Semester V
Theory of Machines and Mechanisms

23MT3501	PCC	Theory of Machines and Mechanisms	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: Engineering Physics

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

CO1	Explain fundamental kinematic concepts, mechanisms, and their applications in mechanical systems.
CO2	Apply graphical methods to determine velocity and acceleration in planer mechanism using Relative velocity and Klien's construction method.
CO3	Analyze the effect of friction on torque transmission in screws, pivot and collar bearings.
CO4	Explain the basics of Gear, Gear Geometry and types of gear profiles.
CO5	Evaluate power transmission efficiency in belt drives.
CO6	Construct Cam Contour for given motion.

Course Contents:

Unit 1:Fundamentals of Kinematics and Mechanisms Classification of mechanisms, Basic kinematic concepts and definitions – Kinematic Link, Pair, Chain and its types, Types of constrained motion, Machine & Mechanism, Structure, Degrees of freedom for planer mechanism, Kutzbach and Grublers criteria, Four bar Chain mechanism, Single Slider crank chain , Double slider chain mechanism and its Kinematic inversions, Condition of correct steering.	[6]
Unit 2: Velocity and Acceleration Analysis Concept of relative Velocity and acceleration of a point on link, Inter-relation between linear and angular velocity and acceleration, Velocity and acceleration diagrams using	[7]

relative velocity method for four bar pin jointed linkages and four bar single slider crank linkages, Velocity and acceleration of single slider crank mechanism by Klein's construction.	
Unit 3: Friction Introduction to friction- Types of friction, Coefficient of friction, Friction on rough horizontal plane, Inclined plane, friction between nut and screw, Friction Circle, Friction at pivot and collars, Classification of Clutches, torque transmitting capacity of plate clutch.	[7]
Unit 4: Toothed Gearing Classification of gears, Introduction to gear types- Spur, Helical, Spiral gears. Gear geometry, Theory of Spur gear in detail, Interference in involute tooth gears and methods for its prevention, Path of contact, Contact ratio. Types of Gear trains - Simple, Compound, Reverted, Epicyclic gear train, Numericals on tabular method for finding the speeds of elements in gear train, Torques in gear train.	[7]
Unit 5:Belts and Dynamometers Types of belt drives, Materials used for belts, Velocity ratio of belt drive, Slip and creep of belt, length of belt, Power transmitted by belt, Angle of lap. Classification of dynamometers, Study of rope brake and Prony brake absorption dynamometer.	[6]
Unit 6: Cams and Followers Classification of cams and followers- Terminology and definitions- Displacement diagrams- Uniform velocity, simple harmonic motion, uniform acceleration and retardation, Cycloidal. Determination of cam profile based on given motion of reciprocating knife edge and roller follower with and without offset.	[7]
Text Books: 1. R.S. Khurmi & J.K. Gupta, Theory of Machines, S. Chand Publishing. 2. S.S. Rattan**,** Theory of Machines, McGraw Hill Education. 3. A.Ghosh & A.K. Mallik, Theory of Mechanisms and Machines, East-West Press. 4. Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw-Hill, 2009.	
Reference Books:	
1. J. E. Shigely, J. J. Uicker, "Theory of Machines and Mechanisms", Tata McGraw Hill Publications, New York, International Student Edition, 1995. 2. Thomas Beven, "Theory of Machines", CBS Publishers and Distributors, Delhi. 3. G.S. Rao and R.V. Dukipatti, Theory of Machines and Mechanism, "New Age Int. Publications Ltd. New Delhi. 4. Abdullah Shariff, Theory of Machines, McGraw Hill, New Delhi.	

Strength of Materials

23MT3502	PCC	Strength of Materials	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: Engineering Mechanics, Engineering Graphics

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

CO1	Explain the fundamental concepts of stress, strain, and elastic constants, and Hooke's law.
CO2	Solve equation of axial deformation, strain energy, and composite systems for beams
CO3	Construct shear force and bending moment diagrams.
CO4	Analyze bending and shear stresses in beams of various cross-sections.
CO5	Determine principal stresses and failure theories.
CO6	Solve torsion, pressure vessel, and column buckling problems.

Course Contents:

Unit 1: Review of Stress, Strain and Elastic constants Concept of Stress (Tensile, Compressive, Shear) and Strain, (Linear, Lateral, Shear, and Volumetric), Hooke's Law, Stress-strain diagram, Elastic Constants: Young's Modulus, Bulk Modulus, Modulus of Rigidity, Poisson's Ratio, Poisson's ratio, Relationship between Elastic Constants, Factor of safety, Material properties, Thermal stress and strain	[6]
Unit 2: Axial Load and Elastic Deformation Simple and Composite Bars, Strain Energy, Resilience and proof resilience, Principle of Superposition, Impact loading, Toughness, Fatigue, Matrix Representation of Stress and Strain	[6]
Unit 3: Shear Force and Bending Moment Introduction, Types of Loading, Types of Supports, Types of beams, Loads and Reactions, Sign conventions of shear forces and bending moments, Relationship between shear force	[7]

and bending moments Rate of loading, Shear force and bending moment diagrams for point loads and uniform distributed loads (UDL) for different types of beams.	
Unit 4: Bending Stresses and Shear Stresses **Section Modulus, Moment of Resistance, (MOR), Bending Stress:** Symmetric pure bending of beams, Bending equation, Flexure formula, moment of resistance of cross-sections, Design of rectangular and circular (solid and hollow) sections, Stress distribution for L, I and T sections **Shear Stresses**: Distribution of shear stresses in beams of various commonly used sections such as circular, rectangular, I, and T.	[6]
Unit 5: Principal Stress-Strain and Theories of Failure Normal and shear stresses on any oblique planes and Derivations, Concept of Principal planes, Positions of principal planes and planes of maximum shear, Analytical Method, Graphical Method (Mohr's Circle Method): Properties, construction and numerical, plane stresses, Theories of failure (Without derivation).	[7]
Unit 6: Torsion of shaft, Pressure Vessels and Theory of Columns **Torsion of Circular Shafts:** Theory of pure torsion, Derivation of torsion equations, Polar section modulus, power transmitted **Pressure Vessels:** Longitudinal and circumferential stresses in thin cylinders, derivations **Buckling of columns:** Buckling of columns for different end conditions	[7]
Text Books: 1. Strength of Materials, S. Ramamruthum, DhanpatRai and Sons, New Delhi. 2. Strength of Materials, R. K. Bansal, Laxmi Publication, 4th Edition. 3. Strength of Materials, Khurmi Gupta, S. Chand Publication. 4. Strength of Materials, R.K. Rajput, S. Chad Publication 5. Mechanics of structure, S.B Junnerkar,Charotar Publication House 6. Strength of Materials, S. S. Bhavikatti, Vikas Publication House 7. Strength of Materials, Timoshenko and Young, CBS Publication 8. Mechanics of Materials, S. S. Ratan, Tata McGraw Hill Publication, 2009 9. Strength of Materials,B. K. Sarkar, McGraw Hill Publication, 2003.	
Reference Books: 1. Strength of Materials, Beer and Johnson, CBS Publication 2. Strength of Materials, G.H. Rider,MacMillan India Ltd 3. Strength of Materials, Nag and Chanda, Willey India Publication 4. Advanced Mechanics of Materials, Boresi, Willey India Publication 5. Strength of Materials, Den Hartong, McGraw Hill Publication	

CAD/CAM/CAE

23MT3503	PCC	CAD/CAM/CAE	2-0-0	2 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 role of CAD, CAM, and CAE in engineering and describe FEA fundamentals.
CO2	Apply geometric modeling techniques and CAD transformations for effective product design.
CO3	Analyze CNC programming methods and CAM integration for various manufacturing operations.
CO4	Evaluate the application of FEA and CAE tools for solving engineering problems.
CO5	Design advanced manufacturing setups incorporating AI, VR, AR, and automation strategies.
CO6	Develop intelligent quality control and Industry 4.0 solutions using digital twins, IoT, and smart factory concepts.

Course Contents:

Unit 1: Introduction to CAD, CAM, and CAE Evolution & Role of CAD, CAM, and CAE in the Product Lifecycle, Concepts of Computer-Aided Design (CAD): Benefits & Applications, Introduction to Computer-Aided Manufacturing (CAM): Basics & Importance, Fundamentals of Computer-Aided Engineering (CAE), Introduction to Finite Element Analysis (FEA): Need & Applications, Overview of Manufacturing Systems: Traditional vs. Digital Manufacturing.	[4]
Unit 2: Computer-Aided Design (CAD) & Geometric Modeling. Types of CAD Systems: 2D CAD vs. 3D CAD, Geometric Modeling Techniques: Wireframe, Surface, and Solid Modeling, Solid Modeling Techniques: Constructive Solid Geometry (CSG) & Boundary Representation (B-Rep), 2D & 3D Geometric Transformations: Translation, Rotation, Scaling, CAD Data Exchange & Interoperability: IGES, STEP, DXF, STL, Software Configuration of CAD Systems.	[4]
Unit 3: Computer-Aided Manufacturing (CAM) & CNC Introduction to CAM & Its Integration with CAD, NC vs. CNC Machines: Features, Advantages & Limitations, Elements & Classification of CNC Machines, CNC Motion	[4]

Control Systems: Open & Closed Loop Systems, CNC Coordinate Systems & Tool Path Control, CNC Machine Tools: Structure, Function & Adaptive Control, CNC Programming Basics: Tool Selection, G-Codes & M-Codes, CNC Lathe & Milling Programming: Linear & Circular Interpolation, Pocketing, Contouring, Drilling Cycles, Computer-Integrated Manufacturing (CIM): Introduction & Role.	
Unit 4: Finite Element Analysis (FEA) & CAE Concept of CAE & Its Application in Engineering Analysis, Fundamentals of Finite Element Analysis (FEA): Types of Elements: 1D, 2D, 3D, Degrees of Freedom, Meshing, Shape Functions, Boundary Conditions & Solution Techniques, Structural Analysis Using FEA: Static & Dynamic Analysis, Thermal Analysis & Heat Transfer Problems, Introduction to Computational Fluid Dynamics (CFD) in CAE.	[4]
Unit 5: Advanced Manufacturing Technologies & Automation Introduction to Flexible Manufacturing Systems (FMS), Transfer Systems & Automated Material Handling in FMS, Integration of Artificial Intelligence & Knowledge-Based Engineering in Manufacturing, Virtual Reality (VR) & Augmented Reality (AR) in Manufacturing.	[4]
Unit 6: Computer-Aided Quality Control (CAQC) & Industry 4.0 Fundamentals of Quality Control & Role of Automation in Quality Inspection, Coordinate Measuring Machines (CMM): Types & Applications, Non-Contact Inspection Methods: Laser Scanning, Optical & Ultrasonic Techniques, Intelligent Manufacturing & Smart Factories in Industry 4.0, Introduction to Digital Twin Technology in CAD/CAM/CAE, Future Trends in Manufacturing: IoT, Cyber-physical Systems & AI in Industry 4.0.	[4]

Text Books:

1. M.P. Groover & E.W. Zimmer – CAD/CAM: Computer-Aided Design and Manufacturing, Prentice Hall, 2014.
2. P.N. Rao – CAD/CAM Principles & Applications, McGraw Hill, 2017.
3. Zied Ibrahim R. Sivasubramanian – CAD/CAM, Tata McGraw Hill, 2009.

Reference Books:

1. K. Lalit Narayan, K. Mallikarjuna Rao, and M. Sarcar – Computer-Aided Design and Manufacturing, PHI Learning, 2008.
2. S.R. Otto and J.P. Denavit – Computational Geometry for Design and Manufacture, Wiley, 1995.
3. T. Radhakrishnan – Computer Graphics and Geometric Modeling for Engineers, Wiley, 2001.
4. David F. Rogers & J. Alan Adams – Mathematical Elements for Computer Graphics, McGraw Hill, 2002.
5. Ibrahim Zeid – Mastering CAD/CAM, McGraw Hill, 2005.

Operation and Supply Chain Analytics

23MT3503A	PEC	Operation and Supply Chain Analytics	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 supply chain management
CO2	Make use of forecasting and demand planning
CO3	Examine Network design and optimization
CO4	Explain supply chain analytics techniques
CO5	Develop case studies and real-world applications
CO6	Justify Sustainability and Green Supply Chains

Course Contents:

Unit 1: Introduction to Supply Chain Management Basic Concepts and Evolution: Explore foundational principles and the historical development of supply chain management. Supply Chain Drivers and Metrics: Understand key performance drivers such as cost, quality, and service, and the metrics used to evaluate them. Strategic Fit and Scope: Learn how to align supply chain strategies with overall business goals and the extent of supply chain activities.	[7]
Unit 2: Forecasting and Demand Planning Inventory Models: Strategies including Economic Order Quantity (EOQ), safety stock, and reorder points to manage inventory levels. Multi-Echelon Inventory Optimization: Techniques for optimizing inventory across multiple stages of the supply chain. Case Studies: Practical examples of inventory management in various industries to illustrate best practices.	[7]

Unit 3: Network Design and Optimization Principles of Network Design: Core concepts in designing an efficient supply chain network. Optimization Models and Tools: Utilization of tools like Excel Solver for network optimization. Design Under Uncertainty: Strategies for network design considering uncertainties and the need for flexibility Transportation and Logistics	[8]
Unit 4: Supply Chain Analytics Techniques Predictive Analytics and Modeling: Using data to predict future supply chain events and trends. Machine Learning Techniques: Application of machine learning to enhance supply chain analytics.	[6]
Unit 5:Case Studies and Real-World Applications Successful Implementations: Analysis of real-world cases where supply chain analytics have been successfully implemented. Projects and Hands-On Exercises: Practical exercises using real-world data to apply supply chain analytics concepts. Industry-Specific Applications: Tailored examples from industries like retail, manufacturing, and healthcare to demonstrate diverse applications. Trends and Future Directions	[6]
Unit 6: Sustainability and Green Supply Chains Sustainable Practices: Implementing eco-friendly practices in supply chain operations. Regulatory Compliance: Understanding and adhering to environmental regulations. Circular Economy: Embracing the principles of a circular economy to minimize waste and enhance resource efficiency. Risk Management.	[6]
Text Books: 1. Supply chain analytics: concepts, techniques and applications 2. Supply chain metrics that matter 3. Big data analytics in supply chain management: Theory and application	
Reference Books:	
1. Supply chain network design: Applying optimization and analytics to the global supply chain.	

