

Integrated Program in Mechanical Engineering

| Semester | Courses for Mechanical Engineering | | |
|--------------|--|--------------------|-------------------|
| | Course Name | Credits per course | Number of Courses |
| I | Engineering Graphics and Design | 3 | 1 |
| II | A Professional's Approach to Law and Ethics (2022 Batch) Design Thinking and Creativity (2023 Batch and subsequent) | 3 | 1 |
| III | Applied Industrial IoT | 3 | 1 |
| IV | i. Ambience Control System Design ii. Industrial Piping & Pipeline Engineering | 3 | 2 |
| V | i) Power Plant Engineering – An Industrial Context ii) Digital Technologies with CPS, IIOT & Cloud in Manufacturing | 3 | 2 |
| VI | i) Collaborative Robotics in Manufacturing with AI, ML & IIOT ii) Heat Exchangers – Design & Applications | 3 | 2 |
| VII | Project Management for Professionals | 3 | 1 |
| Total | | | 10 |

Engineering Graphics & Design

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| Unit 1 | Basics of Engineering Graphics, Projection of Points & Lines |
| <p>Introduction to Engineering Drawing, Manual & Computer-Aided Design, and Drafting, Lettering, Dimensioning, Geometrical Constructions, Plane Curves, Conic Sections, Cycloidal Curves, Involutives – Projection of point placed in a quadrant – Projection of a line using first angle projection method, rotating line method, trapezoidal plane method – Solve & draw projections of a line kept inclined to two planes – Determination of true length, true inclinations & traces of a straight line.</p> | |
| Unit 2 | Projection of Planes & Solids |
| <p>Description of plane shapes & solids - Drawing plane projections & solids using change of position and auxiliary plane method – Projection of solids with inclined axis – Drawing projection of solids using change of position and auxiliary plane method.</p> | |
| Unit 3 | Orthographic Projections & Sections of Solids |
| <p>Visualization & drawing orthographic projections – Description & drawing of Plan, elevation, side elevation of objects, simple machine parts using first angle projection method – Description of section plane & a portion of solid – Drawing sectional top view, front view, the true shape of the section on an auxiliary plane</p> | |
| Unit 4 | Isometric & Perspective Projection, Development of Surfaces |
| <p>Drawing isometric view of solids (Box method) – Drawing isometric scale & construction of isometric projection from orthographic projection – Drawing perspective projection of small, and large objects and building components using suitable methods – Drawing section plane & determining lateral surface – Determination of the shortest distance between points – Drawing & determining the shape of metal sheet to cut objects</p> | |
| Unit 5 | Building Drawing, Solid Modeling, Building Information Modeling |
| <p>Drawing plan, elevation, and sectional elevation of a small residential & office building – Description & creation of Solid models in general and with respect to engineering – Designing and creating a new product & generating various views – Basics of Building Information Modeling (BIM)</p> | |

A Professional's Approach to Law and Ethics

Unit - I

General Principles of Contracts Management : General Principles of Contract, Competency and Enforceable Contracts- Various Types of Contracts and their Features- Government Contracts - Tenders, Request for Proposals and Bid Evaluations- Specific Contract- Insurance, Taxation, Contract Documentation- Performance , Joint Liabilities, Impossibility, Excusable Non-performance and Doctrine of Frustration- Breach of Contract, Consequences, Remedies- Specific Performance and Sale of Goods Act- Public /Private Partnerships- Build, Own, Operate and its Variations- Engineering Contracts, Standard Issues, Certification process and Issues relating to the Final Bill- FIDIC Model Contracts

Professional Ethics: Definition Types and Theories of Ethics- Code of Ethics and Professional Ethics - Gift vs. Bribery and Anti-corruption Laws - Whistle Blowing and Vigil Mechanism - Confidentiality Information and Data Protection - Tortious Liability -Environmental Breaches and Disaster Management - Discrimination at Workplace

