials Handling; Types of storage system - Automated Storage and Retrieval systems, Carousel storage systems, Large Products Storage System, Pallet Storage Systems Selection, Layout of High Rack Storage.							
						TOTAL PERIODS	45
COURSE OUTCOMES							
At the end of this course, students will be able to						BT Mapped (Highest Level)	
CO1	understand the basic concept, scope, and significance of material handling in industrial operations.					Understand (K2)	
CO2	recognize different types of conveyors such as belt, roller, chain, screw, and pneumatic conveyors.					Understand (K2)	
CO3	identify and describe various hoisting equipment, components, and bulk material handling techniques.					Remember (K1)	

CO4	analyze the integration of robotic systems in handling tasks (pick-and-place, palletizing).	Analyze (K4)
CO5	analyze purpose of storage systems (racking, shelving, and binning, automated storage).	Analyze (K4)

TEXT BOOKS

1. Allegri S.R., "Materials Handling Principles and Practice", ED-TECH, 2018.
2. Siddharta Ray, "Introduction to Materials Handling", New Age International Publishers, 2007.

REFERENCES

1. Deshmukh, D. J., "Elements of Mining Technology Vol. 1", India, Denett & Company, 8th Edition, 2010.
2. Peter Darling, "SME Mining Engineering Handbook", Society for Mining, Metallurgy, and Exploration, 2011.
3. Syd S. Peng, "Advances in Coal Mine Ground Control", Elsevier Science, 2017.
4. Walker, S.C., "Mine Winding and Transport", Elsevier Science, 2012.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	-	-	-	-	-	-	-	-	-	3	3	2
CO2	3	3	2	2	2	-	-	-	-	-	-	2	3	3
CO3	3	1	2	2	2	-	-	-	-	-	-	3	3	2
CO4	3	1	3	2	3		-	-	2	-	-	3	3	3
CO5	3	1	2	2	3	3	2	-	2	-	2	2	3	3



MT23456	DIGITAL TWIN AND INDUSTRY 5.0	3	0	0	3
COURSE OBJECTIVES					
To enable the students to					
1	introduce the fundamental concepts and types of Digital Twins.				
2	explain the architecture and components of a Digital Twin solution.				
3	explore real-time applications of Digital Twins across various industries.				
4	describe the evolution and impact of Industry 5.0 on automation and transformation.				
5	analyze transformation strategies in mechatronics and energy sectors using modern technologies.				
UNIT I	INTRODUCTION				9
Digital twin - Introduction, History of Digital Twin, Concept of digital twin, Characteristics of Digital twin, Working principles, Advantages, Limitations, Applications; Insights to digital twin technology concept - Parts twins, product twins, system twins, process twins; Types of digital twins - DTP, DTI, DTE; Traits of digital twins; Value of digital twins.					
UNIT II	DIGITAL TWIN SOLUTION ARCHITECTURE				9
Architecture Considerations; Understanding the Physical Object - Modeling Considerations; Digital Twin and IoT; Digital Twin Solution Architecture - Conceptual Digital Twin Solution Architecture, Infrastructure Platform and IoT Services, Digital Twin Data and Process Model, Digital Twin Services, Digital Twin Applications, Sample Basic Data Flow through Digital Twin, Sample Data Flow for Exception Handling, Sample Data Flow through Digital Twin Applications, Development Considerations.					
UNIT III	APPLICATION OF DIGITAL TWIN				9
Digital Twin in Smart Cities - Traffic Management, Construction - Digital Twin Technology in Medical Sector: Biosignal and Physiological Parameters Analysis for Body Area Network, Medicinal Drug Delivery, Surgical Preplanning - Digital Twin in Healthcare, Digital Twin for Hospital Workflow Management, Digital Twin for a Healthcare Facility, Cardiovascular Digital Twin - Digital Twin in Oil and Gas Industry: Performance Monitoring of Oil Field, Data Analytics and Simulation for Oil Field Production					
UNIT IV	INDUSTRY 5.0				9
Industrial Revolution, First Industrial Revolution, Second Industrial Revolution, Third Industrial Revolution, Fourth Industrial Revolution, Fifth Industrial Revolution; Process Automation - Engineering Process Automation, Manufacturing Process Automation, Business Process Automation, Robotic Process Automation, Digital Process Automation, Intelligent Process Automation; Necessity for Process Automation - Process Transformation, Process Automation to Process Transformation, Challenges to Incur, Value Drivers of Process Transformation.					
UNIT V	TRANSFORMATION IN MECHATRONICS SECTORS				9
Process Revolutions - Six Sigma, Toyota Production System, Lean Manufacturing, World-Class Manufacturing; Process Transformation Revolutions; Implementing PLM - SMEs, Implementing Process Control System (PLC, SCADA) for SMEs, Heat Treatment Process , Predictive Maintenance in Heat Treatment Process, Additive Manufacturing, Virtual Reality and Augment Reality; Solar					

Photovoltaic (PV) - Process Automation and Transformation in Solar Energy Sector, Automation in Solar Power Plant, 3D-Printed Solar Panels, RPA Enhanced Solar Energy, SMART Solar Power Plant.														
												TOTAL PERIODS	45	
COURSE OUTCOMES														
At the end of this course, students will be able to												BT Mapped (Highest Level)		
CO1	describe digital twin concepts and classifications.											Understand (K1)		
CO2	explain the architecture and technical components of a digital twin system.											Understand (K1)		
CO3	apply digital twin concepts to various industry use cases.											Apply (K3)		
CO4	apply the principles of industry 5.0 to identify automation opportunities in industrial processes.											Apply (K3)		
CO5	apply modern technologies like PLC, SCADA, AR/VR, and AI to improve manufacturing and energy systems.											Apply (K3)		
TEXT BOOKS														
1. Manisha Vohra, "Digital Twin Technology: Fundamentals and Applications", Scrivener Publishing LLC, 2023.														
2. Uthayan Elangovan, "Industry 5.0: The Future of the Industrial Economy", CRC Press, 2022.														
REFERENCES														
1. Alp Ustundag and Emre Cevikcan, "Industry 4.0: Managing The Digital Transformation", Springer Series in Advanced Manufacturing, Switzerland, 2018.														
2. Christoph Jan Bartodziej, "The Concept Industry 4.0 an Empirical Analysis of Technologies and Applications in Production Logistics", Springer Gambler, Germany, 2017.														
3. Andrew Yeh Chris Nee, Fei Tao, and Meng Zhang, "Digital Twin Driven Smart Manufacturing", Elsevier Science, United States, 2019.														
4. Ulrich Sandler, "The Internet of Things, Industries 4.0 Unleashed", Springer, Germany, 2018.														
CO-PO MAPPING:														
Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	-	-	2	-	-	-	-	-	-	1	3	2
CO2	3	2	-	-	3	-	-	-	-	-	-	1	3	3
CO3	3	3	2	2	3	1	2	-	-	2	1	2	3	3
CO4	2	2	3	2	3	-	2	-	2	2	2	2	3	3
CO5	3	2	3	3	3	2	2	-	2	3	3	2	3	3



MT23457	TOTAL INTEGRATED AUTOMATION			3	0	0	3
COURSE OBJECTIVES							
To enable the students to							
1	gain knowledge in automation in industries.						
2	gain knowledge in various electrical and electronic programmable automations and their applications.						
3	know about the basic in SCADA and DCS systems						
4	gain knowledge in communication protocols in an integrated system						
5	know about the advanced in automation industries						
UNIT I	TOTALLY INTEGRATED AUTOMATION						9
TIA - Need, components of systems, Advantages, Programmable Automation Controllers (PAC), Vertical Integration structure.							
UNIT II	HUMAN MACHINE INTERFACE (HMI)						9
Necessity and Role in Industrial Automation, Need for HMI systems; Types of HMI - Text display, operator panels, Touch panels, Panel PCs, Integrated displays (PLC & HMI).							
UNIT III	SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA)						9
Overview of Developer and Runtime packages – Architecture, Tools, Tag, Internal & External graphics, Alarm logging, Tag logging, Structured tags, Trends, Report generation, VB & C Scripts for SCADA Application.							
UNIT IV	COMMUNICATION PROTOCOLS OF SCADA						9
Proprietary and open Protocols - OLE/OPC, UPC UA/DA, DDE, Server/Client Configuration, Messaging, Recipe; User Administration - Interfacing of SCADA with PLC, Drive, and Other Field Device .							
UNIT V	DISTRIBUTED CONTROL SYSTEMS (DCS)						9
DCS – Architecture, Local control unit, Programming language, Communication facilities, Operator interface, Engineering interfaces; Applications of PLC & DCS - Case studies of Machine automation, Process automation; Introduction to SCADA Comparison between SCADA and DCS.							
						TOTAL PERIODS	45
COURSE OUTCOMES							
At the end of this course, students will be able to						BT Mapped (Highest Level)	
CO1	knowledge of PLC & PAC automation					Understand (K2)	
CO2	knowledge in HMI systems and to integrate it with other systems.					Apply (K3)	
CO3	ability to apply SCADA and usage of C programming for report generation.					Analyse (K4)	
CO4	acquiring information's on communication protocols in automation systems.					Apply (K3)	

CO5	ability to design and develop automatic control system using distributed control.	Analyse (K4)												
TEXT BOOKS														
1. John. W. Webb & Ronald A. Reis, "Programmable logic controllers: Principles and Applications", Prentice Hall India, 2009.														
2. Stuart A. Boyer, "SCADA: Supervisory Control and Data Acquisition, Prentice Hall India, 2004.														
REFERENCES														
1. Michael P. Lukas, "Distributed Control systems", Van Nostrand Reinhold Company, 2005.														
2. Win C C Software Manual, Siemens, 2003.														
3. RS VIEW 32 Software Manual, Allen Bradley, 2005.														
4. CIMPLICITY SCADA Packages Manual, Fanuc India Ltd, 2004.														
CO-PO MAPPING:														
Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	1	-	3	-	-	-	1	1	-	2	2	2
CO2	2	2	2	1	3	-	-	-	2	2	1	2	2	3
CO3	3	3	2	2	3	1	-	1	2	3	2	2	3	3
CO4	2	2	2	2	3	1	-	1	2	2	2	2	2	3
CO5	3	3	3	2	3	1	1	1	2	3	2	3	3	3



VERTICAL V - INTELLIGENCE

MT23551	APPLIED SIGNAL PROCESSING	3	0	0	3
COURSE OBJECTIVES					
To enable the students to					
1	understand the fundamental concepts of continuous and discrete-time signals and systems, including their classification and basic properties.				
2	know the continuous-time signals and systems using Fourier and Laplace transforms to understand system behavior in time and frequency domains.				
3	understand discrete-time signal analysis techniques such as DTFT, DFT, FFT, and Z-transform for the study and design of digital systems.				
4	know the implementation of digital filters (IIR and FIR) using methods like bilinear transformation and windowing to meet specific frequency response requirements.				
5	gain practical knowledge of digital signal processors (DSPs), their architectures, programming, and applications in real-time signal processing systems..				
UNIT I	INTRODUCTION TO SIGNALS AND SYSTEMS				9
Elementary Signals in Continuous and Discrete Time; Graphical and Mathematical Representation; Elementary Operations and Classification of Continuous and Discrete Time Signals; CT Systems and DT systems - Simple Examples of Systems, Interconnections of Systems; Properties of CT Systems and DT Systems; Classification of Systems.					
UNIT II	ANALYSIS OF CONTINUOUS TIME SIGNALS AND SYSTEMS.				9
The Continuous Time Fourier Series; Fourier Transform Properties; Laplace Transform and Properties; Impulse Response; Convolution Integrals; Fourier and Laplace Transforms in Analysis of CT systems; Frequency Response of Systems Characterized by Differential Equations.					
UNIT III	ANALYSIS OF DISCRETE TIME SIGNALS AND SYSTEMS				9
Fourier Transform of Discrete Time Signals (DTFT) Properties of DTFT; Discrete Fourier Transform; Fast Fourier Transform (FFT); Z Transform and Properties - Linearity Time Shifting, Scaling in the Z-Domain, Time Reversal, Time Expansion; Impulse Response; Convolution Sum System Analysis from Difference Equation Model; Stability of Systems.					
UNIT IV	DESIGN OF DIGITAL FILTERS				9
Design of IIR Filters From Analog Filters; Characteristics of Commonly Used Analog Filters; Frequency Transformation; IIR filters - Properties, Design of IIR Digital Filters using Bilinear Transformation; FIR filters - Characteristics of FIR filters with Linear Phase; Design of FIR Filters using Window Functions.					
UNIT V	DIGITAL SIGNAL PROCESSORS AND APPLCATION				9
Architecture of TMS320C54XX DSP - Addressing Modes, Instructions -Arithmetic Instructions, Move Instructions of 54X, Load/Store Instructions of 54X , Logical Instructions Control Instructions, Conditional Store Instructions and Programming; AI based Applications - Pipeline Operation, Code Composer Studio; Overview of the C5402 Based DSK.					
TOTAL PERIODS					45