Wireless Communication

23MT3504B	PEC	Wireless Communication	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: Concepts of electronics and communication

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

CO1	Demonstrate the evolution of cellular concept and wireless communication system
CO2	Outline various mobile radio propagation mechanisms and models
CO3	Identify the concepts of multipath propagation and multipath channels
CO4	Analyze the different multi access techniques for wireless communication
CO5	Categorize the technologies used for wireless networking
CO6	Explain basic and advanced wireless systems & standards

Course Contents:

Unit 1: Introduction to Wireless Communication 2G, 3G,4G wireless networks, WLL, Cellular Concept	[4]

Unit 2: Mobile Radio Propagation: Large Scale Path Loss Large Scale Path Loss: Introduction to Radio Wave propagation, Free Space propagation model, The three Basic Propagation Mechanisms, Reflection, Ground Reflection (Two-Ray) Model, Outdoor Propagation Models, Indoor Propagation Models	[7]
Unit 3: Mobile Radio Propagation: Small-Scale Fading and Multipath Small-Scale Fading and Multipath: Small-Scale Multipath Propagation, Small-Scale Multipath Measurements, Parameters of Mobile Multipath Channels, Types of small-Scale Fading	[6]
Unit 4: Multi Access Technique for Wireless Communication Introduction, Frequency Division multiple Access (FDMA), Time Division Multiple Access (TDMA) Spread Spectrum Multiple Access, Space Division Multiple Access (SDMA), Comparison of Multi Access Techniques	[6]
Unit 5: Wireless Networking: Introduction to Wireless Networks Development of Wireless Networks, Routing in Wireless Networks, Common Channel Signaling (CCS), Integrated services Digital networks (ISDN), Signaling System No. 7 (SS7), Universal Mobile Telecommunication System (UMTS).	[6]
Unit 6: Wireless Systems & Standards AMPS and ETACS, United States Digital Cellular (IS-54 ad IS-136), Global System for Mobile (GSM), Personal Access Communication Systems (PACS), Pacific Digital Cellular (PDC), Introduction to 5G network and technologies used in 5G	[7]

Text Books:

1. Wireless Communications Principals & Practice- Theodore S. Rappaport, (P.E.)
2. Wireless & Mobile Network Architecture- Yi-Bing Lin, Imrich Chiamtac (John Wiley)
3. Fundamental of Wireless Communication- David Tse, Pramod Viswanath (Cambridge)

Reference Books:

1. Introduction to Wireless and Mobile Systems -Dharma Prakash Agarwal, Qing An Zeng (Cengage Learning, Inc)
2. Wireless Communications - Andrea Goldsmith (Cambridge University Press)

Industry Networks

23MT3503C	PEC	Industry Networks	3-0-0	3 Credits

Teaching Scheme	**Examination Scheme**
Lecture: 3 hrs/week	Continuous Assessment –I :10 Marks Continuous Assessment –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 Network Fundamentals
CO2	Identify network access
CO3	List IP connectivity
CO4	Determine IP services
CO5	Interpret security fundamentals
CO6	Explain automation and program ability

Course Contents:

Unit 1: Network Fundamentals Network Hardware: Understanding different types of network devices like routers, switches, and wireless access points. Network Topologies: Learning about different network layouts and their characteristics. Cabling and Interfaces: Understanding different types of cables and their properties, as well as identifying potential issues with interfaces. IP Addressing: Learning about IPv4 and IPv6 addressing, subnetting, and private addressing. TCP/UDP: Understanding the difference between these two transport layer protocols. Wireless Principles: Understanding basic wireless concepts and technologies. Virtualization: Learning about virtualization fundamentals and technologies. Switching Concepts: Understanding basic switching concepts and how switches operate.	[7]
Unit 2: Network Access VLANs: Understanding VLANs and their configuration. Spanning Tree Protocol**:** Understanding how STP works and its importance in a network. EtherChannel: Learning about EtherChannel and its benefits.	[7]

Wireless LANs: Understanding different wireless LAN concepts and configurations	
Unit 3: IP Connectivity Static and Dynamic Routing: Understanding and configuring static and dynamic routing protocols. Routing Protocols: Learning about different routing protocols like OSPF and EIGRP. Security: Understanding basic network security concepts and configurations.	[8]
Unit 4: IP Services DHCP: Understanding and configuring DHCP servers. DNS: Understanding DNS and its role in the network. NTP: Understanding and configuring NTP servers. NAT: Understanding and configuring Network Address Translation.	[6]
Unit 5:Security Fundamentals Threats and Vulnerabilities: Understanding common network threats and vulnerabilities. Security Measures: Learning about different security measures and configurations.	[6]
Unit 6: Automation and Programmability Automation Tools: Understanding the role of automation in network management. APIs: Understanding how APIs can be used to automate network tasks.	[6]

Text Books:

1. CCNA 200-301official cert guide library
2. Behrouz A. Forouzan Data Communication and Networking McGraw-Hill Higher Education ISBN-13 978-0-07296775-3
3. Behrouz A. Forouzan: TCP/IP Protocol Suit McGraw Hill Education ISBN-13 978-0073376042
4. A.S. Tanenbaum Computer Networks PRENTICE HALL ISBN-10: 0-13-212695-8 ,ISBN13:978-0-13-212695-3
5. Godbole Achyut Data Communication and Networks McGraw Hill Education ISBN-10 9780071077705,ISBN-13 978-0071077705

Reference Books:

1. CCNA Preparation Library (640-801)
2. CCNA Certification Exam Guide
3. Comer Douglas E. TCP/IP Principles, Protocols and Architectures PEARSON ISBN 10: 0-13-608530-X ISBN 13: 9780-13-608530-0

Introduction to Cloud Computing

23MT3503D	PEC	**Introduction to Cloud Computing**	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: Nil

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

CO1	Explain fundamental concepts of cloud computing.
CO2	Illustrate the components of cloud architecture, including cloud types, service models, and standard reference models.
CO3	Apply fundamental concepts of Amazon Web Services (AWS) and Microsoft Azure to configure, deploy, and manage basic cloud infrastructure components.
CO4	Analyze various virtualization techniques, structures, and implementation levels
CO5	Evaluate various cloud security challenges, governance architectures, and IAM standards
CO6	Formulate a comprehensive solution using Google Cloud tools to address a real-world problem

Course Contents:

Unit 1: Introduction to Cloud Computing Introduction to distributed and cluster computing, Definition of Cloud, Evolution of Cloud Computing, Importance of Cloud Computing, Characteristics, Pros and Cons of Cloud Computing, Migrating into the Cloud, Seven-step model of migration into a Cloud, Trends in Computing.	[6]
Unit 2: Cloud Architecture Cloud computing types -Public, Private and Hybrid Clouds, Cloud Reference Model-, Cloud Service Models: SaaS, PaaS, IaaS, Layered Cloud Architecture Design, NIST Cloud Computing.	[6]
Unit 3: Cloud Platforms	[6]

Amazon Web Services (AWS): Amazon Web Services and Components, Elastic Cloud Computing (EC2), Amazon Storage System-S3 Bucket, AWS Identity and Access Management (IAM). Microsoft Cloud Services: Azure core concepts.	
Unit 4: Virtualization in Cloud Computing- Basics of Virtualization, VPC, Types of Virtualizations, Implementation Levels of Virtualization, Virtualization Structures, Tools and Mechanisms, Virtualization of CPU, Memory, I/O Devices, Virtualization Support and Disaster Recovery.	[6]
Unit 5: Cloud Security Basics of Cloud security- Issues and Challenges, Categories of Cloud computing security, Cloud Security Governance, Architecture of security governance, Deployment Framework, Virtual Machine security, IAM security standards.	[6]
Unit 6: Cloud Computing Applications- Healthcare: ECG Analysis in the Cloud, Biology: Protein Structure Prediction, Geosciences: Satellite Image Processing, Business and Consumer Applications: CRM and ERP, Social Networking, Google Cloud Application.	[6]

Text Books:

1. Mastering Cloud Computing, Buyya R, Vecchiola C, Selvi S T, McGraw Hill Education (India), 2013.
2. Cloud Computing Bible, Barrie Sosinsky, Wiley Publishing Inc. 2011(Unit,VI)
3. Buyya R, Broberg J, Goscinski A, "Cloud Computing - Principles and Paradigms", Wiley, 2011.
4. K. Chandrasekaran - "Essentials of Cloud computing", 2015, Taylor & Francis Group, LLC.

Reference Books:

1. J. Hurwitz, R. Bloor, M. Kaufman, and Dr. F. Halper - "Cloud computing for Dummies", 2010, Wiley Publishing, Inc
2. R. L. Krutz, R. D. Vines - "Cloud Security", 2010, Wiley Publishing, Inc. 4. T. Erl, Z.
3. Mahmood, R. Puttini - "Cloud computing: Concepts, Technology & Achitecture", 2013 Arcitura Education Inc.

Basket 1 (AUTOMATION): Green Building Management & Smart Automation

23MTMDA3	MDM	Green Building Management & Smart Automation	3-0-0	3 Credits

Teaching Scheme:	Evaluation 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 green buildings and their role in sustainability.
CO2	Apply green building certification frameworks in sustainable construction
CO3	Examine the role of materials and indoor environment quality in sustainable buildings.
CO4	Analyze energy management strategies and radiant cooling in buildings.
CO5	Evaluate renewable energy integration and smart grid systems.
CO6	Assess the role of smart automation in enhancing building performance and sustainability.

Course Contents:

Unit 1:Introduction to Green Buildings Concept of green buildings and their role in sustainability, Comparison: Traditional vs. Green Buildings, Environmental, Economic, and Social Benefits of Green Buildings, Requisites for Constructing a Green Building, Contribution of Buildings towards Global Warming - Carbon Footprint – Global Efforts to reduce carbon Emissions, Green Buildings in India.	[6]
Unit 2: Green Building Certifications and Regulatory Frameworks Importance of green building certification in sustainable construction, Overview of certification systems: Leadership in Energy and Environmental Design (LEED), Steps to achieve LEED Certification, Green Rating for Integrated Habitat Assessment (GRIHA), Bureau of Energy Efficiency (BEE) Star Ratings, Indian Green Building Council (IGBC) Certification, Government policies for green buildings.	[7]
Unit 3: Green Building Materials and Indoor Environment Quality Introduction- Low emitting materials, Building and material reuse, Construction waste management, Life cycle cost assessment of building materials and products, Factors	[7]

affecting indoor environment quality, Ventilation and filtration, Building materials and finishes- Emittance level, Indoor Environment quality- Measure of IAQ, Reasons for poor IAQ, Measures to achieve Acceptable IAQ levels.	
Unit 4: Energy Management Systems in Green Buildings Role of energy management in sustainable building operations, Principles of Energy Management in Green Buildings, Benefits, Energy consumption in buildings, Passive & Active Design Strategies for energy management in green buildings, Building Energy Management Systems (BEMS), Radiant cooling technology in buildings.	[7]
Unit 5: Renewable Energy Integration in Green Buildings Importance of renewable energy in sustainable construction, role of renewables in reducing carbon footprint, Overview of Net-Zero Energy Buildings (NZEBs) and their significance, Types of Renewable Energy Sources for Green Buildings, Energy Storage Systems for Green Buildings, Smart Grid and Renewable Energy Management.	[6]
Unit 6:Smart Automation in Buildings Introduction to Smart Buildings and Intelligent Infrastructure, Role of AI, ML, and IoT in smart automation, Building Automation Systems (BAS) and Integration - SCADA and PLC-based control systems, Cloud-based automation for remote monitoring, Smart HVAC Control & Occupancy-Based Automation, Real-time occupancy sensors for dynamic energy management, Fire safety and automated emergency response.	[7]

Text Books:

1. Sam Kubba, "Hand book of Green building Design and construction", Elsevier Architecture Press.
2. Kibert, C. "Sustainable Construction: Green Building Design and Delivery", John Wiley & Sons, 2005
3. Abe Kruger and Carl Seville, "Green building: principals and practice in residential construction", Cengage Learning.
4. Mike Montoya, Green Building Fundamentals, Pearson, USA, 2010.

Reference Books:

1. Traci Rose Rider ,W. W. Norton & Company Publisher - Understanding Green Building Guidelines: For Students and Young Professionals,.
2. S N Saud Al-Humairi & Asif Hajamydeen- Sustainable Smart Cities and the Future of Urban Development, IGI Global Publishing house, ISBN13: 9798369367407.
3. K S Jagadeesh, B V Venkata Rama Reddy & K S Nanjunda Rao - Alternative Building Materials and Technologies – New Age International Publishers
4. Charles J. Kibert, Sustainable Construction - Green Building Design and Delivery, John Wiley & Sons, New York, 2008.

Basket 2 (DESIGN AND MANUFACTURING): 3D PRINTING TECHNOLOGY

23MTMDB3	MDM	3D Printing 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: Engineering Physics, Engineering Chemistry, Basics of mechanical engineering.