Unit - II

Arbitration and Mediation : Introduction and Evolution of Arbitration Law Salient -Arbitration Agreements -Notice of arbitration and appointment of arbitrators - Seat v. Venue- Procedure to be followed by arbitral tribunal and jurisdiction of arbitral tribunal- Interim orders and How to challenge them- The Arbitration & the Award - Challenging the Arbitral Award - Arbitration's beyond India's borders- SIAC & LIAC - Enforcement of Foreign awards - Dispute Resolution Boards & Lok Adalats - Difference between Arbitration, Mediation, Conciliation and Negotiation - Alternate Dispute Resolution methods and Confidentiality

Unit - III

Corporate & Commercial Laws : Basic definitions and terms under Company Law- Difference between Companies and other entities - Articles and Memorandum of Association - Authentication of contracts and documents - Piercing of Corporate Veil -Corporate Social Responsibility - Appointment of Directors and Managerial Personnel- Mergers and Amalgamations- Offences Punishable under Companies Act - Adjudicating Authority under Companies Act - Landmark Judgments under Company Law - Basic Definitions and Terms under Insolvency Code - Overview of CIRP Process - Overview of Liquidation Process - Insolvency of Micro, Small and Medium Enterprises (MSME)- Insolvency Process for Personal Guarantors - Landmark Judgments under Insolvency Code - Competition Law - Anti-competitive agreement - Abuse of dominant position - Merger Control Regulations - Landmark Judgments under Competition Law

Unit - IV

Taxation : India Income-tax Introduction and Concepts - TDS-TCS Advanced Tax - Filing return of income - Tax Incentives for commercial entities - Exchange control regulations in India – FEMA - Basic terms and fundamentals - GST- Input tax credit - Customs Duty, FTP & SEZ

Engagement of Labour, and other construction related laws : Industrial Disputes Act - Building and other construction related laws - Sexual Harassment at Workplace - Health and Safety Laws - Environmental Protection laws - Social Security Laws - Labour codes and impact on construction industry

Environmental Protection laws : Environmental Laws in India - Understanding sustainable development - Environmental Impact Assessment an overview - Overview of International Conventions on Environmental Protection

Unit - V

Intellectual Property Rights (IPR) : Intellectual Property Law in India - Copyright and Trademarks - Patents and Designs - Product/ Process Patent and Terminology Role of -engineering students in Patent offices - Preparation of patent documents - IP in engineering companies- Trademarks - definition, concepts, registrable, non-registrable - Domain name and WIPO domain name process – Trademark & Copyright registration process - Computer programs and Copyright - Idea vs expression dichotomy- Designs registration process -Protection of trade sectors in India - Online Piracy - the Law in India - Competition and Confidentiality Issues, Antitrust Laws - Assignment and licensing of IPR – Patent, Trademark, Copyright, Design : infringement and remedies - IP issues in sale of business- Start-ups and IP- Software and Business Method Patenting in India & other Jurisdiction - Ownership of IPR and employment rights

Design Thinking and Creativity

Unit - I: Critical Thinking

Introduction to Critical Thinking, Styles and challenges of Critical Thinking, Benefits of Critical Thinking, Identifying & clarifying issues and arguments, Types of Arguments, Common patterns of Deductive reasoning & Inductive reasoning, Reasoning with Statistics, Fallacies of Relevance, Fallacies of Insufficient Evidence, Evaluating arguments, Critical Thinking models, Principles of Decision making, De Bono's Thinking hats, Effective Argument Writing, Critical Thinking based case study analysis, Analytical view of Science & Pseudoscience based thinking

Unit - II: Design Thinking Fundamentals and Framework

Fundamentals of Design Thinking, Design Thinking for complex problem solving, 7-stages of Design Thinking, Problem and solution spaces, Techniques of Empathy building, Empathy maps and user journey mapping, Storyboarding and role-playing, Exploring solution space, Design Thinking practising use – cases, Design Thinking for Professional Skills, Design Thinking practices for Coding skill, Co-curricular skill, Technical blog writing, Contest preparation, Designing Capstone projects, Design Thinking in industrial projects, Strategy for new technology innovations