COURSE OUTCOMES		
At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	classify and analyze various types of continuous and discrete-time signals and systems.	Understand (K2)
CO2	analyze continuous-time signals and evaluate system behavior using Fourier and Laplace transforms.	Understand (K2)
CO3	utilize DTFT, DFT, FFT, and Z-transform techniques for analysis of discrete-time signals and systems...	Apply (K3)
CO4	design and implement digital filters (IIR and FIR) to meet desired frequency specifications.	Apply (K3)
CO5	analyze and apply digital signal processor architectures and their programming for signal processing applications.	Apply (K3)

TEXT BOOKS

1. Alan V Oppenheim, Alan S Willsky, Hamid Nawab S , "Signals and Systems", 2nd edition, New Learning, New Delhi, 2015.
2. John G. Proakis, Dimitris K Manolakis , "Digital Signal Processing, 5th edition, Pearson Education, New Delhi, 2020.

REFERENCES

1. B Venkataramani, M.Bhaskar, "Digital Signal Processors Architecture, Programming and Applications", Second Edition, Pearson Education, 2012.
2. Emmanuel C Ifeachor, Barrie W Jervis, "Digital Signal Processing", Pearson Education, New Delhi, 2013.
3. Haykin S, Barry Van Veen, "Signals and Systems", John Wiley and sons, New Delhi, 2016.
4. Vinay K Ingle, John G Proakis , "Digital Signal Processing using MATLAB", Cengage Learning, New Delhi, 2012 .

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CO1	3	2	1	-	2	-	-	-	-	-	-	2	2	2
CO2	3	3	2	1	2	-	-	-	-	-	-	2	2	2
CO3	3	3	2	1	3	-	-	-	-	-	-	2	2	3
CO4	3	2	3	2	3	-	-	-	-	-	-	2	3	3
CO5	3	2	2	1	3	-	-	-	1	1	1	3	2	3



MT23552	DEEP LEARNING			3	0	0	3
COURSE OBJECTIVES							
To enable the students to							
1	learn the fundamentals of deep learning.						
2	understanding knowledge on machine learning.						
3	know the concept of neural networks.						
4	understanding knowledge on machine vision system and motion.						
5	acquire the knowledge of robot vision and Applications.						
UNIT I	INTRODUCTION						9
Historical Trends in Deep Learning; Machine Learning Basics; Linear Algebra basics - Principal components analysis; Probability and Information Theory-Probability Distributions; Random variables and marginal, Condition probability, Independence and conditional independence; Bayes' Rule Information Theory; Numerical Computation - Gradient, Based Optimization, Constrained Optimization.							
UNIT II	MACHINE LEARNING						9
Learning Algorithms - Capacity, Over fitting and Under fitting; Hyper parameters and Validation Sets; Estimators, bias and variance; Maximum Likelihood Estimation; Bayesian Statistics; Supervised Learning Algorithms - Unsupervised Learning Algorithms; Stochastic gradient descent; Building a Machine Learning Algorithm - Challenges Motivating Deep Learning.							
UNIT III	DEEP LEARNING AND NEURAL NETWORKS						9
Deep Feed forward Networks - Learning XOR; Gradient - Based Learning, Architecture Design; Back Propagation and Other Differentiation Algorithms; Optimization for Training Deep Models - Challenges in Neural Network Optimization and basic algorithm, Algorithms with adaptive learning rates and second order methods, Optimization strategies and Meta algorithms; Convolutional Networks basics.							
UNIT IV	3-D STRUCTURE AND MOTION						9
Introduction Stereopsis - Simple stereo system; Correspondence Problem - Basics, Correlation based method, Feature based method; Epipolar Geometry - Essential Matrix And Fundamental Matrix - Eight Point Algorithm; 3D Reconstruction by Triangulation and scale factor; Motion -Visual Motion and analysis; Motion Field of Rigid Objects; Notion of Optical Flow - Estimation of Motion Field, 3D Structure and Motion from Sparse and Dense Motion Fields, Motion Based Segmentation.							
UNIT V	ROBOT VISION APPLICATION						9
Robot vision - Open CV, Open NI and PCL; Installing and testing ROS camera drivers and open NI, open kinect drivers; Installing open CV on Ubuntu linux; ROS to Open CV - ROS2 to open CV2; Processing recorded video; Open CV - Face detection Color blob tracking (CAM Shift); Open NI and Skeleton tracking - Installing NITE and openni tracker for ROS indigo, Viewing skeleton in RViz; PCL Nodelets and 3D point clouds - Pass through filter, Combination more than one pass through filter and Voxelgrid filter.							
						TOTAL PERIODS	45

COURSE OUTCOMES														
At the end of this course, students will be able to		BT Mapped (Highest Level)												
CO1	recognize the core principles of deep learning.	Remember (K1)												
CO2	Illustrate how data is used in machine learning.	Understand (K2)												
CO3	develop a basic neural network using a programming framework.	Apply (K3)												
CO4	apply knowledge of machine vision systems and motion to analyze an automated process.	Apply (K3)												
CO5	investigate how robot vision systems influence automation performance.	Analyze (K4)												
TEXT BOOKS														
1. Ian Goodfellow, Youshua Bengo and Aaron Courville, "Deep Learning, Akexpertdecor", Education, Fifth Edition, New Delhi, 2016.														
2. Emanuele Trucco, Alessandro Verri, "Introductory Techniques for 3D Computer Vision", Prentice Hall, South Asia, 2006.														
REFERENCES														
1. R.Patrick Goebel "ROS by Example: A Do It Yourself Guide to Robot Operating System", Volume I A Pi Robot Production, 2012.														
2. Muthukumaran Malarvel, Soumya Ranjan Nayak, Surya Narayan Panda, Prasant Kumar Pattnaik Nittaya Muangnak, "Machine Vision Inspection Systems: Image Processing, Concepts, Methodologies and Applications", Volume 1, Scrivener Publishing LLC, 2020.														
3. E. R. Davies, "Machine Vision Theory, Algorithms, Practicalities", Elsevier Publication, 3rdEdition, 2004.														
4. Ramesh Jain, Rangachar Kasturi, Brian G. Schunck, "Machine Vision", McGraw-Hill, 2005.														
CO-PO MAPPING:														
Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
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CO1	3	2	-	-	1	-	-	-	-	-	-	2	2	1
CO2	3	3	-	-	2	-	-	-	-	-	-	2	2	2
CO3	2	2	2		3	-	-	-	-	-	1	2	1	3
CO4	2	3	3	2	3	-	-	-	-	-	-	2	3	3
CO5	2	3	3	3	3	1	-	-	1	1	2	2	3	3



MT23553	INTRODUCTION TO MACHINE LEARNING	3	0	0	3
COURSE OBJECTIVES					
To enable the students to					
1	understand the basics of machine learning and conditioning.				
2	identify the selection of artificial neural networks.				
3	determine the optimization of supervised learning & instance based learning.				
4	acquire the knowledge of algorithm and types.				
5	know about various reinforcement learning.				
UNIT I	MATHEMATICAL MODELLING OF MACHINE LEARNING				9
Introduction - Learning problems, Designing a learning system, Choosing the training experience and target function; Perspectives and issues in machine learning - Concept learning Task and Search, Finding maximally specific hypotheses; Remarks on Version spaces and candidate elimination algorithm; Inductive bias - Biased hypothesis space, Unbiased learner and the futility of bias free learning.					
UNIT II	PREDICTION & ARTIFICIAL NEURAL NETWORKS				9
Introduction - Decision tree representation, Problems for decision tree learning, Basic decision tree learning algorithms; Hypothesis space search in decision tree learning - Issues in decision tree learning; Artificial Neural Networks - Introduction, Neural Network Representations; Perceptron's - Multilayer network and Back propagation algorithm - Example; Remarks on the back propagation algorithm; Face Recognition example; Advanced topics on ANN; Fuzzy Logic - Fuzzy Control, Hybrid Systems.					
UNIT III	SUPERVISED LEARNING & INSTANCE BASED LEARNING				9
Bayesian learning - Bayes theorem, Concept learning, Maximum likelihood and Least Squared error hypothesis and hypothesis predicting probabilities; Minimum description length principle; Bayes optimal classifier; Gibbs algorithm; Naive bayes classifier - Example; Instance Based Learning; Introduction - K-Nearest neighbor learning-Distance weighted nearest neighbor algorithm, Locally weighted regression; Radial basis functions - Case based reasoning.					
UNIT IV	UNSUPERVISED LEARNING				9
Motivation - Genetic algorithms, Introduction, Representing hypotheses, Genetic operators, fitness and function selection - Example; Hypothesis space search - Population evolution and the schema theorem; Genetic programming - Representing programs and remarks genetic programme, Example; Models of evolution and learning - Lamarckian evolution and baltwin effect; Parallelizing genetic algorithms; Reinforcement learning Introduction - Q learning and algorithm; Non deterministic rewards and actions; Relationship between dynamic programming.					
UNIT V	LEARNING SETS OF RULES				9
Introduction - Sequential covering algorithms; Learning rule sets; Learning sets of First order rules and guiding the search in Foil, Learning recursive rules sets; Induction as inverted deduction - Inverting resolution, First order resolution, Inverting resolution and first order case, Generalization and progol; Analytical learning - Introduction, Inductive and analytical learning problems, Learning with perfect domain theories; Base learning.					
TOTAL PERIODS					45

COURSE OUTCOMES		
At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	recall the basics of machine learning and conditioning.	Remember (K1)
CO2	classify different types of artificial neural networks and explain their suitability for specific tasks.	Understand (K2)
CO3	demonstrate the application of optimization methods in real-world scenarios using supervised and instance-based learning techniques.	Apply (K3)
CO4	select and apply suitable algorithms based on the nature and requirements of the problem.	Apply (K3)
CO5	evaluate and classify different reinforcement learning methods based on efficiency in dynamic environments.	Analyze (K4)

TEXT BOOKS

1. Tom M. Mitchell, "Machine Learning", 1st Edition, McGraw-Hill Education (India), New York, 2017.
2. Alex Smola and S.V.N. Vishwanathan "Introduction to Machine Learning", Press Syndicate of The University of Cambridge, Fifth Edition, United Kingdom, 2010.

REFERENCES

1. Stephen Marsland, "Machine Learning - An Algorithmic Perspective", 2nd Edition, Chapman and Hall/CRC Press, United Kingdom, 2014.
2. Jiawei Han, Micheline Kamber, "Data Mining Concepts and Techniques", 3rd Edition, Elsevier, Morgan Kaufmann, 2012.
3. R. A. Collacott, "Mechanical Fault Diagnosis and Condition Monitoring", Chapman and Hall London A Halstead Press Book John Wiley & Sons, New York, 2015.
4. W.H. Tang, Q.H. Wu, "Condition Monitoring and Assessment of Power Transformers Using Computational Intelligence", Springer Verlag London, 2011.

