Course Title	**:**	**Machining Processes**		**Semester**	**:**	**VI**
Course Code	**:**	**25UME601T**		**Course Category**	**:**	**PCC**
Teaching Scheme	**:**	**L - T - P** **2 - 0 - 0**		**Total Credits**	**:**	**2**

Prerequisites:

- Basics of Engineering and workshop practises

Course Objectives:

- To introduce the fundamentals of machining and metal cutting processes.
- To study tool materials, tool geometry, and cutting parameters.
- To explain the construction and operations of lathe, drilling, shaper, and planer machines.
- To explain the principles and operations of milling and grinding machines.

Course Outcomes: Upon successful completion of the course, students should be able to:

CO1. Explain machining fundamentals, tool materials, tool geometry, and metal cutting principles.
CO2. Describe the construction and operations of lathe and drilling machines with NC basics.
CO3. Explain the working and operations of shaper, planer, and slotting machines.
CO4. Describe the principles and operations of milling and grinding machines.

Course Content:

Unit I	
Introduction to Machining: Classification, tool materials, tool materials properties, tool geometry. **Theory of Metal Cutting:** Orthogonal and Oblique cutting, Chip formation, cutting fluids, cutting speed, feed and depth of cut, tool life.	8 Hrs.
Unit II	
Lathe: Introduction, types, construction, various operations such as facing, turning, taper turning, threading, knurling. Introduction to Capstan, Turret Lathe and fundamentals of NC **Drilling:** Introduction, tools for drilling, classification of drills, type of drilling machines, drilling machines operations.	7 Hrs.
Unit III	
Shaper: Introduction, types, Mechanism of shaper, work holding devices, shaper operations. **Planer:** Introduction, types of planner, driving mechanism, Planer operations **Slotter:** Introduction, types of slotting machines, type of drives, Slotter operations	7 Hrs.
Unit IV	
Milling: Introduction, types, special purpose milling machines, different milling operations, milling cutters. **Grinding:** different operations, grinding wheel, grinding operation, surface grinding, tool & cutter grinding	8 Hrs.

Textbooks:

- Workshop technology (Vol. II), V. S. Raghuwanshi, Dhanpat Rai & Sons
- Manufacturing Science, Ghosh & Mallik, East West Press
- Manufacturing technology (Metal cutting & Machine tools) Vol. II, P. N. Rao, Tata Mc-Graw Hill
- Workshop technology, H. S. Bawa, Tata Mc-Graw Hill
- Introduction to Manufacturing Processes, J. A. Schey, Tata Mc-Graw Hill
- Workshop Technology (Volume II), Hajra Chaudhary, Media Promoters & Publishers

Reference Book:

- Raghuwanshi B. S., A Course in "Workshop Technology" (Machine Tools Vol.II), Dhanpat Rai & Sons.
- HMT, "Production Technology", Tata Mc Graw Hill.
- J P Kaushish, "Manufacturing Processes", PHI Learning Pvt. Ltd.

Course Title	**:**	**Machining Processes**		**Semester**	**:**	**VI**
Course Code	**:**	**25UME601P**		**Course Category**	**:**	**PCC**
Teaching Scheme	**:**	**L - T - P** **0 - 0 -2**		**Total Credits**	**:**	**1**

Prerequisites:

- Students should have prior knowledge of respective theory Machining Processes

Course Objectives:

- To introduce the basic principles of metal cutting used in manufacturing processes.
- To study the working principles and operations of lathe, drilling, shaper, and planer machines.
- To study the construction and operations of milling and grinding machines.
- To evaluate the performance of different machine tools through practical job work.

Course Outcomes: Upon successful completion of the course, students should be able to:

CO1. Explain the fundamentals of metal cutting and machining parameters.
CO2. Study basic operations on lathe, drilling, shaper and planer machines.
CO3. Study construction and operations on milling and grinding machines.
CO4. Assess machine tool through completion of practical machining jobs.

List of Experiments

1. Study of Basics of Metal Cutting
2. Study of Cutting tools
3. Study of Lathe machine
4. Study of Drilling machine
5. Study of Shaper machine
6. Study of Planer machine
7. Study of Milling machine
8. Study of Grinding machine
9. Job 1
10. Job 2

Textbooks:

- Workshop Technology (Volume II), Hajra Chaudhary, Media Promoters & Publishers
- Manufacturing Science, Ghosh & Mallik, East WestPress
- Workshop technology, H. S. Bawa, Tata Mc-Graw Hill

Course Title	**:**	**Automation in Production**		**Semester**	**:**	**VI**
Course Code	**:**	**25UME602T**		**Course Category**	**:**	**PCC**
Teaching Scheme	**:**	**L - T - P** **2 - 0 - 0**		**Total Credits**	**:**	**2**

Prerequisites:

- Linear programming, optimization, project management

Course Objectives:

- To develop the ability to analyze any engineering problem and apply logic for getting solution so as to develop decision making skill in current manufacturing environment
- To get the understanding regarding how automation is used to increase production.
- To develop ability to understand latest automation in production like CNC, Robotics etc.
- To develop understanding of various techniques like FMS,CAPP and CAD/CAM

Course Outcomes: Upon successful completion of the course, students should be able to:

CO1.	Get Acquainted With Automation, Its Type‘s ,Strategies , Assembly Line Balancing And Its Analysis, Methods Of Work Part Transport
CO2.	Recognize fundamentals and constructional features of N.C, CNC and D.N.C machines and prepare a CNC program for given part.
CO3.	Get Acquainted With The Robotic Configuration, Types Of Links, Joints, Grippers, Industrial Robotics And Robot Applications.
CO4.	Cultivate Information About Automated Material Handling Systems, Automated Storage And Retrieval System (AGVS,AS/RS) Its Analysis
CO5.	Get Acquainted With Automated Inspection (CAPP, CAQC, CMM) And Group Technology.
CO6.	Recognize CAD/CAM,CIM,FMS, Understand The Concepts Of Shop Floor Control

Course Content:

Unit I	
Automation -Definition, types, reasons, strategies for automating, Difference between Mechanization and automation, Automated Flow Lines, Analysis of flow lines and of transfer lines without storage, manual assembly lines. Line Balancing Problem, Methods of line balancing. (Largest Candidate Rule & RPW only)	8 Hrs.
Unit II	
Numerical Control Production Systems- Basic concepts, coordinate system, Types of NC systems- Point to point, straight cut and continuous path, NC part programming, APT programming	8 Hrs.
Unit III	
Industrial Robotics - Introduction, robot anatomy, robot control systems, accuracy and repeatability and other specifications, end effectors,. Robot applications Automated Guided Vehicle Systems, Automated Storage & Retrieval System, Carousel storage systems	7 Hrs.
Unit IV	
Automated inspection methods, off-line & on -line inspection, Group Technology, benefits of group technology Computer aided manufacturing, Flexible manufacturing systems,	7 Hrs.

Textbooks:

- Automation, production System & CIMS Third edition (2007) M P, Groover PHI Prentice Hall
- CAD/CAM Fifth edition (2008) Zimmers & Groover PIll Pearson Education India
- Joffrey Boothroyd, Peter Dewhurst and Winston A. Knight, ―Product Design for manufacture and Assembly‖, CRC Press
- Deb S.R., ―Robotics‖, Tata McGraw Hill Publications, New Delhi.
- Yoram Koren, ; Robotics for Engineers;, McGraw Hill Book Co.
- John W Webb and Reis, Ronald A., "Programmable Logic Controllers: Principles & Applications‖,Prentice Hall.

Reference Book:

- Numerical Control And Computer Aided Manufacturing 13th edition (2007)Rao, N K Tiwari, T K Kundra Tata McGraw-Hill Education
- Computer Control of Manufacturing Systems 2005 Koren Mcgraw Hill

Course Title	**:**	**Automation in Production**		**Semester**	**:**	**VI**
Course Code	**:**	**25UM E602P**		**Course Category**	**:**	**PCC**
Teaching Scheme	**:**	**L - T - P** **0 - 0 -2**		**Total Credits**	**:**	**1**

Prerequisites:

Students should have prior knowledge of respective theory subject.

Course Objectives:

1. To introduce the fundamentals of automation systems used in manufacturing.
2. To provide knowledge of NC and CNC systems and their applications in industry.
3. To study the basic concepts and applications of industrial robotics and AGV systems.
4. To develop practical skills through performance and simulation of CNC machines, robotic arms, and automated storage systems.

Course Outcomes: Upon successful completion of the course, students should be able to:

CO1. Explain the basics of automation, NC, CNC, and their role in modern manufacturing
CO2. Describe the working principles and applications of industrial robots and AGV systems.
CO3. Perform basic operations on CNC machines.
CO4. Perform basic operations on robotic arms and AS/RS

List of Experiments

1. Study of basics in Automation and its types
2. Study of NC and CNC Systems
3. Study of Industrial Robotics
4. Study of Automated Guided Vehicle Systems
5. Performance on Robotic arm
6. Performance on Automated Storage and Retrieval System
7. Performance of Simulation of a Lathe machine
8. Performance on CNC Lathe machine
9. Performance of Simulation of Milling machine
10. Performance on CNC Milling machine

Textbooks:

Automation, production System & CIMS Third edition (2007) M P, Groover PHI Prentice Hall

- CAD/CAM Fifth edition (2008) Zimmers & Groover PIll Pearson Education India
- Joffrey Boothroyd, Peter Dewhurst and Winston A. Knight, —Product Design for manufacture and Assembly, CRC Press
- Deb S.R., —Robotics, Tata McGraw Hill Publications, New Delhi.
- Yoram Koren, ; Robotics for Engineers;, McGraw Hill Book Co.

Course Title	**:**	**Design of Machine Elements**		**Semester**	**:**	**VI**
Course Code	**:**	**25UME603T**		**Course Category**	**:**	**PCC**
Teaching Scheme	**:**	**L - T - P** **2 - 0 - 0**		**Total Credits**	**:**	**2**

Prerequisites:

Basic Physics, Basic Mathematics and materials science, strength of materials (mechanics of materials), basic engineering mechanics.

Course Objectives:

Students should apply the concepts of mechanics of solid and material science to design commonly used machine components by considering various design consideration to fulfill the need of society.

Course Outcomes: Upon successful completion of the course, students should be able to:

CO1. Apply fundamental principles of mechanical engineering design and to design machine elements such as knuckle joints, cotter joints, and welded joints.

CO2. Identify and explain the fundamental concepts and design pressure vessels along with associated components such as nuts, bolts, gaskets, and covers.

CO3. Identify and explain the fundamental concepts and design principles of shafts, helical springs, and leaf springs.

CO4. Identify and explain the fundamental concepts and to design clutches and brakes.