Unit - III: Design Thinking in Creativity & Innovation

Unique characteristics of Design Thinking, Difference between Creativity and Innovation, Categories and misconceptions of creativity, Resilience in problem-solving, Analytical Thinking – Driven by Design Thinking, Case study on collaborative creativity enhanced by Design Thinking, Waterfall models and Design Thinking, Agile Development models, Agile process integrated with Design Thinking, Different use-cases, and project problem statements, Design Thinking based Product development - Design methodology, Prototyping, UX design, Value proposition, Business model

Unit - IV: Leadership and Teamwork

Defining leaders and leadership, Types of leaders and leadership styles, Understanding the people, personalities and abilities, Active listening, Non - verbal communication, Feedback, Clarity, Effective teams, Stages of team development, Understanding the psychology of change for individuals and teams, Personal resilience and well- being, Feedback and feed forward, Leaders and teams: Working effectively towards common goals, Role of integrity in leadership, Embracing growth mindset in leadership, Conflict resolution and Managing team dynamics

Unit – V: Verbal and Non-verbal Communication

Verbal and non-verbal communication, LSRW skills, Assertive communication, Persuasion Skills, Interpersonal Skills, Cross-cultural communication, Emotional intelligence, Self - awareness, Interpreting body language, Active listening, Personality development, Time management and Goal setting

L&T EduTech

Applied Industrial IoT

Unit – I: Introduction to Industrial IoT & IoT Architecture

Phases of Industrial Revolution, Concept of Internet of Things, Summary: Overview of Industrial IoT, Drivers, Benefits and Challenges of IoT, Summary of Drivers and Challenges in IIoT, Categories of IoT.

Information and Operational Technology, Layers of IIoT Architecture, Functions of IIoT Architecture Layers, Summary of IoT Architecture, Summary of IoT Layered Architecture, Solar Plant Management, Utility Monitoring in Railways, Components of IIoT Architecture, Introduction to On-premise servers and Cloud, Review of Components in the First two layers of IoT, Review of Components in the Network Layer of IoT, Review of Components in the Application Layer of IoT, Review of the Server architecture in IoT, Annunciator Monitoring.

Unit – II: Data Acquisition

Fundamentals of Sensors, Types of Sensors, Some Common Sensors, Choosing a Sensor, Review of Sensor Fundamentals, Review of Different Types of Sensors, Review of Selection of Sensor,

Pharma Industry, Pharma Industry, Electricity cost distribution in commercial buildings, Electricity cost distribution in commercial buildings, Demo - Energy Measurement, Sensor Technologies, Thermal Sensors, Pressure, Shear and Photo Sensors, Electrical, Magnetic and Mechanical Sensors, Corrugated boxes, Bottling plant, Introduction to Measurements and Direct Measurement, Indirect Measurement, Derived Measurement, Measurement from Industrial Systems, Summary of Concepts of Measurements and Direct Measurement, Summary of Indirect and Derived Measurements, Measurements from Industrial Systems and Calibration, Energy monitoring in Casting process, Heavy Equipment Forging

Unit – III: The Edge Computing

Edge Computing, Gateway Overview, Types and Features of Gateway, Overview of Edge Computing, Summary: Overview of Gateway, Selecting a Gateway, Packaging Industry, Bottle Manufacturing, IoT Gateway, IoT Gateway Hardware, Choice of Gateway, Configuring the Gateway, IoT Video Analytics and Quality Control at the Edge, Summary of the Fundamentals of an IoT Gateway, Summary of the IoT Gateway Hardware and Configuration, Summary of Choice of Components in a IoT Gateway, Automotive Component Manufacturing, Aluminum Extrusion.