Course Outcomes:

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

CO1	Explain the fundamentals of 3D printing technology and its role in modern manufacturing.
CO2	Identify different liquid-based and solid-based 3D printing technologies
CO3	Explain the powder-based 3D printing techniques and assess their industrial significance.
CO4	Compare various 3D printing materials.
CO5	Discover the use of reverse engineering methodologies for product development using 3D printing.
CO6	Evaluate the applications of 3D printing in various industries such as aerospace, healthcare, and automotive.

Unit 1: Fundamentals of 3D Printing & Additive Manufacturing: Introduction to Additive Manufacturing (AM): Evolution, comparison with traditional manufacturing. 3D Printing Workflow: CAD modeling, STL file generation, slicing, printing, post-processing. Advantages and Limitations of 3D Printing. On demand manufacturing – Direct material deposition – Shape Deposition Manufacturing.	[7]
Unit 2: Liquid-Based and Solid-Based 3D Printing Technologies: Liquid-Based Systems: Stereolithography (SLA): Process, materials, advantages, limitations, and applications. Solid-Based Systems: Fused Deposition Modeling (FDM): Working principle, materials, advantages, and uses. Laminated Object Manufacturing (LOM): Process details, advantages, and industrial applications.	[7]

Unit 3: Powder-Based 3D Printing Technologies. Selective Laser Sintering (SLS): Process principles, materials, bonding techniques Industrial applications and research developments, Three-Dimensional Printing (3DP): Printing process, materials, and case studies Laser Engineered Net Shaping (LENS): Process principles, materials Customized plastic and metal part production	[8]
Unit 4:3D Printing Materials Polymers: PLA, ABS, Nylon– Properties and Applications. Metals: Titanium, Aluminum, Stainless Steel, Inconel – Mechanical properties, industries using metal 3D printing. Ceramics & Composite Materials. Biomaterials for Medical Applications. Recycling and Sustainability in 3D Printing.	[8]
Unit 5: Reverse Engineering in 3D Printing 3D Scanning and Digitization Techniques. Data Processing for 3D Printing: Model reconstruction and modification. Selection of RE Systems, Software, and Hardware. Applications in Product Development and Manufacturing	[6]
Unit 6: Applications & Industry Case Studies Aerospace: Lightweight structures, fuel-efficient parts Automotive: Rapid prototyping, spare parts, on-demand manufacturing Healthcare & Bio-Printing: Prosthetics, implants, tissue engineering Construction & Consumer Goods: 3D printed houses, electronics, footwear, and jewelry.	[6]

Textbook/s

1. Ian Gibson, David Rosen, Brent Stucker – Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, Springer, 2nd Edition, 2015.
2. Chua Chee Kai, Leong Kah Fai, Lim Chu Sing – Rapid Prototyping: Principles and Applications, World Scientific, 4th Edition, 2019.
3. Andreas Gebhardt, Jan-Steffen Hötter – Additive Manufacturing: 3D Printing for Prototyping and Manufacturing, Hanser Publications, 2016.

Reference Books

1. Ali K. Kamrani, Emad Abouel Nasr – Engineering Design and Rapid Prototyping, Springer, 2010.
2. L. Lu, J.Y.H. Fuh, Y.-S. Wong – Laser-Induced Materials and Processes for Rapid Prototyping, Springer, 2001.
3. Joachim Behrendt, David L. Bourell, Richard Crawford – 3D Printing of Metals: Current Developments and Research Opportunities, Springer, 2018.
4. Matthew Di Prima et al. – Additive Manufacturing for Medical Applications, ASTM International, 2020.
5. Richard Hague – Direct Writing and Additive Manufacturing: From Prototyping to Production, Wiley, 2021.
6. L. Jyothish Kumar, Pulak M. Pandey, David Ian Wimpenny – 3D Printing and Additive Manufacturing Technologies, Springer, 2019.

Basket 3 (SOFTWARE): Database Management System

23MTMDC3	MDM	Database Management System	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: Data Structures

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

CO1	Outline the concepts of database system
CO2	Illustrate the fundamental concepts of the Relational Data Model and normalization
CO3	Apply fundamental SQL commands using appropriate data types.
CO4	Apply various SQL operators, functions, clauses, joins, and nested queries to retrieve, manipulate, and analyze data from relational databases.
CO5	Analyze the role and implementation of database objects
CO6	Examine transaction processing mechanisms

Course Contents:

Unit 1: Introduction to Database system Data, Database, Database management system, File system Vs DBMS, Applications of DBMS, Levels of Data Abstraction, Overall structure of DBMS Architecture: - Two tier and Three tier architecture of database. Data Models: - Hierarchical, Networking, Relational Data Models, object-oriented model	[5]
Unit 2: Relational Data Model Fundamentals of RDBMS: records, fields, data types, Tables, Tuples, Domains, Attributes, Key concept, :- Candidate Key, Super Keys, , Primary Key, Foreign Key, Normalization: 1NF, 2NF, 3NF E-R model : - ER diagram Notations, ER Diagrams, Strong Entity set, Weak Entity set, Types of Attributes, extended features of E-R model.	[6]

Unit 3: Introduction to SQL Introduction to SQL: -Data types, Components of SQL: Data Definition Language (DDL), Data Manipulation language (DML), Data Control Language (DCL), DQL and their associated commands . Integrity constraints: I/O constraints, Business rule constraints	[7]
Unit 4: SQL operators and functions Operators:- Relational, Arithmetic, Logical, Set operators Functions:- in built functions, Numeric , Date and time, String functions, Aggregate Functions. Clauses:- Where, Group by ,Order by, Having. Joins: Types of Joins, Nested queries.	[6]
Unit 5:Interactive SQL Views : Concept ,Create ,Update, Drop Views, , views and joins ,views and subqueries Sequences :- Concept ,Create, Alter , Drop, Use of Sequence in table, Index: Concept ,Types of Index , Create ,Drop Indexes Synonyms: Create, drop	[6]
Unit 6: Transaction management and Concurrency control Transaction concept, A simple transaction model, ACID properties, serializability and concurrency control, Lock based concurrency control (2PL, Deadlocks), Time stamping model, Recovery systems-Failure Classification, Storage, Recovery and Atomicity, Recovery Algorithm, checkpoint, Shadow paging.	[6]

Text Books:

1. A Silberschatz, H Korth, S Sudarshan, "Database System and Concepts", fifth Edition McGraw-Hill
2. Rob, Coronel, "Database Systems", Seventh Edition, Cengage Learning.

Reference Books:

1. Ramez Elmasri, Shamkant Navathe,"Fundamentals of Database Systems", Seventh Edition, Pearson Publication
2. Abraham Silberschatz , Henry Korth , S. Sudarshan, "ISE Database System Concepts", Seventh Edition, McGraw-Hill Education

Theory of Machines and Mechanisms Laboratory

23MT3505	PCC	Theory of Machines and Mechanisms laboratory	0-0-2	1 Credits

Teaching Scheme:	Evaluation Scheme:
Practical: 2 hours/week/batch	CA –I :25 Marks CA –II :25 Marks

Pre-Requisites: Applied Physics

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

CO1	Explain the fundamental concepts of mechanisms.
CO2	Apply graphical methods such as relative velocity analysis and Klein's construction to determine velocity and acceleration in planar mechanisms.
CO3	Construct Cam profile for specific motion.
CO4	Examine effect of slip on power transmission of belt.
CO5	Determine the torque transmitted in gear train.

List of Experiments:

1. Demonstration of simple linkage models/mechanisms.
2. Study of Various Types of Steering Gear Mechanisms.
3. Graphical solutions to problems on velocity and acceleration in given mechanism by relative velocity method. (Use drawing sheet)
4. Klien's construction method for velocity and acceleration analysis of slider crank mechanism. (Use drawing sheet)
5. Construct cam profile for various types of follower motion. (Use drawing sheet)
6. Experiment on measurement of Slip of belt.
7. Evaluate torque transmitted in Gear train.

Text Books:

5. R.S. Khurmi & J.K. Gupta, Theory of Machines, S. Chand Publishing.
6. S.S. Rattan**,** *Theory of Machines,* McGraw Hill, New Delhi..
7. P.L.Ballany, Thery of Machines & Mechanism, Khanna Publication, New Delhi.
8. A.Ghosh & A.K. Mallik, Theory of Mechanisms and Machines, East-West Press.
9. Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGrawHill, 2009.

Reference Books:

4. J. E. Shigely, J. J. Uicker, "Theory of Machines and Mechanisms", Tata McGraw Hill Publications, New York, International Student Edition, 1995.
5. Thomas Beven, "Theory of Machines", CBS Publishers and Distributors, Delhi.
6. G.S. Rao and R.V. Dukipatti, Theory of Machines and Mechanism, "New Age Int. Publications Ltd. New Delhi.
7. Abdullah Shariff, Theory of Machines, McGraw Hill, New Delhi.

Industrial Measurement Laboratory

23MT3506	PCC	Industrial Measurement Laboratory	0-0-2	1 Credits

Teaching Scheme:	Evaluation Scheme:
Practical: 2 hours/week/batch	CA –I :25 Marks CA –II :25 Marks

Pre-Requisites: Engineering Mechanics, Engineering Mathematics, Engineering Physics

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

CO1	Evaluate mechanical properties (tensile strength, torsional resistance, impact toughness, and thermal stress) of materials
CO2	Analyze the stress-strain behavior under various loading conditions (axial, thermal, and impact) using both experimental methods and computational tools.
CO3	Justify the knowledge associated with various linear and angle measuring instruments.
CO4	Illustrate the methods used for the measurement of screw threads, gear parameters and flatness of given component

List of Experiments:

Following experiments should be performed from list.

Group A: (4 Experiments should be done from list)

1.To perform a tensile test on ductile and brittle materials.

2.To perform a torsion test on mild steel circular sections.

3.To measure thermal stress in materials.

4.To perform an impact test for evaluating material toughness.

5.To analyze stress and strain under different loading conditions using ANSYS/MATLAB.

Group B: (4 Experiments should be done from list)

1. Study and use of Linear Measuring Instruments
2. Study and use of various Comparators
3. Study and use of Angle Measuring Instruments
4. Understand Screw Thread Measurement
5. Study and Measurement of Thread parameters using Profile Projector.
6. Study of Spur Gear Measurement

Text Books:

1. Strength of Materials, S. Ramamruthum, DhanpatRai and Sons, New Delhi.
2. Strength of Materials, R. K. Bansal, Laxmi Publication, 4th Edition.
3. Strength of Materials, Khurmi Gupta, S. Chand Publication.
4. Strength of Materials, R.K. Rajput, S. Chad Publication
5. R.K. Jain, "Engineering Metrology", Khanna Publisher,
6. I.C. Gupta, "Engineering Metrology", Dhanpat Rai Publications.
7. N Sidheshwar,P Kannaiah,"Machine Drawing",TATA Magraw hill,2009.
8. Anand Bewoor, Vinay Kulkarni, "Metrology & Measurement" The McGraw-Hill Comp.

Reference Books:

1. Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall of India, New Delhi, 2001.
2. D.S. Bedi, Strength of Materials, Khanna Book Publishing Company, 2018.
3. R. Subramanian, Strength of Materials, Oxford University Press, 2007.
4. Beckwith T.G, and N. Lewis Buck, Mechanical Measurements, Addison Wesley, 1991,5th edition
5. N.V Raghavendra and L. Krishnamurthy, Engineering Metrology and Measurements, Oxford University Press, 2014.
6. Serope Kalpakjian and Steven R. Schmid, Manufacturing, Engineering & Technology, Pearson, Sixth Edition

Python Programming Laboratory

23MT3507	PCC	Python Programming Laboratory	0-0-2	1 Credit

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

Pre-Requisites: Computer Organization

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

CO1	Explain and apply essentials and fundamentals of Python Programming
CO2	Make use of Decision making and Looping statements
CO3	Analyze the concepts of functions, modules.
CO4	Build code using standard library functions/packages

List of Experiments:

At least minimum 8 experiments should be performed from the following list

1. a) Write python program display welcome message on screen.
   b) Implement the python program to read data from user and display data on screen.
2. Implement a python programs using following operators:
   i) Arithmetic ii) Relational & logical iii)Assignment iv)Bitwise v) Membership vi) Identity
3. Implement a python program to demonstrate the use of following conditional statements:
   i) if statement ii) if..else statement iii) if..elif..else statement iv) nested if statement
4. Implement a python program to demonstrate the use of following looping statements:
   i) while loop ii) for loop iii) nested loop
5. a)Implement a python program to perform following operations on the List:
   i) Create a List ii) Access List iii)Update List iv)Delete List

b) Implement python program to perform following operations on the Tuple:

i) Create a Tuple ii) Access Tuple iii) Print Tuple iv) Delete Tuple v) Convert tuple into list and vice-versa

6. a) Implement a python program to perform following operations on the Set: i) Create a Set ii)Access Set iii) Update Set iv) Delete Set

b) Implement a python program to perform following operations on the Dictionary:

i) Create a Dictionary ii)Access Dictionary iii) Update Dictionary iv) Delete Dictionary v) Create Dictionary from list

7. Write a user define function to implement following features: i) function without argument ii) Function with argument iii) Function returning value

8. Write a python program to demonstrate the use of following module: i) math module ii) random module iii) os module

9. Write a python program to implement i) Single inheritance ii) Multiple Inheritance iii) Multilevel inheritance

10. Write python GUI program to import Tkinter package and create a window and set its title

Text Books:

1.Exploring Python, Timothy Budd, Mc Graw Hill Publication, ISBN:9780073523378, August 2010

2. Beginning Python, Peter C. Norton, Alex Samuel, Dave Aitel, Eric Foster-Johnson, Leonard Richardson, Jason Diamond, Aleatha Parker, Michael Roberts, ISBN: 978- 0-7645-9654-4, August 2005.

