Teaching and Evaluation Scheme for Final Year B. Tech.

Department of Mechatronics Engineering

Semester: VII

INDUSTRY 4.0

23MT4701	PCC	Industry 4.0	3-0-0	3 Credits

Teaching Scheme	**Examination Scheme**
Lecture: 3 hrs/week	CA –I :10 Marks CA –II :10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites:

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

CO1	Explain Industry 4.0 scenario.
CO2	Illustrate industrial IOT and smart manufacturing.
CO3	Make use of Robotic Automation and Augmented Reality for Industry 4.0
CO4	Examine security aspects of Industry 4.0.
CO5	Justify applications of Industry 4.0.
CO6	Discuss smart grid technologies.

Course Contents:

Unit 1: Introduction to Industry 4.0: The Various Industrial Revolutions - Drivers, Enablers, Compelling Forcesand Challenges for Industry 4.0 - Need – Reason for Adopting Industry 4.0	[8]
Unit 2: Industry 4.0 And IOT: Internet of Things (IoT) and Industrial Internet of Things (IIoT) & Internetof Services - Smart Manufacturing - Smart Devices and Products – Smart Logistics - Lean Production system	[7]

Unit 3: Robotic Automation and Augmented Reality: Recent Technological Components of Robots- Advanced Sensor Technologies - Internet of Robotic Things - Introduction, AR Hardware and Software Technology, Industrial Applications of AR	[8]
Unit 4: Industry 4.0 And Cyber Physical System: Introduction to Cyber Physical Systems (CPS), Architecture of CPS-Components - Emerging applications in CPS in different fields. Case study: Application of CPS in various domains.	[7]
Unit 5: Applications of Industry 4.0: Understanding Smart Appliances -Smart Operation-Smart Monitoring- Smart Energy Savings-Smart Maintenance, Case Study-Smart Cars, Self- Driving Cars, Introducing Google 's Self-Driving Car	[8]
Unit 6: SMART GRID: Smart grid definition and development Smart Grid, Understanding the Smart Grid, Smart grid solutions, Design challenges of smart grid andIndustry 4.0.	[6]

Text Books:

1. Klaus Schwab, "The Fourth Industrial Revolution".
2. Jean-Claude André, ―Industry 4.0‖, Wiley- ISTE, July 2019, ISBN: 781786304827,2019
3. Hossam A. Gabbar, ―Smart Energy Grid Engineering‖, Academic Press, 2017, ISBN 978- 0-12-805343-0.

Reference Books:

1. Miller M, ―The internet of things: How smart TVs, smart cars, smart homes, and smart cities are changing the world‖, Pearson Education, 2015, ISBN: 9780134021300.
2. Pengwei Du and Ning Lu, ―Energy storage for smart grids: planning and operation for renewable and variable energy resources VERs ‖, Academic Press, 2018, Reprint edition, ISBN-13:978-0128100714
3. P. Kaliraj, T. Devi, Innovating with Augmented Reality: Applications in Education and Industry, 2022, ISBN 9781032008127, CRC Press, Taylor & Francis Group

PLC and SCADA

23MT4702	PCC	PLC and SCADA	3-0-0	3 Credits

Teaching Scheme	**Examination Scheme**
Lecture: 3 hrs/week	CA –I :10 Marks CA –II :10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites:

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

CO1	Illustrate the concepts and I/O modules of programmable logic controller
CO2	Develop Ladder Diagrams using various ladder programming instructions.
CO3	Test for ladder logic of PLC Timer and Counter instructions.
CO4	Analyze different programming applications of ladder programming.
CO5	Explain SCADA and HMI systems for PLC.
CO6	Interpret the applications of SCADA.

Course Contents:

Unit 1: Programmable Logic Controller: Introduction to PLC, Definition of PLC, Advantages, Types of PLC: Unitary PLC, Modular PLC, Small PLC, Medium PLC, Large PLC, Block Diagram of PLC: Input/output (I/O) section, Processor Section, Power supply, Memory, Central Processing Unit: Processor Software / Executive Software, program scan PLC Languages, Ladder Language. PLC input output (I/O) modules: Discrete input module, Analog I/O Module, Sinking and sourcing. Special Modules	[6]
Unit 2: PLC Instructions Introduction to ladder logic: PLC I/O Addressing, Relay type instructions, Arithmetic (Math) instructions, Logical Instructions, Comparison instructions, Data Handling instructions, Introduction to logic: Equivalent Ladder diagram of Logic Gates, equivalent ladder diagram to demonstrate De Morgan theorem. Ladder design.	[7]

Unit 3: PLC Timers and Counters PLC Timer Instruction: On Delay and OFF delay timers, Timer-on Delay, Timer off delay, Retentive and non-retentive timers. Format of a timer instruction. PLC Counter Instruction: Operation of PLC Counter, Counter Parameters, Count up (CTU) Count down (CTD). Ladder Programming using Timer/Counter	[6]
Unit 4: Applications of PLC Automatic switching ON/OFF lights, Liquid level control, Traffic light control, Bottle filling plant, other ladder programming examples.	[5]
Unit 5: Introduction of SCADA and HMI Introduction to SCADA, Application areas of SCADA, Block Diagram, Benefits, Types of SCADA: Single Master Single Remote, Multiple Master Multiple Remote, SCADA System Hardware: RTUs, MTUs, Communication System, Human Machine Interface (HMI): Definition, Application areas of HMI, Difference between HMI and SCADA	[6]
Unit6: Interfacing and Applications of SCADA Interfacing SCADA system with PLC: Connection Diagram, object linking and embedding for process control (OPC) architecture, Steps in creating SCADA screen for simple object, steps for linking SCADA object with PLC, ladder programming using OPC, Concept of Tag, Types of tags, Addressing of Tags, Alarm generation, Trend types Applications of SCADA: ON-OFF Control of lamp, traffic light control, level control system	[6]

Text Books:

1. "Programmable Logic Controller – Principles and Applications", 5/e, J. W. Webb, R.A. Reis; Prentice Hall of India Ltd.ISBN 81-203-2308-4.
2. "Programmable Logic Controller – Principles and Applications, by NIIT; Prentice Hall Publications Pvt.Ltd. India, ISBN 81-203-2525-7.
3. "Programmable Logic Controller – Programming methods and Applications", Hackworth John R. and Hackworth Frederick D. Jr.; Pearson Education LCE, ISBN 81-297-0340

Reference Books:

1. Introduction to PLC – Gary Dumming – Delmar Pub.
2. Various PLC manufacturers catalogue.
3. Programmable Logic Controller – FESTO Pneumatics, - Bangalore
4. SCADA, Stuart A. Boyer (ISA Publi.) ISBN 1-55617-660-0.
5. Practical SCADA for industry, David Bailey, (Elsevier Publi.) ISBN 0-7506-5805-3.

Professional Elective -III

A. Robot Kinematics and Dynamics
B. Nano Technology
C. Computer Integrated manufacturing
D. Tool design

Robot Kinematics and Dynamics

23MT4703A	PEC	Robot Kinematics and Dynamics	3-0-0	3 Credits

Teaching Scheme	**Examination Scheme**
Lecture: 3 hrs/week Tutorial: 1hr/week	CA –I :10 Marks CA–II :10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Theory of machines, Robotics, Mathematics

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

CO1	Illustrate the various components and basics of a robotics system
CO2	Outline classification, application, and specifications of robots
CO3	Solve the problems related to rotation, translation, and transformation in robotics
CO4	Analyze the problems related to forward and inverse kinematics in robotic systems
CO5	Interpret the concepts of trajectory and motion planning in the robotics system.
CO6	Explain the basics of dynamic analysis in the robotics system.