Unit – IV: IoT Connectivity Protocols

IoT Connectivity Overview, Wireless Long Range (WAN) Protocols, Wireless Short Range Protocols
IIoT Example of Sensors and Gateway - Wheel Loader, Summary of IIoT Connectivity, Summary of IIoT Wireless Short- & Long-Range Protocols, Automotive Component Casting, Tool Bit Manufacturing, LAN Protocols, Serial Protocols, Optical Networks, Transmission Protocols in IoT, Choice of Protocols, Industrial IoT Example - Smart City, Wired LAN and Fiber Optic Protocols, Serial Protocols in IIoT Solutions, Review of Transmission Protocols, Fasteners – Production Monitoring, Bucket Wheel Excavator Monitoring, Demo - Linear Level Transmitter

Unit – V: Platform Architecture & IIoT Security

Platform Architecture Overview, Types of Server Architecture, Data Architecture, Data Ingestion and Stream Processing, Smart Monitoring of Diesel Generators, Review of the Fundamental Concepts of Platform Architecture, Review of the Different Types of Server Architecture, Big Data Architecture and Stream Processing, Aerospace Parts Manufacturing, Metal Stampings, Demo - Pulse counting with Control Input, Storage Devices, Storage Technologies, Storage Dimensioning, Database, Summary of Storage Devices and Technologies, Review of Storage Dimensioning, Databases and Data Lakes, Polymer Extrusion, Steam Turbine Monitoring, Analytics Overview, Types of Analytics, Algorithms and Machine Learning, Visualization, Summary of Data Analytics, Summary of Algorithms and Machine Learning, Summary of Visualization, Examples of Different Algorithms, Diesel Generator Monitoring, Diesel Generator Monitoring, Water Management in Public Utilities, Water Management in Public Utilities, Demo - Flow Sensing with Totalizer.
IIoT Security Concerns, IIoT Device Security, IIoT Connection Security, IIoT Application Platform and Cloud Security, Threat Modelling, Industrial Example - IoT Connected Workplace Solution, Summary of IoT Security, Securing Access, Authenticity and Data in IoT Solution, Review of Concepts of Threat Modelling, Bulk Milk Cooler Monitoring, Air Compressor Monitoring

Ambience Control System Design

Unit - I

Fundamentals of Air-conditioning & Refrigeration & Heat load Calculation

Introduction to air conditioning & refrigeration, Properties of air and vapor, Psychrometry and its importance, Infiltration & Ventilation, Sensible & Latent Heat, Factors to be considered to calculate Heat load, External & Internal Heat gains, Heat load estimation, Sample Heat Load Calculation.

Unit - II

Ventilation & Life safety system, Smoke Extraction system, Piping & Duct Design

Introduction & Types of Ventilation system, Air flow rate calculation, Life Safety in a Building, Fire Tower, Pressurization System, Lift well and lift lobby pressurization system, Smoke extraction system, Chilled water pipe sizing, Duct system and design, Duct Sizing Methods, Pressure losses in Air Distribution System

Unit - III

Chiller & Cooling tower design, Air Handling Units & Chilled water pumps

Chiller performance and selection, Vapor absorption refrigeration system and absorption chiller, Cooling tower design, Air Handling Unit, Fundamental terms and characteristics of pumps, Piping and Pumping Arrangement, Important Terminologies in Pump Head Calculations, Piping Circuit in HVAC.

Unit - IV

Demand Control Ventilation, VAV and Fans, External Static Pressure, High and Low Side Equipment's

Applying DCV to CAV system, Fan Performance curves, Velocity Pressure and Total Pressure, Friction Loss and Dynamic Losses in Duct System, Loss of Coefficient for Duct Fittings, Critical Path in Static Pressure Calculation, Introduction - High Side Equipment's, Need of Air Distribution system, Components of air distribution system, Ductwork, Duct & Pipe Accessories.