Reference Books:

1. Python: Create - Modify - Reuse, James O. Knowlton, Wrox Publication, ISBN: 978-0-470-25932-0, July 2008.

2. Professional Python Frameworks: Web 2.0 Programming, Dana Moore, Raymond Budd, William Wright, Wrox Publication, ISBN: 978-0-470-13809-0, October 2007.

CAD/CAM/CAE Laboratory

23MT3508	VSEC	CAD/CAM/CAE Lab	0-0-2	1 credit

Teaching Scheme	**Examination Scheme**
Practical: 2 hrs/week/Batch	CA –I :15 Marks CA –II :15 Marks End Semester Exam: 20 Marks

Pre-Requisites: Engineering Graphics, Engineering Mathematics.

Course Outcomes:

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

CO1	Develop 3D models and assemblies using CAD software.
CO2	Make use of CNC turning and milling programs for automated machining.
CO3	Analyze mechanical components using CAE tools for structural and shape optimization.
CO4	Determine the application of industrial robots and automation in manufacturing.

List of Experiments

1. Creating mechanical components using any 3D modeling software.
2. Developing engineering product assemblies and sub-assemblies.
3. CNC Turning Operations – Writing and simulating at least two programs.
4. CNC Milling Operations – Writing and simulating at least two programs.
5. Shape Optimization – Using CAE software to optimize mechanical components.
6. Structural Analysis – Solving at least two structural analysis problems in CAE software.
7. Industrial Robot Case Study – Exploring applications in automated manufacturing.

Textbooks:

1. "CAD/CAM: Principles and Applications" – P. N. Rao, McGraw Hill, 2017.
2. "CNC Programming Handbook" – Peter Smid, Industrial Press, 2008.
3. "Finite Element Analysis: Theory and Applications with ANSYS" – Saeed Moaveni, Pearson, 2011.
4. "Automation, Production Systems, and Computer-Integrated Manufacturing" – Mikell P. Groover, Pearson, 2015.

Reference Books:

1. "Computer-Aided Manufacturing" – T. K. Kundra, P. N. Rao, and N. K. Tewari, Tata McGraw Hill, 2013.
2. "Mastering CAD/CAM" – Ibrahim Zeid, McGraw Hill, 2009.
3. "Introduction to Robotics: Mechanics and Control" – John J. Craig, Pearson, 2021.
4. "Rapid Prototyping: Principles and Applications" – Chua Chee Kai, Leong Kah Fai, World Scientific, 2010.

Aptitude Skills III: Verbal Ability

23HSSM05	VEC	Aptitude Skills- III	1-0-0	Audit

Teaching Scheme:	Examination Scheme:
Lecture: 1hr/Week	CA-I: 25 Marks CA-II: 25 Marks

Pre-Requisites: Aptitude Skills-I and II

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

CO1	Solve the questions on ordering of words & Parts of Speech
CO2	Organize contents of Business Communications such as CV, emails and letters.
CO3	Solve the questions based on jumbled paragraphs and reading comprehension.
CO4	Solve the questions on spotting error and sentence correction.
CO5	Summarize proceedings of any event or conference.
CO6	Discuss about current and critical issues during group discussion.

Course Contents:

Unit 1	Parts of Speech, Punctuation Word Family (Using the same word as different Parts of Speech)	**[2]** **[2]**
Unit 2	Analogy, Letter Writing (Formal), E-Mail Writing, CV Writing	**[2]**
Unit 3	Reading Comprehension, Paragraph Jumbles	**[2]**
Unit 4	Spotting Errors (in different parts of sentence), Subject-Verb Agreement Sentence Correction, Sentence Completion	**[2]**
Unit 5	One Word Substitution, Narrating Events/Reports, Summary/Precis Writing	**[2]**
Unit 6	Dialogue writing Group Discussion, Interview Skills (Using formal notations & gestures etc.)	**[2]**

Text Books:

1. Raymond Murphy, Essential English Grammar with Answers, Murphy
2. Objective General English by R.S. Aggarwal, S Chand Publishing; Revised edition (15 March 2017)

Reference Books:

1. Rao and ,D,V,Prasada, Wren & Martin High School English Grammar and Composition Book, S Chand Publishing, 2017
2. Murphy, Intermediate English Grammar with Answers, Cambridge University Press;Second edition

Language Skill- III

23HSSM06	VEC	Language Skill- III	0-0-2	Audit

Teaching Scheme:	Examination Scheme:
Practical: 2 hrs/week	CA-I: 25 Marks CA_II: 25 Marks

Pre-Requisites: Language Skill I & II

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

1	Develop a program to read input and return output.
2	Develop a program using data types, Strings and variables
3	Develop a program using Unary, Binary and Ternary operator
4	Develop a program using Conditional and Logical statements.

1. **Write a Python program to print "Hello, World!"** o Objective: Understand basic syntax, indentation, and output.	**[2]**
2. **Write a program to demonstrate the use of different types of comments in Python.** o Objective: Single-line and multi-line comments.	**[2]**
3. **Write a Python program that declares different types of variables and displays their data types using the type() function.** o Objective: Variables, data types, and type identification.	**[2]**
4. **Write a program to demonstrate type casting and type conversion between int, float, and string.** o Objective: Type conversion, casting functions.	**[2]**
5. **Write a Python script to perform string operations such as slicing, concatenation, upper(), lower(), and len().** o Objective: String manipulation and built-in functions.	**[2]**
6. **Write a program to demonstrate the use of all arithmetic, logical, and bitwise operators.** o Objective: Operator functionality.	**[2]**
7. **Write a Python program to use membership and identity operators with examples.** o Objective: in, not in, is, is not.	**[2]**
8. **Write a Python program using a ternary operator to find the larger of two numbers.** o Objective: Conditional (inline) expressions.	**[2]**

9. **Write a program that takes user input for age and prints whether the person is a child, teenager, adult, or senior citizen using if-elif-else.** o Objective: Conditional statements and user input.	**[2]**
10. **Write a program to find the sum of the first 10 natural numbers using a while loop.** o Objective: Looping with while.	**[2]**
11. **Write a Python script to display the multiplication table of a number using a for loop.** o Objective: Looping with for and range().	**[2]**
12. **Write a program that uses break, continue, and pass statements in appropriate looping scenarios.** o Objective: Loop control statements.	**[2]**
Text Books: 1. Python Projects (Author: Laura Cassell, Alan Gauld) Wrox publication 2. murach's Python Programming. Aut.:Michael Urban, Joel Murach, murach's Publication.	
Reference Books: 1. Fundamentals of Python (First Program) Cengage MINDTAP Publication 2nd Edition. Author: K.A. Kambert	

Mini Project -IV

23MT3509	CEP	Mini Project IV	0-0-2	1 Credit

Teaching Scheme:	**Examination Scheme:**
Practical: 2 hrs/week	CA –I :25 Marks CA –II :25 Marks

Pre-Requisites: NA

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

CO1	Select the appropriate method for solving the problem
CO2	Make use of various engineering techniques and tools to give a solution
CO3	Justify the method/tools used to develop the solution.
CO4	Demonstrate tangible solutions to the problem
CO5	Describe the solution with the help of a project report and presentation.

The project is a part of addressing societal and industrial needs. Mini project is one of the platforms that students will use to solve real-world challenges. This course focuses on the selection of methods/engineering tools/analytical techniques for problem-solving. Through this course, students gain a thorough understanding of engineering basics and ideas, gain practical experience, have the opportunity to display their skills and learn about teamwork, financial management, communication skills, and responsibility.

Guidelines

1. Every student shall undertake the Mini project activity for semester V.
2. The same group of minimum three and maximum of five students who were working for mini project II should work together in Mini project IV
3. The students have to work on different approaches and finalize the best methodology to solve the problem in consultation with the project guide.
4. The students should use different tools /Techniques for the development of the solution to the problem.
5. While developing solutions, the student can take care of effective use of resources, follow ethical practices, finance management,
6. The solution should be optimal, affordable, user-friendly and environment friendly.
7. Critically analysis and testing of the solution provided.

8. By using IPR, students should reserve their rights of innovations as well as communicate new findings to society with the help of research papers.

The committee of senior faculty members and a project guide will be appointed to monitor the progress and continuous evaluation of each project. The assessment shall be done jointly by the guide and committee members.

Industrial Training / Field Training

23MT3510	VSEC	Industrial Training / Field Training	0-0-0	Audit

Teaching Scheme:	**Examination Scheme:**
Practical:	End Semester Exam :50 Marks

Course Description: -
Internship / Training is educational and career development opportunity, providing practical experience in a field or discipline. At the end of the fourth semester, every student should undergo practical training in an industry / professional organization / Research laboratory with the prior approval of the HoD/TPO/Principal of the college and submit the report along with the completion certification from the Industry/ Organization. The report will be evaluated during the fifth semester by the department.
Course Learning Outcomes: -
After successful completion of the course, students will be able to
1. Verify the Technical knowledge in real industrial situations.
2. Develop interpersonal communication skills.
3. Discuss activities and functions of the industry in which the Internship/training has done.
4. Write the technical report.
Prerequisite: - Basics of Mechatronics Engineering, Good written and Oral Communication.
Guideline for Students: -
1. Arrive at work as per schedule, ready to work and stay for the agreed upon time.
2. Present yourself in a professional manner at all times, including being appropriately dressed at workplace.
3. Communicate any concerns with your supervisor and the internship/Training coordinator in a timely manner and respectfully.
4. Demonstrate enthusiasm and interest in what you are doing, ask questions and take the initiative as appropriate.
5. Complete and submit assigned tasks by designated timelines. Meet all deadlines.
Student's Diary/ Daily Log
The main purpose of writing daily diary is to cultivate the habit of documenting and to encourage the students to search for details. It develops the students' thought process and reasoning abilities. The students should record in the daily training diary the day-to-day account of the observations,

impressions, information gathered and suggestions given, if any. It should contain the sketches & drawings related to the observations made by the students.
The daily training diary should be signed after every day by the supervisor/ in charge of the section where the student has been working. The diary should also be shown to the Faculty Mentor.
Student's Diary and Internship Report should be submitted by the students along with attendance record and an evaluation sheet duly signed and stamped by the industry to the SITCOE immediately after the completion of the training. It will be evaluated on the basis of the following criteria:
• Regularity in maintenance of the diary.
• Adequacy & quality of information recorded.
• Drawings, sketches and data recorded.
• Thought process and recording techniques used.
• Organization of the information.
Internship Report
After completing the internship, the student should prepare a comprehensive report to indicate what he/she has observed and learned in the training period. Daily diary will also help to a great extent in writing the industrial report since much of the information has already been incorporated by the student into the daily diary. The competent authority should sign the training report. The Internship report should be evaluated on the basis of following criteria:
i. Originality.
ii. Adequacy and purposeful write-up.
iii. Organization, format, drawings, sketches, style, language etc.
iv. Variety and relevance of learning experience.
v. Practical applications, relationships with basic theory and concepts taught in the course.
Evaluation of Internship/Training
The student should be evaluated based on his training report and presentation, before an expert committee constituted by the concerned department as per norms. The evaluation will be based on the following criteria: •Quality of content presented. •Proper planning for presentation.
• Effectiveness of presentation.
• Depth of knowledge and skills.
• Attendance record, daily diary, departmental reports shall also be analyzed along with the Internship Report.

Semester VI
Design of Machine Elements and Transmission Systems

23MT3601	PCC	Design of Machine Elements and Transmission Systems	3-0-0	3 Credits

Teaching Scheme	**Examination Scheme**
Practical: 2hrs/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	Summarize the concept of machine design while designing component against static and dynamic load.
CO2	Relate the concept of Detachable and Permanent Joints; and analyze when it is subjected to different loading conditions
CO3	Develop the equation to find strength of shaft and coupling used in transmission systems
CO4	Analyze the use of different types of gears and belts for engineering applications
CO5	Justify the selection of sliding contact and rolling contact bearings from manufacturers catalogue
CO6	Design the power screws for various applications.