Course Content:

Unit I

8 Hrs.

Introduction to Mechanical Engineering Design, design types, factors to be considered in machine design, Aesthetic and Ergonomics Consideration in design, Material properties and their uses in design, Basic principles of Machine Design, Modes of failures, I. S. codes, Preferred Series and numbers.

Design of Knuckle joint, Socket & Spigot type cotter joint.

Design of welded joints under axial and eccentric loading conditions.

Unit II

7 Hrs.

Design of Cylinder & Pressure Vessels: Types of pressure vessel, stresses induced in pressure vessel, Lame's, Clavarino's and Bernie's equations. Design of cylindrical & spherical pressure vessels. Design of nut, bolt, gasket & covers for pressure vessel.

Unit III

8 Hrs.

Design of shaft for power transmission, static and fatigue criteria for shaft design, ASME codes for shaft design, Design of keys.

Introduction and Design of Helical and Leaf Springs.

Unit IV

7 Hrs.

Introduction and Design of clutches and brakes: Single and multiple plate clutch, cone clutch, centrifugal clutch, constant wear and constant pressure theory for plate clutches, Internal and external shoe brakes.

Textbooks:

- Design of Machine Element, Shiwalkar B. D, Denett & Co.
- Mechanical Engg. Design, Shigley J. E, McGraw-Hill
- Design of machine elements, Bhandari V.B., Tata Mc-Graw Hill publications
- Shiwalkar B. D, Design Data for Machine Elements, Central Techno Publications (Design Data Book Permitted)

Reference Book:

- Machine Design, Grover O. P. , Maleeve and Hartmans , Fifth Edition, CBS Publisher and distributers PVT. LTD.
- Machine Design, Black P. H.,, Mc-Graw Hill publications.
- Machine Design, Norton,, Pearson publication.

Course Title	**:**	**Energy Conversion-I**		**Semester**	**:**	**VI**
Course Code	**:**	**25UME604T**		**Course Category**	**:**	**PCC**
Teaching Scheme	**:**	**L - T - P** **2 - 0 - 0**		**Total Credits**	**:**	**2**

Prerequisites:

- Basic Physics, Basic Mathematics and thermodynamics

Course Objectives:

- To expose the students to the practical applications of engineering thermodynamics & working of steam turbine,steam condenser.
- To gain the knowledge of various components of the thermal power plant like boiler, nozzles, turbines and condensers and will be able to evaluate the performance parameters of these components.

Course Outcomes: Upon successful completion of the course, students should be able to:

CO1.	Explain & classify draught cogeneration principle of steam generators,boiler mountings & accessories and evaluate performance of steam generator
CO2.	Explain the concepts of fluidized bed boilers and importance of steam nozzle and determine its throat area, exit area, exit velocity.
CO3.	Compare impulse and reaction steam turbines and explain the concept of governing of steam turbine & the methods of compounding of steam turbine.
CO4.	Explain, classify steam condensers, cooling towers and evaluate performance parameters of surface condenser.

Course Content:

Unit I

Steam Generators

Principles of steam generation, Classification of Steam Generators, Fire tubes and Water tube Steam Generator s, Boiler Mountings and Accessories.

Draught

Draught and its classification, Chimney height, Chimney Efficiency, Condition for maximum

discharge. Performance of Steam Generators, Evaporative Capacity, Equivalent Evaporation, Factor of Evapor ation, Boiler Efficiency

8 Hrs

Unit II

Fluidized Bed Boilers:

Bubbling Fluidized Bed Boiler, Circulating Fluidized Bed Boiler.

Steam nozzles:

Adiabatic expansion in nozzles, maximum discharge, critical pressure ratio and effects of friction, calculation

of throat, exit areas and exit velocity of nozzle, supersaturated flow, Wilson Line.

7 Hrs

Unit III

Steam turbines:

Working principle of steam turbines, classification of steam turbines, and comparison of impulse and reaction turbine, governing of steam turbines.

Compounding of steam turbines

Energy losses in steam turbines, flow of steam through turbine blades, reheat factors, velocity diagrams, graphical and analytical methods, work done, thrust and power, dimensions and proportioning of the blades, steam turbine efficiencies, condition for maximum efficiencies

7 Hrs

Unit IV

Steam Condensers and Cooling Towers

Steam Condensers and Cooling Towers: Types of Condensers, Classification of Condenser, Quantity of cooling water Required, Design Calculations for Surface Condenser, Daltons Law of Partial Pressures, Sources of Air Leakage and Air Removal. Wet and Dry Pumps, Air Ejectors, Cooling Towers, Cooling Ponds.

8 Hrs.

Textbooks:

- Thermal Engineering, M.M. Rathode, TMH publication
- Thermal Engineering, R. K. Rajput, Laxmi publications

A Course in Thermal Engineering, Anand Domkundwar, C.P. Kothandaraman, S.Domkundwar, Dhanpat Rai & Sons

Reference Book:

- Heat Engineering, V.P. Vasandani & D.S. Kumar, Metropolian Book Publishers
- Power Plant Engineering, M. M. EI- Wakil, McGraw Hill International
- Thermal Engineering, P. L. Ballani, Khanna Publications.
- Fluidized Bed Combustion, S. Oka and E. Anthony, Marcel Dekker Inc.
- Thermal Engineering, Mathur & Mehtra, Jain Brothers Publications, New Delhi.

Course Title	**:**	**Mechatronics**		**Semester**	**:**	**VI**
Course Code	**:**	**25UME621T**		**Course Category**	**:**	**PEC-2**
Teaching Scheme	**:**	**L - T - P** **3 - 0 - 0**		**Total Credits**	**:**	**3**

Prerequisites:

- Basic Electrical and Electronics Engineering, Engineering Mechanics and Dynamics

Course Objectives:

- To introduce students to the fundamentals of Mechatronics systems and their integration in mechanical engineering.
- To provide an understanding of sensors, actuators, and signal conditioning in Mechatronics applications.
- To develop knowledge of microcontrollers, PLCs, and industrial automation systems.
- To explore the use of modeling and control techniques in Mechatronics systems.
- To apply data acquisition, signal processing, and communication techniques for real-world applications.
- To study modern trends in Mechatronics, including AI, IoT, and smart manufacturing systems.

Course Outcomes: Upon successful completion of the course, students should be able to:

CO1. Explain the fundamental concepts of Mechatronics and its importance in modern mechanical systems. (2)
CO2. Analyze the working principles of sensors, actuators, and signal conditioning circuits in Mechatronics applications. (4)
CO3. Apply microcontroller and PLC-based control techniques in Mechatronics system design. (3)
CO4. Implement control system modeling and feedback mechanisms for automated systems. (3)
CO5. Use data acquisition and signal processing techniques for Mechatronics applications. (3)
CO6. Evaluate emerging trends in Mechatronics, including IoT, AI, and Industry 4.0-based systems. (4)

Course Content:

Unit I: Introduction to Mechatronics
8 Hrs.
Definition and scope of Mechatronics
Components of Mechatronics systems
Interdisciplinary nature of Mechatronics
Industrial applications and case studies
System response and performance characteristics
Unit II: Sensors and Actuators
8 Hrs.
Classification of sensors: Position, Speed, Temperature, Pressure, and Force sensors
Optical, Ultrasonic, Capacitive, and Hall-effect sensors
Actuators: Pneumatic, Hydraulic, and Electric actuators
Stepper motors and Servo motors in Mechatronics

Signal conditioning techniques: Filtering, Amplification, and Noise reduction
Unit III: Microcontrollers, PLCs, and Industrial Control Systems
8 Hrs.
Introduction to Microcontrollers: Architecture and Programming Basics Interfacing of sensors and actuators with microcontrollers Introduction to Programmable Logic Controllers (PLCs) PLC Programming: Ladder Diagrams and Functional Block Programming Industrial applications of PLC-based automation systems
Unit IV: Control Systems and Modeling in Mechatronics
8 Hrs.
Open-loop and Closed-loop control systems PID controllers and their tuning methods Mathematical modeling of mechanical and electromechanical systems Time-domain and Frequency-domain analysis of control systems Case studies of control systems in robotics and automation
Unit V: Data Acquisition and Digital Signal Processing in Mechatronics
8 Hrs.
Introduction to Data Acquisition Systems (DAQ) Analog-to-Digital (ADC) and Digital-to-Analog (DAC) conversion Sampling, Quantization, and Signal Reconstruction Digital Filters and Signal Processing techniques Real-time data acquisition and applications in industry
Unit VI: Modern Trends in Mechatronics
8 Hrs.
Introduction to Industry 4.0, Smart Manufacturing, and IoT AI and Machine Learning applications in Mechatronics Cyber-Physical Systems and Digital Twins Wireless Communication in Mechatronics systems Case Studies on AI-driven Mechatronics and Robotics

Textbooks:

- Mechatronics: Principles and Applications, Godfrey C. Onwubolu, Elsevier
- Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, W. Bolton, Pearson Education
- Introduction to Mechatronics and Measurement Systems, David G. Alciatore & Michael B. Histand, McGraw-Hill

Reference Book:

- Mechatronics: Integrated Mechanical Electronic Systems, K.P. Ramachandran, G.K. Vijayaraghavan, and M.S. Balasundaram, Wiley India
- Industrial Automation and Robotics, A.K. Gupta, S.K. Arora, University Science Press
- Control Systems Engineering, Norman S. Nise, Wiley

Course Title	**:**	**Mechatronics**		**Semester**	**:**	**VI**
Course Code	**:**	**25UME621P**		**Course Category**	**:**	**PEC-2**
Teaching Scheme	**:**	**L - T - P** **0 - 0 - 2**		**Total Credits**	**:**	**1**

Prerequisites:

- Students should have prior knowledge of respective theory from the subject 25UME605T-1 Mechatronics

Course Objectives:

- To understand Sensors and Actuators
- To develop Automation and Control using Microcontrollers and PLCs
- To apply Control System Techniques in Mechatronics
- To explore Industry 4.0 and IoT-based Mechatronics Applications

Course Outcomes: Upon successful completion of the course, students should be able to:

CO1. Demonstrate the working of sensors and actuators (2)
CO2. Implement automation techniques using microcontrollers and PLCs (3)
CO3. Apply control system concepts for system modeling and performance analysis (3)
CO4. Analyze modern trends in Mechatronics, including IoT and signal processing (4)

List of Experiments

1. Study of Mechatronics Components and System Integration
2. Measurement of Position and Speed using Optical and Hall-effect Sensors
3. Implementation of Temperature and Pressure Measurement using Sensors
4. Stepper Motor and Servo Motor Control using a Microcontroller
5. Programming a Microcontroller for Sensor-Actuator Interfacing
6. PLC-based Industrial Automation System
7. Interfacing a Pneumatic/Hydraulic Actuator with a PLC
8. Implementation of a PID Controller for Speed Control of a DC Motor
9. Mathematical Modeling and Simulation of a Mechatronics System
10. Data Acquisition using ADC and DAC for Signal Processing
11. Digital Filtering for Noise Reduction in Sensor Signals
12. IoT-based Smart Mechatronics System Implementation

Textbooks:

- Mechatronics: Principles and Applications – Godfrey C. Onwubolu, Elsevier
- Introduction to Mechatronics and Measurement Systems – David G. Alciatore, Michael B. Histand, McGraw-Hill
- Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering – W. Bolton, Pearson

Reference Book:

- Mechatronics: A Multidisciplinary Approach – William Bolton, Pearson

Course Title	**:**	**Design of Transmission System**		**Semester**	**:**	**VI**
Course Code	**:**	**25UME622T**		**Course Category**	**:**	**PEC-2**
Teaching Scheme	**:**	**L - T - P** **3 - 0 - 0**		**Total Credits**	**:**	**3**

Prerequisites:

- Engineering Mechanics, Strength of Materials, Machine Design Basics, Engineering Mathematics

Course Objectives:

- This course is aimed to make the students conversant with design principles & design procedure of mechanical drives like coupling, flywheel, belt drive, chain drive, gear drive, wire rope etc.