Course Contents:

Unit 1: Introduction Kinematics and dynamics, Kinematic joints, Link, Kinematic pair, Constrained motion, Mechanism and machines, Robotics system, Robot joints, Robotic Terminology, components of robotics, Robot manipulation, Future of robotics	[6]
Unit 2: Robot Kinematics Basics Robot configurations, Classification of robots, Robot End-effectors, Workspace, Specification of Robot, Application of Robots, Robotics sensors, sensor calibration, Grubler's Formula, Degrees of Freedom of robot manipulators.	[6]

Unit 3: Kinematics Representation of Robot Manipulator Representation of planer motion, Representation of spatial motion, Descriptions: Positions, Orientations, and Frames, Representation: Rotation, translation, transformation, Homogeneous transformation, Rolling, Pitching, and Yawing	[6]
Unit 4: Kinematics Analysis of robotic manipulators Forward and Inverse kinematics of robotic manipulators, Denavit Hartenberg Parameters, Rules for coordinate assignments, Robot coordinate system	[6]
Unit 5: Trajectory and Motion Planning Trajectory, General Considerations in Path Generation, work envelope of a robot, Cartesian space technique, Joint space technique- Cubic polynomial, Fifth order polynomial, Linear trajectory function, Robot motion planning, Sequence of robotic action, Motion planning approaches, classification of Robot motion planning	[7]
Unit 6: Basics of Robotic Dynamics (Theory) Key aspects of the dynamics of robotics systems, Forces in Manipulator, Robot dynamics – Rigid body dynamics, Newton-Euler, Lagrange-Euler, generalized D'Alembert equations of motion.	[6]

Text Books:

- Renfrew, Alasdair. "Introduction to robotics: Mechanics and control." International Journal of Electrical Engineering & Education 41.4 (2004): 388.
- Lumelsky, Vladimir J. Sensing, intelligence, motion: how robots and humans move in an unstructured world. John Wiley & Sons, 2005.
- Vukobratovic, Miomir. Introduction to robotics. Springer Science & Business Media, 2012.

Reference Books:

- Lewis, Frank L., Darren M. Dawson, and Chaouki T. Abdallah. Robot manipulator control: theory and practice. CRC Press, 2003.
- Robotics: Modelling, Planning and Control, Lorenzo Sciavicco, Luigi Villani, Giuseppe Oriolo, Springer Science & Business Media, 07-Nov-2008 - Technology & Engineering - 632 pages
- Mueller, Andreas. "Modern robotics: Mechanics, planning, and control [bookshelf]." IEEE Control Systems Magazine 39.6 (2019): 100-102.

Nanotechnology

23MT4703B	PEC	Nanotechnology	3-0-0	3 Credits

Teaching Scheme	**Examination Scheme**
Lecture: 3 hrs/week	CA –I :10 Marks CA–II :10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites:

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

CO1	Explain length scales concepts, nanostructures and nanotechnology.
CO2	Summarize the composition, properties of nanostructure metals and alloys, Nano-composites and carbon nanotubes.
CO3	Identify the nanoparticles manufacturing methodology depending on its phase and application.
CO4	Examine behavior of materials at nanoscale.
CO5	Justify the phenomenal behaviors and functions of materials and structures at molecular scale.
CO6	Interpret the functional benefits of using nanotechnology in electronics.

Course Contents:

Unit 1: Introduction to Nanotechnology: Nanoscience, Nanotechnology, Applications of nanotechnology, Nanomaterials, types of Nanotechnology, Nano machines, Multiscale hierarchical structures built out of Nano sized building blocks (Nano to macro). Nanomaterials in Nature: Nacre, Gecko. Properties of Nanomaterials, Characterization of Nanomaterials.	[6]
Unit 2: Nanomaterials: Fundamental concept, materials used, Allotropes of carbon, graphene, fullerenes, carbon nanotubes- properties and application.	[7]

Unit 3: Fabrication of Nanomaterials: Gas phase synthesis, liquid phase synthesis, solid phase synthesis, Lithography.	[7]
Unit 4: Nano Shapes: Nanoparticles and colloid, nanogold, nanocomposite, nanocrystal, nanostructure, Quantum dots-application of quantum dots, Nano wires, Nano tubes.	[6]
Unit 5: Molecular Nanotechnology: Projected applications and capabilities-Smart material, nano sensors. Molecular assembler, molecular machines and its types, Nanorobotics, self-reconfigurable, DNA nanotechnology.	[7]
Unit 6: Nanoelectronics: Diodes, Sensors, memories, batteries, super-capacitors, Micro-electromechanical system, nano-electromechanical system.	[7]

Text Books:

1. 1.N. Phani Kumar, "Principles of nanotechnology" SciTech publications India Pvt. Ltd.
2. 2. G. Mohan Kumar, "Nanotechnology: Nanomaterials and nanodevices" Narosa Publishing
3. House, 2016.
4. 3. C. Koch, "Nanostructured materials: Processing, Properties and Potential Applications",
5. Noyes Publications, 2002.
6. 4. C. Koch, I. A. Ovidko, S. Seal and S. Veprek, "Structural Nano crystalline Materials:
7. Fundamentals & Applications", Cambridge University Press, 2011.

Reference Books:

1. Bharat Bhushan, "Springer Handbook of Nanotechnology", Springer, 2nd edition, 2006.
2. Laurier L. Schramm, "Nano and Microtechnology from A-Z: From Nano-systems to Colloids and Interfaces", Wiley, 2014.

Computer Integrated Manufacturing

23MT4703C	PEC	Computer Integrated Manufacturing	3-0-0	3 Credits

Teaching Scheme	**Examination Scheme**
Lecture: 3 hrs/week	CA –I :10 Marks CA –II :10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites:

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

CO1	Explain the basic concepts of CAD, CAM and computer integrated manufacturing system
CO2	Summarize the production planning and control and computerized process planning
CO3	Identify the different coding systems used in group technology
CO4	Inspect the concepts of flexible manufacturing system (FMS) and automated guided vehicle (AGV) system
CO5	Interpret automated material handling and storage systems for a typical production system
CO6	Elaborate the concept of smart manufacturing.

Course Contents:

Unit 1: Introduction Brief introduction to CAD and CAM – Manufacturing Planning, Manufacturing control-Introduction to CAD/CAM – Concurrent Engineering-CIM concepts – Computerized elements of CIM system – Types of production - Manufacturing models and Metrics – Mathematical models of Production Performance – Simple problems – Manufacturing Control – Simple Problems – Basic Elements of an Automated system – Levels of Automation – Lean Production and Just-In-Time Production.	[8]
Unit 2: Production Planning and Control and Computerized Process Planning Process planning – Computer Aided Process Planning (CAPP) – Logical steps in Computer Aided Process Planning – Aggregate Production Planning and the Master Production Schedule – Material Requirement planning – Capacity Planning- Control Systems-Shop Floor Control-Inventory Control – Brief on Manufacturing Resource Planning-II (MRP-II) & Enterprise Resource Planning (ERP) - Simple Problems.	[7]
Unit 3: Cellular Manufacturing Group Technology (GT), Part Families – Parts Classification and coding – Simple Problems in Opitz Part Coding system – Production flow Analysis – Cellular Manufacturing – Composite part concept – Machine cell design and layout – Quantitative analysis in Cellular Manufacturing – Rank Order Clustering Method - Arranging Machines in a GT cell – Hollier Method – Simple Problems.	[8]

Unit 4: Flexible Manufacturing System (FMS) and Automated Guided Vehicle System (AGVS) Types of Flexibility - FMS – FMS Components – FMS Application & Benefits – FMS Planning and Control – Quantitative analysis in FMS – Simple Problems. Automated Guided Vehicle System (AGVS) – AGVS Application – Vehicle Guidance technology – Vehicle Management & Safety.	[7]
Unit 5 : Automatic Material Handling and Storage system Design Considerations in Material Handling, Material Transport Equipment-Industrial Trucks, Automated Guided Vehicles, Monorails and Other Rail-Guided Vehicles, Conveyors, Cranes and Hoists, Analysis of Vehicle Based Systems, Conveyor Analysis. Automated Storage/Retrieval Systems, Carousel Storage Systems, Engineering Analysis of AS/RS and Carousel Systems.	[6]
Unit 6: Smart Manufacturing Introduction to additive manufacturing, IoT, Smart Sensing, Smart Machines, Data Visualization and Analysis, Augmented Reality, Cyber-security for manufacturing.	[6]

Text Books:

1"Automation, Production Systems and Computer Integrated Manufacturing", Groover, M.P. Pearson Education, ISBN: 81-7808-511-9 2nd Edition (2004).