Unit - V

Valves, VARIABLE REFRIGERANT FLOW (VRF) SYSTEMS

Introduction to Valves, Valve Fundamentals, Globe Valve, Gate Valve, Ball Valve, Butterfly Valve, Check Valves, Balancing Valves, Multi-Purpose Valves, Y - strainers, PIBCV, Motorized valves, VRF system, Evolution of VRF system, Need for VRF system, Selection of VRF Systems, VRF Salient features

Industrial Piping and Pipeline Engineering

Unit – I Single-Phase: Pipe Hydraulics, Sizing & Pressure Drop

Regimes: Flow Regime Identification

Pressure Drop: Derivation of Pressure Drop in Pipe, Darcy & Fanning Friction Factor, Friction Factor Correlations, Pipe Sizing, Pressure Drop Calculation in Piping Components, Pressure Drop Calculations in Pipe Network, Pressure Drop Calculation in Header & Branching Pipes

Unit – II Two-Phase Flow: Regimes, Notations & Pressure Drop Models

Regimes: Formation of Two-Phase Flow Regimes in Horizontal & Vertical Pipes, Influence of Bend on Upstream & Downstream Two-Phase Flow Regime Formation

Notations: Two-Phase Terminologies, Relationships for Two-Phase Parameters, Flow Pattern Maps for Identification of Two-Phase flow Regimes

Models: Homogeneous Model, Two-Phase Multiplier, Evaluation of Pressure Drop, Separated Model, Drift Flux Model, Slip Ratio Correlations, K_{α_H} Correlations, Drift Flux Correlations

Unit – III Two-Phase Flow Pressure Drop, Pipes, Pipe Fittings, Flanges & Valves

Two-Phase Pressure Drop: Sudden Enlargement & Contraction, Orifice, Nozzle, Venturi, Bend, Fittings, Parallel Pipes, Series Pipes & Pipe Network

Pipes & Fittings: Pipe End Connections, Pipe Size & Schedule Numbers, Pipe Types based on Manufacturing, Materials, Ends & Joints, Fitting Types & End Connections

Flanges: Flanges (Types, End Connections, Facing, Materials, Temperature & Pressure Rating), Gaskets & Bolting **Valves:** Description & Functioning of Valves (Isolation, Regulating, Non-Return, Special Purpose Valves), Manufacturing & Assembly of Valves

Unit - IV Piping Drawings, Symbols, Stresses, Flexibility Analysis, Transient Analysis, Water & Steam Hammer

Drawings: PFDs, P&IDs, Orthographic & Isometric Views,

Symbols: Symbols, Abbreviations, 3D Modelling Software

Stresses: Induced Stresses, Pipe Stress Analysis, Stress Analysis Demonstration using **Software**

Transient: Transient Fluid Flow Analysis, Water Hammer, Steam Hammer, Gravity Flow of Liquids

Unit – V Pipe Supports, ASME B31 Standards, Pipeline Construction

Supports & Hangers: Pipe Supports, Expansion Joints, Design of Jacketed Piping, Vibration, Insulation, Buried Pipe, Cathodic Protection

ASME B31 Code: Interpretation of the various ASME codes such ASME 31.1 - Power Piping, ASME B31.3 - Process Piping, and ASME B31.4 - Pipeline Transportation...

Pipeline Construction: Right of Way, Stringing, Trenching, Bending, Coating, Lowering, Back Filling, Markers, Clan-up, HDD Method, Thrust Boring, Micro Tunneling, Hot Tapping Work

Power Plant Engineering - An Industrial Context

Unit - I

Energy Scenario, Coal Based Power Plant: Introduction, Steam Generator Auxiliaries

Energy scenario and Power generation technologies, Thermodynamic Cycles, Subcritical & Supercritical Power plants, Coal Based thermal power plant: Overview, Site Selection: Major Factors, Concept of Steam Generation, Steam Generator, Heat Transfer in Steam Generator, Efficiency of the Steam Generator.