Course Outcomes: Upon successful completion of the course, students should be able to:

CO1. Apply principles of machine design to design couplings and flywheels by evaluating load conditions, energy fluctuations, stresses, and speed variations.
CO2. Analyze lubrication systems and bearing performance and design suitable hydrodynamic journal bearings and anti-friction bearings for radial and thrust loads.
CO3. Design flat belt and V-belt drive systems by calculating belt tensions, power transmission capacity, and selecting appropriate belt and pulley dimensions.
CO4. Analyze and design roller chain drives and wire rope drives, including chain length, sprocket dimensions, stresses in wire ropes, and design of sheaves and drums.
CO5. Analyze gear kinematics and tooth geometry and design spur and helical gear drives considering strength, wear, and interference conditions.
CO6. Evaluate and design bevel and worm gear drives using force analysis, AGMA equations, and wear load considerations for efficient power transmission.

Course Content:

Unit I

Coupling: Types of coupling, design of flange coupling, flexible bush coupling.

Design of Flywheel: Functions, Coefficient of fluctuation of energy and Coefficient of fluctuation of speed, energy storage in flywheel, stresses in flywheel, design of flywheel. 8 Hrs.

Unit II

Design of Bearings: Lubrication, Types of Lubrication, oil seals, design of hydrodynamic journal bearings for radial loads, selection of ball and roller bearing for radial and thrust loads. Failures of antifriction bearing, bearing housing. 7 Hrs.

Unit III

Design of Flat belt drive: Types of belts & belt material, analysis of belt tension, condition for transmitting maximum power, design of flat belt, flat belt pulley.

Design of V belt drive: Types of V-belt, analysis of V-belt tension, design of V belt & pulley. 8 Hrs.

Unit IV

Design of Roller chain drive: Velocity ratio and length of chain, design of chain, dimensions of tooth profile, design of sprocket.

Design of wire rope drive: Introduction to wire rope, stresses in hoisting wire rope. Design of wire rope, sheave and drum. 7 Hrs.

Unit V

Design of Gears: Review of kinematics of gears & terminology, interference, tooth profiles, formative number

of teeth etc. Design of Spur Gear drive, Helical Gear drive. 7 Hrs.
Unit VI
Design of Bevel Gear Drive: Types of bevel gear, proportions of bevel gear, force analysis of bevel gear drive, design of bevel gear drive. Design of Worm Gear Drive: Worm Gearing—AGMA Equation; Worm-Gear force analysis. Designing a Worm-Gear Mesh; Buckingham Wear Load. 8 Hrs.

Textbooks:

- Machine Design, Maleev & Hartman, CBS publishers.
- Machine Design, P.H. Black, TMH.
- Mechanical Engg. Design, Shigley, TMH.
- Design Data book, B.D. Shiwalkar, Central Techno publications.
- Design data book for engine parts, Khandare, Kale, Akshaya publications, Nagpur.
- Design of Machine Elements, V. B. Bhandari., McGraw Hill education.
- Design of Machine Elements, B.D. Shiwalkar. Central Techno publications.
- Elements of Machine Design, Pandya N. C. and Shah C. S., Charoter publishing.
- Mechanical Design Analysis, M. F. Spotts, Prentice-Hall.
- Design of Machine Elements, Sharma & Purohit, PHI.
- Machine Component Design, Robert C. Juvinall, Kurt M. Marshele, Wiley.
- Design Data Hand Book, Mahadevan, CBS publishers. 13. Design Data Book, PSG.
-

Reference Book:

- Hand book of Machine Design, Shigley & Mischke, McGraw Hill.
- Mechanical Engineering Hand book Vol 1 & 2, Kent, John Willey & Sons.
- Machine Tool Design Data Book, CMTI.
- Engineering Design, Dieter G E., McGraw Hill education.
- Machine Design, Robert L.Norton, Pearson. .

Course Title	**:**	**Design of Transmission System**		**Semester**	**:**	**VI**

Course Code	**:**	**25UME622P**		**Course Category**	**:**	**PEC-2**
Teaching Scheme	**:**	**L - T - P** **0 - 0 -2**		**Total Credits**	**:**	**1**

Prerequisites:
• Students should have prior knowledge of respective theory from the subject 25UME605P- Design of Transmission System.
Course Objectives:
• This course is aimed to make the students conversant with design principles & design procedure of mechanical drives like coupling, flywheel, belt drive, chain drive, gear drive, wire rope etc.
Course Outcomes: Upon successful completion of the course, students should be able to:
CO1. Apply the design procedure for coupling and flywheel and finding its failure criteria.
CO2. Evaluate the radial and thrust load for journal bearings, antifriction bearings and finding its failure criteria.
CO3. Apply the design process for flat belt, V belt, chain drive and rope drive, and finding its failure criteria.
CO4. Apply the design process for spur gear, Helical Gear, worm and Bevel Gears.

LIST OF PRACTICALS:

A) Design problems (at least 8 problems should be included in the Journal)

1. Design of fly wheel.
2. Design of coupling.
3. Design of Journal Bearing.
4. Design & Selection of Antifriction bearing.
5. Design of Belt drive.
6. Design of chain drive.
7. Design of Wire rope.
8. Design of Spur Gear drive.
9. Design of Helical Gear drive.
10. Design of Bevel Gear drive.
11. Design of Worm Gear drive.

Textbooks:

- Machine Design, Maleev & Hartman, CBS publishers.
- Mechanical Engg. Design, Shigley, TMH.
- Design Data book, B.D. Shiwalkar, Central Techno publications.
- Design of Machine Elements, V. B. Bhandari., McGraw Hill education.

Reference Book:

- Hand book of Machine Design, Shigley & Mischke, McGraw Hill.

Course Title	**:**	**Refrigeration and Air-conditioning**		**Semester**	**:**	**VI**

Course Code	**:**	**25UME623T**		**Course Category**	**:**	**PEC-2**
Teaching Scheme	**:**	**L - T - P** **3 - 0 - 0**		**Total Credits**	**:**	**3**

Prerequisites:

- Fluid Mechanics, Thermodynamics and Heat Transfer

Course Objectives:

- Understand the fundamentals of refrigeration and analyze vapor compression and absorption refrigeration systems, along with refrigerant properties and environmental impacts.
- Explore multistage vapor compression systems and study refrigeration components like compressors, evaporators, expansion devices, and defrosting methods.
- Learn alternative refrigeration techniques such as air cycle refrigeration, vortex tube cooling, thermoelectric refrigeration, and cryogenics applications.
- Study psychrometry and human comfort by analyzing psychrometric properties, charts, processes, and factors affecting thermal comfort.
- Apply advanced psychrometry concepts to air conditioning systems and perform heat load calculations for HVAC applications.
- Understand air distribution and transmission principles including duct design, air filtration, grilles, diffusers, and air conditioning controls.

Course Outcomes: Upon successful completion of the course, students should be able to:

CO1. **Explain** the fundamentals of refrigeration and analyze vapor compression and absorption refrigeration systems, including refrigerants and environmental impacts.
CO2. **Evaluate** multistage vapor compression systems and understand the functioning of refrigeration components and defrosting techniques.
CO3. **Apply** knowledge of alternative refrigeration techniques such as air cycle refrigeration, vortex tube cooling, thermoelectric refrigeration, and cryogenics.
CO4. **Analyze** psychrometric properties and human comfort factors for air conditioning applications.
CO5. **Design** air conditioning systems and **perform** heat load calculations.
CO6. **Demonstrate** air distribution and transmission principles by designing duct systems and understanding air conditioning controls.

Course Content:

Unit I

REFRIGERATION: Introduction, Definition, Applications

STUDY OF SIMPLE VAPOUR COMPRESSION REFRIGERATION SYSTEM :

Analysis of simple vapour compression refrigeration system, effect of subcooling, superheating, polytropic compression & pressure drops on the performance of the system.

STUDY OF VAPOUR ABSORPTION REFRIGERATION SYSTEM :

Introduction Ammonia –Water, Lithium bromide-water system, three fluid refrigerator.

REFRIGERANTS:

Nomenclature of refrigerants, refrigerant properties, mixture refrigerant, global warming potential & Ozone depletion potential, Montreal & Kyoto protocol, alternate refrigerants. **8 Hrs.**

Unit II

MULTISTAGE VAPOUR COMPRESSION SYSTEM,

Multiple compressors & multiple evaporator system, cascade refrigeration systems. Study of equipments such as compressors, evaporators, expansion devices & controls, defrosting methods. (Types & principle only) **7 Hrs.**

Unit III

OTHER REFRIGERATION TECHNIQUES:

Air cycle refrigeration, Application in air refrigeration systems, Vortex tube, thermoelectric refrigeration.

CRYOGENICS :

Introduction, Application of cryogenics, Jules-Thomson coefficient,inversion curve, methods of liquification of air. **7 Hrs.**

Unit IV

PSYCHROMETRY

Introduction, psychrometric properties of air, psychometric chart, psychrometric processes, bypass factor, apparatus dew point temperature.

HUMAN COMFORT:

Mechanism of body heat losses, factors affecting human comfort, effective temperature comfort charts. **8 Hrs.**

Unit V

ADVANC PSYCHROMETRY:

Application of psychrometry to various air conditioning system, RSHF, GSHF, ESHF, air washers, air coolers.