2. Industrial Instrumentation and Control By. S.K. Singh The McGraw Hill Companies

Reference Books:

1. Mikell P Groover, Automation, production Systems and Computer Integrated Manufacturing, 3 rdEdition, Prentice Hall Inc., New Delhi, 2012.

2. Nanua Singh, System Approach to Computer Integrated Manufacturing, Wiley & Sons Inc., 1996.

3. Andrew Kusiak, Intelligent Manufacturing System, Prentice Hall Inc., New Jersey, 1992PHI

Tool Design

23MT4703D	PEC	Tool Design	3-0-0	3 Credits

Teaching Scheme	**Examination Scheme**
Lecture: 3 Hours/Week	CA-I: 10 Marks CA-II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Fundamentals of Mechanical Engineering.
Course Outcomes: At the end of the course, students will be able to:

CO1	Interpret geometries of various cutting tools.
CO2	Make use of relevant cutting tool insert and tool holder for different machining operations.
CO3	Choose relevant locating and clamping devices for components.
CO4	Compare jigs and fixtures for components and machining operations.
CO5	Determine design parameters for press tool design.
CO6	Analyze parameters for bending, drawing and forging dies.

Course Contents:

Unit 1: Basics of Tool Engineering Principles in tool engineering, Mechanics of cutting: requirements of tool, Cutting forces: Merchant Circle, types of chips, chips thickness ratio, shear angle, concept, need, and method to give shear angle on punch and die.	[6]
Unit 2: Cutting Tool Material and Holding Devices Tool cutting materials: types, composition, properties and applications, Carbide inserts: types, ISO designations, applications, other inserts like CBN and PCBN, Tool holders for turning, milling and CNC machines, ISO designations of tool holders, Tool sharpening method for single point cutting tool.	[6]
Unit 3: Locating and Clamping Devices Concept, definition locating and clamping, Use of locating and clamping principles on shop floor, Degree of freedom concept and importance, Locator: types construction, working and applications, Clamping devices: types construction, working and applications, Fool proofing and ejecting techniques.	[6]
Unit 4: Jigs and Fixtures Concept definition of jigs and fixtures, Difference between jigs and fixtures, Jigs: types construction, working and applications, Fixtures: types construction, working and applications, Design considerations and procedures and procedures for jigs and fixtures.	[6]
Unit 5: Press Tool Design Press working processes: types, sketches and applications, Press tools: types, sketches and	[6]

applications, Concept, meaning, definitions and calculations of press tonnage and shut height of press tool, Shear action in die cutting operation, Centre of pressure: concept, meaning, definition, methods of finding and importances, Die clearance: concept, meaning, definition, reasons, effects and methods of application, Cutting force: Methods to calculate and method of reducing, Sharp strip layout: concept, importance, method to prepare and determining percentage stock utilization, Types, working and applications of stock stop, pilots, strippers and knockouts, Cutting dies: types and applications, Design of progressive die.	
Unit 6: Bending, Drawing and Forging Dies Bending dies: types and parts, definition, calculations and factors affecting bend radii, bend allowance and spring back, method to compute bending pressure, types, sketch, working and applications of bending dies, Drawing dies: types and methods to determine blank size for drawing operation, types, sketch, working and applications of drawing dies (embossing, curling, bulging, coining, swaging and hole flanging), Forging dies: terminology, types, sketch, working and applications.	[6]
Text Books: 1. Tool Engineering and Design, G.R. Nagpal. 2. Fundamentals of Tool Design, ASTME PHI. 3. Tool Design, Donaldson & Lecain. 4. Tool Engineering, Doyal. 5. Die Design Fundamentals, J. R. Paquino. 6. Principles of Tool & Jig Design, M. H. A. Kempster. 7. Principles of Tool & Jig Design, M. H. A. Kempster. 8. Principles of Tool & Jig Design, M. H. A. Kempster.	

Professional Elective -IV

A. Automotive Electronics
B. Automotive Safety and Ergonomics
C. Battery and Fuel cell Technology
D. Electrical Hybrid vehicles

Automotive Electronics

23MT4704A	PEC	Automotive Electronics	3-0-0	3 Credits

Teaching Scheme	**Examination Scheme**
Lecture: 3 hrs/week	CA –I :10 Marks CA–II :10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites:
Course Outcomes: At the end of the course, students will be able to:

CO1	Explain the evolution, structure, and components of automotive systems
CO2	Identify various types of sensors and actuators used in automotive electronics and their functions
CO3	Analyze digital engine control strategies including ignition timing, fuel control modes, and emission regulation mechanisms.
CO4	Evaluate the architecture and functioning of automotive instrumentation and communication systems
CO5	Explain vehicle motion control technologies such as braking, steering, suspension, and onboard diagnostics.
CO6	Elaborate conceptual models of future automotive electronic systems

Course Contents:

Unit 1: Automotive Fundamentals Overview Evolution of Automotive Electronics, Survey of major Automotive Systems, Major Electrical components, Four Stroke Cycle, Engine Control, Ignition System, Spark plug, Spark pulse generation, Ignition Timing, Drive Train, Transmission, Brakes, Steering System, Battery, Starting System. Air/Fuel Systems, Fuel Handling, Air Intake System, Air/Fuel Management.	[7]
Unit 2: Sensors and Actuators in Automotive Electronics Systems Sensors – Automotive control system, Application of sensors and actuators, Typical Electronic engine control system, Variables to be measured, Oxygen (O2/EGO) Sensors, Throttle Position Sensor (TPS), Engine Crankshaft Angular Position (CKP) Sensors, Hall effect Position Sensor, Optical Crankshaft Position Sensor, Manifold Absolute Pressure	[7]

(MAP) Sensor – Strain gauge and Capacitor capsule, Engine Coolant Temperature (ECT) Sensor, Intake Air Temperature (IAT) Sensor, Knock Sensor, Airflow rate sensor, Throttle angle Sensor. Actuators: Fuel Metering Actuator, Fuel Injector, Ignition Actuator. Exhaust After-Treatment Systems, Catalytic Converter, Exhaust Gas Recirculation (EGR), Evaporative Emission System.	
Unit 3: Digital Engine Control Systems Digital engine control features, Control modes for fuel control (Seven Modes), EGR Control, Electronic Ignition Control – Closed loop Ignition timing, Spark Advance Correction Scheme, Integrated Engine Control System – Secondary Air Management, Evaporative Emissions Canister Purge, Automatic System Adjustment, System Diagnostics.	[7]
Unit 4: Automotive Instrumentation and Communication Sampling, Measurement & Signal Conversion of various parameters (Speed, fuel, pressure), Serial Data, Communication Systems, Protection, Body and Chassis Electrical Systems, Remote Keyless Entry, GPS.	[6]
Unit 5: Vehicle Motion Control Cruise control, Chassis, Power Brakes, Antilock Brake System (ABS), Electronic Steering Control, Power Steering, Traction Control, Electronically controlled suspension. Automotive Diagnostics – Timing Light, Engine Analyzer, On-board diagnostics, Off-board diagnostics, Expert Systems.	[6]
Unit 6: Future Automotive Electronic Systems Alternative Fuel Engines, Electric and Hybrid vehicles, Fuel cell powered cars, Collision Avoidance Radar Warning Systems, Low tire pressure warning systems, Heads Up display, Speech Synthesis, Navigation, Voice Recognition Cell Phone dialing,	[6]

Text Books:

1. Kirpal Singh, Automobile Engineering Vol 1 & 2, Standard Publishers, Seventh Edition, New Delhi
2. Tom Denton, Automobile Electrical and Electronic Systems, BH Publication, Third Edition, 2004
3. Judge A.W., Modern Electrical Equipment of Automobiles, Chapman & Hall, London, 1992
4. William B. Ribbens, Understanding Automotive Electronics, 5th Edition, Butterworth Heinemann, Woburn, 1998
5. Robert Bosch GmbH (Ed.), Bosch Automotive Electrics and Automotive Electronics – Systems and Components, Networking and Hybrid Drive, 5th Edition, John Wiley & Sons Inc., 2007

Reference Books:

1. William Harry Crouse, Automotive Electronics and Electrical Equipment, Edition 10, Gregg Division, McGraw-Hill, 1986
2. Tom Denton, Automobile Electrical & Electronics, 3rd Edition, Elsevier Butterworth-Heinemann, 2004
3. Spreadbury, F.G., Electrical Ignition Equipment, Constable & Co Ltd., London, 1962
4. Automotive Electrical and Electronic Systems, Volume 2, Harper & Row/Check-Chart Automotive Series, Roger Fennema, Chek-Chart (Firm), 2nd Edition, HarperCollins Canada Limited, 1987
5. Frank C. Derato, Automotive Electrical and Electronic Systems, 2nd Edition, Glencoe, 1994
6. Kohli, P.L., Automotive Electrical Equipment, Tata McGraw-Hill Co., Ltd., New Delhi, 1975

Automotive Safety and Ergonomics

23MT4704B	PEC	Automotive Safety and Ergonomics	3-0-0	3 Credits

Teaching Scheme	**Examination Scheme**
Lecture: 3 hrs./week	CA –I:10 Marks CA –II:10 Marks Mid-Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Automobile, Basic engineering, Mathematics

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

CO1	Illustrate fundamental vehicle safety concepts, crash physics, and global safety standards.
CO2	Outline types of road accidents, occupant protection, and the role of speed and attention in safety.
CO3	Categorize key active and passive safety systems and their functions in crash prevention and protection.
CO4	Assess the impact of ergonomics and driver comfort on safety and vehicle design.
CO5	Explain driver-vehicle interaction, minimizing distractions, and managing visibility and fatigue.
CO6	Discuss future vehicle safety technologies, regulations, and the role of government in road safety.

Unit 1: Basics of Vehicle Safety Why safety matters, Real-life accident examples, Types of safety: Active, Passive, and Preventive, Simple physics of crashes: Speed, force, and impact, Introduction to global safety standards (NCAP, basic regulations), Common causes of road accidents, Driver mistakes and human errors	[6]
Unit 2: Road Accidents and Human Safety Types of road accidents (frontal, side, rear, rollover), how accidents affect the driver and passengers, Importance of wearing seat belts, Introduction to crash testing, and crash reports. Role of speed and driver attention in safety	[6]
Unit 3: Active and Passive Safety Systems	[6]

Active Safety Systems: ABS (Anti-lock Braking System), ESC (Electronic Stability Control): Preventing skidding, Basics of Adaptive Cruise Control (ACC) & Automatic Emergency Braking (AEB) Passive Safety Systems: Seatbelts: How they work (inertia, locking mechanisms), Airbags: Types (front, side) and when they inflate, Crumple Zones: Why cars crumple in accidents, Protecting pedestrians: Soft hoods, bumper designs, Child safety seats (ISOFIX)	
Unit 4: Driver Comfort & Ergonomics Basics of ergonomics, relation between driver comfort and safety, seat adjustments and lumbar support, steering and pedal positioning, easy-to-use dashboard controls, noise and vibration reduction, visibility, mirror placement, and cabin layout design.	[6]
Unit 5: Driver-Vehicle Interaction Human-Machine Interface (HMI): How drivers use screens/buttons, Avoiding distractions: Phone use vs. voice commands, Simple gauges (speedometer, fuel) vs. modern touchscreens Why good visibility (mirrors, windows) matters, Driver fatigue: Signs and prevention	[7]
Unit 6: Future Trends ADAS features (self-parking, blind-spot alerts), EV safety (battery protection, silent operation), basics of self-driving and connected cars, importance of traffic rules and safe driving habits, overview of Indian and international safety standards (AIS, NCAP), government role in road safety, introduction to electric and automated vehicle safety, future trends in vehicle safety design.	[6]

Text Books:

1. Bhise, Vivek D. Ergonomics in the Automotive Design Process: Advanced Topics, Measurements, Modeling and Research. CRC Press, 2024.
2. Automotive Ergonomics. (2021). Germany: Springer Fachmedien Wiesbaden.
3. Automotive Ergonomics: Driver-Vehicle Interaction. (2016). United States: CRC Press.

Reference Books:

1. Advances in Physical Ergonomics and Safety. (2012). (n.p.): CRC Press.
2. Handbook of Human Factors and Ergonomics in Health Care and Patient Safety, Second Edition. (2012). United Kingdom: Taylor & Francis.

Battery and Fuel Cell Technology

23MT4704C	PEC	Battery and Fuel Cell Technology	3-0-0	3 Credits

Teaching Scheme	**Examination Scheme**
Lecture: 3 hrs/week	CA –I :10 Marks CA–II :10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites:

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

CO1	Relate electrochemical principles related to energy systems and their significance in the functioning of batteries and fuel cells.
CO2	Compare the chemistry, construction, and performance of primary and secondary batteries.
CO3	Analyze emerging and advanced battery technologies in terms of materials, design, and application challenges.
CO4	Examine the types, internal reactions, and construction of different fuel cells, and evaluate their advantages and limitations.
CO5	Evaluate the performance and durability of fuel cell systems through testing methods and component analysis.
CO6	Design integrated energy storage systems involving batteries and fuel cells, considering hydrogen production, safety, control, and cost efficiency.

Course Contents:

Unit 1: Electrochemical cells galvanic and electrolytic, electrical double layer, electrode potential, Nernst equation, reference electrodes (calomel, Ag/AgCl), reversible and irreversible processes, Butler-Volmer equation, Tafel equation, overpotentials (activation, concentration, ohmic), charge transfer, exchange current density, efficiency of electrochemical reactions.	[6]
Unit 2: Classification of batteries primary batteries: zinc-carbon, alkaline, zinc-air, lithium primary cells, secondary batteries: lead-acid, VRLA, nickel-cadmium, nickel-metal hydride, lithium-ion batteries, battery ratings and packaging, energy and power densities, discharge characteristics, battery safety and storage, environmental aspects.	[5]
Unit 3: Lithium-ion battery materials anodes, cathodes, electrolytes, separators, sodium-ion batteries: working mechanism, cathode and anode materials, electrolytes, lithium-oxygen batteries, aluminum-ion batteries: cathodes, electrolytes, classification, dual-ion batteries: working mechanism, materials, redox flow batteries: principle and components, battery recycling, battery safety, battery management systems.	[6]

Unit 4: Fuel cells definition and classification, proton exchange membrane fuel cells (PEMFC), alkaline fuel cells (AFC), phosphoric acid fuel cells (PAFC), solid oxide fuel cells (SOFC), molten carbonate fuel cells (MCFC), direct methanol fuel cells (DMFC), fuel cell reactions: anode, cathode, cell level, catalysts, electrodes, membranes (Nafion), fuel types: hydrogen, methane, methanol, fuel processing and storage, environmental comparison.	[6]
Unit 5: Fuel cell performance IV characteristics, voltage efficiency, power density, overpotentials, loss mechanisms, mass transport limitations, bipolar plates, humidifiers, cooling plates, membrane-electrode assemblies (MEA), testing protocols, electrochemical impedance spectroscopy, durability testing, aging analysis, water and thermal management.	[5]
Unit 6: System-level integration of batteries and fuel cells balance of plant, system configuration and sizing, hydrogen production: electrolysis, steam reforming, biomass-based, hydrogen storage: compressed, liquid, hydride-based, power and control systems, battery management systems (BMS), safety issues: thermal runaway, fire, explosion, applications: electric vehicles, grid storage, cost analysis, commercialization.	[6]

Text Books:

1. Jack Erjavec and Jeff Arias, "Hybrid, Electric and Fuel Cell Vehicles", Cengage Learning, 2012.
2. Jack Erjavec and Jeff Arias, "Alternative Fuel Technology – Electric, Hybrid and Fuel Cell Vehicles", Cengage Learning Pvt. Ltd., New Delhi, 2007
3. Mehrdad Ehsani, Yimin Gao, sebastien E. Gay and Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", CRC Press, 2009.