CO-PO MAPPING:

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(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	-	-	-	-	-	-	-	-	-	-	2	2	1
CO2	3	2	-	-	2	-	-	-	-	-	-	2	2	2
CO3	3	2	-	-	3	-	-	-	-	-	-	2	2	3
CO4	3	3	2	-	3	-	-	-	-	-	-	2	1	3
CO5	2	3	2	2	3	-	-	-	-	-	-	3	2	3



MT23554	APPLIED IMAGE PROCESSING	3	0	0	3
COURSE OBJECTIVES					
To enable the students to					
1	understand the fundamental concepts of image formation and digital image processing techniques including geometric, photometric, and Fourier domain operations.				
2	know the feature detection, description, and matching for object localization and tracking.				
3	aware of various segmentation techniques including graph-based, region-based, and energy-based methods used in object boundary identification.				
4	understand the computational photography techniques like HDR, super-resolution, deblurring, and image matting.				
5	know the implement image recognition systems using traditional and AI-based methods, including object, face, and scene recognition...				
UNIT I	IMAGE FORMATION AND PROCESSING				9
Introduction; Geometric Primitives and Transformations - 2D Transformation, 3D Transformation; Photometric Image formation - Lighting, Reflectance and shading; The Digital camera; Introduction to image processing - Point Operators, Pixel Transform, Color Transform, Fourier Transform; Pyramids and Wavelets - Interpolation, Decimation; Geometric Transformations - Global Optimization.					
UNIT II	FEATURE EXTRACTION AND MATCHING				9
Introduction; Points and Patches - Feature Detectors, Feature Descriptors, Feature extraction; Filtering Techniques - Linear filtering, Low pass filter, Band pass filter, Feature Matching; Feature Tracking - Edges, Edge Detection, Edge Linking, Application - Edge Detecting and Enhancement; Lines - Successive Approximation, Hough Transforms, Vanishing Points, Application - Rectangle Detection.					
UNIT III	SEGMENTATION				9
Introduction; Active Contours - Snakes, Scissors, Level Sets; Split and Merge - Watershed, Region Splitting, Region Merging and Graph Based Segmentation; Mean Shift and Mode Finding; Normalized Cuts; Graph Cuts and Energy Based Methods; AI based Applications.					
UNIT IV	COMPUTATIONAL PHOTOGRAPHY				9
Photometric Calibration - Radiometric Response Function, Noise Level Estimation, Vignetting, Optical Blur; High Dynamic Range Imaging; Super Resolution and Blur Removal - Color image demosaicing, Application; Image Matting and Compositing - Blue Screen Matting, Natural Image Matting, Optimization based matting, Video Matting; Texture Analysis and Synthesis.					
UNIT V	IMAGE RECOGNITION				9
Object detection - Face detection, Pedestrian detection; Face recognition – Eigen faces, Active appearance and 3D shape models; Instance recognition - Geometric alignment, Large databases, Application - Location recognition; Category recognition - Bag of words, Part based models, Recognition with segmentation; Context and scene understanding - Learning and large image collections, Application- Image search.					
TOTAL PERIODS					45

COURSE OUTCOMES		
At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	understand geometric and photometric image formation; apply basic image processing techniques including transforms and color operations.	Understand(K2)
CO2	analyse and implement feature detection, matching, and tracking algorithms.	Analyse(K4)
CO3	apply segmentation techniques including active contours, graph-based methods, and AI-based approaches.	Apply(K3)
CO4	apply computational photography concepts such as HDR, blur removal, and matting for image enhancement.	Apply(K3)
CO5	design image recognition systems using descriptors, part-based models, and image collection.	Analyse(K4)

TEXT BOOKS

1. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer, 2010.
2. Hartley R, Zisserman A, "Multiple View Geometry in Computer Vision", Cambridge University Press, 2004.

REFERENCES

1. Forsyth D A, Ponce J, "Computer Vision: A Modern Approach", 2nd Edition Boston, 2005.
2. Duda R O, Hart P E, Stork D G, "Pattern Classification", Wiley, 2001.
3. Richard Sc "Computer Vision: Algorithms and Applications", Springer, 2010.
4. Simon J.D.Prince "Computer Vision: Models, Learning and Inference", Cambridge University Press, New York, 2014.

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CO1	3	2	2	1	3	-	-	-	-	-	-	1	3	3
CO2	3	3	3	2	3	-	-	-	1	-	-	2	3	3
CO3	3	3	3	2	3	-	-	-	1	-	-	2	3	3
CO4	3	2	2	1	3	-	-	-	-	-	-	1	2	3
CO5	3	3	3	2	3	-	-	-	2	1	1	2	3	3



MT23555	INTRODUCTION TO INTERNET OF THINGS	3	0	0	3
COURSE OBJECTIVES					
To enable the students to					
1	introduce the fundamentals, architecture, and real-time applications of IoT.				
2	understand M2M communication and IoT system management protocols.				
3	understand the IoT development methodology and device integration using Raspberry Pi.				
4	know the IIoT architecture, sensing, industrial processes, and AI applications in the context of industry 4.0.				
5	know the cloud computing and its integration with IoT through the Cloud of Things.				
UNIT I	INTRODUCTION AND APPLICATIONS				9
Introduction to IoT - Definition, Characteristics; Physical design - Things in IoT, IoT protocols; Logical Design - Functional blocks, Communication models, Communication APIs; Applications - Home Automation - Smart Lightning, Cities - Smart Parking, Smart Roads; Environment - Weather Monitoring, Air Pollution Monitoring; Agriculture - Smart Irrigation, Green House Control, Health and Life Style; Health & Fitness Monitoring.					
UNIT II	M2M AND SYSTEM MANAGEMENT				9
Introduction; M2M; Difference between M2M and IoT; SDN and NFV for IoT - Software Defined Networking, Network Function Virtualization; System Management - Need of IoT System Management, Simple Network Management Protocol (SNMP) - Limitations of SNMP, NETCONF, YANG, IoT Systems Management with NETCONF YANG, NETOPEER.					
UNIT III	DEVELOPING INTERNET OF THINGS				9
IoT Methodology - Purpose & Requirements Specification, Process Specification, Domain Model Specification, Information Model Specification, Service Specification, IoT Level Specifications, Fundamental View Specifications, Operational View Specifications, Device and Component Integration, Application Development; IoT Devices - Basic Building Blocks of an IoT Device, Raspberry Pi - About the Board, Linux on Raspberry Pi, Raspberry Pi Interfaces.					
UNIT IV	INDUSTRIAL INTERNET OF THINGS				9
Introduction - IIoT and Industry 4.0, IIC; Industrial Internet Systems - Design of industrial internet systems ,Impact of industrial internet, Benefits of industrial internet; Industrial sensing -Traditional sensing, Contemporary sensing; Industrial Processes - Features of IIoT for industrial processes, Industrial plant, The future architecture, Viewpoint of Industrial processes, Digital Enterprise, Applications of Industry 4.0; AI for the Industrial IoT - Introduction to AI powered industrial IoT, Predictive maintenance using AI, Electrical load forecasting in industry.					
UNIT V	THE CLOUD OF THINGS				9
Cloud Computing - Definition, Grid/SOA and Cloud Computing, Cloud Middleware, NIST's SPI Architecture and Cloud Standards, Cloud Providers and Systems; The Cloud of Things - The Internet of Things and Cloud Computing, Mobile Cloud Computing, MAI versus XaaS, The Long Tail and the Big Switch, The Cloud of Things Architecture.					
TOTAL PERIODS					45

COURSE OUTCOMES		
At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	describe the basic concepts, architecture, protocols, and applications of IoT.	Understand (K2)
CO2	explain M2M communication and system management technologies like SDN, NFV, SNMP, and YANG.	Understand (K2)
CO3	interpret the IoT system development methodology and describe the role of Raspberry Pi in device integration.	Understand (K2)
CO4	analyze the design, impact, and benefits of industrial internet systems.	Analyze (K4)
CO5	dissect cloud computing models and Cloud of Things architecture for effective IoT integration.	Analyze (K4)

TEXT BOOKS

1. Arshdeep Bahga, Vijay Madiseti, "Internet of Things a Hand-on Approach", Universities Press, 2015.
2. Honbo Zhou, "The Internet of Things in the Cloud: A Middleware Perspective", CRC Press 2012.

REFERENCES

1. Sudip Misra, Chandana roy, Anandarup Mukherjee, "Introduction to Industrial Internet of Things and Industry 4.0", CRC Press, Taylor & Francis Group, 2021.
2. Dr. Ovidiu Vermesan, Dr. Peter Friess, "Internet of Things: From research and innovation to market deployment", River Publishers, 2014.
3. Robert Barton, Patrick Grossetete, David Hanes, Jerome Henry, Gonzalo Salgueiro, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", CISCO Press, 2017.
4. Amita Kapoor, "Hands-on Artificial Intelligence for IoT", Packt, 2019.

CO-PO MAPPING:

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CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	1	-	2	1	-	-	-	2	-	2	2	2
CO2	3	2	2	1	3	-	-	-	-	1	-	2	2	3
CO3	2	2	3	-	3	-	-	-	-	1	1	3	3	3
CO4	2	3	3	2	3	2	2	-	-	2	1	3	3	3
CO5	2	2	3	2	3	-	-	-	-	2	1	3	3	3



MT23556	SOFT COMPUTING			3	0	0	3
COURSE OBJECTIVES							
To enable the students to							
1	assess the various types of neural networks.						
2	compute the pattern association algorithm in soft computing						
3	use the art and neural networks.						
4	demonstrate the use of fuzzy logic concepts in soft computing						
5	justify genetic algorithm in real time problems						
UNIT I	INTRODUCTION TO NEURAL NETWORKS						9
Differences between Biological and Artificial Neural Networks; Neural network - Typical Architecture, Setting the weights, Common Activation Functions; McCulloch Pitts Neuron - Architecture, Algorithm, Applications; Biases and thresholds - Linear Separability, Data representation; Hebb Net - Algorithm, Applications; Perceptron - Architecture, Algorithm, Application; Adaline and Madaline - Architecture, Algorithm, and Simple Applications.							
UNIT II	PATTERN ASSOCIATION						9
Training Algorithms for Pattern Association - Hebb rule for pattern association and Delta rule for pattern association, Hetero associative memory neural network, Architecture, Applications; Auto associative Net – Algorithm, Application, storage capacity; Iterative Auto associative Net - Recurrent linear auto associator, Brain state in a box, Auto associator with threshold function, Discrete hopfield net; Bidirectional Associative Memory – Architecture, Algorithm, Application.							
UNIT III	ADAPTIVE RESONANCE AND BACK PROPAGATION NEURAL NETWORKS						9
ART1 and ART2 - Basic Architecture, Basic Operation, Algorithm, Applications; Derivation of learning Rules, Boltzmann Machine - Continuous Hopfield net, Gaussian machine, Cauchy machine; Modified hebbian learning - Boltzmann machine with learning, Simple recurrent net; Back propagation in time - Architecture, Algorithm and Simple Applications.							
UNIT IV	CLASSICAL, FUZZY SETS AND RELATIONS						9
Classical sets - Operations of Classical Sets, Properties of Classical Sets, Mapping of Classical sets to functions; Fuzzy Sets - Fuzzy Set Operations, Properties Fuzzy Sets, Non interactive Fuzzy Sets, Alternative Fuzzy Set; Crisp Relations - Cardinality of Crisp Relations, Operation on Crisp Relations, Properties of Crisp relations; Fuzzy Relations - Cardinality, Properties and Operations, Composition, Tolerance and Equivalence Relations, Simple Applications.							
UNIT V	GENETIC ALGORITHM						9
Introduction - Genetic algorithm, Robustness of traditional optimization and search methods, Goals of optimization, Simple genetic algorithm; Computer implementation of genetic algorithm - Data structures, Reproduction, Crossover and Mutation, Fitness scaling, Coding, Discretization, Constraints; Advanced operations and techniques in genetic search - Inversion and other reordering operations, other micro operators, Multi objective optimization, Knowledge based techniques.							
						TOTAL PERIODS	45