HEAT LOAD CALCULATIONS :

Data collection for load calculation, various components of heat load estimate, method of cooling load calculation. **8 Hrs.**

Unit VI

AIR TRANSMISSION & DISTRIBTION:

Principle of air distribution, types of grilles & diffusors & their selection criteria, air filteration, types of air filters, distribution of air through ducts, pressure losses in ducts, method of dust designing, duct friction chart, air conditioning controls. 7 **Hrs.**

Textbooks:

- A text book of Refrigeration & Air Conditioning by R.S. Khurmi & J.K. Gupta.
- Refrigeration & Air conditioning by Dr. P.L.Ballany-Khanna Pub
- Refrigeration & Air conditioning by Dr C.P. Arora – TMH Pub.
- Refrigeration & Air conditioning by S.V. Domkundwar –Dhanpat Rai & Sons Pub..

Reference Book:

- Refrigeration & Air conditioning by Stocker & Jones – McGrawi Hill Publication.
- Principle of Refrigeration & Air conditioning by Roy J. Dossat- Pearson Edu.
- Refrigeration & Air conditioning by/ Jordon & Pristar – PHt Publication.
- Thermal Environmental Engg. by james Throlkeld.

- Modern refrigeration Practice by Guy R. King.
- Modern Air conditioning Practice by Harris –McGrawi Hill Publication.
- ASHRAE hand books - McGrawi Hill Publication.
- Carrier's air conditioning design data book – McGrawi Hill Publication.
- Air conditioning Principles & System Energy approach by E.G. Pita Pearson.

Course Title	**:**	**Refrigeration and Air-conditioning**		**Semester**	**:**	**VI**
Course Code	**:**	**25UME623P**		**Course Category**	**:**	**PEC-2**
Teaching Scheme	**:**	**L - T - P** **0 - 0 - 2**		**Total Credits**	**:**	**1**

Prerequisites:

- Basic Physics, Basic Mathematics and Fluid Mechanics

Course Objectives:

- Students will be able to Analyze the performance of a vapor compression refrigeration system by determining its coefficient of performance (COP).
- Students will be able to Identify and understand different components of refrigeration and air conditioning systems, including compressors, condensers, evaporators, and expansion devices.
- Students will be able to Operate and evaluate the performance of air-conditioning systems, including window air conditioners and desert coolers.
- Students will be able to Demonstrate proficiency in using tools and equipment for installation, maintenance, and repair of refrigeration systems.
- Students will be able to Perform testing and charging of vapor compression refrigeration systems while ensuring safety and efficiency.

Course Outcomes: Upon successful completion of the course:

CO1. Determine the coefficient of performance (COP) of a vapor compression refrigeration system through experiments.
CO2. Identify and compare different types of compressors, condensers, evaporators, and expansion devices used in RAC systems.
CO3. Evaluate the performance of air-conditioning systems, including window air conditioners and desert coolers.
CO4. Demonstrate proficiency in using tools and equipment for installation, maintenance, and repair of refrigeration systems.
CO5. Perform testing and charging of vapor compression refrigeration systems while following safety protocols.

Course Content:

List of Experiments:

1. To perform experiments on vapour compression test rig to determine COP of the system.
2. Study of various types of compressor.
3. Study of various types of condenser, expansion devices and evaporators used in RAC.
4. Study of various types of air conditioning systems
5. To perform experiments on Air-conditioning test rig.
6. Study & performance of window air conditioner.

7. To perform experiments on desert cooler to evaluate its performance.
8. Demonstration of use of various tools and equipments used for installation, maintenance & repair o refrigeration systems.
9. Testing and charging of vapour compression refrigeration system.
10. Report on visit to refrigeration plant/AC plant/cold storage plant.

Course Title	**:**	**Computer Integrated Manufacturing Techniques**		**Semester**	**:**	**VI**
Course Code	**:**	**25UME624T**		**Course Category**	**:**	**PEC-2**
Teaching Scheme	**:**	**L - T - P** **3 - 0 - 0**		**Total Credits**	**:**	**3**

Prerequisites:

- Engineering fundamentals and basics of Manufacturing Techniques

Course Objectives:

- This course is aimed to make the students conversant with modern manufacturing systems, and associated control systems, Computer-integrated manufacturing (CIM) and its impact on productivity and quality.

Course Outcomes: Upon successful completion of the course, students should be able to:

CO1. Discuss the fundamentals of CIM
CO2. Demonstrate design GT cell
CO3. Discuss the fundamentals of flexible manufacturing system
CO4. Interpret CNC programs
CO5. Illustrate fundamentals of automated material handling & storage
CO6. Discuss application of robots in industries

Course Content:

Unit I
Introduction to CIM: Types of Manufacturing, Concept of CIM, Elements of CIM, CIM hardware and software, benefits, limitations, CIM database. 8 Hrs.
Unit II
Introduction to Group Technology: Limitations of traditional manufacturing systems, Part families, classification and coding, Production flow analysis, Machine cell design, benefits of GT and issues in GT. 7 Hrs.
Unit III
Introduction to flexible manufacturing systems: Types of FMS, FMS components, Workstations, Material handling & storage system and computer control systems. Advantages & disadvantage of FMS. 8 Hrs.
Unit IV
Introduction to NC, CNC & DNC: NC basics, NC words, Manual Part Programming, CNC machine tools, Automatically Programmed Tool. 7 Hrs.
Unit V
Automated material handling & storage: Automated Guided Vehicle Systems, Vehicle guidance & routing, applications, Automated Storage & Retrieval System, Basic components & special features. 8 Hrs.
Unit VI
Industrial Robotics: Robot anatomy, Robot control, End Effectors, robot programming, robot applications in material handling, processing, assembly and inspection. 7 Hrs.

Textbooks:

1. Automation, production System & CIMS Third edition(2007)M P, Groover PHI Prentice-Hall of India Pvt. Ltd., New Delhi, 2002
2. CAD/CAM Fifth edition (2008) Zimmers & GrooverPIll Pearson Education India
3. Radhakrishnan P, Subramanyan S.and Raju V., "CAD/CAM/CIM", 2nd Edition, New Age International (P) Ltd, New Delhi, 2000.
4. Systems Approach to Computer Integrated Design and Manufacturing1996 Nanua Singh Wiley & Sons, 1996.
5. Handbook of Flexible Manufacturing Systems1991 Jha, N.K Academic Press nc.,

Reference Book:

1. Numerical Control And Computer Aided Manufacturing 13th edition (2007) Rao, N K Tiwari, T K Kundra Tata McGraw-Hill Education
2. Computer Control of Manufacturing Systems 2005 Koren Mcgraw Hill
3. G.T Planning and Operation, in The automated factory Hand Book: Technology and Management1991 Askin, R.G.and Vakharia, A.J Cleland, D.I. and Bidananda, B (Eds), TAB Books, NY, 1991.

Course Title	**:**	**Computer Integrated Manufacturing Techniques**		**Semester**	**:**	**VI**
Course Code	**:**	**25UME624P**		**Course Category**	**:**	**PEC-2**
Teaching Scheme	**:**	**L - T - P** **0 - 0 - 2**		**Total Credits**	**:**	**1**

Prerequisites:

- Manufacturing Techniques, Industrial Robotics,

Course Objectives:

- This course is aimed to make the students conversant with applications of Computer-integrated manufacturing (CIM) in industry.

Course Outcomes: Upon successful completion of the course, students should be able to:

CO1: Discuss the fundamentals of CIM, GT, NC and FMS

CO2: Perform simulation of CNC Lathe and Milling machine

CO3: Demonstrate Manual Part Programming of CNC Lathe and Milling machine

CO4: Demonstrate part programming of Robotic arm

Course Content:

List of Experiments
1. Study of CIM and its elements 2. Study of Group Technology 3. Study of Numeric Control Systems 4. Study of Flexible Manufacturing Systems 5. Simulation of a CNC Lathe machine 6. Simulation of a CNC Milling machine 7. Manual Part Programming of Lathe machine 8. Manual Part Programming of Milling machine 9. Performance on AS/RS system 10. Part Programming of Robotic arm

Textbooks:

1. Automation, production System & CIMS Third edition(2007)M P, Groover PHI Prentice-Hall of India Pvt. Ltd., New Delhi, 2002
2. CAD/CAM Fifth edition (2008) Zimmers & GrooverPIll Pearson Education India
3. Radhakrishnan P, Subramanyan S.and Raju V., “CAD/CAM/CIM”, 2nd Edition, New Age International (P) Ltd, New Delhi, 2000.

Reference Book:

1. Numerical Control And Computer Aided Manufacturing 13th edition (2007) Rao, N K Tiwari, T K Kundra Tata McGraw-Hill Education
2. Computer Control of Manufacturing Systems 2005 Koren Mcgraw Hill

Course Title	**:**	**Mechanical Vibrations**		**Semester**	**:**	**VI**
Course Code	**:**	**25UME625T**		**Course Category**	**:**	**PEC-2**
Teaching Scheme	**:**	**L - T - P** **3 - 0 - 0**		**Total Credits**	**:**	**3**

Prerequisites:

- Student should have the knowlege of basics of Engineering mathematics of Applied physics

Course Objectives:

- To Interpret and analyse vibrations in various mechanical systems by using
- mathematical treatment and identify methods of vibration reduction.

Course Outcomes: Upon successful completion of the course, students should be able to:

CO1. Summarize the knowledge on basic concept of vibrations considering free and force vibrations.

CO2. Evaluate the transient, impulse and forced vibration response for SDF and vibration control

CO3. Describe and Analyse Multidegree freedom system using Matrix Iteration and Holzer method .

CO4. Describe and Analyse Dunkeleys method, Stodola method to estimate natural frequencies.

CO5. Restate and Illustrate the Vibration Phenomenon of Continous System

CO6. Restate and Illustrate the Vibration Based Condition Monitoring and related intrumentations.

Course Content:

Unit I

Brief History of Vibations, Intoduction to Free & forced vibration, undamped and damped single degree of freedom systems, structural damping, estimation of natural frequency for single and two degree of freedom 7Hrs

Unit II

Introduction of Impulse, transient and forced vibration response of Single degree freedom, isolation and transmissibility and vibration control.

7Hrs

Unit III

Intoduction to Numerical techniques for Multi degree of freedom systems. Matrix iteration method. Holzer‘s method for torsional vibration. 7Hrs

Unit IV

Dunkeleys method for critical speed determination of multi disc rotor. Stodola method for determination of all the natural frequencies and mode shapes. Free and forced response by modal analysis. 8 Hrs. 8 Hrs.

Unit V

Vibration of continuous systems. Longitudinal vibration of beams, transverse vibration of beams and torsional vibration of shafts.

8 Hrs.

Unit VI

Vibration pickup, seismometers, accelerometer, proximity probe spectrum analyzer, FFT & DFT (DiscreteFT), vibration measurement, digital vibration measurement, philosophy of vibration condition monitoring

8 Hrs.

Textbooks:

1. Mechanical Vibration, V. P. Singh, Dhanpatrai & Co.
2. Mechanical Vibrations, J. S. Rao, New Age publishers.
3. Mechanical Vibration, Shrikant Bhave, Pearson publications.
4. Theory of Vibration, W.T. Thomson, CBS.
5. Mechanical Vibration, Debabrata Nag, Wiley.