Reference Books:

1. James Larminie, J. Lowry, "Electric Vehicle Technology Explaned", John Wiley & Sons Ltd. 2003.
2. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies",Springer, 2015.
3. Iqbal Hussein, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press, 2003.

Electrical Hybrid Vehicles

23MT4704D	PEC	Electrical Hybrid Vehicles	3-0-0	3 Credits

Teaching Scheme	**Examination Scheme**
Lecture: 3 hrs/week	CA –I :10 Marks CA–II :10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites:

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

CO1	Illustrate working principle of electric vehicles.
CO2	Explain hybrid electric vehicle architecture and the power electronics devices used in hybrid electric vehicles.
CO3	Apply control techniques for different electric motor drives used in EVs and HEVs.
CO4	Analyze criteria for sizing of propulsion motors and power electronics in HEV systems.
CO5	Interpret different energy storage technologies used for hybrid electric vehicles.
CO6	Elaborate different energy management strategies in vehicles.

Course Contents:

Unit 1: Introduction to Electric Vehicle: Electric Vehicle- Need, Types of Electric Vehicles – Battery Electric Vehicle, Hybrid (ICE & others), Fuel Cell EV, Solar Powered Vehicles. Motion and Dynamic Equations of the Electric Vehicles: various forces acting on the Vehicle in static and dynamic conditions.	[6]
Unit 2: HEV Fundamentals: Vehicle Performance, Series Hybrid Vehicle, Parallel Hybrid Vehicle, Architecture of Electric Drive, Power electronics including switching, AC-DC, DC-AC conversion, electronic devices and circuits used for control and distribution of electric power, Thermal Management of HEV Power Electronics.	[6]
Unit 3: Electric Drive Trains: Basic concept of electric traction, introduction to various electric drivetrain topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Induction Motor Drives, Permanent Magnet Motor Drives, Switched Reluctance Motors.	[7]

Unit 4: : Integration of Subsystems Integration of Subsystems: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems.	[6]
Unit 5: Energy Storage: Introduction, Different batteries for EV, Battery Characterization, Comparison of Different Energy Storage Technologies for HEVs, Battery Charging Control, Charge Management of Storage Devices, Flywheel Energy Storage System, Hydraulic Energy Storage System, Fuel Cells and Hybrid Fuel Cell Energy Storage System and Battery Management System.	[6]
Unit 6: Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies. Introduction to various charging techniques and schematic of charging stations.	[6]

Text Books:

1. Jack Erjavec and Jeff Arias, "Hybrid, Electric and Fuel Cell Vehicles", Cengage Learning, 2012.
2. Jack Erjavec and Jeff Arias, "Alternative Fuel Technology – Electric, Hybrid and Fuel Cell Vehicles", Cengage Learning Pvt. Ltd., New Delhi, 2007
3. Mehrdad Ehsani, Yimin Gao, sebastien E. Gay and Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", CRC Press, 2009.

Reference Books:

1. James Larminie, J. Lowry, "Electric Vehicle Technology Explaned", John Wiley & Sons Ltd. 2003.
2. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies",Springer, 2015.
3. Iqbal Hussein, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press, 2003.

Total Integrated Automation

23MTMDA5	MDM	Total Integrated Automation	3-0-0	3 Credits

Teaching Scheme	**Examination Scheme**
Lecture: 3 hrs/week	CA –I :10 Marks CA –II :10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites:

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

CO1	Outline the components of TIA systems
CO2	Summarize the need of HMI in TIA
CO3	Identify the architecture–Tools used in SCADA systems.
CO4	List the communication protocols used in an integrated system
CO5	Explain the basic concepts of DCS systems.
CO6	Interpret the use of total integrated systems in engineering fields.

Course Contents:

Unit 1: Totally Integrated Automation Need, components of TIA systems, advantages, Programmable Automation Controllers (PAC), Vertical Integration structure.	[6]
Unit 2: HMI Systems: Necessity and Role in Industrial Automation, Need for HMI systems. Types of HMI-Text display operator panels-Touch Panels-Panel PCs-Integrated displays (PLC & HMI). Check with PLC 502 and remove	[7]
Unit 3: Supervisory Control and Data Acquisition (SCADA) Overview–Developer and runtime packages–architecture–Tools–Tag–Internal & External graphics, Alarm logging–Tag logging–structured tags–Trends–history–Report generation, VB & C Scripts for SCADA application.	[7]
Unit 4: Communication Protocols of Scada Proprietary and open Protocols–OLE/OPC–DDE–Server/Client Configuration–Messaging Recipe–User administration–Interfacing of SCADA with PLC, drive, and another field device	[7]
Unit 5: Distributed Control Systems (DCS) DCS–architecture–local control unit-programming language–communication facilities–operator interface–engineering interfaces. Applications Of PLC & DCS, Introduction to SCADA Comparison between SCADA and DCS.	[6]

Unit 6: Case Studies: Case studies of Machine automation, Process automation and other relevant area.	[7]

Text Books:

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

Reference Books:

1. Win C C Software Manual, Siemens, 2003
2. RS VIEW 32 Software Manual, Allen Bradly, 2005
3. CIMPLICITY SCADA Packages Manual, Fanuc India Ltd, 2004
4. Helmut Koopmann, Integrated Automation Systems for Manufacturers, Springer, 2013
5. David Bailey, Edwin Wright, ―Practical SCADA for industry, Newnes, Burlington, 2003.
6. Gordon Clarke, Deon Reynders,Edwin Wright, ―Practical Modern SCADA Protocols: DNP3, 60870.5 and Related systems‖, Newnes Publishing, 2004.

Mechatronics System Design

23MTMDB5	MDM	Mechatronics System Design	3-0-0	3 Credits

Teaching Scheme	**Examination Scheme**
Lecture: 3 hrs/week	CA –I :10 Marks CA –II :10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites:

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

CO1	Explain the principles of Mechatronics and automation for the development of system.
CO2	Outline appropriate sensors and actuators for an engineering application
CO3	Identify Drives and Actuators
CO4	List Micro and Nano Manufacturing methods.
CO5	Interpret Micro mechatronic systems
CO6	Discuss various applications of design of Mechatronic systems.

Course Contents:

Unit 1: Introduction: Definition of Mechanical Systems, Philosophy and approach; Systems and Design: Mechatronics approach, Integrated Product Design, Modelling, Analysis and Simulation, Man-Machine Interface Recognition of the Need, Conceptual Design and Functional Specification, First principle Modular Mathematical Modeling, Detailed Modular Mathematical Modeling, Control System Design, Design Optimization, Prototyping Hardware-in-the-loop Simulation, Deployment/Life Cycle, Deployment of Embedded Software, applications of RFID technology and machine vision	[8]
Unit 2: Sensors and transducers: classification, Development in Transducer technology, Sensor and Actuator Selection, Opto-Electronics-Shaft encoders, CD Sensors, Vision System, etc. Sensor Materials and Technologies- Materials, Surface Processing, Nano-Technology. Performance characteristics of sensors and transducers.Selection criteria for sensors and actuators, interfacing of sensors and actuators	[7]