COURSE OUTCOMES														
At the end of this course, students will be able to		BT Mapped (Highest Level)												
CO1	understand fundamental concepts and architectures of neural networks, including perceptron models and learning algorithms.	Understand (K2)												
CO2	apply training algorithms for pattern association in various associative memory networks.	Apply (K3)												
CO3	comprehend adaptive resonance theory and back propagation networks along with boltzmann machine learning principles.	Analyze (K4)												
CO4	understand properties and operations of classical and fuzzy sets and relations, including crisp and fuzzy relations.	Understand (K2)												
CO5	grasp the working principles, coding, and operators of genetic algorithms and their application in optimization problems.	Apply (K3)												
TEXT BOOKS														
1. Laurene Fausett., “Fundamentals of Neural Networks Architectures, Algorithms and Applications”, Dorling Kindersley (India) Pvt. Ltd, New Delhi, 2013.														
2. David E. Goldberg, “Genetic Algorithms in Search, Optimization & Machine Learning”, Dorling Kindersley (India) Pvt. Ltd, New Delhi, 2013.														
REFERENCES														
1. S.N.Sivanandam and S.N.Deepa, Principles of Soft Computing, Wiley India(P) Ltd, 2011.														
2. Timothy J.Ross, Fuzzy Logic with Engineering Applications, McGraw-Hill, 2011.														
3. Davis E.Goldberg, Genetic Algorithms: Search, Optimization and Machine Learning, Addison Wesley, N.Y., 2009.														
4. Jang.J.S.R., Sun.C.T.and Mizutami.E, Neuro fuzzy and Soft computing, Prentice Hall, New Jersey 2015.														
CO-PO MAPPING:														
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(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
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	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	3	-	2	-	-	-	-	-	-	1	3	2
CO2	3	2	3	2	2	-	-	-	-	-	-	2	3	3
CO3	3	2	3	3	2	-	-	-	-	-	-	2	3	3
CO4	2	2	2	-	2	-	-	-	-	-	-	1	2	2
CO5	3	3	2	3	3	-	-	-	-	-	-	2	3	3



MT23557	ARTIFICIAL INTELLIGENCE FOR MECHATRONICS	3	0	0	3	
COURSE OBJECTIVES						
To enable the students to						
1	familiarize with the concepts of artificial intelligence techniques.					
2	learn neural network technology that supports in decision making.					
3	learn the concepts of genetic algorithms.					
4	familiarize fuzzy techniques for building well engineered and effective artificial intelligence systems.					
5	create AI techniques in the fields of chaos and fractural.					
UNIT I	OVERVIEW OF THE FIELD OF ARTIFICIAL INTELLIGENCE				9	
Introduction to Artificial Intelligence - Neural Network, Neuron, Basic Idea of the Back Propagation Model; Details of the Back Propagation Model - A Cookbook Recipe to Implement the Back Propagation Model, Additional Technical Remarks on the Back Propagation Model, Simple Perceptions, Applications of the Back Propagation Model and General Remarks on Neural Networks.						
UNIT II	NEURAL NETWORKS				9	
Prelude - Associative Memory, Hopfield Networks, The Hopfield, Tank Model for Optimization Problems , One dimensional layout, Two dimensional layout, Applications of Hopfield; Tank Model - Queen problem, Traveling Salesman problem; The Kohonen model - Simulated Annealing, Boltzmann Machines, Unsupervised learning by the Boltzmann machine, Basic structure and algorithms.						
UNIT III	GENETIC ALGORITHMS AND EVOLUTIONARY COMPUTING				9	
Fundamentals of Genetic Algorithms and Evolutionary computing - Simple Illustration of Genetic Algorithm, Optimization using Gas, Travelling Salesman Problem, Similarities and Dissimilarities; Schemata - Changes of Schemata over generations, Example of Schema processing, Examples of Selection, Genetic Programming.						
UNIT IV	FUZZY SYSTEMS				9	
Fundamentals of fuzzy sets - Basic fuzzy set relations, Basic fuzzy operations and their properties, Operations unique to fuzzy sets; Fuzzy Relations - Fuzzy relations defined on ordinary sets, Fuzzy relation derived from fuzzy sets; Fuzzy Logic - Fuzzy Control, Hybrid Systems, Fuzziness, Possibility and Uncertainty, Rough Sets, Knowledge Representations Systems.						
UNIT V	CHAOS				9	
Fundamentals of Chaos - Representing Dynamical Systems, Discrete dynamical systems, Continuous dynamical systems; Trajectory - Orbit and flow, Cobwebs, Equilibrium Solutions and Stability; Attractors - Fixed point attractors, Periodic attractors, Quasi periodic attractors, Chaotic attractors; Bifurcations - Fractals, Applications of Chaos.						
					TOTAL PERIODS	45
COURSE OUTCOMES						
At the end of this course, students will be able to					BT Mapped (Highest Level)	
CO1	interpret the role of AI techniques for building intelligent systems and solve engineering problems.				Understand (K2)	

CO2	apply concepts of neural networks for pattern recognition.	Apply (K3)
CO3	examine genetic algorithms for optimization and learning.	Understand (K2)
CO4	design fuzzy systems for reasoning under uncertainty.	Analyze (K4)
CO5	demonstrate the ability to understand and apply chaos theory in analyzing and solving dynamic systems that exhibit chaotic behavior.	Apply (K3)

TEXT BOOKS

1. Toshinori Munakata, "Fundamentals of the New Artificial Intelligence," 2nd Edition, Springer, 2008.
2. Uma Rao, "Artificial Intelligence and Neural Networks," Pearson Education, Asia, 2011.

REFERENCES

1. Sivanandam and Deepa, "Introduction to Genetic Algorithms," Springer, 2008.
2. Timothy J. Ross, "Fuzzy Logic with Engineering Applications," 3rd Edition, John Wiley & Sons Ltd., New Delhi, 2011.
3. S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach," Prentice Hall, Third Edition, 2009.
4. I. Bratko, "Prolog: Programming for Artificial Intelligence," Fourth edition, Addison-Wesley Educational Publishers Inc., 2011.

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CO1	3	2	-	-	2	-	-	-	-	-	-	1	3	2
CO2	3	3	2	-	2	-	-	-	-	-	-	1	2	3
CO3	3	3	3	2	2	-	-	-	-	-	-	2	2	3
CO4	3	3	2	-	3	-	-	-	-	-	-	2	2	3
CO5	3	2	3	2	2	-	-	-	-	-	-	2	2	3



VERTICAL VI - AVIONICS AND DRONE TECHNOLOGY

MT23651	AVIONICS	3	0	0	3	
COURSE OBJECTIVES						
To enable the students to						
1	introduce the basic and needs of avionics systems.					
2	impart knowledge about the avionic architecture and various avionics data buses.					
3	gain more knowledge on various avionics subsystems.					
4	understand the concepts of navigation systems.					
5	gain knowledge on auto pilot system.					
UNIT I	INTRODUCTION TO AVIONICS				9	
Importance and Role of Avionics - Systems Interface with Pilot, Aircraft State Sensor Systems, Navigation Systems, Outside World Sensor Systems, Task Automation Systems; The Avionic Environment - Minimum Weight, Environmental Requirements. Flight Management Systems - Navigation, Flight Planning, Operational Modes, 4D Flight Management.						
UNIT II	DIGITAL AVIONICS ARCHITECTURE				9	
Introduction to Data Bus Systems - Electrical Data Bus Systems - MIL STD 1553 Bus System, ARINC 429; Optical Data Bus Systems - STANAG 3910 Data Bus System; Parallel Data Bus; Integrated Modular Avionics Architectures - Civil Integrated Modular Avionic Systems; Commercial Off-the-Shelf (COTS).						
UNIT III	FLIGHT DECKS AND COCKPITS				9	
Control and display technologies - Tactile Control Panels, Direct Voice Input, Speech Output System, Eye Trackers; HUD - Principles, Civil Aircraft HUDs; HMD - Design Factors, Display, Tracking System and Virtual Cockpit; HDD - Civil cockpit and military cockpit, Solid State Standby Display Instrument; Intelligent Displays Management.						
UNIT IV	NAVIGATION SYSTEMS				9	
Introduction and Basic Principles; Inertial Navigation - Principles and Schuler Tuning, Platform Axes, Initial Alignment and Gyro Compassing, Vertical Navigation Channel, Strap down IN System Computing; GPS - GPS System Description, Basic Principles of GPS, Integration of GPS and INS; Terrain Reference Navigation - Civil Exploitation of TRN.						
UNIT V	AIR DATA SYSTEMS AND AUTO PILOT				9	
Air Data Quantities and its Importance; Air Data Laws and Relationships - Altitude and Static Pressure Relationship, Variation of Ground Pressure, Speed of Sound, Mach Number, Static Air Temperature, Pressure Error; Autopilots - Basic Principles, Height Control, Heading Control Autopilot Automatic Landing, Satellite Landing Guidance Systems, Speed Control and Auto Throttle Systems.						
					TOTAL PERIODS	45
COURSE OUTCOMES						
At the end of this course, students will be able to					BT Mapped (Highest Level)	
CO1	explain the importance and role of avionics in modern aircraft.				Understand (K2)	

CO2	integrate avionics system using digital data buses.	Apply (K3)
CO3	apply various cockpit display technologies for avionics.	Apply (K3)
CO4	design and build navigation systems.	Analyze (K4)
CO5	design autopilot for small aircrafts.	Analyze (K4)

TEXT BOOKS

1. R.P.G. Collinson, "Introduction to Avionics", 3rd Edition, Chapman & Hall Publications, New York, 2011.
2. Albert Helfrick.D., "Principles of Avionics", Avionics Communications Inc., 2004.

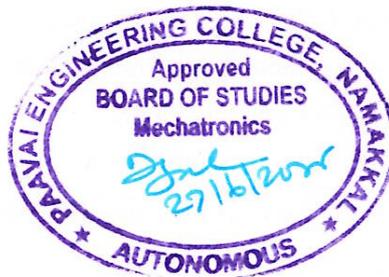
REFERENCES

1. Pallet.E.H.J., "Aircraft Instruments and Integrated Systems", Pearsons, Indian edition 2011.
2. Middleton, D.H., Ed., "Avionics systems, Longman Scientific and Technical", Longman Group UK Ltd., England, 2006.
3. Spitzer, C.R. "Digital Avionics Systems", Prentice-Hall, Englewood Cliffs, N.J.,U.S.A. 2003.
4. Spitzer. C.R. "The Avionics Hand Book", CRC Press, 2007.