Reference Book:

1.Mechanical Vibrations, S.S. Rao, Pearson.
2. Advanced Theory of Vibration, J.S. Rao, New Age International.
3. Vibration Condition Monitoring of Machines, J. S. Rao, Narosa publications.
4. Random Vibration in Mechanical Systems, Crandall & Mark, Academic press.
5. Mechanical Vibration, William J.Palm, John Wiley.

Course Title	**:**	**Mechanical Vibrations**		**Semester**	**:**	**VI**

Course Code	**:**	**25UME625P**		**Course Category**	**:**	**PEC-2**
Teaching Scheme	**:**	**L - T - P** **0 - 0 - 2**		**Total Credits**	**:**	**1**

Prerequisites:

- Student should have the knowledge of basics of Engineering mathematics of Applied physics

Course Objectives:

- To Interpret and analyse vibrations in various mechanical systems by using
- mathematical treatment and identify methods of vibration reduction.

Course Outcomes: Upon successful completion of the course, students should be able to:

CO1. Describe and analyse single degree of freedom, and two degree of freedom system for its vibration response

CO2. Evaluate the response of practical application and estimation of natural frequencies of system with various methods.

CO3 Restate and Illustrate the vibration based condition monitoring and use of related instrumentations using experimental setup.

CO4. Describe and analyse vibration phenomenon of continuous system and multidegree freedom system using Holzer method .

List of Practicals

1) Study of single degree of freedom system with damping and without damping.

2) Study of two degree of freedom system for its response.

3) Study of multi degree of freedom system & estimation of natural frequency by Dunkeleys method, Stodola method .

4) To develop an expression for the damping coefficient of the dashpot.

5) Estimation of vibration response of follower of cam and follower mechanism.

6) General overview of vibration based condition monitoring.

7) Study of set up of drag system & diagnosis of machine component used in Drag simulator

8) Study of Vibration response of continuous system.

9)Study & analysis of multidegree of freedom system using Holzers Method.

Course Title	**:**	**Industrial Fluid Power**		**Semester**	**:**	**VI**
Course Code	**:**	**25UME626T**		**Course Category**	**:**	**PEC-2**
Teaching Scheme	**:**	**L - T - P** **3 - 0 - 0**		**Total Credits**	**:**	**3**

Prerequisites:

- Basic Physics, Basic Mathematics and Fluid Mechanics

Course Objectives:

- To introduce the fundamental concepts of fluid power systems, including Pascal's and Bernoulli's principles, and analyze the properties, advantages, and limitations of fluid power.
- To provide an in-depth understanding of hydraulic components, including pumps, actuators, valves, and accessories, essential for designing and maintaining hydraulic systems.
- To enable students to analyze and design hydraulic circuits, explore their industrial applications, and incorporate safety, efficiency, and maintenance considerations.
- To compare pneumatic and hydraulic systems, study air compressors and pneumatic components, and develop basic pneumatic circuit designs for industrial applications.
- To introduce electrical control strategies in fluid power, including solenoid-operated valves and PLCs, for designing and analyzing electro-hydraulic and electro-pneumatic automation systems.
- To equip students with troubleshooting skills for hydraulic and pneumatic systems, including fault diagnosis, maintenance strategies, adherence to safety standards, and exploration of emerging trends in fluid power applications.

Course Outcomes: Upon successful completion of the course, students should be able to:

CO1: Students will be able to explain the fundamentals of fluid power, apply the Paskal's and Bernaullis Principles, evaluate the advantages and limitations and analyse the properties of fluid power.

CO2: Students will be able to explain the working principles, performance, and applications of hydraulic pumps, actuators, valves, and accessories, essential for designing and maintaining hydraulic systems.

CO3: Students will be able to analyze and design basic hydraulic circuits, understand their industrial applications, and apply safety, efficiency, and maintenance considerations in hydraulic system design.

CO4: Students will be able to compare pneumatic and hydraulic systems, understand the working of air compressors, pneumatic components, and air preparation units, and design basic pneumatic circuits for industrial applications.

CO5: Students will be able to apply electrical control strategies, including solenoid-operated valves and PLCs, to design and analyze electro-hydraulic and electro-pneumatic circuits for automation in manufacturing and material handling.

CO6: Students will be able to diagnose common failures in hydraulic and pneumatic systems, implement preventive and predictive maintenance strategies, adhere to fluid power safety standards, and analyze emerging trends through industrial case studies.

Course Content:

Unit I
Basics of fluid power: Hydraulic vs Pneumatic systems Pascal's Law, Bernoulli's Principle, and their applications Advantages and disadvantages of fluid power systems Applications of fluid power in industrial automation, robotics, and heavy machinery Properties of hydraulic fluids: Viscosity, Compressibility, Contaminants & Filtration. **8 Hrs.**

Unit II
Hydraulic Pumps: Gear, Vane, Piston, and Screw Pumps – Working Principles & Performance Hydraulic Actuators: Linear and Rotary Actuators (Cylinders & Motors) Hydraulic Valves: Pressure Control, Flow Control, and Direction Control Valves Hydraulic Accessories: Reservoirs, Filters, Accumulators, Coolers, and Pipes. **7 Hrs.**
Unit III
Basic hydraulic circuits: Meter-in, Meter-out, Bleed-off circuits Regenerative circuits, Sequencing circuits, and Speed control circuits Industrial hydraulic applications: Press machines, Conveyor systems, Injection molding machines Design considerations: Safety, Efficiency, and Maintenance. **7 Hrs.**
Unit IV
Comparison of Pneumatic vs Hydraulic Systems Air Compressors: Reciprocating, Rotary Screw, and Vane Compressors Pneumatic Valves and Actuators: Directional Control Valves, Cylinders, and Motors Air Preparation Units: Filters, Regulators, Lubricators (FRL Units) Pneumatic Circuit Design: Basic & Industrial Applications. **8 Hrs.**
Unit V
Control Strategies: Electrical control of hydraulic & pneumatic circuits Solenoid-operated Valves & Relays Programmable Logic Controllers (PLC) in Fluid Power Systems Electro-hydraulic & electro-pneumatic circuits for automation Application case studies in manufacturing and material handling. **8 Hrs.**
Unit VI
Common failures in hydraulic & pneumatic systems Fault diagnosis techniques: Leak detection, Pressure loss, Overheating issues Preventive & predictive maintenance strategies Fluid power safety standards (ISO, OSHA) Industrial case studies & emerging trends in fluid power. **7 Hrs.**

Textbooks:

- Introduction to Fluid Power, James L Johnson, Tata McGraw-Hill Publication.
- Modi and Seth, “Hydraulics, Fluid Mechanics and Machinery”, Standard Book House, NewDelhi
- Vasandani V. P., “Theory of Hydraulic Machinery”, Khanna Publishers, Delhi
- Vickers Manual on Industrial Hydraulics

Reference Book:

- Lal J., “Hydraulic Machines”, Metropolitan Book Co., Delhi.
- Karassic, “Hand Book of Pumps”, Tata McGraw Hill Ltd. Delhi
- Majumdar, “Oil Hydraulics-Principle and Maintenance”, Tata McGraw Hil
- Pipenger J. J., “Industrial Hydraulics”, McGraw Hill

Course Title	**:**	**Industrial Fluid Power**		**Semester**	**:**	**VI**
Course Code	**:**	**25UME626P**		**Course Category**	**:**	**PEC-2**
Teaching Scheme	**:**	**L - T - P** **0 - 0 - 2**		**Total Credits**	**:**	**1**

Prerequisites:

- Basic Physics, Basic Mathematics and Fluid Mechanics

Course Objectives:

- To equip students with knowledge of hydraulic and pneumatic systems, including their components, performance analysis of pumps and turbines, and industrial automation applications.

Course Outcomes: Upon successful completion of the course:

CO1: Students will explain the working of pneumatic components, speed control circuits, and the role of accumulators and intensifiers in industrial applications.

CO2: Students will demonstrate and analyze the performance of hydraulic and pneumatic circuits, including actuators, for industrial applications.

CO3: Students will analyze the performance characteristics of impulse and reaction turbines, including Pelton, Kaplan, and Francis turbines.

CO4: Students will evaluate the performance characteristics of axial flow, centrifugal, and reciprocating pumps used in fluid power systems.

CO5: Students will design a hydraulic or pneumatic system using manufacturer catalogs and analyze industrial automation through practical exposure.

Course Content:

List of Experiments:

1. Study of Compressor, FRL unit and 5/3 DCV.
2. Study of Speed Control circuits: meter-in, meter-out and bleed off.
3. Study of accumulators and intensifiers.
4. Demonstration and performance of Hydraulic circuit.
5. Demonstration and performance of Pneumatic circuit.
6. Demonstration and performance of Hydraulic Actuators.
7. Demonstration and performance of Pneumatic Actuators.
8. Demonstration and performance of Impulse Turbine - Pelton Turbine.
9. Demonstration and performance of Reaction Turbines - Kaplan Turbine.
10. Demonstration and performance of Reaction Turbines - Francis Turbine.
11. Demonstration and performance of Axial Flow Pump.
12. Demonstration and performance of Centrifugal Pump.
13. Demonstration and performance of Reciprocating Pump.
14. Design report of a hydraulic or pneumatic system using manufacturer's catalogue.
15. Industrial visit to study automation by means of Hydraulic and Pneumatic Systems.

Course Title	**:**	**INDUSTRIAL ENGINEERING**		**Semester**	**:**	**VI**
Course Code	**:**	**25UME631T**		**Course Category**	**:**	**PEC-3**
Teaching Scheme	**:**	**L - T - P** **2 - 0 - 0**		**Total Credits**	**:**	**2**

Prerequisites:

Basic Mechanical Engineering, Manufacturing Processes / Machines, Production Engineering. Industrial visit

Course Objectives:

The objectives of this course are to:

- To introduce the discipline and profession of industrial engineering.
- This course provides knowledge and skills for designing work system as a form of integrated system, planning and controlling of a production system.
- Ability to design a facility layout, problem and organization of design process and value engineering and skill.

Course Outcomes: Upon successful completion of the course, students should be able to:

1. Apply methods in value engineering to improve the competitiveness of product/service.
2. To apply ergonomics principles in industry and for planning and controlling maintenance system.

CO1**:** To apply the fundamentals to industry.

CO2. To apply the different charts & ergonomics system to industry.

CO3. To develop the prediction methods.

CO4. To generate the maintenance technique for industry.