Unit 3: Drives and Actuators: Hydraulic and Pneumatic drives, Electrical Actuators such as servo motor and Stepper motor, Drive circuits, open and closed loop control; Embedded Systems: Hardware Structure, Software Design and Communication, Programmable Logic Devices, Automatic Control and Real Time Control Systems, applications of Arduino and Raspberry, Pi microcontroller, Applications of Microcontroller.	[8]
Unit 4: Micro and Nano Manufacturing: Nanofabrication Techniques: E-Beam and Nano-Imprint Fabrication, Epitaxy and Strain Engineering, Scanned Probe Techniques, Self-Assembly and Template Manufacturing. MEMS devices and applications: Pressure sensor, Inertial sensor, Optical MEMS and RF-MEMS, Micro-actuators for dual-stage servo systems	[7]
Unit 5: Micro Mechatronics systems: Micro sensors, Micro actuators; Micro-fabrication techniques LIGA Process: Lithography, etching, Micro-joining etc. Application examples; Case studies Examples of Mechatronics Systems from Robotics, Manufacturing, Machine Diagnostics, Road vehicles and Medical Technology	[6]
Unit 6: Mechatronics systems: Traditional Vs Mechatronics Design, Case studies of Mechatronics systems designs, like piece counting system, pick and place manipulator, simple assembly task involving a few parts, part loading / unloading system, automatic tool and pallet changers etc. Design of Autonomous Mobile Robot, Design of cantilever beam vibration control system based on piezo sensors and actuators	[6]
Text Books: 1. Sami Franssila, "Introduction to Micro fabrication", Wiley 2nd Edition. 2. Marc J Madou, Fundamentals of Microfabrication, The Science of minituarization, second edition, CRC press. 3. Yi Qin, Micromanufacturing Engineering and Technology, Micro and Nanotechnology series, Elsevier. . 4. A Textbook of Mechatronics, R.K.Rajput, S. Chand & Company Private Limited. 5. Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, William Bolton, Prentice Hall.	
Reference Books:	
1. Mechatronics System Design, Devdas Shetty & Richard A. Kolk, PWS Publishing Company (Thomson Learning Inc.). 2. Mechatronics: A Multidisciplinary Approach, William Bolton, Pearson Education. 3. Nadim Mulaf and Kirt Williams, "An Introduction to Microelectromechanical systems Engineering", Artech House. 4. Stanley Wolf and Richard Tauber, "Silicon Processing for the VLSI era Volume -1 Technology", Lattice press. 5. Vijay K. Varadan, K.J.Vinoy and S. Gopalkrishnan, "Smart Material Systems and MEMS: Design and Development Methodologies", John Wiley and sons Ltd.	

Introduction to AIML

23MTMDC5	MDM	Introduction to AIML	3-0-0	3 Credits

Teaching Scheme	**Examination Scheme**
Lecture: 3 hrs/week	CA –I :10 Marks CA –II :10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Probability, Statistics, Logical Reasoning.

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

CO1	Illustrate concept of artificial intelligence and machine learning
CO2	Apply feature extraction and selection techniques.
CO3	Apply machine learning algorithms for classification and regression problems.
CO4	Examine a machine learning model using various steps.
CO5	Explain concepts of reinforced and deep learning.
CO6	Discuss machine learning model in mechanical engineering problems

Course Contents:

Unit 1: Introduction to AI & ML History of AI, Comparison of AI with Data Science, Need of AI in Mechanical Engineering, Introduction to Machine Learning. Basics: Reasoning, problem solving, Knowledge representation, Planning, Learning, Perception, Motion and manipulation. Approaches to AI: Cybernetics and brain simulation, Symbolic, Sub-symbolic, Statistical. Approaches to ML: Supervised learning, Unsupervised learning, Reinforcement learning.	[6]
Unit 2: Feature Extraction and Selection Feature extraction: Statistical features, Principal Component Analysis. Feature selection: Ranking, Decision tree - Entropy reduction and information gain, Exhaustive, best first, Greedy forward & backward, Applications of feature extraction and selection algorithms in Mechanical Engineering	[7]
Unit 3: Classification & Regression Classification: Decision tree, Random Forest, Naive Bayes, Support vector machine. Regression: Logistic Regression, Support Vector Regression. Regression trees: Decision tree, random forest, K-Means, K-Nearest Neighbor (KNN). Applications of classification and regression algorithms in Mechanical Engineering	[7]
Unit 4: Development of ML Model Problem identification: classification, clustering, regression, ranking. Steps in ML modeling, Data Collection, Data pre-processing, Model Selection, Model training (Training, Testing, K-fold Cross Validation), Model evaluation (understanding and interpretation of confusion matrix, Accuracy, Precision, Recall, True positive, false positive etc.), Hyper parameter Tuning, Predictions.	[7]

Unit 5: Reinforced and Deep Learning Characteristics of reinforced learning; Algorithms: Value Based, Policy Based, Model Based; Positive vs Negative Reinforced Learning; Models: Markov Decision Process, Q Learning. Characteristics of Deep Learning, Artificial Neural Network, Convolution Neural Network. Application of Reinforced and Deep Learning in Mechanical Engineering	[6]
Unit 6:Applications Human Machine Interaction, Predictive Maintenance and Health Management, Fault Detection, Dynamic System Order Reduction, Image based part classification, Process Optimization, Material Inspection, Tuning of control algorithms	[7]

Text Books:

1. Deisenroth, Faisal, Ong, Mathematics for Machine Learning, Cambridge University Press, 2020.
2. B Joshi, Machine Learning and Artificial Intelligence, Springer, 2020.
3. Parag Kulkarni and Prachi Joshi, "Artificial Intelligence – Building Intelligent Systems", PHI learning Pvt. Ltd., ISBN – 978-81-203-5046-5, 2015
4. Stuart Russell and Peter Norvig (1995), "Artificial Intelligence: A Modern Approach," Third edition, Pearson, 2003.

Reference Books:

1. Solanki, Kumar, Nayyar, Emerging Trends and Applications of Machine Learning, IGI Global, 2018.
2. Mohri, Rostamizdeh, Talwalkar, Foundations of Machine Learning, MIT Press, 2018.
3. Kumar, Zindani, Davim, Artificial Intelligence in Mechanical and Industrial Engineering, CRC Press, 2021.
4. Zsolt Nagy - Artificial Intelligence and Machine Learning Fundamentals-Apress (2018)
5. Artificial Intelligence by Elaine Rich, Kevin Knight and Nair, TMH

Robotics Laboratory

23MT4705	PCC	Robotics Laboratory	0-0-2	1 Credits

Teaching Scheme:	Evaluation Scheme:
Practical: 2 hours/week/batch	CA –I :15 Marks CA –II :15 Marks End Semester Exam: 20 Marks

Pre-Requisites: Industrial Automation and Robotics

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

CO1	Demonstrate robotic configurations, link positions, and coordinate transformations.
CO2	Analyze the accuracy, repeatability, and motion performance of industrial robots through simulations and real-world demonstrations.
CO3	Evaluate industrial robotic applications by conducting case studies, industrial visits, and programming tasks to assess real-world integration.

List of Experiments:

At least minimum of Eight experiments should be performed from the following list

1. Demonstration of various robotic configurations using an industrial robot
2. Determination of the maximum and minimum position of links.
3. Verification of transformation (Position and orientation) with respect to the gripper and world coordinate system
4. Estimation of accuracy, repeatability, and resolution.
5. Robot programming and simulation for any industrial process (Packaging, Assembly)
6. Demonstration components of a real robot and its DH parameters.
7. One Industrial visit for Industrial robotic application
8. Case study for industrial robotics.
9. Virtual modeling for kinematic and dynamic verification (Any one robotic structure using suitable software)
10. Robot Teaching Using VAL (Versatile Assembly Language) Programming

Text Books:

1. Groover, M.P. Weiss, M. Nagel, R.N. & Odrey, N.G., Ashish Dutta, Industrial Robotics, Technology, Programming & Applications, Tata McGraw Hill Education Pvt. Ltd. New Delhi
2. S. R. Deb, Robotics Technology and Flexible Automation, Tata McGraw Hill.
3. Groover M.P.-Automation, production systems and computer integrated manufacturing-Prentice Hall of India.