Unit - II

Coal Based Power Plant: Steam Generator, Emission control, Auxiliary Systems & Material Handling Systems

Coal Milling System, Overview of Emission Control Systems, Overview of SCR-SNCR systems, Overview of steam turbine, Steam Turbine Auxiliary Systems, Condensate system and its major equipment, Feed water system and its major equipment, Material Handling System, Coal Handling System (CHP), Ash Handling System

Unit - III

Power Plant Water, Compressed Air systems, Combine Cycle & Nuclear Power Plant

Raw Water Intake System, Steam and Water Analysis System (SWAS), Compressed Air System, Advantages of Gas based power plant, Overview of Gas Turbine and its components, Heat Recovery Steam Generator, Layout of a open cycle and combine cycle power plant, Introduction to Nuclear Power Plant, Nuclear Power Plant –Thermodynamic Cycle

Unit - IV

Basics of Power Plant Piping, Electrical Generator and its Auxiliary Systems, Electrical System

Basics of Power Plant Piping and Piping Components, Pipe Stress Analysis, Pipe Supports, Basics of Generator, Generator auxiliaries type and functions, Cooling water system, Electrical System – Introduction, Main Power System, Plant Auxiliary Distribution System, LV and MV Motors, Electrical Power System Studies

Unit - V

Power Plant Measuring Instruments & Control system

Instruments: Introduction & Selection Criteria, Final Control elements: Introduction, Overview, Sizing and Selection Criteria, Power Plant Control System: Overview, Control system Architecture, Control system configuration & Communication, Automated Control System, Wireless Communication, Foundation Fieldbus and ProfiBus in Power Plant

Digital Technologies with CPS, IIoT & Cloud in Manufacturing

Unit - I Evolution of Industry 4.0 and Smart tools

Introduction to Digital transformation- Evolution of digital manufacturing, Drivers of digital transformation, Introduction to Cyber physical system, Internet of things, Digital thread and twin

Evolution of Industry 4.0 – Origin of Industry 4.0, Key components, Connectivity of components, Design principles, Architecture models in Industry 4.0, Digital Resource Modelling and Simulation - Factory Model

Technology for Smart Design and Manufacturing - Geometric Modelling and kernels, Simulated motion analysis of Machine component, CAE -Implementation, Geometric Dimensioning and Tolerancing (GD&T)

Unit - II Smart Factory

Digital Product life cycle (PLM) and Value Chain – Elements in PLM, Digital product life cycle, Connectivity of Enterprise Resource Planning (ERP), PLM platform, Digital Transformation of Supply chain, Integration of Value Chain

Digital enabled Applications -Robotic Process Automation (RPA), Robot work flow Management, Machine health monitoring, Smart material flow, Additive Manufacturing Process Chain, Process Selection of Additive Manufacturing

Smart Factory Initiatives - Smart Energy Management system, predictive maintenance, Horizontal vertical Integration in smart factory, Augmented reality, Quality Management 4.0

Unit - III Cyber Physical System (CPS)

Demystifying Cyber Physical Systems- Evolution of Processors, Making Processor Chips from Sand, Embedded Memory Systems, Sensors and Actuators in Cyber Physical Systems, Serial Communication and protocols in CPS

Design and Development of CPS - Interfacing Sensors with ARM Cortex Processor – Humidity, Temperature, Ultrasonic Distance Sensor, Sound, Current, Voltage, moisture and Hall effect sensors

Design of Robotic ARM – Degree of freedom in robots, controlling solenoids in Hydraulics and Pneumatics, Introduction to Ardiuno nano, Interfacing servo motor using ardiuno nano