Course Content:

Unit I
8 Hrs.
Work Study: Productivity – Concept and objectives of productivity, Types of productivity, factors affecting productivity. Tools and techniques to improve productivity, Measurement of productivity. Work study and methods study : Definitions, objectives, steps in method study, process charts, string diagram, motion study, micro motion study, SIMO Chart.
Unit II
7 Hrs.
Work measurement : Objectives, definition, stop watch study, work sampling , PMT s, MTM & Work factor method. Ergonomics : Objectives, Human factors in Engg., Man machine system, display design, design of controls. Principles of motion economy, work place design.

Unit III
7 Hrs.
Forecasting: Need for forecasting, classification of forecasting methods like judgmental technique, time series analysis, least square method, moving average method, exponential smoothing method.
Unit IV
8 Hrs.
Maintenance: Objectives, Types of maintenance, preventive, predictive, break down maintenance. Reliability and maintainability analysis. Failure data analysis, reliability, MTBT, MTTR, Batch tub curve, series parallel and stand by system.

Textbooks:

1. Industrial Engineering & Production Management, Martand Telsang, S. Chand & co.
2. Maynard H.B.: Industrial Engineering Handbook, McGraw Hill.
3. Industrial Engineering. & Management, Arun Vishwanath, SciTech Publication.
4. Industrial Engineering and Management, N.V.S. Raju, Cengage Publication.
5. Statistical Quality Control, E. Grant & R. S. Leavenworth, McGraw Hill.

Reference Book:

1. Work Study, ILO.
2. Motion & Time study by R.M. Barnes, John Wiley
3. Ergonomics by K.F.H. Murell, Springer.

Course Title	**:**	**Synthesis of Mechanisms**		**Semester**	**:**	**VI**
Course Code	**:**	**25UME632T**		**Course Category**	**:**	**PEC-3**
Teaching Scheme	**:**	**L - T - P** **2 - 0 - 0**		**Total Credits**	**:**	**2**

Prerequisites:
Student should have the knowledge of basics of Engineering mathematics of Applied physics
Course Objectives:
To provide knowledge to students with different synthesis techniques of mechanisms used in machines and its use for dynamic analysis.
Course Outcomes: Upon successful completion of the course, students should be able to:
CO1. Explain existing machines and mechanisms. CO2. Analyse and Synthesize mechanisms Quick return Mechanism using graphical technique CO3.Illustrate and Synthesize mechanisms Planer Mechanism using graphical technique CO4. Explain and Analyse mechanisms using analytical technique and prepare computer algorithms.

Course Content:

Unit I
Introduction Intoduction to synthesis of mechanisms ,Types of mechanisms, kinematics synthesis, science of relative motion, tasks of kinematic synthesis. Function generation, Path generation & Motion generation problem with practical applications. Concept of Transmission angle, limiting conditions, toggle position, circuit and branches in linkages. Degree of Freedom, Class-I, Class-II Chain. Hardings notations, Grashof criterion, Grublers criterion, 10Hrs
Unit II
Graphical Synthesis Co-ordination of input-output link motion, relative pole technique, inversion technique, overlay technique, graphical synthesis of Quick-Return Mechanism for optimum transmission angle. 10Hrs
Unit III
Graphical Synthesis. Introduction to path generation problem , synthesis for path generation, with & without prescribed timing using graphical method, Kinematic Synthesis of planar mechanisms, accuracy (precision) points, Chebesychev spacing, types of errors. 10Hrs
Unit IV
Analytical synthesis Synthesis of four-bar mechanisms. Freudenstein's equation, synthesis for three, four and five accuracy points. Introduction to computer aided analysis and design of mechanism using computer programming. 10 Hrs.

Textbooks:

1. Theory of Machines and Mechanisms, J. E. Shigley and J. J. Uicker, McGraw-Hill.

2. Design of Machinery: An Introduction to the Synthesis and Analysis of Mechanisms and Machines, Robert L.Norton, Tata McGraw Hill.

Reference Book:

1. Advanced Mechanism Design–Analysis and Synthesis - Vol. I and II, A.G.Erdman and G.N. Sandor, Prentice – Hall.

2. Kinematics and Mechanism Design, C.H. Suh and C.W. Radcliffe, John Wiley & Sons.

3. Kinematics and Linkage Design, Hall, A.S., Balt Publishers.

4. Kinematic Synthesis of Linkages, R.S. Hartenberg and J. Denavit, McGraw Hill.

5. Kinematics and Dynamics of Machinery, R L Norton, McGraw Hill.

6. Mechanism synthesis and analysis, A. H. Soni, McGraw Hill

Course Title	**:**	**Automobile Engineering**		**Semester**	**:**	**VI**
Course Code	**:**	**25UME633T**		**Course Category**	**:**	**PEC-2**
Teaching Scheme	**:**	**L - T - P** **2 - 0 - 0**		**Total Credits**	**:**	**2**

Prerequisites:

- Basic Mechanical & Electrical Systems and Internal Combustion Engines

Course Objectives:

- Understand the history and development of automobiles along with chassis, frames, and power plant systems.
- Learn the working and types of clutch and gearboxes used in automobile transmission systems.
- Analyze the transmission system components including propeller shaft, differential, axles, and braking systems.
- Study steering and suspension systems for vehicle stability, handling, and ride comfort.
- Explore automobile electrical systems including battery, ignition, lighting, and air-conditioning, along with wheels and tires.
- Understand vehicle body design, safety considerations, and modern advancements in automobile technology.

Course Outcomes: Upon successful completion of the course, students should be able to:

CO1. Explain the history, development, and structural components of automobiles, including chassis, frames, and power plants.
CO2. Analyze the working principles and types of clutch and gearbox systems used in vehicle transmission.
CO3. Demonstrate knowledge of the transmission system, differential, axles, and braking mechanisms for vehicle control and safety.
CO4. Explain the principles of steering and suspension systems and their role in vehicle stability and comfort.

Course Content:

Unit I
Introduction, Automobile history and development. Chassis and Frame: Layout of chassis & its main components. Types of frames, conventional frames and unitized chassis, articulated, rigid vehicles, prime movers, hybrid car & electric car. Power Plant: Constructional features of different types of engines used in automobiles. Fuel supply systems, cooling systems, lubrication systems. **8 Hrs.**
Unit II
Clutch: Necessity, requirements of a clutch system. Types of Clutches, centrifugal clutch, single & multi plate clutch, fluid clutch. Gear Box: Necessity of transmission, principle, types of transmission, sliding mesh, constant mesh, synchromesh, transfer gear box, gear selector mechanism, lubrication and control. Torque converter, semiautomatic & automatic transmission. **7 Hrs.**
Unit III

Transmission system: Propeller shaft, universal joint, Hotchkiss drive, torque tube drive. Differential – Need and types. Rear axles and Front axles. Brakes: Need & types, mechanical, hydraulic & pneumatic brakes, electrical brakes, engine exhaust brakes, drum and disc brakes, comparison and details of components. Brake adjustment. **7 Hrs.**
Unit IV
Steering systems: principle of steering, center point steering, steering linkages, steering geometry and wheel alignment, power steering. Suspension systems: Function of spring and shock absorber, conventional and Independent suspension system, Telescopic shock absorber, linked suspension systems, rubber, plastic, hydro & pneumatic suspension system. **8 Hrs.**

Textbooks:

- Automobile Engineering Vol. I & II, Kirpal Singh, Standard Publishers.
- Automotive Mechanics, Joseph Heitner, East West Press.
- Automobile Engineering, R.K.Rajput, Laxmi Publications.
- Automobile Engineering R.B. Gupta, Satya Prakashan New Delhi
- Course in Automobile Engineering, Sharma R. P, Dhanpat Rai and Sons.
- Automobile Engineering, Ramakrishna, PHI Learning Pvt. Ltd.

Reference Book:

- Automobile Mechanics, Crause, W.H., Tata McGraw Hill.
- Vehicle and Engine Technology, Heinz Heisler, Arnold London.
- Automotive Engines, Srinivasan S., Tata McGraw Hill.
- Motor Vehicle Technology, J.A. Dolan, Heinemann Educational Books.
- Automobile Engineering Vol. I, II & III, P. S. Gill, Kataria and Sons.
- Automobile Engineering, K.K. Jain, R.B. Asthana, Tata McGraw Hill.

Course Title	**:**	**Operation Research**		**Semester**	**:**	**VI**
Course Code	**:**	**25UME634T**		**Course Category**	**:**	**PEC-2**
Teaching Scheme	**:**	**L - T - P** **2 - 0 - 0**		**Total Credits**	**:**	**2**

Prerequisites:

- Linear programming, optimization, project management

Course Objectives:

- To introduce the fundamentals of Operations Research and teach the formulation and solution of linear programming problems.
- To enable students to formulate and solve transportation models using different methods.
- To teach the formulation of assignment problems and the application of replacement models for maintenance decisions.
- To introduce network-based project management techniques like CPM and PERT and analyze project cost and completion probability.

Course Outcomes: Upon successful completion of the course, students should be able to:

CO1. Formulate and solve linear programming problems using graphical and simplex methods.
CO2. Analyze and solve assignment problems and apply replacement techniques for individual and group replacements.
CO3. Solve transportation problems, including unbalanced cases, using appropriate techniques.
CO4. Apply project management techniques to manage project schedules and to perform cost and probability analysis.

Course Content:

Unit I	
Introduction to OR & Basic OR Models, Linear programming, formulation of Dual of LPP, LPP by graphical methods and simplex method	8 Hrs.
Unit II	
Assignment Models: Formulation of the Assignment problem, unbalanced assignment problem, travelling salesman problem. Replacement Models- Concept of replacement technique, Individual replacement models & Group replacement models.	8 Hrs.
Unit III	
Transportation Models: Formulation of transportation model, Basic feasible solution using different methods (North-West corner, Least Cost, Vogel's Approximation Method), Unbalanced transportation problem	7 Hrs.
Unit IV	
Drawing of Network, CPM & PERT, probability of completion of project, Cost Analysis of Project	7 Hrs.

Textbooks:

- Operation Research, Heera & Gupta, S Chand Publications
- Operation Research, JK Sharma, Mc Millian Publications

Reference Book:

- Operation Research, Hamdy Taha, Prentice Hall.
- Operation Research, Liberman, McGraw Hill Publications.
- Operation Research, S. D. Sharma, Kedarnath Ramnath & Co.
- Operations Research, Pannerselvam: Prentice Hall of India 2010.

Course Title	**:**	**Power Plant Engineering**		**Semester**	**:**	**VI**
Course Code	**:**	**25UME635T**		**Course Category**	**:**	**PEC-3**
Teaching Scheme	**:**	**L - T - P** **2 - 0 - 0**		**Total Credits**	**:**	**2**

Prerequisites:

- Basic Physics, Basic Mathematics and Fluid Mechanics

Course Objectives:

- Explain the fundamentals of thermal power plants, including site selection, fuel handling, boiler components, and auxiliary systems.
- Describe gas turbine and diesel-electric power plants, their layouts, components, performance, and efficiency improvement methods.
- Analyze hydrology concepts and hydroelectric power plants, including site selection, turbine selection, and system components.
- Evaluate load analysis, load fluctuations, load curves, and economic analysis of power generation costs.