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CO2	3	2	2	2	3	-	-	-	1	2	1	3	3	3
CO3	2	2	3	2	3	-	-	1	2	3	1	2	3	3
CO4	3	3	3	3	3	-	-	-	2	2	2	3	3	3
CO5	3	3	3	3	3	1	1	-	2	2	2	3	3	3



MT23652	DRONE TECHNOLOGY				3	0	0	3
COURSE OBJECTIVES								
To enable the students to								
1	understand the basics of drone concepts.							
2	learn and understand the fundamentals of design, fabrication and programming of drone.							
3	impart the knowledge of an flying and operation of drone.							
4	know about the various applications of drone.							
5	understand the safety risks and guidelines of fly safely.							
UNIT I	INTRODUCTION TO DRONE TECHNOLOGY							9
Introduction - Brief History of Autonomous Flight, RC Model Airplane; The Advent of Microchips - Drones Technology, Launch of GPS internet, Smartphone; Small Autopilot Flight Controller - Principles of Flight, Gravity, Lift , Drag, Thrust, Flight Man oeuvres; Aircraft Movement with Stick Mapping - Throttle, Yaw/Rudder, Pitch, Roll; Airframes - Thrust Vectoring, Aircraft Designs, Materials, Building the Little Dipper Airframe, Step by Step Build Instructions.								
UNIT II	DRONE DESIGN, FABRICATION AND PROGRAMMING							9
Propellers - Direction, Size and Pitch, Balancing Props, Motors, Sizes, kV Rating; Pairing with the Right Props - Total Lift, Electronic Speed Controllers, Flight Battery; Step by Step Build Instructions - Mount the Power Distribution Board (PDB), Solder on the Bullet Connectors, Mount the Speed Controllers, Solder up the Power Supply, Mount Brushless Motors, Connect Brushless Motors, Clean Up, Wrapping Up.								
UNIT III	DRONE FLYING AND OPERATION							9
Flight Controller; Open Source Versus Closed Source – Sensors, Flight Characteristics; Software Assistant - Step by Step Build Instructions, Mount the Flight Controller, Wire up the Flight Controller Outputs; Attach the Two Sub frames to Each Other - Wrapping Up, GPS, Compass, and Battery Monitor, GPS, Flight Modes, Battery Monitor, Step by Step Build Instructions.								
UNIT IV	DRONE COMMERCIAL APPLICATIONS							9
Transmitter - Most Common Frequency Bands, Different Modes Around the World, PWM Versus PPM; Step by Step Build Instructions - Telemetry Radios, Software Monitoring and Control; Step by Step Build Instructions - Mount the Ground Station Radio, Prep the Aircraft Radio for Mounting, Plug in the Radio, Mount the Aircraft Radio; Camera and FPV Equipment - Popular Drone Cameras, Micro Four Thirds Cameras, the Mobius Action am, FPV for a live stream.								
UNIT V	FUTURE DRONES AND SAFETY							9
Safe and Responsible Flight; Training and Education - Resources, Links, Key Flight Safety Rules; Person View - Where and When to Fly, Preflight Checklist and Flight Log Information, Aircraft Inspection, Flight and Maintenance Logs, Laws and Regulations; Real World Applications - Beneficial Drones, Aerial Photography, Mapping and Surveying, Precision Agriculture, Search and Rescue, Infrastructure Inspection, Conservation.								
							TOTAL PERIODS	45
COURSE OUTCOMES								
At the end of this course, students will be able to							BT Mapped (Highest Level)	
CO1	understand the basics of drone technology, flight principles, and airframe design.						Understand (K2)	

CO2	explain drone components, fabrication steps, and propulsion system details.	Understand (K2)
CO3	apply the knowledge of drone components and flight controller configurations to assemble and operate a basic drone system including GPS, compass, and battery monitoring features.	Apply(K3)
CO4	identify drone communication systems, telemetry, and camera applications.	Apply(K3)
CO5	analyze the safety protocols, legal regulations, and real-world applications of drone operations to ensure responsible and effective usage in diverse environments.	Analyze(K4)

TEXT BOOKS

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

REFERENCES

1. John Baichtal, "Building Your Own Drones: A Beginners Guide to Drones, UAVs, and ROVs", Que Publishing, 2016.
2. Završnik, "Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance", Springer, 2018.
3. Terry Kilby, "Make: Getting Started with Drones", Maker Media, Inc, 2015.
4. Robert C. Nelson "Flight stability & Automatic Control", McGraw-Hill 2010.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2	-	2	-	-	-	-	1	-	2	2	1
CO2	3	2	2	1	3	-	-	-	1	1	-	2	2	3
CO3	3	3	3	2	3	-	-	-	2	2	1	2	3	3
CO4	3	2	2	1	3	-	-	-	2	2	1	2	2	3
CO5	2	3	2	2	2	3	2	2	2	2	2	3	2	2



MT23653	GUIDANCE AND CONTROL			3	0	0	3
COURSE OBJECTIVES							
To enable the students to							
1	learn about the aircraft equations of motion and method of linearization.						
2	study about the Longitudinal Autopilots and Lateral Dynamics.						
3	determine the optimum solution for lateral autopilots.						
4	acquire the knowledge of missile control systems and guidance Systems.						
5	understand the concept of integrated flight and fire control system.						
UNIT I	INTRODUCTION						9
Introduction - The Meaning of Velocities in a Moving Axis System; Development of the Equations of Motion; Aircraft Attitude with Respect to the Earth - linearization and Separation of the Equations of Motion; Derivation of Equations for the Longitudinal Stability Derivatives - Solution of the Longitudinal Equations, Longitudinal Transfer Function for Elevator Displacement; Transient Response of the Aircraft - Effect of Variation of Stability Derivatives on Aircraft Performance.							
UNIT II	LONGITUDINAL AUTOPILOTS						9
Displacement Autopilot - Pitch Orientation Control System, Acceleration Control System, Glide Slope Coupler and Automatic Flare Control; Flight Path Stabilization - Vertical Gyro as the Basic Attitude Reference, Gyro Stabilized Platform as the Basic Attitude Reference; Effects of Nonlinearities; Lateral Dynamics - Lateral Equations of Motion, Solution of Lateral Equations, Lateral Transfer Function for Aileron Displacement.							
UNIT III	LATERAL AUTOPILOTS						9
Introduction - Damping of the Dutch Roll; Methods of Obtaining Coordination - Discussion of Coordination Techniques; Yaw Orientation Control System; Other Lateral Autopilot Configurations - Tum Compensation, Automatic Lateral Beam Guidance, Nonlinear Effects; Inertial Cross - Coupling, Effects of High Roll Rate; Determination of the aircraft subject to inertial cross coupling.							
UNIT IV	MISSILE CONTROL SYSTEMS AND GUIDANCE SYSTEMS						9
Introduction - Roll Stabilization, Control of Aerodynamic Missiles, Transfer Function for a Ballistic; Type Missile; Vanguard Control System (Rigid Missile) - Alternate Missile Control System; Guidance Systems - Proportional Navigation Guidance, Command Guidance, Comparison of Guidance System Performance; Bank to Tum Missile Guidance, Short/Medium - Range BIT Missile.							
UNIT V	INTEGRATED FLIGHT AND FIRE CONTROL SYSTEM						9
Introduction - Director Fire Control System, Longitudinal Flight Control System; Lateral Flight Control System; Verification of lateral control system analysis - Velocity Control System, Movable Gun Control, Gimballed Tracker Design, Tracking Control Laws (TCL), Discrete Analysis; Simulation results.							
						TOTAL PERIODS	45
COURSE OUTCOMES							
At the end of this course, students will be able to						BT Mapped (Highest Level)	
CO1	recall the meanings of lift, drag, and moment coefficients used in aircraft stability and control.					Remember (K1)	

CO2	investigate the aircraft's response along the lateral axis to assess the effects on directional stability and control.	Understand (K2)
CO3	apply robust control methodologies to enhance the lateral autopilot's performance and disturbances in the aircraft's dynamics.	Apply (K3)
CO4	develop autopilot systems for missiles and implement control laws to achieve desired flight performance.	Apply (K3)
CO5	apply feedback control techniques to enhance aircraft and sideslip angle control to improve dynamic response.	Analyze (K4)

TEXT BOOKS

1. Blakelock, J. H., "Automatic Control of Aircraft and Missiles", 2nd Ed., John Wiley & Sons, 2015.
2. Collinson R.P.G, "Introduction to Avionics", Chapman and Hall, India, 2017.

REFERENCES

1. Garnel. P. & East. D. J, "Guided Weapon control systems", Pergamon Press, Oxford, 2007.
2. Michael V. Cook, "Flight Dynamics Principles: A Linear Systems Approach to Aircraft Stability and Control", Elsevier, 2010.
3. Nelson R.C, "Flight stability & Automatic Control", McGraw Hill, 2009.
4. Pierre T. Kabamba, Anouck R. Girard., "Fundamentals of Aerospace Navigation and Guidance", Cambridge university press, 2014.

CO-PO MAPPING:

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CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	-	-	-	-	-	-	-	-	-	-	2	2	2
CO2	3	3	-	-	-	-	-	-	-	-	-	2	2	2
CO3	3	3	2		2	-	-	-	-	-	-	2	2	2
CO4	3	2	3		3	-	-	-	-	-	2	2	2	2
CO5	3	3	2	2	2	-	-	-	-	-	-	2	2	2



MT23654	NAVIGATION AND COMMUNICATION SYSTEM	3	0	0	3
COURSE OBJECTIVES					
To enable the students to					
1	introduce navigation and communication system.				
2	understand the navigation system.				
3	learn the concepts of transmitters and receivers.				
4	apply knowledge of VHF navigation and HF navigation system.				
5	acquire knowledge about weather radar systems and ATCS.				
UNIT I	INTRODUCTION				9
The Radio Frequency Spectrum; Electromagnetic Waves; Frequency And Wavelength; The Atmosphere; Radio Wave Propagation; The Ionosphere; MUF And LUF; Silent Zone And Skip Distance; Antennas - The Isotropic Radiator, The Half-Wave Dipole, Impedance And Radiation Resistance, Radiated Power And Efficiency, Antenna Gain, The Yagi Beam Antenna, Feeders, Connectors, Standard Wave Ratio, Waveguide, Vector Network Analysis.					
UNIT II	RADIO NAVIATION & SATELLITE NAVIGATION				9
Doppler Navigation; Area Navigation - RNAV, Kalman Filters, Required Navigation Performance; Inertial Navigation Systems – Principles, System Description, Alignment Process, Inertial Navigation Accuracy; Global Navigation Satellite System - GPS, Principles of Wave Propagation, GPS Segments, GPS Signals, GNSS Operation.					
UNIT III	TRANSMITTERS AND RECEIVERS				9
A Simple Radio System; Modulation and Demodulation; AM Transmitters; FM Transmitters; Tuned Radio Frequency Receivers; Superhet Receivers; Selectivity; Image Channel Rejection; Automatic Gain Control; Double Superhet Receivers; Digital Frequency Synthesis; A Design Example; Software Defined Radio; Emergency Locator Transmitters - Types of ELT, Maintenance and Testing of ELT, ELT Mounting Requirements, Typical ELT, Cospas, Sarsat Satellites.					
UNIT IV	AIRCRAFT COMMUNICATION SYSTEMS				9
VHF Communications - VHF Range and Propagation, DSB Modulation, Channel Spacing, Depth of Modulation, Compression, Squelch, Data Modes, ACARS, VHF Radio Equipment; HF Communications - HF Range and Propagation, SSB Modulation, SELCAL, HF Data Link, HF Radio Equipment, HF Antennas and Coupling Units; Flight Deck Audio Systems - Flight Interphone System, Cockpit Voice Recorder.					
UNIT V	WEATHER RADAR & AIR TRAFFIC CONTROL SYSTEM				9
Weather Radar - Airborne Equipment, Precipitation and Turbulence, System Enhancement, Lightning Detection; Air Traffic Control System - ATC Transponder Modes, Airborne Equipment, System Operation, Automatic Dependent Surveillance Broadcast (ADS B), Communications, Navigation And Surveillance/Air Traffic Management (CNS/ATM).					
TOTAL PERIODS					45

COURSE OUTCOMES		
At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	recall and explain electromagnetic wave propagation and antenna characteristics.	Remember (K1)
CO2	illustrate and analyze various radio and satellite navigation techniques.	Understand (K2)
CO3	describe and evaluate transmitter and receiver technologies.	Understand (K2)
CO4	apply concepts of aircraft communication systems including VHF and HF operations.	Apply (K3)
CO5	analyze weather radar and air traffic control systems for aviation applications.	Analyze (K4)

TEXT BOOKS

1. Mike Tooley and David Wyatt, "Aircraft Communications and Navigation systems", Reed Elsevier, India, Noida, 2007.
2. Michael H. Tooley, David Wyatt, "Aircraft communications and navigation systems: principles, operation and maintenance", Butterworth-Heinemann, 2007.

REFERENCES

1. Chris Binns, Wiley, "Aircraft Systems: Instruments, Communications, Navigation, and Control", 2019
2. Thomas K Eismen, "Aircraft Electricity and electronics", McGraw- Hill Book Co, 2004.
3. Diane Vaughan, "Dead Reckoning: Air Traffic Control, System Effects, and Risk", University of Chicago Press, 2021.
4. James Powell, "Aircraft Radio system", Sterling book house, Mumbai, Indian edition, 2006.