Course Contents:

Unit 1: Introduction Fundamentals of Machine Design- Phases of design, Design Standards and Codes, Simple stresses in Machine Parts, Design against Static and Dynamic Load –Modes of failure, Factor of safety, Theories of failure, Stress Concentration, Stress Concentration Factors, Variable Stress, Fatigue Failure, Endurance Limit, Design for Finite and Infinite Life- Soderberg, Gerber, and Goodman Criteria	[6]
Unit 2: Detachable and Permanent Joints	[7]

Design of Riveted Joints and Welded Joints, Design of Bolts- Design of Bolts under Static Load, Design of Bolt with Tightening/Initial Stress, Design of Bolts subjected to Fatigue	
Unit 3: Shafts Keys and Coupling Design of Shaft – For Static and Varying Loads, For Strength and Rigidity Design of Keys -Types, Design of Square and Flat Keys Design of Coupling- Types, Flange Coupling, Muff Coupling, and Flexible Coupling	[7]
Unit 4: Gears and Belt Drives Design of Spur and helical Gears: Definitions, Nomenclature, Force analysis in gear tooth, Design for Beam strength and wear strength, estimation of module based on beam strength and wear strength. Design of Belt Drives-Design and selection of flat belt, V-belt from manufacturer's catalogue.	[7]
Unit 5: Design of Springs and Bearings Design of Springs: Terminology, materials and specifications-Classification and Applications of Springs, Stresses in springs, Wahl's correction factor, Deflection of springs-Design of Helical compression springs subjected to uniform applied loads Rolling contact Bearing-Types, Static and dynamic load carrying capacities, Stribeck's Equation, Equivalent load, load and life relationship, selection of bearing life, Load factor, selection of bearing from manufacturer's catalogue, Sliding Contact Bearings: Introduction and Methods of lubrication, bearing failure, causes and remedies	[6]
Unit 6: Design of Power Screws Power Screws: Types of threads used for power screw and their applications, torque analysis for square and trapezoidal threads, efficiency of screw, collar friction, overall efficiency, self- locking in power screws, stresses in the power screw.	[7]

Text Books:

1. Shigley, Joseph E., and Charles R. Mischke. Mechanical engineering design (in SI units). Tata McGraw Hill, 2006.
2. Juvinall, Robert C., and Kurt M. Marshek. Fundamentals of machine component design. John Wiley & Sons, 2020.
3. Mahadevan, K., and B., Reddy, "Design Data Hand Book", CBS Publishers
4. Bhandari, V. B. Design of machine elements. Tata McGraw-Hill Education, 2010.
5. Bhandari, V. B. Introduction to machine design. Tata McGraw-Hill Education, 2013.
6. Sidheswar, N., "Machine Drawing", McGraw-Hill
7. R. L. Nortan, "Machine Design: An Integrated Approach", Pearson Education Singapore, 2001
8. A Machine Design R.S. Khurmi & J.K.Gupta S. Chand publication.
9. Machine design S G Kulkarni McGraw Hill Education Publications

Reference Books:

1. R. C. Juvinall, K. M. Marshek, " Fundamental of machine component design", John Wiley & Sons Inc., New York, 3rd edition, 2002.
2. J. Hamrock, B. Jacobson and Schmid Sr., " Fundamentals of Machine Elements", International Edition, New York, 2nd edition, 1999.
3. S. Hall, A. R. Holowenko, H. G .Langhlin, "Theory and Problems of Machine Design", Schaum's Outline Series, Tata McGraw Hill book Company, New York, 1982.
4. J. E. Shigley and C. Mischke, "Mechanical Engineering Design", Tata McGraw Hill Publications, 7th edition, 2004.
5. M. F. Spotts, "Design of Machine Elements", Prentice Hall of India, New Delhi. 6. Machine Design by Robert L.Norton, Tata Mc- Graw Hill Publication
6. Fundamentals of Machine Component Design by Junvinall Wiley India
7. Mechanical System Design by Anurag Dixit SCITECH publication
8. Design of Machine Element/Machine Design by Kannaiah SCITECH publication
9. Design of Machine Element by Spotts/Shoup/Hornberger/Jayram/Venketesh PiersonEducation

Machine Design by T H WentzellCengage Learning

DESIGN DATA HANDBOOK:

1. Design Data Hand Book , K. Lingaiah, McGraw Hill, 2nd Ed.
2. Data Hand Book, K. Mahadevan and Balaveera Reddy, CBSPublication
3. Design Data Hand Book, H.G. Patil, I. K. International Publisher, 2010.
4. Design data PSG College of Technology Coimbatore

Control System

23MT3602	PCC	Control System	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 basic concepts of control systems.
CO2	Summarize Feedback control systems.
CO3	Solve concept of time response of the system.
CO4	Examine the frequency response of the system.
CO5	Simplify the system equations in state variable form.
CO6	Explain concepts of Controllers and Digital Control Systems.

Course Contents:

Unit 1: Introduction to control problem Industrial Control examples. Transfer function. System with dead-time. System response. Control hardware and their models: potentiometers, synchro's, LVDT, dc and ac servomotors, tacho-generators, electro hydraulic valves, hydraulic servomotors, electro pneumatic valves, pneumatic actuators. Closed-loop systems. Block diagram and signal flow graph analysis.	[7]
Unit 2 Feedback control systems Stability, steady-state accuracy, transient accuracy, disturbance rejection, insensitivity and robustness. proportional, integral and derivative systems. Feed- forward and multi-loop control configurations, stability concept, relative stability, Routh stability criterion.	[7]
Unit 3: Time response of second-order systems steady-state errors and error constants. Performance specifications in time-domain. Root locus method of design. Lead and lag compensation.	[8]
Unit 4: Frequency-response analysis Polar plots, Bode plot, stability in frequency domain, Nyquist plots. Nyquist stability criterion. Performance specifications in frequency-domain. Frequency- domain methods of design, Compensation & their realization in time & frequency domain. Lead and Lag	[7]

compensation. Op-amp based and digital implementation of compensators. Tuning of process controllers. State variable formulation and solution.	
Unit 5:State variable Analysis- Concepts of state, state variable, state model, state models for linear continuous time functions, diagonalization of transfer function, solution of state equations, concept of controllability & observability. ntroduction to Optimal control & Nonlinear control, Optimal Control problem, Regulator problem, Output regulator, trekking problem. Nonlinear system – Basic concept & analysis.	[6]
Unit 6: Controllers and Digital Control Systems (6) Introduction to PLC: Block schematic, PLC addressing, any one application of PLC using Ladder diagram, Introduction to PID controller: P, PI, PD and PID Characteristics and concept of Zeigler-Nicholas method .Digital control systems: Special features of digital control systems, Necessity of sample and hold operations for computer control ,z-transform and pulse transfer function,Stability and response of sampled-data systems	[6]

Text Books:

1. Gopal. M., "Control Systems: Principles and Design", Tata McGraw-Hill, 1997.
2. Kuo, B.C., "Automatic Control System", Prentice Hall, sixth edition, 1993.
3. Ogata, K., "Modern Control Engineering", Prentice Hall, second edition, 1991.
4. Nagrath & Gopal, "Modern Control Engineering", New Age International, New Delhi.
5. Ambikapathy A., Control System, Khanna Book Publishing Company, 2018.

Reference Books:

1. Benjamin C. Kuo, "Automatic control systems", Prentice Hall of India, 7th Edition,1995.
2 .Schaum's Outline Series, "Feedback and Control Systems" Tata McGraw-Hill, 2007.
3. John J. D'Azzo& Constantine H. Houpis, "Linear Control System Analysis and Design", Tata McGraw-Hill, Inc., 1995.
4. Richard C. Dorf and Robert H. Bishop, "Modern Control Systems", Addison – Wesley, 1999.
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Industrial Automation and Robotics

23MT3603	PCC	Industrial Automation and Robotics	2-0-0	2 Credits

Teaching Scheme	**Examination Scheme**
Lecture: 2 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 automation technologies and control systems.
CO2	Build Hydraulics and Pneumatics circuits used for automatic process controls of industrial systems.
CO3	Analyze Electro-Pneumatic circuits used for automatic process controls of industrial systems.
CO4	Importance of various robot configurations in industrial automation.
CO5	Develop different robot program to do specific task using the various robot language.
CO6	Formulate Homogeneous transformations and robot kinematics equations for various task.

Course Contents:

Unit 1: Factory Automation and Integration and Control system Basic concepts, types of automation, automation strategies, automation technologies, applications around us and in manufacturing industries. Introduction to Programmable Logic Controllers (PLC), Human Machine Interface (HMI) & Supervisory Control and Data Acquisition System (SCADA); motion controller, applications of RFID technology and machine	[4]
Unit 2: Design and Operation of Logic Control Circuits for Hydraulics and Pneumatics Basic elements of hydraulics/pneumatics, fluid power control elements and standard graphical symbols for them, hydraulic & pneumatic cylinders, hydraulic & pneumatic valves for pressure, flow & direction control, Circuit design approach and real time examples; sequence operation of two/more than two cylinders as per the design requirement to automate the systems. Hydraulics/pneumatic safety and their applications to clamping, traversing and releasing operations.	[4]
Unit 3: Design and Operation of Electro-Pneumatic Logic Control Circuits	[3]

Electro-pneumatic systems, solenoid valves, different sensors, factory automation sensors, electrical sensors, process automation sensors and their interfaces as per application criteria. Circuit design approach using relay logic circuits and real time examples; sequence operation of two/more than two cylinders as per the design requirement to automate the systems. Electro pneumatic & electro hydraulic systems using relay logic circuits.	
Unit 4: Introduction to Robotics: Definition, Classification of Robot – Industrial Robot & Service Robot, Anatomy, Spatial coordinates, Geometric configurations and work envelope, Machine intelligence, Criteria for robot selection, Safety standards for Industrial Robot, Economic justification, Robot Applications-Material handling, Machine loading and unloading, Assembly, Inspection, Welding, Spray painting, Medical Industry, Future of Robotics	[5]
Unit 5: Robot Programming: Introduction, On-line programming: Manual input, Lead through -programming, Teach pendant programming, Off-line programming language, Simulation, Introduction to ROS Concept	[4]
Unit 6: Kinematics and Control of Robotic Manipulators: Introduction to manipulator kinematics, Homogeneous transformations and robot kinematics, Denavit- Hartenberg (D-H) representation, Concept of forward and inverse kinematics. Open and closed loop control system, Control system concepts, Linear control schemes, PID control system, Types of motion control, drives and control, Planning of trajectories, Human Robot Collaboration	[4]

Text Books:

1. Groover, M. P., Automation, Production System & Computer Integrated Manufacturing, Pearson Education Asia (2009).
2. Esposito, A., Fluid Power with Applications, Sixth Edition, Pearson Education (2009).
3. Majumdar, S. R., Pneumatic Systems, McGraw Hill (2005).
4. Nakra, B. C., Theory and Applications of Automatic Controls, Revised 2nd Edition, New Age International Publishers (2014).
5. Morriss, S. B., Automated Manufacturing Systems, McGraw Hill (2006).
6. Auslander, D. M. and Kempf, C. J., Mechatronics: Mechanical System Interfacing.
7. Garry Dunning Programmable Logic Controller.
8. Programmable Logic Controllers by Frank Petruzella.
9.YoremKoren, "Robotics for Engineers"
10. J. F. Engelberger, "Robotics in Practice"
11. Ulrich Rembolds, ChristialBlume, "Computer Integrated Manufacturing Technology and Systems"
12. Ramamurthy, "Computer Aided Design in Mechanical Engineering"
13. Mark Spong, "Robot Dynamics and Control", Wiley India

Reference Books:

1. Fluid Power with Applications by Anthony Esposito - Pearson Education 2000.
2. Power Hydraulics by Michael J, Prinches and Ashby J. G, - Prentice Hall, 1989
3. Industrial Hydraulics: Pippenger
4. Vickers Manual on Hydraulics

5. Fluid Mechanics and Fluid Power Engineering by Dr.D S Kumar , Kataria Publishers 2014
6. Fluid Mechanics and Hydraulic machines by Modi & Seth, Standard Publishers Distributors
7. Pneumatic Controls by Joji P, Wiley India Pvt.Ltd
8. Pneumatic Circuits and Low Cos by Fawcett J.R.
9. Fundamentals of pneumatics: Festo series
10. Fundamentals of hydraulics: Festo series
11. Saeed B. Niku, "Introduction to Robotics – Analysis, Systems and Application" : PHI 2006.
12. Richard D, Klafter, Thomason A ChmielOwski, Michel Nagin "Robotics Engg-an Integrated Approach" PHI 2005.
13. R.K. Mittal & I.J. Nagrath, "Robotics & Control" TMH-2007.
14. Saha, S.K., "Introduction to Robotics, 2nd Edition, McGraw-Hill Higher Education, New Delhi, 2014.
15. Ghosal, A., "Robotics", Oxford, New Delhi, 2006.

Internet of Things

23MT3604	PCC	Internet of Things	2-0-0	2 Credits

Teaching Scheme	**Examination Scheme**
Lecture: 2 hrs/week	CA –I :10 Marks CA –II :10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Computer organization

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

CO1	Explain the function blocks, three-layer model and five-layer model of IoT
CO2	Choose various communication network: HAN, NAN, FAN, WAN andWSNs
CO3	Categorize privacy, security and design related challenges of IoT
CO4	Select proper sensor technology for IoT application
CO5	Explain challenges in IOT design and development
CO6	Discuss various IoT applications

Course Contents:

Unit 1. Introduction to Internet of Things: IoT: Definition and importance**,** Characteristics of IoT,Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Three-layer and Five-layer model of IoT.	[8]
Unit 2. IoT Communication network: Architecture of IoT, Communication network: Home Area Network (HAN), Neighborhood Area Network (NAN), Field Area Network (FAN), Wide Area Network (WAN), Wireless Sensor Networks (WSNs).	[7]
Unit 3. IoT Protocols: IoT Access Technologies: Physical and MAC layers,	[8]

topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRa WAN, Network Layer: IP versions, Constrained Nodes and Constrained Networks, Optimizing IP for IoT: From 6LoWPAN to6Lo, Routing over Low Power and Lossy Networks, Application Transport Methods: Supervisory Control and Data Acquisition, Application Layer Protocols: CoAP and MQTT	
Unit 4. IoT Sensors/Actuators: IoT: Sensor Technology, Mobile Phone Based Sensors, Medical Sensors, Neural Sensors, Environmental and Chemical Sensors, Radio Frequency Identification, Actuators,	[7]
Unit 5. IoT Challenges: Design challenges, Development challenges, Privacy and Security challenges, Data Management and Other challenges	[6]
Unit 6. Application of IoT: Smart Homes: Smart Appliances, Security and Safety. Smart Energy: Smart Meters, Automatic Meter Reading (AMR), Advanced Metering Infrastructure (AMI), Real Time Pricing, Smart grid, Smart Cities: Smart Vehicles, Smart Lighting, Smart Parking etc.	[6]
Text Books: 1. Internet of Things By Rajkamal, Tata McGraw Hill publication 2. Internet of things(A-Hand-on-Approach) By Vijay Madisetti and ArshdeepBahga1st Edition,Universal Press	
Reference Books: 1. 1. The Internet of Things: Connecting Objects By Hakima Chaouchi Wiley publication 2. The Internet of Things – Key applications and Protocols By Olivier Hersent, DavidBoswarthick, Omar Elloumi,, Wiley, 2012	

Additive Manufacturing Technology

23MT3604A	PEC	Additive Manufacturing 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	Identify the need of Rapid prototyping.
CO2	Understand the basic use of Selective Laser Sintering and Fusion Deposition Modeling.
CO3	Understand Laminated Object Manufacturing and Concepts Modelers.
CO4	Understand Rapid tooling for various applications.
CO5	Identify the RP Process Optimization techniques.
CO6	Understand the RP applications in various fields.