Course Outcomes: Upon successful completion of the course, students should be able to:

CO1. **Explain** the working principles, layout, and components of thermal power plants, including fuel handling and boiler systems.
CO2. **Analyze** the operation, efficiency improvement methods, and performance of gas turbine and diesel-electric power plants.
CO3. **Apply** hydrology concepts to hydroelectric power plants and evaluate turbine selection, site suitability, and system performance.
CO4. **Interpret** load analysis parameters, load fluctuations, and economic aspects of power generation.

Course Content:

Unit I
Introduction to thermal power plants and power plant layouts. Site selection. Fuel characteristics, handling, storage, preparation & firing methods. Ash & dust collection and handling. • Boiler: classification, general arrangement, details of different components and system like draught system, steam turbine systems, condenser, cooling towers. **8 Hrs.**
Unit II
Gas Turbine Power Plant: -Introduction, power plant layouts, Open cycle, close cycle power plants. Various components and systems. Methods to improve efficiency. Reheat and Regeneration cycle and their combinations Diesel Electric Power Plant: - Introduction, Outline, type of engines, different components, performance, plant layout. Comparison with other power plant. (visit to nearby power plant shall be arrange for the students). **7 Hrs.**
Unit III
Hydrology: - Rainfall, Runoff, Hydro graph, flow duration curve, mass curve. Hydroelectric power plant: - Site selection, classification of hydroelectric power plant, general arrangement, details of different components, turbine selection. Governing. • Comparison with other power plant. **7 Hrs.**

Unit IV
Load Analysis - Fluctuating Load on power plants, Load curves, various terms & definition, peak load, effect of fluctuating load. • Economic Analysis: - Cost of electric energy. **8 Hrs.**

Textbooks:

- "Power Plant Engineering" by A.K. Raja, Amit Prakash Srivastava, and Manish Dwivedi, published in its 1st edition by New Age International Publisher
- "Power Plant Engineering" by Frederick T. Morse, now in its 3rd edition and published by Van Nostrand Reinhold
- "Power Plant Engineering" by P.K. Nag, which is currently in its 4th edition and published by McGraw Hill Education

Reference Book:

- Power Plant Engineering Larry Drbal, Kayla Westra, and Pat Boston 1st Edition Springer
- Power Plant Technology, M. M. EI-Wakil, McGraw Hill publication
- Power Plant Engineering, S.Gautam, Vikas Publication Pvt. Ltd

Course Title	**:**	**Introduction to Cryogenics**		**Semester**	**:**	**VI**
Course Code	**:**	**25UME636T**		**Course Category**	**:**	**PEC-3**
Teaching Scheme	**:**	**L - T - P** **2 - 0 - 0**		**Total Credits**	**:**	**2**

Prerequisites:

- Basic Physics, Basic Fluid Mechanics, Basic Thermodynamics, Refrigeration

Course Objectives:

- Understand the fundamentals of cryogenics and explore its applications across various engineering and scientific fields.
- Analyze the behavior of materials at cryogenic temperatures and study insulation techniques for low-temperature applications.
- Examine cryogenic liquefaction systems and evaluate the efficiency of different liquefaction cycles.
- Study cryogenic refrigeration systems and their applications in space technology, superconductivity, and medical fields.

Course Outcomes: Upon successful completion of the course, students should be able to:

CO1. Explain the fundamentals of cryogenics and its applications in engineering, medicine, space, and food preservation.
CO2. Analyze the properties of materials at cryogenic temperatures and evaluate different cryogenic insulation techniques.
CO3. Demonstrate knowledge of cryogenic liquefaction systems and assess the efficiency of various liquefaction cycles.
CO4. Explain cryogenic refrigeration systems and their applications in space, superconductivity, and medical fields.

Course Content:

Unit I
Introduction to Cryogenics: Definition and scope of cryogenics Applications of cryogenics in engineering, medicine, space, and food preservation Historical development and advancements in cryogenic technology Properties of materials at cryogenic temperatures. **8 Hrs.**
Unit II
Low-Temperature Properties of Materials: Mechanical, thermal, and electrical properties of materials at cryogenic temperatures Superconductivity and its applications Cryogenic insulation: vacuum insulation, multi-layer insulation (MLI), and foam insulation Thermal contraction and embrittlement at low temperatures. **7 Hrs.**
Unit III
Cryogenic Liquefaction Systems: Thermodynamic principles of gas liquefaction Ideal and actual liquefaction cycles Linde-Hampson, Claude, Kapitza, and Stirling liquefaction systems Liquefaction of air, nitrogen, oxygen, hydrogen, and helium Efficiency analysis of cryogenic liquefaction processes. **7 Hrs.**

Unit IV
Cryogenic Refrigeration Systems: Joule-Thomson effect and regenerative heat exchangers Cryocoolers: Stirling, Gifford-McMahon, Pulse Tube, and Joule-Thomson refrigerators Cryogenic temperature measurement techniques Applications in space technology, superconducting magnets, and medical applications. **8 Hrs.**

Textbooks:

1. **"Cryogenic Systems"** – Randall F. Barron, Oxford University Press, 1985
2. **"Cryogenic Engineering"** – Thomas M. Flynn, Marcel Dekker, New York
3. **"Cryogenic Process Engineering"** – K. D. Timmerhaus & T. M. Flynn, Kluwer Academic / Plenum Publishers (1 December 1989)
4. **"Fundamentals of Cryogenics Engineering"**, Mamta Mukhopadhyay, PHI (30 October 2010)

Reference Book:

1. Research papers and industrial case studies related to cryogenics

Course Title	**:**	**Fundamentals of Aerodynamics**		**Semester**	**:**	**VI**
Course Code	**:**	**25UAE 606T**		**Course Category**	**:**	**MDM-4**
Teaching Scheme	**:**	**L - T - P** **3 - 0 - 0**		**Total Credits**	**:**	**3**

Prerequisites :

- Fundamentals of Aeronautical Engineering, Fluid Mechanics, Thermodynamics

Course Objectives:

Course Objective		
Sr. No.	**The objective of this course is–** **students should be able to:**	
1	Develop a fundamental understanding of aerodynamic principles governing lift, drag, and pressure distribution around airfoils.	
2	Analyze airfoil geometry parameters and classify different airfoil types based on shape, characteristics, and performance.	
3	Apply knowledge of airfoil classifications to evaluate their suitability in various aircraft design applications and mission requirements.	
	Course Outcomes	**BL**
	After successful completion of this course the student will be able to:	
CO1	Explain the fundamentals of airfoils, their nomenclature, classification, and applications, including NACA series airfoils.	**2**
CO2	Discuss the aerodynamic characteristics of low-speed airfoils, including pressure distribution, lift curve slope, flow separation, and stalling behavior.	**2**
CO3	Apply classical thin airfoil theory to determine lift and pitching moment for symmetric and cambered airfoils, and evaluate viscous flow effects such as drag estimation, transition, and separation.	**3**
CO4	Interpret finite-wing aerodynamics by applying Prandtl's lifting line theory and vortex concepts, and assess spanwise flow effect and downwash on wing performance.	**2**
CO5	Solve governing equations for one-dimensional compressible flow, and analyze flow features such as speed of sound, shock waves, and expansion waves using relations like Prandtl–Meyer function.	**3**
CO6	Demonstrate working principles, layouts, and types of wind tunnels, and differentiate testing methods, flow visualization, and techniques for measuring aerodynamic forces and moments.	**3**

Course Content:

Unit I
6 Hrs.
Fundamentals of Aerodynamics: Airfoil, Types of Airfoils, Airfoil Nomenclature and its characteristics, NACA series, Applications of Airfoils.

Unit II
6 Hrs.
Characteristics of Low Speed Airfoil: Effect of incidence on pressure distribution, Lift Curve, Airfoil stalling, Flow Separation, Pitching moment, Span-wise flow variation, downwash.
Unit III
6 Hrs.
Incompressible flow over a Two Dimensional Wing: Vortex Sheet, The Kutta Condition, Kelvin's Circulation Theorem and starting vortex, Classical Thin Airfoil Theory – 1. Symmetrical Airfoil 2. Cambered Airfoil, Viscous flow over Airfoil – Estimation of airfoil drag for laminar flow & Turbulent flow, Transition and flow separation.
Unit IV
6 Hrs.
Incompressible flow over a Finite Wings: Introduction to Finite Wing, The Vortex system, Laws of Vortex motion – The vortex filament, Biot-Savart Law and Helmholtz's theorem, Prandtl's Classical Lifting Line Theory, A Numerical Nonlinear Lifting Line Method.
Unit V
6 Hrs.
Compressible Flow: Introduction, Compressibility, Governing equations for inviscid compressible flow, Total conditions, Flow with Normal shock waves: Introduction, Development of a Shockwave, Rarefaction wave, Speed of sound with derivation, Prandtl-Meyer relation.
Unit VI
6 Hrs.
Wind Tunnels: Wind Tunnel, layouts and nomenclature, Types of Wind Tunnels – continuous and intermittent - closed circuit and open circuit - closed jet and open jet test section – application, flow visualization techniques, measurements of forces and moments.

Textbooks:

1. Fundamentals of Aerodynamics by John D Anderson, McGraw Hill

2. Fundamentals of Compressible Flow by S M Yahya, New Age International Publishers

3. Aerodynamics by L J Clancy, Sterling Book House

Reference Books:

1. Aerodynamics for Engineering Students by E L Houghton and P W Carpenter, Edward Arnold Ltd. 2. Aerodynamics for Engineers by John J Bertin, Pearson Education Inc.

Course Title	**:**	**Fundamentals of Aerodynamics Lab**		**Semester**	**:**	**VI**
Course Code	**:**	**25UAE 606P**		**Course Category**	**:**	**MDM-4**
Teaching Scheme	**:**	**L - T - P** **0 - 0 - 2**		**Total Credits**	**:**	**1**

Prerequisites:

- Fundamentals of Aeronautical Engineering, Fluid Mechanics, Thermodynamics

Course Objective		
Sr.No.	**The objective of this course is students should be able to:**	
1	Understand the fundamentals of wind tunnels and different types of airfoils.	
2	Apply computational tools such as CFD software to investigate and analyze aerodynamic properties over airfoils.	
Course Outcomes		**BL**
	After successful completion of this course the student will be able to:	
CO1	Demonstrate the fundamentals of wind tunnel operation, types, and applications; understand the aerodynamic characteristics.	**3**
CO2	Apply fluid mechanics principles to experimentally determine velocities, manometer deflections, and surface pressure distributions on aerofoils.	**3**
CO3	Analyze aerodynamic forces such as lift, drag, and side forces during yawing motion on aircraft models.	**4**

Course Content:

List of Experiments (Any Eight):

Sr. No.	**List of Experiments**
01	Introduction to Wind tunnel and its types.
02	To Study different types of airfoil with applications and its characteristics.
03	Apply principles to graph different velocities versus manometer deflection.
04	Analyze forces (Lift & Drag) acting on a symmetrical aerofoil.
05	Examine forces (Lift & Drag) acting on a flat plate.
06	Generate a graph displaying pressure distribution on a circular cylinder.
07	Investigation of side forces in yawing motion of an aircraft.