CO-PO MAPPING:

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CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	-	-	-	2	-	-	-	-	-	-	1	2	2
CO2	2	3	-	-	3	-	-	-	-	-	-	1	2	2
CO3	2	2	-	-	3	-	-	-	-	-	-	1	2	2
CO4	2	2	-	1	3	-	-	-	-	1	-	1	2	2
CO5	2	3	-	2	3	2	-	-	-	1	-	1	2	3



MT23655	DESIGN OF UAV	3	0	0	3
COURSE OBJECTIVES					
To enable the students to					
1	understand the basic concepts, history, and evolution of UAS.				
2	learn the classifications and types of unmanned aircraft.				
3	explore uas components: airframe, propulsion, avionics, communication, and ground control.				
4	understand regulatory, ethical, and safety considerations.				
5	introduce applications of UAS in various sectors like agriculture, defense, and logistics.				
UNIT I	INTRODUCTION TO UNMANNED AIRCRAFT SYSTEMS				9
Introduction of UAS - System Composition, Conceptual Phase, Preliminary Design, Detail Design Selection of the System, Applications of UAS.					
UNIT II	DESIGN OF UAV SYSTEMS				9
UAV System - Long endurance, Long range Role Aircraft , Medium range, Tactical Aircraft Close range/Battlefield; Aircraft - MUAV Types, MAV and NAV Types, UCAV, Novel Hybrid Aircraft Configuration - Research UAV.					
UNIT III	DEVELOPMENT OF UAV SYSTEMS				9
System Development - Certification, Establishing Reliability; UAV Component Testing - UAV Sub assembly and Sub system Testing, Testing Complete UAV, Control Station Testing, Catapult Launch System Tests, Documentation, Test Sites, Preparation for In-flight Testing.					
UNIT IV	DEPLOYMENT OF UAV SYSTEMS				9
Introduction to Network Centric Operations (NCO) - Teaming with Manned and Other Unmanned Systems; Naval Roles - Fleet Detection and Shadowing, Radar Confusion, Missile Decoy, Anti-submarine Warfare; Port Protection - Army Roles, Covert Reconnaissance and Surveillance, Fall-of-shot Plotting, Target Designation by Laser, NBC Contamination Monitoring, IED and Landmine Detection and Destruction.					
UNIT V	UAS FUTURE				9
Introduction to Operation in Civilian Airspace - Power plant Development, Developments in Airframe Configuration; Autonomy and Artificial Intelligence - Improvement in Communication Systems, References; Case Study - Autonomous Drone Swarms for Defense, AI-Enabled UAS in Smart Farming, UAS in Healthcare Logistics.					
				TOTAL PERIODS	45
COURSE OUTCOMES					
At the end of this course, students will be able to				BT Mapped (Highest Level)	
CO1	understand uas concepts, applications, system composition, and design phases.			Understand (K2)	
CO2	analyze uav designs by role, range, and classification.			Analyze (K4)	
CO3	uav development, testing, certification, and documentation processes.			Understand (K2)	
CO4	analyze uav deployment in military operations and network-centric environments.			Analyze (K4)	

CO5	assess future uas trends including civilian integration, autonomy, and technology advances.	Analyze (K4)												
TEXT BOOKS														
1. Rag Austin “unmanned aircraft systems UAV design, development and deployment”, Wiley, 2010.														
2. Robert C. Nelson, Flight Stability and Automatic Control, McGraw-Hill, Inc, 2008.														
REFERENCES														
1. Armand J. Chaput, “Design of Unmanned Air Vehicle Systems”, Lockheed Martin Aeronautics Company, 2011.														
2. Kimon P. Valavanis, “Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy”, Springer, 2007.														
3. Paul G Fahlstrom, Thomas J Gleason, “Introduction to UAV Systems”, UAV Systems, Inc, 2008.														
4. Daniel Tal, Jon Altschuld, “Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation”, John Wiley & Sons, 2011.														
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Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	1	-	2	2	1	2	-	1	-	2	2	1
CO2	3	3	3	2	2	-	-	-	1	1	-	2	3	2
CO3	3	2	3	2	3	1	-	2	1	1	1	2	3	2
CO4	2	3	3	2	2	3	2	2	1	2	2	2	2	2
CO5	2	3	2	2	3	2	3	2	-	1	1	3	2	3



MT23656	AERODYNAMICS OF DRONES	3	0	0	3	
COURSE OBJECTIVES						
To enable the students to						
1	introduce students to the basic concepts of payloads in UAV.					
2	understand the various sensor system of an UAV.					
3	introduce with the concepts of data algorithms and architectures.					
4	introduce the concepts of artificial neural networks.					
5	expose students to the concept of fuzzy logic.					
UNIT I	PAYLOAD FOR UAV				9	
Introduction to Unmanned Aircraft Systems (UAS) - Payload, Nondispensable, Electro optic Payload Systems, Electro optic systems integration, Radar Imaging Payloads, Other Nondispensable Payloads; Dispensable Payloads; Payload Development.						
UNIT II	SENSOR				9	
Data fusion applications to multiple sensor systems - Selection of sensors, Benefits of multiple sensor systems, Influence of wavelength on atmospheric attenuation, Fog characterization; Effects of operating frequency on MMW sensor performance - Absorption of MMW energy in rain and fog, Backscatter of MMW energy from rain; Effects of operating wavelength on IR sensor performance, Visibility metrics - Atmospheric and sensor system computer simulation models.						
UNIT III	DATA FUSION ALGORITHMS AND ARCHITECTURES				9	
Definition of data fusion - Level 1 processing, Detection, classification, and identification algorithms for data fusion; State estimation and tracking algorithms for data fusion, Level 2, 3, and 4 processing, Data fusion processor functions; Definition of architecture - Data fusion architectures, Sensor-level fusion, Central-level fusion, Hybrid fusion.						
UNIT IV	ARTIFICIAL NEURAL NETWORKS				9	
Applications of artificial neural networks - Adaptive linear combiner - Linear classifiers - Capacity of linear classifiers - Nonlinear classifiers - Madaline - Feedforward network - Capacity of nonlinear classifiers - Supervised and unsupervised learning - Supervised learning rules - Voting Logic Fusion.						
UNIT V	FUZZY LOGIC AND FUZZY NEURAL NETWORKS				9	
Conditions under which fuzzy logic provides an appropriate solution - Illustration of fuzzy logic in an automobile antilock braking system - Basic elements of a fuzzy system - Fuzzy logic processing - Fuzzy centroid calculation, Balancing an Inverted Pendulum with Fuzzy Logic Control, Fuzzy Logic Applied to Multi-target Tracking, Scene Classification Using Bayesian Classifiers and Fuzzy Logic, Fusion of Fuzzy-Valued Information from Multiple Sources, Fuzzy Neural Networks.						
					TOTAL PERIODS	45
COURSE OUTCOMES						
At the end of this course, students will be able to					BT Mapped (Highest Level)	
CO1	calculate the payloads in UAV.				Apply (K3)	

CO2	explain the concepts sensor systems.	Understand (K2)
CO3	predict the data fusion algorithms and architectures.	Apply (K3)
CO4	learn the basics neural network systems.	Understand (K2)
CO5	design various network schemes.	Analyze (K4)

TEXT BOOKS

1. Reg Austin Aeronautical Consultant, AJohn “Unmanned aircraft systems UAVs design, development and deployment” Wiley and Sons, Ltd., Publication, 2010.
2. Lawrence A. Klein, “Sensor and Data Fusion: A Tool for Information Assessment and Decision Making”, Second Edition, SPIE Press, 2013.

REFERENCES

1. Martin Liggins II David Hall, James, “Handbook of Multisensor Data Fusion: Theory and Practice”, Second Edition (Electrical Engineering & Applied Signal Processing Series), 2008.
2. Jitendra R. Raol, “Multi-Sensor Data Fusion with MATLAB”, CRC Press, 2010.
3. David L. Hall, Sonya A. H. McMullen, “Mathematical Techniques in Multi-sensor Data Fusion”, by Artech, 2004.
4. Paul G. Fahlstrom, Thomas J. Gleason, “Introduction to UAV Systems”, Wiley 4th Edition, 2012.

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CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2	-	2	-	-	-	-	-	-	2	3	2
CO2	3	2	-	-	2	-	-	-	-	-	-	2	2	3
CO3	3	3	2	2	3	-	-	-	-	-	-	3	3	3
CO4	2	2	-	-	3	-	-	-	-	-	-	3	2	3
CO5	3	3	3	2	3	-	-	-	-	-	2	3	3	3



MT23657	AIRCRAFT MECHATRONICS	3	0	0	3	
COURSE OBJECTIVES						
To enable the students to						
1	introduce the basic of avionics and its need for civil and military aircrafts.					
2	impart knowledge on avionic architecture and various avionics data bases.					
3	know the potential failure modes in flight control systems.					
4	familiar in navigation data and assess the performance.					
5	know the application of mechatronics in aircraft.					
UNIT I	AIRCRAFT AERODYNAMICS				9	
Continuity Equation; Incompressible and Compressible Flow; Speed of Sound; Measurement of Airspeed; Airfoil Nomenclature; Lift and Drag; Infinite versus Finite Wings; Pressure Coefficient; Elements of Airplane performance - Drag Polar, Thrust/Power available, Rate of Climb, Gliding Flight, Range and Endurance Jet Airplane, take off and landings performance.						
UNIT II	AIRCRAFT PROPULSION				9	
Introduction; Propeller; Reciprocating Engine; Jet Propulsion - The Thrust Equation; Turbojet Engine - Thrust Buildup for a Turbojet Engine; Turbofan Engine; Ramjet Engine; Rocket Engine; Rocket Propellants - Liquid Propellants, Solid Propellants; Quest for Engine Efficiency - Propulsive Efficiency, The Green Engine.						
UNIT III	PRIMARY FLIGHT CONTROLS				9	
Air Data - Atmospheric Temperature and pressure, Air speed, sensors, Temperature, pilot and static system, Angle of Attack Indicator, Air Data Computer System; Flight control system - Introduction; Control Systems; Servo Motors; Flight Control System Modes; FCS Control Panel; Aircraft Dynamics; Yaw Damper, Fly By Wire, Inertial Navigation; The Stabilized Platform; Improving Long Term Accuracy of INS; Accelerometers; Lightwave Gyros.						
UNIT IV	NAVIGATION SYSTEMS				9	
Terrestrial En Route Radio Navigation - VOR Ground Station, VOR Receiver, VOR Test Equipment, Distance Measuring Equipment, DME Ground Station; Terrestrial Landing Aids - ILS, Marker Beacons, TAWS; Satellite Navigation - GPS, GPS Navigation; Surveillance Systems - Collision Avoidance.						
UNIT V	APPLICATIONS OF MECHATRONICS IN AVIATION				9	
Introduction to Aircraft Mechatronics System - Definition, Scope; Electro-Hydro-Mechanical Actuators (EHAs) and Electro Mechanical Actuators (EMAs); Mechatronics in Landing Gear Systems - Brake control, Anti skid systems; Cabin and Environmental Control Systems Air conditioning, Fire Detection Systems; Avionics Systems - Role of sensors, Microcontrollers, and Real Time Systems in Cockpit automation; Health Monitoring Systems (HUMS).						
					TOTAL PERIODS	45
COURSE OUTCOMES						
At the end of this course, students will be able to					BT Mapped (Highest Level)	
CO1	recognize the Basics in aerodynamics, aircraft propulsion,					

	materials and controls.	Understand (K2)
CO2	know about the various concepts used in aerodynamics.	Understand (K2)
CO3	evaluate the performance and reliability of different flight control actuation systems	Apply (K3)
CO4	apply the integrated navigation systems	Apply (K3)
CO5	analyze the fundamental concepts of mechatronics and its role in modern aircraft.	Analyze (K4)

TEXT BOOKS

1. John Anderson Jr., "Introduction to Flight", McGraw Hill.2012.
2. Pallet. E.H.J., "Aircraft Instruments and Integrated Systems", Pearsons, Indian edition. 2011.