Pre-Requisites: Material and Manufacturing Technology

Course Contents:

Unit 1: Introduction Need for the compression in product development, history of RP systems, Survey of applications, Growth of RP industry, and classification of RP systems. Stereo Lithography Systems: Principle, Process parameter, Process details, Data preparation, data files and machine details, Application.	[6]

Unit 2: Selective Laser Sintering and Fusion Deposition Modeling Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications, Principle of Fusion deposition modeling, Process parameter, Path generation, Applications. Solid Ground Curing: Principle of operation, Machine details, Applications	[6]
Unit 3: Laminated Object Manufacturing Principle of operation, LOM materials. Process details, application. **Concepts Modelers:** Principle, Thermal jet printer, Sander's model market, 3-D printer. GenisysXs printer HP system 5, object Quadra systems	[6]
Unit 4: Rapid Tooling Indirect Rapid tooling -Silicone rubber tooling – Aluminum filled epoxy tooling Spray metal tooling, Cast kirksite, 3Q keltool, etc. Direct Rapid Tooling Direct. AIM, Quick cast process, Copper polyamide, Rapid Tool, DMILS, Prometal, Sand casting tooling, Laminate tooling soft Tooling vs. hard tooling.	[6]
Unit 5:RP Process Optimization Factors influencing accuracy. Data preparation errors, Part building errors, Error in finishing, influence of build orientation.	[6]
Unit 6: RP applications Design, Engineering, Analysis and planning applications, Rapid tooling, Reverse engineering, medical applications of RP.	[6]

Text Books:

6. Stereo lithography and other RP & M Technologies - Paul F. Jacobs - SME, NY 1996.
7. Rapid Manufacturing - Flham D.T &Dinjoy S.S - Verlog London

Reference Books:

1. Wohler's Report 2000 - Terry Wohlers - Wohler's Association - 2000. Limited, 1987

Factory Automation

23MT3604B	PEC	Factory 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: Material and Manufacturing Technology

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

CO1	Explain automation principles, strategies, and types, and differentiate fixed, programmable, and flexible automation.
CO2	Apply control strategies in manufacturing and analyze the role of PLC, SCADA, and DCS in automation.
CO3	Analyze transfer mechanisms, material handling, and storage systems for efficient production.
CO4	Evaluate FMS components, control, and optimization techniques for smart manufacturing.
CO5	Develop CNC programs and optimize machining processes with appropriate tooling and fixturing.
CO6	Examine robotic motion control and apply safety mechanisms for work cell automation.

Course Contents:

Unit 1: Introduction to Factory Automation: Automation in Production Systems, Principles and Strategies of Automation, Types of Factory Automation -Fixed Automation, Programmable Automation, Flexible Automation. Basic Elements of an Automated System- Power, control, and program execution. Flow lines and transfer mechanisms in automated systems. Levels of Automation & Economic Aspects.	[6]
Unit 2: Industrial Control Systems: Role of control systems in factory automation, Difference between process and discrete manufacturing. Types of Control in Manufacturing - Continuous Control, Discrete Control, Hybrid control systems in modern factories. Computer-Based Process Control: LAN, Analog	[6]

& Digital I/O Modules, Supervisory Control and Data Acquisition (SCADA), Programmable Logic Controllers (PLCs) and Distributed Control Systems (DCS).	
Unit 3: Transfer Lines & Material Handling Systems: Fundamentals of Transfer Lines - Configurations and transfer mechanisms, Storage buffers, Control strategies for transfer lines. Transfer lines with and without storage buffers. Principles of material handling in automation, Automated transport systems (AGVs, conveyors, robotic arms). Automatic Identification & Storage Systems - Barcode, RFID, vision-based identification, Automated storage and retrieval systems (AS/RS).	[7]
Unit 4: Flexible Manufacturing System (FMS): Introduction to Flexible Manufacturing System: Concept, Need, and Evolution; Components of FMS: Workstations, Automated Material Handling, and Storage Systems; FMS Layouts and Configurations: Single Machine, Flexible Cells, and Flexible Lines; Control and Communication in FMS: CNC Integration, Sensors, and Industrial Networks; FMS Scheduling and Optimization: Production Planning, Machine Loading, and Bottleneck Analysis; Advantages, Challenges, and Future Trends in FMS for Smart Manufacturing.	[6]
Unit 5: CNC (Computer Numerical Control): Introduction to CNC Machines: Basics, Classification, and Evolution; CNC Machine Structure: Components, Drives, Motors, and Feedback Systems; CNC Programming: G-code, M-code, Tool Path Generation, and Execution; CNC Tooling: Tool Holders, Cutting Tools, and Automatic Tool Changers; CNC Operations and Process Planning: Workpiece Setup, Fixturing, and Machining Strategies; CNC Applications, Advantages, and Future Trends in Smart Manufacturing.	[6]
Unit 6: Fundamentals of Industrial Robots: Introduction, Specifications, and Characteristics; Criteria for Selection; Robotic Control Systems: Types of Drives, Actuators, Power Transmission Systems, and Robot Controllers; Robot Motions and Degrees of Freedom; Dynamic Properties of Robots: Stability, Control Resolution, Spatial Resolution, Accuracy, Repeatability, and Compliance; Performance Metrics and Their Influence on Robot Functionality; Work Cell Control: Safety, Interlocks, and Industrial Applications.	[6]

Text Books:

1. Mikell P. Groover, "Automation, Production Systems, and Computer-Integrated Manufacturing," Pearson Education, Fourth Edition, New Delhi.
2. S. R. Deb and S. Deb, "Robotics Technology and Flexible Automation," Tata McGraw-Hill Education, Second Edition, New Delhi.
3. Frank D. Petruzella, "Programmable Logic Controllers," McGraw-Hill Education, Fourth Edition, New Delhi.
4. B. R. Mehta and Y. J. Reddy, "Industrial Process Automation Systems: Design and Implementation," Butterworth-Heinemann (Elsevier), First Edition, New Delhi.
5. Andrew S. Tanenbaum and David J. Wetherall, "Computer Networks," Pearson Education, Fifth Edition, New Delhi.

Reference Books:

1. Richard D. Klafter, Thomas A. Chmielewski, and Michael Negin, "Robotic Engineering: An Integrated Approach", Prentice Hall, First Edition, New Delhi.
2. John J. Craig, "Introduction to Robotics: Mechanics and Control", Pearson Education, Fourth Edition, New Delhi.
3. Hugh Jack, "Automating Manufacturing Systems with PLCs", Engineering Technology Press, First Edition, New Delhi.
4. William Bolton, "Programmable Logic Controllers", Newnes (Elsevier), Sixth Edition, New Delhi.
5. Frank Lamb, "Industrial Automation: Hands-On", McGraw-Hill Education, First Edition, New Delhi.
6. J. A. Rehg and H. W. Kraebber, "Computer-Integrated Manufacturing", Pearson, Third Edition, New Delhi.
7. T. K. Kundra, P. N. Rao, and N. K. Tewari, "Numerical Control and Computer-Aided Manufacturing", Tata McGraw-Hill, First Edition, New Delhi.

Smart Materials

23MT3604C	PEC	Smart Materials	3-0-0	3 Credits

Teaching Scheme:	Evaluation 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: Material and Manufacturing Technology

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

CO1	Explain the characteristics of smart materials over conventional materials.
CO2	Interpret the shape memory effect, Super elasticity, and mechanical behavior of Shape Memory Alloys.
CO3	Make use of principles of piezoelectric and magnetostrictive materials for sensing, actuation, and energy harvesting.
CO4	Analyze the working principles of Electroactive Polymers and Magnetorheological fluids in smart systems.
CCO5	Assess the mechanisms and applications of self-healing and bio-inspired smart materials.
CCO6	Justify the role of smart sensors and actuators in mechatronic applications.

Course Contents:

Unit 1:Introduction to Smart Materials Definition and characteristics of smart materials, Classification of smart materials, Comparison with conventional materials: Advantages and limitations, Smart materials for sensing and actuating, Direct effect and converse effect, Smart structures, Applications.	[6]
Unit 2: Shape Memory Alloys Introduction to Shape Memory Effect (SME), One-way and two-way shape memory effect, Superelasticity, Types of Shape Memory Alloys - Nitinol, Copper-based SMA, and Iron-based SMA, Manufacturing of SMA, Mechanical and thermal characterisation of shape memory alloys.	[7]
Unit 3: Piezoelectric and Magnetostrictive Materials Principles of piezoelectricity and inverse piezoelectric effect, Common piezoelectric materials: PZT, PVDF, and their properties, Applications of piezoelectric materials in	[7]

sensors, actuators, and energy harvesting, Magnetostrictive materials: Fundamentals and key materials, Applications of magnetostrictive materials.	
Unit 4: Electroactive Polymers and Magnetorheological Fluids Electroactive Polymers (EAP): Working principles and classification, Types: Ionic EAPs (IPMC) and electronic EAPs (Dielectric elastomers), Magnetorheological (MR) and Electrorheological (ER) fluids, Comparison, Applications.	[6]
Unit 5:Self-Healing and Bio-Inspired Smart Materials Concept and importance of self-healing materials, Self-healing mechanisms: Intrinsic and extrinsic healing, Types: Polymer-based self-healing materials, metal-based self-healing, Bio-inspired smart materials: Gecko-inspired adhesives, Lotus-effect coatings, Introduction to Nanoparticles, Classification and Properties.	[7]
Unit 6: Applications of Smart Materials in Mechatronics Smart sensors and actuators, Different types of Smart sensors & their working, Application of Smart Sensors for Structural Health Monitoring (SHM), Integration of smart materials in various applications like Automation & robotics, Aerospace, Automotive, Medical etc.	[7]

Text Books:

1. Encyclopedia of Smart Materials- Mel Schwartz, John Wiley & Sons, New York, 2002.
2. Smart Structures: Analysis and Design - A. V. Srinivasan, Cambridge University Press, Cambridge; New York, 2001 (ISBN: 0521650267).
3. T W Duerig, "Engineering Aspects of Shape Memory Alloys", Butterworth-Heinemann,1st Edition,2013.
4. Smart Structures and Materials - B. Culshaw, Artech House, Boston, 1996, (ISBN :0890066817).

Reference Books:

1. Smart Materials and Structures - M. V. Gandhi and B. So Thompson, Chapman and Hall, London; New York, 1992 (ISBN: 0412370107).
2. Shape Memory Materials- K.Otsuka and C.M. Wayman, Cambridge University Press, London, 1998.
3. Fundamentals of Smart Materials, (2020) Mohsen Shahinpoor, Print ISBN 978-1-78262-645.
4. Nanomaterials: An Introduction to Synthesis, Properties and Applications- Dieter Vollah, 2nd Edition Wiley-VCH, 2013.

Finite Element Analysis

23MT3604D	PEC	Finite Element Analysis	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: Engineering Mathematics

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

CO1	Explain the basic concepts, need, and steps involved in the Finite Element Method (FEM).
CO2	Solve variational principles and weighted residual methods for formulating finite element equations.
CO3	Develop stiffness matrices for one-dimensional bar, truss, and beam elements.
CO4	Analyze two-dimensional plane stress and plane strain problems using finite elements.
CO5	Evaluate complex three-dimensional problems using tetrahedral and hexahedral elements.
CO6	Discuss use of FEA software to simulate structural, thermal, and fluid problems.

Course Contents:

Unit 1: Introduction to Finite Element Method Basic concepts of FEA, Need and importance of FEA, Steps in FEA, Direct stiffness method, Applications of FEA in engineering	[8]
Unit 2: Mathematical Formulation Variational principles, Rayleigh-Ritz method, Weighted residual methods, Galerkin's method, Strong and weak formulation	[7]
Unit 3: One-Dimensional Element Bar and truss elements, Beam elements, Shape functions and stiffness matrix, Assembly and boundary conditions, Numerical integration	[8]
Unit 4: Two-Dimensional Elements Triangular and quadrilateral elements, Plane stress and plane strain problems, Axisymmetric elements, Isoparametric formulation, Gauss quadrature	[7]

Unit 5: Three-Dimensional Elements and Applications Tetrahedral and hexahedral elements, Stiffness matrix and load vector formulation, Heat transfer and fluid flow problems, Structural dynamics and vibration analysis	[6]
Unit 6: FEA Software and Case Studies Introduction to FEA software (ANSYS, ABAQUS, etc.), Pre-processing, solving, and post-processing, Case studies on structural, thermal, and fluid problems, Error analysis and solution verification	[6]

Text Books:

1. T. R. Chandrupatla, A.D. Belegundu, "Introduction to Finite Elements in Engineering", Prentice Hall of India Pvt. Ltd., 3rd edition, New Delhi, 2004.
2. P. Seshu, "A Textbook of Finite Element Analysis", Prentice Hall of India Pvt. Ltd., New Delhi, 2003.
3. R. D. Cook, D. S. Malkus, M. E. Plesha, R. J. Witt, "Concepts and Applications of Finite Element Analysis", John Wiley & Sons, Inc.