Reference Books:

1. S B Niku, Introduction to Robotics, Analysis, Control, Applications, 2nd Edition, Wiley Publication, 2015.
2. Mikell P. Groover, Automation, Production Systems & Computer Integrated Manufacturing, PHI Learning Pvt. Ltd., New Delhi, ISBN:987-81-203-3418-2, 2012
3. John Craig, Introduction to Robotics, Mechanics and Control, 3rd Edition, Pearson Education, 2009
4. R K Mittal & I. J. Nagrath, Robotics and Control, McGraw Hill Publication, 2015.
5. Mike Wilson, Implementation of Robotic Systems, ISBN: 978-0-124-04733-4

PLC and SCADA Laboratory

23MT4706	PCC	PLC and SCADA Laboratory	0-0-2	1 Credits

Teaching Scheme:	**Evaluation Scheme:**
Practical: 2 hours/week/batch	CA –I :15 Marks CA–II :15 Marks End Semester Exam: 20 Marks

Pre-Requisites:

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

CO1	Demonstrate PLC hardware and software
CO2	Develop the ladder diagrams for using PLC ladder instructions
CO3	Examine the HMI/SCADA System for various applications

List of Experiments:

At least minimum 08 experiments should be performed from the following list

1. Study hardware and software used in PLC.
2. Implementation of logic functions and De Morgan's theorems using Ladder Diagram
3. Implementation of arithmetic instructions using Ladder Diagram
4. Implement ladder diagram using timers and counters.
5. Logic implementation of switching of lights
6. Logic implementation of Door Bell operation
7. Logic implementation of traffic light control
8. Logic implementation of bottle filling application
9. HMI implementation for any one application
10. SCADA implementation for any one application

Text Books:

1.ProgrammableLogicController–Principles and Applications,5/e,J. W. Webb, A.Reis; Prentice Hall of India Ltd.ISBN81-203-2308-4.
2.Programmable Logic Controller–Principles and Applications, by NIIT; Prentice Hall Publications Pvt. Ltd. India, ISBN81-203-2525-7.
3.Programmable Logic Controller –Programming methods and Applications, Hackworth John R. And Hackworth Frederick D.J.; Pearson Education LCE, ISBN81-297-0340

Reference Books:

1. Introduction to PLC–Gary Dumming –Delmar Pub.
2. Various PLC manufacturers catalogue.
3. Programmable Logic Controller–FESTO Pneumatics, -Bangalore
4. SCADA, Stuart A. Boyer (ISA Publi.) ISBN1-55617-660-0.
5. Practical SCADA for industry, David Bailey, (Elsevier Publi.) ISBN 0-7506-5805-3.

Research Methodology

23MT4707	RM	Research Methodology	3-0-0	3 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs/week	CA –I :25 Marks CA –II :25 Marks

Pre-Requisites:

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

CO1	Summarize the fundamentals of Research concepts
CO2	Classify different types of research concepts.
CO3	Identify different methods of sampling, data collection and its analysis
CO4	Discover components, structure and referencing styles of research report
CO5	Justify the need of research ethics.
CO6	Elaborate use of recent ICT tools for research

Course Contents:

Unit 1: Introduction to Research The concept of research, characteristics of good research, Application of Research, Meaning and sources of Research problem, characteristics of good Research problem, Research process, outcomes, application of Research, Meaning and types of Research hypothesis, Importance of Review of Literature, Organizing the Review of Literature	[7]
Unit 2: Types of Research Types of research, pure (basic, fundamental) and applied research, qualitative and quantitative. Research Design: Meaning, need, types of research design – Exploratory, Descriptive, Casual research Design, Components of research design, and Features of good Research design. Experiments, surveys and case study Research design.	[7]
Unit 3: Sampling, Data Collection and analysis Types and sources of data – Primary and secondary, Methods of collecting data, Concept of sampling and sampling methods – sampling frame, sample, characteristics of good sample, simple random sampling, purposive sampling, convenience sampling, snowball sampling, classification and tabulation of data, graphical representation of data, graphs and charts – Histograms, frequency polygon and frequency curves, bell shaped curve and its properties. Statistical Methods for Data Analysis: Applications of Statistics in Research, measures of central tendency and dispersion	[8]
Unit 4: Research Report Research report and its structure, journal articles – Components of journal article. Explanation of various components. Structure of an abstract and keywords. Thesis and dissertations. components of thesis and dissertations. Referencing styles and bibliography	[6]
Unit 5: Research Ethics Plagiarism - Definition, different forms, consequences, unintentional plagiarism, copyright infringement, collaborative work. Qualities of good Researcher	[6]

Unit 6: ICT Tools for Research Role of referencing software such as Mendeley, Endnote etc. Introduction to Web based search engines and advanced search tools. Introduction to citation and indexing of research articles.	[6]

Text Books:

1. Donald Cooper and PS Schindler (2009) Business Research Methods, 9th edition, Tata McGraw Hill.
2. Kothari C. R Research Methodology

Reference Books:

1. Uma Sekaran (2010) Research Methods for Business, 4th edition, Wiley.
2. Ranjit Kumar (2009) Research Methodology, 2nd edition, Pearson Education
3. Naresh Malhotra and S Dash (2009) Marketing Research, 5th edition, Pearson Prentice Hall.
4. Michael V. P Research Methodology.
5. Fred N. Kerlinger : Foundations of Behavioral Research.

23MT4708	ELC	Capstone Project – II	0-0-8	2 Credits

Teaching Scheme:	**Examination Scheme:**
Practical: 2 hours/week/batch	CA-I: 25 Marks CA-II: 25 Marks End Semester Examination: 50 Marks

Pre-Requisites: All courses

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

CO1	Identify real life problem and feasibility of solution to the problem.
CO2	Analyze and optimize solutions to real life problems with individual and team work through modern tool usage
CO3	Improve professional ethics and communication skill and engage with environment

The students in a group of not more than FOUR will work under the guidance of the faculty member on the project work undertaken by them. The completion of work and the submission of the report and assessment should be done at the end of VII Sem. The project work should consist of any of the following or an appropriate combination:

1. A comprehensive and up-to-date survey of literature related to the study of a phenomenon or product.
2. Design of any equipment and/or its fabrication and testing.
3. Critical Analysis of any design or process for optimizing the same.
4. Experimental verification of principles used in applications related to various specializations related to Mechatronics Engineering.
5. Software development for particular applications.
6. A combination of the above.

The objective is to prepare the students to examine any design or process or phenomenon from all angles, to encourage the process of independent thinking and working, and to expose them to industry. The students may preferably select the project works from their opted elective subjects. The students should submit the report in a prescribed format, before the end of the VIIth semester. The report shall be comprehensive and presented typed on A_4 size sheets and bound. The number of copies to be submitted is the number of students plus two. The assessment would be carried out by the panel of examiners for both, term work and oral examinations.

Project Report:

Project report should be of 50 to 60 pages (typed on A4 size sheets).
For standardization of the project reports the following format should be strictly followed.
1. Page Size: Trimmed A4

2. Top Margin: 1.00 Inch
3. Bottom Margin: 1.32 Inches
4. Left Margin: 1.5 Inches

5. Right Margin: 1.0 Inch
6. Para Text: Times New Roman 12 Point. Font
7. Line Spacing: 1.5 Lines
8. Page Numbers: Right Aligned at Footer. Font 12 Point Times New Roman
9. Headings: Times New Roman, 14 Point Bold face
10. Certificate: All students should attach standard format of Certificate as described by the department. Certificate should be awarded to batch and not to individual student. Certificate should have signatures of Guide, Head of Department and Principal /Director
11. Index of Report:
    i) Title Sheet ii) Certificate iii) Acknowledgement iv) Table of Contents. v) List of Figures vi) List of Tables
    1. Introduction
    2. Literature Survey/ Theory
    3. Design/ Fabrication/ Production/ Actual work carried out for the same and Experimentation.
    4. Observation Results
    5. Discussion on Result and Conclusion
12. References:

References should have the following format

For Books: "Title of Book", Authors, Publisher, Edition

For Papers: "Title of Paper, Authors, Journal/Conference Details, Year

13. The Project report shall be signed by each student in the group, approved by the guide and endorsed by the Head of the Department
14. Presentation: The group has to make a presentation in front of the faculty of department at the end of semester.