REFERENCES

1. Middleton, D.H., Ed., "Avionics systems, Longman Scientific and Technical", Longman Group UK Ltd., England, 2009.
2. Dr. O. P. Sharma and Lalit Gupta "Fundamentals of Flight" Pearsons, Indian edition, 2006.
3. Spitzer, C.R. "Digital Avionics Systems", Prentice-Hall, Englewood Cliffs, N.J.,U.S.A., 2003.
4. Ian Moir, Allan Seabridge., "Aircraft Systems: Mechanical, Electrical, and Avionics Subsystems Integration", John Wiley & Sons 3rd edition, 2008.

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CO2	3	2	1	-	-	-	-	-	-	-	-	1	2	2
CO3	3	3	2	2	3	-	-	-	1	1	-	2	3	2
CO4	3	3	2	2	3	-	-	-	1	-	-	2	3	3
CO5	3	3	2	2	3	-	1	-	1	1	-	3	3	3



MINOR DEGREE IN AUTOMATION ENGINEERING

MT23851	BASICS OF AUTOMATION SYSTEMS	3	0	0	3
COURSE OBJECTIVES					
To enable the students to					
1	enable students to identify and understand the different types of sensors, actuators, and PLCs used in automation systems.				
2	impart knowledge on communication and control systems with a focus on their application in real-time interfacing.				
3	demonstrate the use of SCADA systems for enhancing efficiency and control in factory automation.				
4	examine the components and functions of robots used in factory automation.				
5	design and implement plant-level automation for real-world process applications using PLC, SCADA and robotics.				
UNIT I	OVERVIEW				9
Automation overview - Requirement of automation systems, Architecture of factory automation system; Basic components of automation - Sensors for temperature, pressure, force, displacement, speed, flow, level, humidity and pH measurement, Actuators, Process control valves.					
UNIT II	PROGRAMMABLE AUTOMATION CONTROLLERS				9
Programmable controllers - Programmable logic controllers; Analog digital input and output modules; PLC programming - Ladder diagram, PLC selection, PLC installation; Basic discrete I/O programming and maintenance of PLC using timer/counter functions.					
UNIT III	COMMUNICATION AND CONTROL SYSTEMS				9
Man machine interface; Computer aided process control hardware and software; Process related interfaces; Communication and networking - Data transfer techniques; Computer based data acquisition system; Internet of Things (IOT) for plant automation.					
UNIT IV	SCADA				9
Definition - Elements of SCADA, SCADA control; Remote terminal units; Master station; Interfacing PLC with SCADA; Data logging and trending.					
UNIT V	ROBOTS FOR FACTORY AUTOMATION				9
Basic construction and configuration of robot; Pick and place robot; Welding robot; Robots in Sorting; Mobile robots; Cobots and Humanoid robots.					
				TOTAL PERIODS	45
COURSE OUTCOMES					
At the end of this course, students will be able to				BT Mapped (Highest Level)	
CO1	identify the different types of sensors, actuators and PLC used in automation system.			Remember (K1)	

CO2	infer the knowledge about communication and control system in real time interfacing.	Understand (K2)
CO3	integrate SCADA components into industrial control systems for automated factory operations.	Apply (K3)
CO4	interpret the basic configuration and application of robot in factory automation.	Apply (K3)
CO5	develop plant level automation for real process plant using PLC/SCADA/ robotics.	Analyze (K4)

TEXT BOOKS

1. Bolton W., "Mechatronics", 7th Edition, Pearson Education, New Delhi, 2022.
2. Petruzella Frank D., "Programmable Logic Controllers", 5th Edition, McGraw-Hill, New York, 2023.

REFERENCES

1. Stuart Boyer A., "SCADA Supervisory Control and Data Acquisition", 4th Edition, ISA, USA, 2022.
2. James L.Johnson, "Introduction to Fluid Power", Delmar Thomson Learning, 2018
3. Avinash G. patil, Vinayak K.Gaikwad and Dr.Vikas V.Shinde, "Hydraulic and Pneumatic", 2nd edition, Technical Publications, 2019.
4. Ilango, Sivaraman, "Introduction to Hydraulics and Pneumatics", 3rd edition, PHI Learning, 2017.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	-	-	2	-	-	-	-	-	-	1	3	2
CO2	3	2	-	-	3	-	-	-	-	-	-	2	2	3
CO3	2	2	2	-	3	-	-	-	-	-	-	2	3	3
CO4	2	-	2	-	3	-	-	-	-	-	-	1	3	2
CO5	3	2	3	2	3	-	-	-	-	-	1	3	3	3



MT23852	SENSORS AND ACTUATORS	3	0	0	3	
COURSE OBJECTIVES						
To enable the students to						
1	understand the fundamental principles and classifications of sensors and transducers.					
2	develop a comprehensive understanding of capacitive and radiation sensors.					
3	examine the operating principles and applications of thermal and magnetic sensors.					
4	acquire knowledge of smart sensors and their practical uses in modern systems.					
5	study different types of actuators and analyse their real-world applications.					
UNIT I	INDUCTIVE TRANSDUCERS				9	
Difference Between Sensors and Transducer; Principles; Classification of Sensors; Static And Dynamic Characteristics of Sensors; Environmental Parameters; Characterization; Inductive Sensors - Sensitivity and Linearity of the Sensor, Ferromagnetic Plunger Type Transducer, Inductance with a Short Circuited Sleeve, The Transformer Type Transducer, Electromagnetic Transducer, Magnetostrictive Transducer, Materials.						
UNIT II	CAPACITIVE & RADIATION SENSORS				9	
Capacitive Transducers - The Parallel Plate Capacitive Sensor, Serrated Plate Capacitive Sensor, Variable Permittivity Sensor, Electro Static Transducer; Radiation Sensors - Types of Photosensistors / Photo Detectors - The Photo Emissive Cell and the Photomultiplier, The Photoconductive Cell, Photovoltaic and Photo Junction Cells, Position-Sensitive Cell; Fibre Optic Sensors - Liquid Level Sensing, Fluid Flow Sensing.						
UNIT III	THERMAL AND MAGNETIC SENSORS				9	
Thermal Sensors - Gas Thermometric Sensors, Acoustic Temperature Sensor, Resistance Change Type Thermometric Sensors, Thermo emf Sensors - Thermocouple; Magnetic Sensors - Sensors and the Principles, Magneto Resistive Sensors, Hall Effect Sensors, Inductance and Eddy Current Sensors.						
UNIT IV	SMART SENSORS AND APPLICATIONS OF SENSORS				9	
Smart Sensors - Introduction, Primary Sensors, Excitation, Amplification, Filters, Converters, Compensation; Sensors Applications - On Board Automobile Sensors, Home Appliance Sensors, Aerospace Sensors, Medical Diagnostic Sensors, Sensors For Environmental Monitoring.						
UNIT V	ACTUATORS				9	
Thermo Mechanical Sensors and Actuators; Optical Actuators; Capacitive Actuators; Magnetic Actuators - Voice Coil Actuators, Motors as Actuators; Acoustics Actuators - Loudspeakers, Hedsphones and Buzzers; Piezo Electric Actuators; Chemical Actuation - The Catalytic Converter, The Airbag, Electroplating.						
					TOTAL PERIODS	45
COURSE OUTCOMES						
At the end of this course, students will be able to					BT Mapped (Highest Level)	
CO1	explain the theory and working behind the inductive transducers				Understand (K2)	

CO2	describe the construction and working of Capacitive and Radiation sensors	Understand (K2)
CO3	elaborate the various types of thermal and magnetic sensors and its principle of operation	Understand (K2)
CO4	demonstrate the working of various types of sensors used in real world applications	Apply (K3)
CO5	illustrate the working principle of Actuators and electrical actuating systems	Understand (K2)

TEXT BOOKS

1. Patranabis, "Sensors and Transducers", 2nd Edition, PHI Publications, 2020.
2. Nadhan, Ida, "Sensors, Actuators, and their Interfaces: A Multidisciplinary Introduction", Sci Tech Publishing, 2013.

REFERENCES

1. De Silva and Clarence W, "Sensors and Actuators Engineering System Instrumentation", 2nd Edition, CRC Press, 2015.
2. Jacob Fraden, "Handbook of Modern Sensors: Physics, Design and Applications", 5th Edition, Springer, 2015.
3. Sawney A K and Puneet Sawney, "A Course in Mechanical Measurements and Instrumentation and Control", 12th edition, Dhanpat Rai & Co, New Delhi, 2013.
4. Ernest O Doebelin, "Measurement Systems - Applications and Design", Tata McGraw-Hill, 2009.

CO-PO MAPPING:

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(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	-	-	-	-	-	-	-	-	-	2	3	1
CO2	3	2	-	-	-	-	-	-	-	-	-	2	3	1
CO3	3	2	-	-	-	-	-	-	-	-	-	2	3	1
CO4	3	3	2	2	2	1	1	-	1	1	-	3	3	2
CO5	3	2	2	-	2	-	-	-	-	-	-	2	3	2



MT23853	HYDRAULICS AND PNEUMATICS	3	0	0	3
COURSE OBJECTIVES					
To enable the students to					
1	acquire the concepts of fluid power.				
2	understand the fundamentals of hydraulic pumps.				
3	impart knowledge on hydraulic actuators and motors.				
4	learn about basics of pneumatics system and applications.				
5	familiarize with the hydraulic and pneumatic valves.				
UNIT I	INTRODUCTION				9
Introduction to Fluid power - Advantages and Applications; Component of fluid power system - Hydraulic system and pneumatics system; Fluid Power ANSI Symbols; Types of fluids; Properties of fluids; Pascal's law and Applications - Hand operated hydraulic jack, Air-to-Hydraulic Pressure Booster; Darcy's equation - Frictional losses, Losses in valves and fittings.					
UNIT II	HYDRAULIC PUMPS				9
Basics of Hydraulic pump - Principles of flow; Dynamic pump types - Centrifugal and axial flow pump, Mixed flow pump; Positive displacement pump types - External gear pump and internal gear pump, lobe pump, screw pump; Vane pump types; Pitons pumps type s- Characteristics, Construction, Working, Selection criteria of pumps, Advantages, Disadvantages.					
UNIT III	HYDRAULIC ACTUATORS AND MOTORS				9
Hydraulic cylinders Construction Working principle Single acting cylinder, Double acting Double rod cylinder and Telescopic cylinder, Application, Hydraulic cushioning; Hydraulic shock absorbers; Hydraulic motors Control Components - Gear motors, Vane motors and piston motors - In-line Piston Motor and Axial Piston Motor; Hydraulic motor theoretical torque, power, and flow rate.					
UNIT IV	PNEUMATICS SYSTEM				9
Introduction - Properties of air; Perfect Gas Laws; Filter, Regulator, Lubricator; Pneumatic actuators - Pneumatic Cylinders, Pneumatic Rotary Actuators and Rotary Air Motors; Basic pneumatic circuits - Operation of single acting cylinder and double acting; Design of pneumatic circuit cascade method; Accumulators - Bladder type, Diaphragm type, weight loaded type, Piston type and applications; Pneumatic vacuum systems and application.					
UNIT V	HYDRAULIC AND PNEUMATICS VALVES				9
Directional Control Valves - Check valve, Pilot operated check valve; Methods of valve actuation working Principle of 2/2, 3/2, 4/2, 4/3 and 5/2 DCV and Shuttle valve; Pressure control Valves - Pressure relief valves, Pressure reducing valve; Unloading valves - Counterbalance valves; Flow control valves - Pressure Compensated Valve; Servo valve - Mechanical type servo valves and Electro hydraulic Servo Valves; Proportional control valves.					
TOTAL PERIODS					45