Reference Books:

1. K. J. Bathe, "Finite Element Procedures", Prentice Hall of India Pvt. Ltd., 2006.

Basket 1 (AUTOMATION): Intelligent Manufacturing Systems

23MTMDA4	MDM	**Intelligent Manufacturing Systems**	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: Energy Efficient Automation

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

CO1	Explain concept of Intelligent manufacturing systems.
CO2	Outline various components of IMS.
CO3	Plan the use of supporting systems in IMS.
CO4	Distinguish the smart manufacturing with the other traditional methods.
CO5	Importance of the role of advanced process modelling in smart manufacturing.
CO6	Discuss the various case studies of intelligent and smart manufacturing systems.

Course Contents:

Unit 1: Introduction Introduction to Manufacturing systems, various subsystems in manufacturing systems, procurement, design, manufacturing, inspections, assembly, prototyping, material handling, storage systems, concept of Intelligent manufacturing: Internet of Things enabled manufacturing, cloud manufacturing. Characteristics of Intelligent manufacturing systems: Intelligent decision-making, Application of Artificial Intelligence and Machine learning in developing intelligent manufacturing systems.	[6]
Unit 2: Component of Intelligent Manufacturing Technologies Component of Intelligent Manufacturing Technologies, Development of Intelligent systems for Design, Process planning, Controls, Scheduling, Quality Management, Maintenance and Diagnostics.	[7]
Unit 3: Supporting technologies for IMS Supporting technologies for IMS: Industry Internet of Things, Cyber Physical Systems, Cloud computing, RFID Technologies, Data Analytics, other Information and Communications Technology.	[7]

Unit 4: Smart Manufacturing Introduction to Smart Manufacturing, Smart Sensors and Smart Tooling, Smart machines and intelligent machining, digital and smart factories, implementing smart manufacturing across an industrial organization, cyber infrastructure for the democratization of smart manufacturing, the role of hardware and software in smart manufacturing Infrastructure changes, Reinvigorating the manufacturing workforce, benefits of smart manufacturing to value chain.	[7]
Unit 5: Components of Smart Manufacturing Measuring, managing, and transforming data for operational insights, the role of advanced process modelling in smart manufacturing, Industrial AI and predictive analytics for smart manufacturing systems, Model-predictive safety: A new evolution in functional safety, Inferential modelling and soft sensors, A decision support framework for sustainable and smart manufacturing	[6]
Unit 6: Case studies Applications and case studies in intelligent manufacturing systems implementation and smart manufacturing, Smart Manufacturing in the Food Industry, Advancing Smart Manufacturing in the Pharmaceutical Industry, Smart Reservoir Management in the Oil and Gas Industry, Smart Manufacturing in the Paints and Coatings Industry	[7]

Text Books:

1. Masoud Soroush, McKetta Michael Baldea, Thomas Edgar, Smart Manufacturing -Concept and Methods, Elsevier Publications Ist Edition, August 4, 2020.
2. Andrew Kusiak, Intelligent Manufacturing Systems, Prentice Hall international series-industrial & systems engineering, 1990.
3. Intelligent Manufacturing in the Context of Industry 4.0: A Review, Engineering, Elsevier Publications, Volume 3, Issue 5, October 2017, Pages 616-630.
4. Peigen Li, Special Issue: Intelligent Manufacturing, Engineering, Elsevier Publications, 3, 2017, 575.

Reference Books:

1. Yubao Chen, Integrated and Intelligent Manufacturing: Perspectives and Enablers, Engineering, Engineering 3, 2017, Pages 588–595.
2. Hamid R. Parsaei and Mohammad, Jamshidi, Design and Implementation of Intelligent Manufacturing Systems: From Expert Systems, Neural Networks, to Fuzzy Logic, Prentice Hall Series Publication, 1995.
3. Jongwon Kim, Manufacturing Systems 1997 - IFAC Proceedings Volumes, Elsevier publications, 1997.
4. Jim Davis, Denise Swink, Julie Tran, white paper, CMTC's Guide to Smart Manufacturing, 2015.

Basket 2 (DESIGN AND MANUFACTURING): Robotics Engineering

23MTMDB4	MDM	Robotics Engineering	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: Theory of machines and Mechanisms

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

CO1	Explain the basic concepts and anatomy of robots
CO2	Summarize the working of different robot actuators and drives
CO3	Identify and integrate different types of robot sensors and vision systems
CO4	Analyze kinematic models for robot motion and manipulation
CO5	Determine and implement robot programming techniques
CO6	Discuss various robot control systems

Course Contents:

Unit 1: Robot Basics: Basic concepts, Need, Anatomy, specifications. Robot configurations: Cartesian, cylinder, polar, and articulated. Robot wrist mechanism, Precision and accuracy of the robot.	[8]
Unit 3: Robot Actuators and Drives: Electrical Actuators (DC Motors, Stepper Motors, Servo Motors) Hydraulic and Pneumatic Actuators, Motor Selection Criteria and Performance Parameters, Industrial Servo Drives and Controllers, Drive Circuits and Feedback Mechanisms	[7]
Unit 3: Robot Sensors and Vision Systems: Contact and Non-contact Sensors, Position, Velocity, and Acceleration Sensors, Force and Torque Sensors, Proximity and Range Sensors, Machine Vision Systems (Cameras, Image Processing), Sensor Calibration and Integration, sensor calibration,	[7]
Unit 4 –Robot kinematics: Basics of direct and inverse kinematics, Robot trajectories, Transformation-Scaling, Rotation, Translation, Homogeneous transformation. Control of robot manipulators – Point to point, Continuous Path Control	
Unit 5– Robot Programming: Basics of Robot Programming, Online vs Offline Programming, Robot Operating System (ROS) Overview, Programming Languages for Robots, Robot Motion Control Programming, Tool Center Point (TCP) Calibration	[6]

Unit 6: Robot Control Systems: Open-loop and Closed-loop Control, PID Controllers and Gain Tuning, Adaptive and Intelligent Control, Trajectory Planning and Motion Control, Real-Time Control Systems, Path and Obstacle Avoidance	[6]

Text Books:

1. K.S Fu, R.C. Gonzalez, C.S.G. Lee, Robotics, McGraw Hill, 1987.
2. Y. Koren, Robotics for Engineers, McGraw Hill, 1985
3. J.J. Craig, Robotics, Addison-Wesley, 1986.
4. Saeed B. Niku, "Introduction to Robotics – Analysis, Systems and Application" : PHI 2006.
5. Richard D, Klafter, Thomason A ChmielOwski, Michel Nagin "Robotics Engg-an Integrated Approach" PHI 2005.
6. R.K. Mittal & I.J. Nagrath, "Robotics & Control" TMH-2007.
7. Saha, S.K., "Introduction to Robotics, 2nd Edition, McGraw-Hill Higher Education, New Delhi, 2014.
8. Ghosal, A., "Robotics", Oxford, New Delhi, 2006.

Reference Books:

1. Ashitava Ghoshal, Robotics-Fundamental Concepts and Analysis', Oxford University Press, Sixth impression, 2010.
2. K. K.Appu Kuttan, Robotics, I K International, 2007.
3. Edwin Wise, Applied Robotics, Cengage Learning, 2003.
4. R.D.Klafter,T.A.Chimielewski and M.Negin, Robotic Engineering–An Integrated Approach, Prentice Hall of India, New Delhi, 1994.
5. B.K.Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers,Chennai, 1998.
6. S.Ghoshal, ― Embedded Systems & Robotics‖ – Projects using the 8051 Microcontroller‖, Cengage Learning, 2009.

Basket 3 (SOFTWARE): Operating Systems

23MTMDC4	MDM	Operating Systems	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 fundamental concepts, types, and structures of operating systems
CO2	Illustrate the fundamental concepts of process management
CO3	Apply process synchronization techniques, such as semaphores, Peterson's solution, and monitors, to solve critical section problems.
CO4	Analyze various deadlock handling techniques by examining system models
CO5	Contrast among various memory management techniques such as paging, segmentation, and virtual memory
CO6	Evaluate the design choices and performance trade-offs in file system architecture and I/O subsystems.

Course Contents:

Unit 1- Introduction Basics of Operating Systems: Definition – Generations of Operating systems – Types of Operating Systems, OS Service, Views of Operating System, System Calls, and Types of system Calls, System programs, OS structure: Layered, Monolithic,Microkernel Operating Systems. Overview of Linux and Android OS	[6]
Unit 2- Process Management Processes: Definition, Process states, Process Control Block, Threads – Concept of multithreads, Benefits of threads, Multithreading Models, Users and Kernel threads. Inter-process Communication-Introduction, Shared memory system and message passing system, Examples.	[6]
Unit 3- Process Synchronization Background, the critical section problem, Peterson's solution, synchronization hardware, semaphores, classic problems of Synchronization, Monitor	[6]
Unit 4: Deadlock	

System model, deadlock characterization, methods for handling deadlocks, deadlock preventions, deadlock avoidance, deadlock detection, deadlock recovery.	[6]
Unit 5: Memory Management Basic Memory Management: Definition, Logical and Physical address map, Memory allocation: Contiguous Memory allocation – Fixed and variable partition – Internal and External fragmentation and Compaction, Paging and Segmentation **Virtual Memory:** Basics of Virtual Memory, Page fault, Demand paging, Page Replacement policies: Optimal Page Replacement (OPT), First in First Out (FIFO), Least Recently Used (LRU)	[7]
Unit 6: File System & I/O Subsystem File System: File concept, access methods, Directory and disk structure, Disk Scheduling, file-system mounting, file sharing, protection, Overview of I/O system, I/O hardware, Application I/O interface, Kemel I/O subsystem.	[5]
Text Books: 1. William Stallings, Operating System: Internals and Design Principles, Prentice Hall,ISBN-10: 0-13- 380591-3, ISBN-13: 978-0-13-380591-8, 8thEdition. 2. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, Operating System Concepts,WILEY, ISBN 978-1- 118-06333-0 , 9thEdition 3. Andrew S. Tanenbaum & Herbert Bos, Modern Operating System, Pearson, ISBN-13: 9780133592221, 4th Edition.	
Reference Books:	
1. Tom Adelstein and Bill Lubanovic, Linux System Administration, O'Reilly Media,ISBN-10: 0596009526,ISBN- 13:978-0596009526 2. Harvey M. Deitel, Operating Systems, Prentice Hall, ISBN-10: 0131828274, ISBN-13:978-0131828278 3. Thomas W. Doeppner, Operating System in depth: Design and Programming, WILEY, ISBN: 978-0-471-68723	

Design and Simulation Laboratory

23MT3606	PCC	Design and Simulation Laboratory	0-0-2	1 Credits

Teaching Scheme:	Evaluation Scheme:
Practical: 2 hours/week/batch	CA –I :25 Marks CA –II :25 Marks

Pre-Requisites:

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

CO1	Demonstrate understanding of various design considerations.
CO2	Apply basic principles of machine design
CO3	Develop skill in preparing production drawings of various components designed.
CO4	Design concept of welded & threaded joint, and analyze when it is subjected to different loading condition

List of Experiments:

Group A: Design laboratory

Design exercises in the form of design calculations with sketches and or drawings on following machine system with using 3D software (any 4)

Minimum 2 exercises from the following list

1. Design of machine components such as knuckle joint, cotter joint and lever (Anyone)
2. Design of coupling system.
3. Design of screw jack.
4. Design of welded joints

Minimum 2 exercises from the following list

1. To develop Industrial/Real life application demonstration model of different types of Joints. (Cotter joint and Knuckle joint)
2. To observe the system where transmission of power takes place through shaft, Keys,

coupling, like Transmission of power from motor to pump/generator/lathe machine/drilling machine. By selecting suitable materials, design the shaft, key and coupling. To prepare design report and assembly drawing indicating overall dimensions, tolerances, and surface finish. Also to prepare bill of materials

4.Design a Mini-Project to develop and apply the knowledge of Machine Design and drafting software for any mechanical system on the basis of: (a) Idea generation, (b) Creativity, Reliability and safety, (c) Design parts of the system (d) Ergonomic Considerations (e) Use of International standards

Group B: Simulation laboratory

Minimum 4 exercises from the following list

1. Introduction to MATLAB SIMULINK.
2. Simulation of Spring-mass system using MAT LAB SIMULINK
3. Simulation of Mechatronics system using MATLAB SIMULINK
4. Simulation of single-phase inverter using MAT LAB SIMULINK
5. Simulation of single-phase inverter using MAT LAB SIMULINK
6. Introduction of PID controller using MAT LAB SIMULINK

Text Books:

1. Thomas Bevan, Theory of Machines, 3rdedition, CBS Publishers & Distributors,2005.
2. Cleghorn W.L., Mechanisms of Machines, Oxford University Press,2005.
3. Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGrawHill,2009.
4. Ghosh A. and Mallick A.K., Theory of Mechanisms and Machines, Affiliated East- West Pvt. Ltd, New Delhi.