08	Visualize flow patterns over the surface of various models.
09	To find out aerodynamic properties over an airfoil using CFD software.
10	Construct a graph illustrating pressure distribution on an unsymmetrical aerofoil.

Textbooks:

1. Anderson, J.D., “Fundamentals of Aerodynamics”, McGraw-Hill Book Co., New York, 1985
2. Aerodynamics by L J Clancy, Sterling Book House

Reerence Book:

1. Standard Lab Manual

Course Title	**:**	**Principles of Robotics**		**Semester**	**:**	**VI**
Course Code	**:**	**25URO606T**		**Course Category**	**:**	**MDM-4**
Teaching Scheme	**:**	**L - T - P** **3 - 0 - 0**		**Total Credits**	**:**	**3**

Prerequisites: Fundamentals of robotics, which includes various drives and actuators, end effectors, robot sensor and vision. Robot Locomotion of various types.

Course Objectives:

Provide comprehensive understanding of robotic fundamentals including joints, drive systems, end effectors, sensors, applications, and path planning techniques.

Course Outcomes:

On completion of the course, learner will be able to

CO1: Demonstrate basic concepts of robotics
CO2: Apply appropriate drive for Robotic applications.
CO3: Demonstrate knowledge of industrial robots, characteristics, end effectors and actuators
CO4: Describe working principle of various sensors and program different operations
CO5: Appreciate applications of robots in industry
CO6: Solve robot dynamics problems, generate joint trajectory for path planning

Course Content:

UNIT I Fundamentals of Robotics

Historical development of Robotics, Definitions of Industrial Robot, Type and Classification of Robots, Asimov's laws of robotics, Robot configurations, Robot Components, Robot Degrees of Freedom, Work volume and work envelope, Robot Joints and symbols, Resolution, accuracy and precision of Robot, Work cell control. **[6 Hours]**

UNIT II Robot Drive Systems

Pneumatic Drives, Hydraulic Drives, Mechanical Drives, Electrical Drives-D.C. Servo Motors, Stepper Motors, A.C. Servo Motors, Micro actuators, Motion conversion, variable speed drive arrangements **[6 Hours]**

Grippers- Mechanical Grippers, Pneumatic and Hydraulic- Grippers, Magnetic Grippers, Vacuum

UNIT-III End Effectors for Robotics – Grippers & Tools

Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Advance Grippers- Adaptive grippers, Soft Robotics Grippers, Tactile Sensor Grippers; Various process tools as end effectors; Robot end effectors interface **[6 Hours]**

UNIT IV Robot Sensors

Transducers and sensors, Sensors in robotics, Principles and applications of the following types of sensors-Proximity Sensors, Photo Electric Sensors, Position sensors, Gas sensor, Temperature sensor, Encoders – Absolute and Incremental: - Optical, Magnetic, Capacitive, pneumatic Position Sensors, Range Sensors- LIDAR, RADAR, Touch Sensors, Force and torque sensors, Machine vision **[6 Hours]**

UNIT V Field Robots

Arial robots, Agricultural robots, wheeled and legged robot, space robot, military robots, mining robot, underwater robot, special purpose robot. **[6 Hours]**

UNIT VI Planning and Navigation

Introduction to path planning, types of path planning, Advantages of path planning, definition forward kinematics, inverse kinematics, homogeneous transformation matrix for path planning. **[6 Hours]**

Suggested Self Readings

Sr. No.	Suggested Text Books/Reference Books/ Web page (URL)/Research paper, etc.
	Text Books:
1	Groover, M.P. Weiss, M. Nagel, R.N. & Odrey, N.G., Ashish Dutta, Industrial Robotics, Technology, Programming & Applications, Tata McGraw Hill Education Pvt. Ltd. New Delhi
2	S. R. Deb, Robotics Technology and Flexible Automation, Tata McGraw Hill.
3	Groover M.P.-Automation, production systems and computer integrated manufacturing Prentice Hall of India.
	Reference Books:
1	**An Introduction to Robotics: Mechanical Aspects"** by Michel Geradin: A comprehensive guide that delves into the mechanical aspects of robotics University of Ledge November 2009
2	Niku, S. B. Introduction to Robotics: Analysis, Systems, Applications. Upper Saddle River, NJ: Prentice Hall, 2000.
3	John Craig, Introduction to Robotics, Mechanics and Control, 3rd Edition, Pearson Education, 2009
4	R K Mittal & I. J. Nagrath, Robotics and Control, McGraw Hill Publication, 2015.
5	Murphy, R. R. Introduction to AI Robotics. Cambridge, MA: MIT Press, 2000.

Course Title	**:**	**Principles of Robotics**		**Semester**	**:**	**VI**
Course Code	**:**	**25URO606P**		**Course Category**	**:**	**MDM-4**
Teaching Scheme	**:**	**L - T - P** **0 - 0 - 2**		**Total Credits**	**:**	**1**

Prerequisites:

Basics of mechanical engineering concepts such as kinematics and dynamics, Fundamental knowledge of sensors and actuators, fundamental robotics theory like joints, DOF

Course Objectives:

It Provide the basic structure and principles of robotic systems, workspace analysis, sensors, actuators, microcontrollers, testing simple robotic tasks, analyze, simulate, and evaluate robotic mechanisms using software tools.

Course Outcomes:

On completion of the course, learner will be able to

CO1: Develop and analyze workspace models for 2-axis, 3-axis, and 4-axis robotic arms.

CO2: Simulate robot motion and trajectories using Robo DK for various robotic configurations.

CO3: Understand industrial applications such as robotic arc welding and gripping mechanisms.

CO4: Apply simulation tools to model, test, and interpret robotic operations effectively.

List of Experiments:

1. To develop the workspace model for pick and place operation of a four- axis robot arm
2. To do the Robo DK for four axis robot arm.
3. To develop the workspace model for pick and place operation of a three-axis planar robot arm.
4. To do the Robo DK for a three-axis planar robot arm.
5. To develop the workspace model for pick ad place operation of a two-axis planar robot arm.
6. To do the Robo DK for a two-axis planar robot arm.
7. To study applications of robotic arc welding
8. To develop a model in Robo DK for robotic arc welding

Suggested Self Readings

Sr. No.	Suggested Text Books/Reference Books/ Web page (URL)/Research paper, etc.
1	Dr. T.C.Manjunath, “Fundamentals of Robotics”, Nandu Publishers, 5th Edn., India, 2005 (Programming with CD/DVD)
2	https://robodk.com/doc/en/Basic-Guide.
3	https://robodk.com/doc/en/Basic-Guide.html#Nav3D

Course Title	**:**	**Tool Design**		**Semester**	**:**	**VI**
Course Code	**:**	**25UME605P**		**Course Category**	**:**	**PC-PEC**
Teaching Scheme	**:**	**L - T - P** **0 - 0 - 2**		**Total Credits**	**:**	**2**

Prerequisites:

- Manufacturing Techniques, Industrial Robotics,

Course Objectives:

- To enable students to understand and apply the fundamental principles of tool design by analyzing cutting tools, press tools, dies, moulds, jigs, and fixtures through design calculations, material selection, and standard practices, thereby bridging theoretical manufacturing concepts with practical industrial tool room applications.

Course Outcomes: Upon successful completion of the course, students should be able to:

CO1: Design and analyze single-point and multi-point cutting tools by calculating cutting forces, tool life, feeds, and speeds for given machining conditions.

CO2: Design press tools such as blanking, piercing, bending, and drawing dies with appropriate clearances and force calculations.

CO3: Understand and apply forging die and mould design principles for manufacturing applications.

CO4: Apply the 3-2-1 locating principle to design jigs and fixtures and interpret industrial tool drawings using standard design methodology.

Course Content:

List of Experiments
1. Design of Single-Point Cutting Tool
2. Design of Multi-Point Cutting Tool – Drill
3. Design of Milling Cutter
4. Design of Blanking Die
5. Design of Piercing Die
6. Design of Bending Die
7. Design of Drawing Die.
8. Design of Forging Dies (Open & Closed)
9. Design of Simple Blow Mould
10. Design of Jigs and Fixtures

Textbooks:

3. Metal Cutting and Design of Cutting Tools, Jigs & Fixtures – N.K. Mehta (McGraw Hill)
4. Design of Jigs, Fixtures and Press Tools – K. Venkataraman (John Wiley & Sons)
5. Tool Design – Cyril Donaldson, G.H. Lecain, V.C. Goold (Tata McGraw Hill)

Reference Book:

1. Tool Engineering and Design – Donaldson, Black & Kohser, McGraw Hill

Course Title	**:**	**Robot Programming**		**Semester**	**:**	**VI**
Course Code	**:**	**25UME606P**		**Course Category**	**:**	**PCC**
Teaching Scheme	**:**	**L - T - P** **0 - 0 - 2**		**Total Credits**	**:**	**1**

Prerequisites:

- Basic mechanical engineering concepts, programming knowledge and automation fundamentals

Course Objectives:

- To introduce the basic concepts and applications of industrial robotics.
- To study the anatomy and configuration of industrial robots.
- To study the fundamentals of robot kinematics and motion.
- To study robot path planning and motion control techniques.

Course Outcomes: Upon successful completion of the course, students should be able to:

CO1. Explain the basic principles and applications of industrial robots.
CO2. Describe robot anatomy, drive systems, end effectors, and sensors used in robotics.
CO3. Explain robot kinematics, path control, and motion control methods.
CO4. Develop and execute basic robot programs for motion study and pick-and-place operations.

List of Experiments

1. Study of basics in Industrial Robotics
2. Study of Robot Anatomy
3. Study of Robot Kinematics
4. Study of Robot Path and Motion Control
5. Study of Robot Drive Systems
6. Study of End Effectors
7. Study of Sensors Used in Robotics
8. Study of Robot programming commands
9. Robot program for motion study
10. Robot program for pick and place operation

Textbooks:

- Introduction to Robotics: Mechanics and Control – John J. Craig, Pearson
- Robot Modeling and Control – Mark W. Spong, Seth Hutchinson, M. Vidyasagar, Wiley
- Fundamentals of Robotics: Analysis and Control – Robert J. Schilling, Pearson