COURSE OUTCOMES															
At the end of this course, students will be able to		BT Mapped (Highest Level)													
CO1	recall the symbols and characteristics of fluids used in hydraulic and pneumatic applications.	Remember (K1)													
CO2	interpret the role of various components in the operation of hydraulic pumps.	Understand (K2)													
CO3	demonstrate the procedure to manage and uphold different hydraulic actuators in industrial settings	Apply (K3)													
CO4	analyze the structure and functioning of pneumatic systems across different applications.	Analyze (K4)													
CO5	employ a suitable pneumatic valve for a straightforward industrial task.	Apply (K3)													
TEXT BOOKS															
1. Anthony Esposito, "Fluid power with applications", 7 th edition. Pearson Education, 2021.															
2. Cassi Piccuillo, "Pneumatic system: principle and Maintenance: Pneumatic", Independent Publications, 2020.															
REFERENCES															
1. Majumdar S.R., "Pneumatic systems - Principles and maintenance", Tata McGraw Hill, 2017.															
2. James L.Johnson, "Introduction to Fluid Power", Delmar Thomson Learning, 2018.															
3. Avinash G. patil, Vinayak K.Gaikwad and Dr.Vikas V.Shinde, "Hydraulic and Pneumatic", 2 nd edition, Technical Publications, 2019.															
4. Ilango, Sivaraman, "Introduction to Hydraulics and Pneumatics", 3 rd edition, PHI Learning, 2017.															
CO-PO MAPPING:															
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(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak															
CO's	Programme Outcomes PO's												PSO's		
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CO1	3	2	-	-	-	-	-	-	-	-	-	2	3	2	
CO2	3	3	2	-	2	-	-	-	-	-	-	2	2	2	
CO3	3	3	3	2	2	-	-	-	1	-	-	2	3	3	
CO4	3	3	3	3	3	-	-	-	2	2	-	3	3	3	
CO5	3	3	2	2	3	-	-	-	1	-	-	2	2	3	



MT23854	PLC AND SCADA	3	0	0	3	
COURSE OBJECTIVES						
To enable the students to						
1	introduce the basic architecture and working principles of PLC.					
2	classify different types of timers and counters used in PLC.					
3	describe program control instructions like jump and subroutine.					
4	design ladder logic programs for real-time systems like traffic control, car wash, etc.					
5	define and explain the concept, architecture, and components of SCADA.					
UNIT I	PROGRAMMABLE LOGIC CONTROLLER				9	
Introduction; Parts of PLC; Principles of Operation; PLC Sizes; I/O Section - Analog I/O Modules, Digital I/O Modules; PLC Programming Simple Instructions; Output Controlled Devices; Converting Simple Relay Diagram into PLC Ladder Diagram.						
UNIT II	TIMERS AND COUNTERS				9	
Timer Instructions - ON Delay, OFF Delay, Cascading Timers, Retentive Timers; Counter Instructions - UP Counter, DOWN Counter, Cascading Counters.						
UNIT III	PROGRAM CONTROL, DATA MANIPULATION AND MATH INSTRUCTION				9	
Program Control Instruction - Jump Instruction, Subroutine Functions; Data Manipulation Instruction - Data Transfer Operation, Data Compare Instruction; Math Instruction - Addition Instruction, Subtraction Instruction, Multiplication Instruction, Division Instruction.						
UNIT IV	APPLICATIONS OF PLC				9	
Simple Materials Handling Applications; Automatic Control of Warehouse Door; Traffic Light Controller; Automatic Car Washing Machine; Bottle Label Detection.						
UNIT V	SCADA				9	
Supervisory Control and Data Acquisition Systems - Introduction, Definition, Evolution of SCADA, Elements of SCADA, SCADA Architecture; Master Terminal Unit; Remote terminal units; Master station; Applications of SCADA.						
					TOTAL PERIODS	45
COURSE OUTCOMES						
At the end of this course, students will be able to					BT Mapped (Highest Level)	
CO1	understand and explain simple PLC instructions and ladder diagrams.				Understand (K2)	
CO2	apply timer and counter instructions to create functional automation logic.				Apply (K3)	
CO3	apply control, data manipulation, and mathematical functions in ladder programming.				Apply (K3)	
CO4	analyze real-world applications of PLC in automation systems.				Analyze (K4)	
CO5	describe SCADA architecture and explain its evolution and components.				Understand (K2)	

TEXT BOOKS														
1. Frank D. Petruzella, "Programmable Logic Controllers", 5th edition, McGraw Hill, 2019.														
2. Rajesh Mehra, Vikrant Vij, "PLCs & SCADA Theory and Practice", Pearson Education, 2019.														
REFERENCES														
1. Bolton, "Programmable Logic Controllers", 6th edition, Elsevier India, 2016.														
2. James A. Rehg and Glenn J. Sartori, "Programmable Logic Controllers", 2nd edition, Pearson Education, 2016.														
3. R.G.Jamkar, "Industrial Automation Using PLC SCADA & DCS", Global Education Limited, second edition, 2018.														
4. Tanuj Kumar Bisht, Jamal, R. and Picklik, H., "SCADA and Energy Management System", S.K. Kataria & Sons, 2013.														
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(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
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CO1	3	2	-	-	2	-	-	-	-	-	-	2	3	2
CO2	3	3	2	-	3	-	-	-	-	-	-	2	3	3
CO3	3	2	2	-	3	-	-	-	-	-	-	2	3	3
CO4	3	3	3	2	3	1	1	-	-	-	1	3	3	3
CO5	3	2	2	-	3	1	-	-	-	-	1	2	2	2



MT23855	LOW COST AUTOMATION	3	0	0	3	
COURSE OBJECTIVES						
After successful completion of this course, the students should be able to:						
1	provide basic knowledge to implement low-cost automation in various industries.					
2	study the pneumatics devices and circuits and its applications					
3	understand the hydraulics devices and circuits.					
4	configure the automation assembly lines used in industries.					
5	know the applications in material handling and packaging industries.					
UNIT I	INTRODUCTION TO AUTOMATION				9	
Automated manufacturing systems - Fixed/programmable/flexible automation, Need of automation, Basic elements of automated systems, program and control; Levels of automation; Control systems - Continuous and discrete control; Low cost automation - Economic and social aspects of automation						
UNIT II	BASICS OF PNEUMATICS AND CIRCUIT DESIGN				9	
Operational principles and application - Air compressors, Pneumatic cylinders and air motors, Pneumatic valves, Design of pneumatic circuits, speed control, reciprocating, synchronization and sequencing circuits; Hydro pneumatic, Electro pneumatic Control in pneumatic systems						
UNIT III	BASICS OF HYDRAULICS AND CIRCUIT DESIGN				9	
Principles of hydraulics, Hydraulic fluids, Filtration technology, Hydraulic- pumps, valves, and actuators. Standards in circuit diagram representation, Power pack design layout, Basic hydraulic circuits.						
UNIT IV	ASSEMBLY AUTOMATION				9	
Types and configurations, Parts delivery at workstations-Variety vibratory and non-vibratory devices for feeding, hopper feeders, rotary disc feeder, centrifugal and orientation, Product design for automated assembly.						
UNIT V	APPLICATIONS AND CASE STUDIES				9	
Material handling - Sorting, Door opening, Labeling Alignment method examples - Direction Change Automatic Screw Fastening, Locking and clamping devices.						
					TOTAL PERIODS	45
COURSE OUTCOMES						
At the end of this course, students will be able to					BT Mapped (Highest Level)	
CO1	provide basic knowledge to implement low cost automation in various industries.				Understand(K2)	
CO2	study the pneumatics devices and circuits and its applications.				Understand(K2)	
CO3	understand the hydraulic devices and circuits.				Understand(K2)	
CO4	apply the automation concepts assembly lines used in industries.				Apply(K3)	

CO5	analyse the applications in material handling and packaging industries.	Analyze (K4)												
TEXT BOOKS														
1. Mikell P Groover, "Automation, Production System and Computer Integrated Manufacturing", Prentice Hall Publications, 2019.														
2. E.G. Phillips, "Pneumatic Conveyer Systems", Tata McGraw Hill, 2017.														
REFERENCES														
1. Anthony Esposito, "Fluid Power with Applications", Prentice Hall international, 2014.														
2. Kuo.B.C, "Automatic Control Systems", Prentice Hall India, New Delhi, 2007.														
3. James A Sullivan, "Fluid Power Theory and Applications", 4th edition, C.H.I.P.S, 2007.														
4. Mujumdar.S. R, "Pneumatic System", Tata McGraw Hill, 2009.														
CO-PO MAPPING:														
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CO1	3	2	2	-	2	1	1	-	-	-	-	2	3	2
CO2	3	2	2	-	2	-	-	-	-	-	-	2	3	2
CO3	3	2	2	-	2	-	-	-	-	-	-	2	3	2
CO4	3	2	3	-	3	-	1	-	2	2	2	2	3	3
CO5	3	3	3	2	3	1	1	-	2	2	2	2	3	3



MT23856	SYSTEM DESIGN INTEGRATION	3	0	0	3	
COURSE OBJECTIVES						
To enable the students to						
1	know the basic system design process.					
2	understand the concept of system modelling.					
3	utilize the design of mechatronics system interfacing.					
4	plan the case studies of mechatronics system in varies fields.					
5	know the variety of applications of advanced system.					
UNIT I	INTRODUCTION TO MECHATRONICS SYSTEM				9	
Introduction - Key elements, Mechatronics design process, Design parameters, Mechatronics and traditional design; Advanced approaches in mechatronics design; Introduction to industrial design, modelling, Simulation and analysis; Ergonomics and safety.						
UNIT II	SYSTEM MODELLING				9	
Introduction - Model Categories - Fields of Application, Model Development, Model Verification, Model Validation, Model Simulation; Design of Mixed Systems - Electro Mechanics Design; Model Transformation Domain; Independent Description Forms- Bond graph and Block Diagram, Simulator Coupling.						
UNIT III	SYSTEM INTERFACING				9	
Introduction - Elements of data acquisition and control system; Overview of I/O process - Installation of I/O card and software - TIA/EIA serial interface standards (RS232/422/485), General Purpose Interface Bus (IEEE 488), GUI card, Ethernet switch, Man Machine Interfaces.						
UNIT IV	CASE STUDIES ON MECHATRONICS SYSTEM				9	
Introduction - Thermal Cycle Fatigue Test of an Aluminium Plate; PH Control System; Windscreen Wiper Motion; Pick and Place Robot; Car Park Barrier; Car Engine Management; Bar Code Reader; Skip Control of a CD Player; Strain Gauge Weighing System; Rotary Optical Encoder; De Icing Temperature Control System.						
UNIT V	APPLICATIONS ON ADVANCED SYSTEMS				9	
Machine tool control system - Electronics engine management system; Pick and place industrial manipulator; Autonomous mobile robot; Artificial Intelligence in Mechatronics; Fuzzy controlled washing machine.						
					TOTAL PERIODS	45
COURSE OUTCOMES						
At the end of this course, students will be able to					BT Mapped (Highest Level)	
CO1	identify various mechatronics system design process.				Understand (K2)	
CO2	categorize the different system modelling.				Understand (K2)	
CO3	select the suitable interface for mechatronics system				Apply (K3)	

CO4	develop the physical system integration based on mechatronics design process	Apply (K3)
CO5	build the mechatronics systems for real time applications	Analyse (K4)

TEXT BOOKS

1. Devdas Shetty and Richard A. Kolk, "Mechatronics System Design", 2nd edition, Cengage, 2020.
2. Georg Pelz, "Mechatronics Systems: Modeling and Simulation with HDL's", 2nd edition, John Wiley and Son Ltd, New Delhi, 2013.

REFERENCES

1. Bolton W., "Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering", 6th Edition, Pearson Education Limited, New York, 2015.
2. Robert H. Bishop, "The Mechatronics Hand book", 2nd Edition, CRC Press, 2018.
3. David Allan Bradley, "Mechatronics: Electronics in Products and Processes", 1st edition, Routledge, 2018.
4. Farid Golnaraghi and Benjamin Kuo, "Automatic Control Systems", 5th edition, McGraw-Hill Education, 2017.

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CO's	Programme Outcomes PO's												PSO's	
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CO1	2	-	-	-	-	-	-	-	-	-	-	2	3	2
CO2	2	2	-	-	2	-	-	-	-	-	-	2	3	2
CO3	2	2	-	-	3	-	-	-	-	-	-	-	2	3
CO4	3	2	3	-	3	-	-	-	2	2	2	-	3	3
CO5	3	3	3	2	3	-	2	-	2	2	2	3	3	3