Reference Books:

1 .J. E. Shigely, J. J. Uicker, "Theory of Machines and Mechanisms", Tata McGraw Hill Publications, New York, International Student Edition, 1995.
2.Thomas Beven, "Theory of Machines", CBS Publishers and Distributors, Delhi
3..Shigley, Theory of Machines and Mechanism, McGraw Hill, New York
4. G.S. Rao and R.V. Dukipatti, Theory of Machines and Mechanism, "New Age Int. Publications Ltd. New Delhi.
5.Abdullah Shariff, Theory of Machines, McGraw Hill, New Delhi
6.Shah and Jadhawani, Theory of Machines, Dhanpat Rai & Sons

Control System Laboratory

23MT3607	PCC	Control System 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	Develop the mathematical model of the physical systems.
CO2	Solve the response of the closed and open loop systems.
CO3	Analyze the stability of the closed and open loop systems.
CO4	Simplify state space models.

Text Books:

1. Gopal. M., "Control Systems: Principles and Design", Tata McGraw-Hill, 1997.
2. Kuo, B.C., "Automatic Control System", Prentice Hall, sixth edition, 1993.

List of Experiments:

1. Different Toolboxes in MATLAB, Introduction to Control Systems Toolbox or its equivalent open-source freeware software like Scilab.
2. Determine transpose, inverse values of given matrix.
3. Plot the pole-zero configuration in s-plane for the given transfer function.
4. Determine the transfer function for a given closed loop system in block diagram representation.
5. Plot Module step response of given transfer function and find delay time, rise time, peak time and peak overshoot.
6. Determine the time response of the given system subjected to any arbitrary input.
7. Plot root locus of given transfer function, locate closed loop poles for different values of k. Also find out Wd and What for a given root.
8. Create the state space model of a linear continuous system.
9. Determine the State Space representation of the given transfer function.
10. Plot bode plot of given transfer function. Also determine the relative stability by measuring gain and phase margins.
11. Determine the steady state errors of a given transfer function.
12. Plot Nyquist plot for given transfer function and to discuss closed loop stability. Also determine the relative stability by measuring gain and phase margin.

3. Ogata, K., "Modern Control Engineering", Prentice Hall, second edition, 1991.
4. Nagrath & Gopal, "Modern Control Engineering", New Age International, New Delhi.
5. Ambikapathy A., Control System, Khanna Book Publishing Company, 2018.

Reference Books:

1. Benjamin C. Kuo, "Automatic control systems", Prentice Hall of India, 7th Edition,1995.
2 .Schaum's Outline Series, "Feedback and Control Systems" Tata McGraw-Hill, 2007.
3. John J. D'Azzo& Constantine H. Houpis, "Linear Control System Analysis and Design", Tata McGraw-Hill, Inc., 1995.
4. Richard C. Dorf and Robert H. Bishop, "Modern Control Systems", Addison – Wesley, 1999.

Industrial Automation and Robotics Laboratory

23MT3608	PCC	Industrial Automation and 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: 20Marks

Pre-Requisites:

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

CO1	Demonstrate the structure and layouts of hydraulic and pneumatic systems.
CO2	Identify various types of control valves used in hydraulic and pneumatic system
CO3	Examine different parts and components of robotic systems
CO4	Develop Robot programming for Industrial Process

List of Experiments:

At least minimum 6 experiments should be performed from the following list

1 Minimum two circuits on Pneumatics to be developed on Pneumatic trainer kit

2. Minimum two circuits on Electro-Pneumatics to be developed on Electro Pneumatic trainer kit

3. Minimum two circuits on Hydraulics to be developed on Hydraulic trainer kit

4. Demonstration of different types of control valves used in hydraulic and pneumatic system.

5. Study components of a real robot and its DH parameters. (**Experiments that May Be Performed Through Virtual Labs)**

6. Integration of assorted sensors (IR, Potentiometer, strain gages etc.), micro controllers and ROS (Robot Operating System) in a robotic system.

7.Exercise on any Robotic Simulation Software

a. Determination of maximum and minimum position of links.
b. Study Forward kinematics and validation.

8. Robot programming for Industrial Process (Any two).

9. Study of ISO/JIC Symbols for hydraulic and pneumatic systems.

Text Books:

1. Saha, S.K., "Introduction to Robotics, 2nd Edition, McGraw-Hill Higher Education, New Delhi, 2014.
2. Richard D, Klafter, Thomason A ChmielOwski, Michel Nagin "Robotics Engg-an Integrated Approach" PHI 2005.
3. R.K. Mittal & I.J. Nagrath, "Robotics & Control" TMH-2007
4. "Hydraulics and Pneumatics", Shaikh and Khan, R.K. Publication.
5. "Fluid Power with Application", Esposito, Pearson Education, 7th Edition.
6. "Basic Hydraulic – Festo Manual"
7. "Basic Pneumatic – Festo Manual"

Reference Books:

1. Deb.S.R., Robotics technology and flexible Automation, John Wiley, USA 1992.
2. Asfahl C.R., Robots and manufacturing Automation, John Wiley, USA 1992.
3. Klafter R.D., Chimielewski T.A., Negin M., Robotic Engineering – An integrated approach, Prentice Hall of India, New Delhi, 1994.
4. Mc Kerrow P.J. Introduction to Robotics, Addison Wesley, USA, 1991.
5. Issac Asimov I Robot, Ballantine Books, New York, 1986
6. "Hydraulic and Pneumatic",H.L.Stewart,Industrial Press. 7. "Industrial Hydraulic", J. J. Pipenger, Tata McGraw Hill.
8. "Power Hydraulics", Goodwin 1st Edition. 4. "Introduction to Hydraulic and Pneumatics",S. Ilango and V Soundararajan, Prentice Hall of India, 2nd Edition.

Internet of Things Laboratory

23MT3609	PCC	Internet of Things Laboratory	0-0-2	1 Credits

Teaching Scheme:	Evaluation Scheme:
Practical: 2hours/week/batch	CA –I :25 Marks CA–II:25Marks

Pre-Requisites:

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

CO1	Select Arduino Uno/ Raspberry Pi/Intel processors for IOT applications
CO2	Make use of Arduino Uno/ Raspberry Pi/Intel processors for interfacing various sensors and peripherals
CO3	Examine the working of IOT applications

List of Experiments:
At least minimum 10 experiments should be performed from the following list.
1. First experiments should be fundamental of all platforms like Ardunio, Raspberry Pi and Intel
2. Last experiments should be life project on the based on Raspberry Pi or Intel
3. Take 2-3 experiments from Arduino Uno
4. Take 3-5 experiments from Raspberry Pi
5. Take 2-3 experiments from Intel

Arduino Uno:
Experiment List:
1. Interfacing of LED and Tricolor LED with Arduino Uno
2. Interfacing of Push Button Switch with Arduino Uno
10 9500 95,000
3. Interfacing of Buzzer with Arduino Uno
4. Interfacing of 7 segment display with Arduino Uno
5. Interfacing of Light sensor with Arduino Uno
6. Interfacing of PIR Motion sensor with Arduino Uno
7. Interfacing of Ultrasonic sensor with Arduino Uno
8. Interfacing of Temperature and humidity (DHT11) sensor with Arduino Uno
9. Interfacing of 16 X 2 LCD Display with Arduino Uno
10. Interfacing of Servo motor with Arduino Uno

Raspberry Pi :
Experiment List:
1. Interfacing of LED and Tricolor LED with Raspberry Pi
2. Interfacing of Push Button Switch with Raspberry Pi
3. Interfacing of Buzzer with Raspberry Pi
4. Interfacing of 7 segment display with Raspberry Pi
5. Interfacing of Light sensor with Raspberry Pi
6. Interfacing of PIR Motion sensor with Raspberry Pi
7. Interfacing of Ultrasonic sensor with Raspberry Pi
8. Interfacing of Temperature and humidity (DHT11) sensor with Raspberry Pi
9. Interfacing of 16 X 2 LCD Display with Raspberry Pi
10. Interfacing of Servo motor with Raspberry Pi

Intel Processor based:
1. Interfacing of Temperature and humidity (DHT11) sensor using IoT
3. Interfacing of 16 X 2 LCD Display using IoT
4. Interfacing of Servo motor using IoT
5. IoT based life project based on Intel processor platform.

Text Books:
1. Foundational Elements of an IOT Solution - The Edge, Cloud and Application Development, Joe Biron& Jonathan Follett, Oreilly, First Edition, March 2016 2. Designing Connected Products, 1st Edition, Elizabeth Goodman, Alfred Lui, Martin Charlier, Ann Light, Claire Rowland 3. The Internet of Things (A Look at Real World Use Cases and Concerns), Kindle Edition, 2016, Lucas Darnell
Reference Books:
1.Bahga A, Madisetti V. Internet of Things: A hands-on approach; 2014. 2.Tanenbaum A S. Computer Networks. Fifth Edition, Pearson Education India; 2013. 3. Shriram K Vasudevan, Abhishek SN and Sundaram RMD. Internet of Things, First Edition, Wiley India;2019. 4.Raj P, Raman AC. The Internet of things: Enabling Technologies, Platforms, and Use-cases. Auerbach Publications; 2017. 5,Adrian McEwen. Designing the Internet of Things, Wiley;2013.

Aptitude Skills IV: Numerical Ability

23HSSM07	VEC	Aptitude Skills- IV	1-0-0	Audit

Teaching Scheme:	Examination Scheme:
Lecture: 1hr/week	CA-I:25 Marks CA-II: 25 Marks

Pre-Requisites: Aptitude Skills-I, II and III

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

1	Solve the questions on ordering of words & Parts of Speech
2	Organize contents of Business Communications such as CV, emails and letters.
3	Solve the questions based on jumbled paragraphs and reading comprehension.
4	Solve the questions on spotting error and sentence correction.
5	Summarize proceedings of any event or conference.
6	Discuss about current and critical issues during group discussion.

Course Contents:

Unit 1	Parts of Speech, Punctuation Word Family (Using the same word as different Parts of Speech)	**[2]** **[2]**
Unit 2	Analogy, Letter Writing (Formal), E-Mail Writing, CV Writing	**[2]**
Unit 3	Reading Comprehension, Paragraph Jumbles	**[2]**
Unit 4	Spotting Errors (in different parts of sentence), Subject-Verb Agreement Sentence Correction, Sentence Completion	**[2]**
Unit 5	One Word Substitution, Narrating Events/Reports, Summary/Precis Writing	**[2]**
Unit 6	Dialogue writing Group Discussion, Interview Skills (Using formal notations & gestures etc.)	**[2]**

Text Books:

1. Raymond Murphy, Essential English Grammar with Answers, Murphy
2. Objective General English by R.S. Aggarwal, S Chand Publishing; Revised edition (15 March 2017)

Reference Books:

1. Rao and ,D,V,Prasada, Wren & Martin High School English Grammar and Composition Book, S Chand Publishing, 2017
2. Murphy, Intermediate English Grammar with Answers, Cambridge University Press; Second edition

Language Skill- IV

23HSSM08	VEC	Language Skill- IV	0-0-2	Audit

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

Pre-Requisites: Language Skill I, II and III

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

CO1	Make use of Function in Python Programming.
CO2	Make use of Python collections.
CO3	Make use of classes and its objects in python.
CO4	Make use of file and it's handling functions.

1. Write a Python program to define a user-defined function that takes a number as input and returns whether it is even or odd. Call the function and display the result. o *Concepts: Function definition, arguments, return value.*	**[2]**
2. Create a Python program to define and call a function with default arguments and keyword arguments. o *Concepts: Function calling, argument types.*	**[2]**
3. Write a Python program using a lambda function to compute the square, cube, and factorial of a given number. o *Concepts: Lambda function basics*	**[2]**
4. Write a Python program to demonstrate list operations such as creation, adding items, removing an item, slicing, and sorting. o *Concepts: List constructor, change, remove, sort, list comprehension*	**[2]**
5. Write a Python program to demonstrate the use of tuples and sets. Perform operations such as checking membership, adding/removing elements (set), and iterating. o *Concepts: Tuple immutability, set operations.*	**[2]**

6. Write a Python program to create a dictionary of employees with their ID as key and name as value. Perform operations like adding a new entry, updating existing, and deleting one. o *Concepts: Dictionary operations, loop through dictionary.*	**[2]**
7. Write a Python program to create a class Student with attributes name, roll_no, and a method display(). Create an object and access its members. o *Concepts: Class, object, method access.*	**[2]**
8. Create a class with an __init__() constructor to initialize data members and a destructor to display a message when the object is deleted. o *Concepts: Constructor, destructor.*	**[2]**
9. Write a program to demonstrate single inheritance where a class Vehicle is inherited by a class Car. Use super() to access base class methods. o *Concepts: Inheritance, super().*	**[2]**
10. Write a Python program to open a text file in write mode and write your personal information (name, age, department). Then, read and display the content of the file. o *Concepts: File open, write, read, file modes.*	**[2]**
11. Write a program to read a file line by line using readline() and count the number of characters in each line. o *Concepts: File reading, character offset.*	**[2]**
12. Create a program to open a file in append mode and add new content. Use exception handling to manage file not found or access errors. o *Concepts: File handling with exception management.*	**[2]**

Text Books:

1. Python Projects (Author: Laura Cassell, Alan Gauld) Wrox publication
2. Murach's Python Programming. Aut.:Michael Urban, Joel Murach, murach's Publication.

Reference Books:

1.Fundamentals of Python (First Program) Cengage MINDTAP Publication
2nd Edition. Author: K.A. Kambert

Capstone Project -I

23MT3610	ELC	Capstone Project -I	0-0-4	2 Credits

Teaching Scheme:	**Examination Scheme:**
Practical: 4 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	State the exact title of the project and problem definition.
CO2	Explain the motivation, objectives, and scope of the project.
CO3	Review the literature related to the selected topic of the project.
CO4	Design the mechanism, and components of the system and prepare detailed drawings.
CO5	Evaluate the cost considering different materials/manufacturing processes.

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.

It is expected that the students should complete at least 50% of the total project work in the VI Semester. 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.