23MT4709	RM	Public Speaking and Presentations Skills	0-0-2	1 Credits

Teaching Scheme:	Examination Scheme:
Practical: 2 hours/week/batch	CA-I: 25 Marks CA-II: 25 Marks

Pre-Requisites: All courses

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

CO1	Identify the topic of the seminar related to recent trends and technology.
CO2	Survey literature related to topic and prepare report.
CO3	Improve effective written and verbal communication.

Course Contents:

Before the end of Semester VII, each student will have to deliver a seminar on a subject mutually decided by candidate and his/her guide. The student should select the topic for his/her seminar which is latest and relevant. The student, as a part of the term work, should submit the write-up of the seminar topic in duplicate, typed on A4size sheets in a prescribed format and bound at the end of semester. The performance of the student will be evaluated on the basis of the contents, the presentation and discussion during the delivery of seminar before the evaluation committee appointed by the Department.

Values & Ethics

23MT4710	HSSM	Values & Ethics	2-0-0	Audit

Teaching Scheme	**Examination Scheme**
Lecture: 3 hrs/week	CA-I:25 Marks CA-II: 25 Marks

Pre-Requisites: Nil

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

CO1	Interpret the principles of ethics and human values by examining their influence on personal behavior, public conduct, and value formation through family, society, and education.
CO2	Demonstrate improved attitude, morals, aptitude, and integrity in contributing positively to society
CO3	Distinguish between values and skills, happiness and accumulation of physical facilities, the Self and the Body, Intention and Competence of an individual, etc.
CO4	Explain the significance of value inputs in a classroom and start applying them in their life and profession.
CO5	Analyze publication ethics and misconduct to ensure adherence to ethical standards, authorship guidelines, and responsible research dissemination.
CO6	Evaluate the role of ethics, professional values, and gender sensitization in promoting responsible and equitable conduct in engineering and public life.

Course Contents:

Unit 1: Ethics and Human Interface Ethics and Human Interface, Essence, determinants and consequences of ethics in human actions; Dimensions of ethics; ethics in private and public relationships Human Values – lessons from the lives and teachings of great leaders, reformers and administrators, Role of family, society in inculcating values, role of educational institutions in inculcating values.	[4]
Unit 2: Attitude, Morals, Aptitude, Integrity towards Society Attitude: content, structure, function, Attitude and its influence and relation with thought and behavior, Aptitude and foundational values towards society, integrity, impartiality and non-partisanship, objectivity, dedication towards society, empathy, tolerance and compassion intelligence-concepts, and their utilities and application.	[4]
Unit 3: Understanding Harmony in the Human Being - Harmony in Myself Understanding human being as a co-existence of the sentient 'I' and the material 'Body', Understanding the needs of Self ('I') and 'Body', Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer), Understanding the characteristics and activities of 'I' and harmony in 'I', Understanding the harmony of I with the Body; correct appraisal of Physical needs, meaning of Prosperity in detail, Programs to ensure Sanyam and Swasthya, Understanding harmony in the Family.	[4]
Unit 4: Value Education Need, Guidelines, content and process for Value Education, Self-Exploration–; Natural Acceptance and Experiential Validation, Continuous Happiness and Prosperity, Right understanding, Relationship and Physical Facilities, Understanding Happiness and Prosperity correctly, Method to fulfill the above human aspirations: understanding and	[4]

living in harmony at various levels.	
Unit 5: Publication Ethics Publication Ethics: Introduction, Scope & importance, best practices/standards initiatives & Guidelines: COPE, WAME, etc., Conflict of Interest, Publication Misconduct: definition, concept, problems that lead to unethical behavior & Vice versa, Violation of Publication Ethics, Authorship & Contributor ship, Identification of Publication misconduct, complaints & appeals, Predatory publishers & Journals.	[4]
Unit 6: Ethics and Gender Sensitization Ethics - Meaning, Importance, & Types of Ethics, Values and Attitudes of Professional Engineers, Seven Principles of Public Life. Gender Sensitization: Introduction, Sex vs. Gender, Social construction of Gender, Gender Roles, Gender Stereotypes, ending violence against girls/ women: Advancing safety and rights, Gender Equality.	[5]

Text Books:

1. R R Gaur, R Sangal, G P Bagaria, 2009, A Foundation Course in Human Values and Professional Ethics.
2. M Govindrajran, S Natrajan & V.S. Senthil Kumar, Engineering Ethics (including Human Values), Eastern Economy Edition, Prentice Hall of India Ltd.
3. Neeraj Kumar, "Lexicon for Ethics, Integrity & Aptitude", Chronicle Publication, 2016.
4. Santosh Ajmera, Nand Kishor Reddi, "Ethics - Integrity and Aptitude", Tata Mc Graw Hill Publication, 2014.
5. M. Karthikeyan"Ethics, Integrity and Aptitude", Tata Mc Graw Hill Publication, 2015.
6. Dr. Vara Lakshmi G, Dr. R V Anuradha, "Gender Sensitization", Neelkamal Publications.

Reference Books:

1. Ivan Illich, 1974, Energy & Equity, The Trinity Press, Worcester, and Harper Collins, USA.
2. A N Tripathy, 2003, Human Values, New Age International Publishers.
3. E G Seebauer & Robert L. Berry, 2000, Fundamentals of Ethics for Scientists &Engineers , Oxford University Press.
4. B P Banerjee, 2005, Foundations of Ethics and Management, Excel Books.
5. B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.
6. P L Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Publishers.

Teaching and Evaluation Scheme for Final Year B. Tech.

Department of Mechatronics Engineering

Semester: VIII

Internship/On Job Training

23MT4801	ELC	Internship/On Job Training	0-0-0	12 Credits (For 18-20 Weeks)

Teaching Scheme	**Examination Scheme**
Lecture: Nil	CA –I :50 Marks CA –II :50 Marks End Semester Examination: 100 Marks

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

CO1	Apply foundational engineering knowledge to effectively address real-world industrial challenges during the internship.
CO2	Demonstrate heightened interpersonal communication skills by interpreting and expressing ideas effectively within various professional environments.
CO3	Apply a comprehensive understanding of industry activities and functions, showcasing the ability to navigate and contribute effectively in professional engineering settings.
CO4	Analyze and synthesize experiences, observations, and learned concepts from the internship to compose technically proficient reports for effective communication.
CO5	Apply professionalism, punctuality, and responsible task completion as manifestations of a strong work ethic within the internship.
CO6	Synthesize initiative, curiosity, and active engagement, creating a mindset conducive to meaningful contributions to assigned tasks during the internship period.

Description:

An essential step in bridging the knowledge gap between academic study and practical application for engineering students is the internship program. Minimum eighteen-week internship program begins at the end of the seventh semester and allows students to interact with industries, associations for professionals, or research facilities. Strong communication skills and a basic comprehension of technical topics are essential qualities. The course outcomes place a strong emphasis on developing interpersonal communication skills, confirming technical knowledge in real-world situations, comprehending industry processes in depth, and writing thorough technical reports. It is encouraged of students to be on time, act professionally, and take initiative in their internships.

Guidelines emphasize the need of communication and call on students to promptly and politely discuss any problems they may have with coordinators and supervisors. Additionally stressed are initiative, enthusiasm, and timely execution of duties assigned. After the internship, students must put together a thorough report that is an invaluable tool. This report is evaluated according to standards including uniqueness, sufficiency, structure, and real-world application of principles learnt. In addition, a panel of experts evaluates the quality, efficiency, and organization of students' content delivery when assessing their presenting abilities.

A comprehensive assessment of the students' performance is provided by the overall evaluation, which also includes departmental reports and attendance records. The internship program's all-encompassing strategy attempts to promote engineering students' overall growth as they enter the workforce by instilling practical skills, industry understanding, and good communication.