Demo examples

Unit - IV Industrial Internet of Things (IIOT) fundamentals and use cases

Technologies Building the Digital Transformation in Industries, Concept of Internet of Things; Drivers, Benefits and challenges of IoT; Overview of Industrial IoT ; Demo - Introduction to Panel Box, Temperature Monitoring; Pharma Industry; Botting Plant; Energy Monitoring in Casting process; Heavy Equipment Forging; Packaging Industry; Automotive Component Manufacturing; Aluminum Extrusions ; Fasteners - Production Monitoring; Aerospace Parts Manufacturing; Metal Stampings; Interfacing sensors in a CNC machine for Tool life monitoring; Robot Programming with the aid of Virtual Reality Platform

Unit - V Fundamentals of Cloud services and Artificial Intelligence (AI)

Cloud services - Relational model of cloud with Industry 4.0; Adoption Trends and Manufacturing Infrastructure; Building Blocks of Cloud Computing; Cloud Service Models: Paas, FaaS and CaaS
Implications of AI in Industry 4.0 - AI Layer in Digital Factory Framework, Fundamental of AI and Edge Devices, Scope of Machine learning (ML) in Digital Transformation, Preparing Data for Optimization in production manhours - Demo with EDA procedures, Deep Learning Techniques in Construction Industry

Collaborative Robotics in Manufacturing with AI, ML & IIoT

Unit - I Sensor technologies in M/C tools & Robots

Evolution of Mechatronics and its importance, Range of sensors from Domestic appliances to Machinery on the shop floor, Sensors in Machine tools, Sensors in e Robots, Standards & specifications of sensors, Interfacing sensors in a CNC Machine for Tool life monitoring, and advanced Mechatronics systems in Machines

Open & closed-loop control systems, Digital Motors, Servo Motors, Characteristics, Various electrical drives in powering different machine tools, and Troubleshooting in Electrical Drives

Unit - II Industrial Fluid systems

Hydraulic actuators for heavy and light-duty applications, Pneumatic actuators for Machine tools, Hydro Pneumatic Actuators, Intensifiers, and Accumulators in Fluid system applications.

Essential Pneumatic and Hydraulic circuit components, Hydraulic and Pneumatic circuits for cascading operations in machine tools, Design of Electro- Hydro-Pneumatic Circuits, A fluid system for Robot, Fluidics and Logic circuits in Machine tools, and Trouble Shooting in the Drive system.

Unit - III Robotic engineering

Robotic configurations, Robotic grippers with sensing capabilities, Robot Kinematics and Control, Mentoring the robots, Robot Programming relevant to Industrial applications, and Robotic Intelligence in Manufacturing.

Robotic Vision sensors, Frame Grabbing, Sensing and Digitizing, Image Processing, Enhancement, Object recognition & Algorithms, Robot operating systems, and Applications of Robotic vision systems.

Unit - IV Robotic Design considerations

Materials used in the Fabrication of a Robot, Selection and Design Criteria, Application-based Grippers and their design, Energy Supply to Robots, and Robot communication

Automated Guided Vehicles, Types of AGVs, Traffic management & Control, Rail Guided Vehicles, and Applications of robots in various fields.

Unit - V Interfacing and Simulation

Micro Processors, Microcontrollers, and Programmable Logic Controllers. Mechatronics system design, Utilizing IoT in Mechatronics systems, Data Applications in Manufacturing, Embedded systems, and the Role of Fuzzy logic in Manufacturing.

Design of Robot link using MAT Lab Simulink and Design of RR Robot Forward Kinematics using MATLAB Simulink

Heat Exchangers – Design and Applications

Unit – I Heat Transfer & Classification of Heat Exchangers

Heat Transfer & Fluid Flow: Heat Transfer & Mediums; Heat Exchange Applications in Plants; Allowable Pressure Drop; Fluid Velocities; Impact of Allowable Pressure Drop

Classification: Based on – Heat Supply Mechanism, Fabrication, Heat Exchange Application, Operating Parameters, TEMA Standard

Case Studies:

- *Impact of Pressure Drop on Heat Exchanger Sizing and Performance*

Unit – II Shell and Tube Heat Exchangers

Shell and Tube Heat Exchangers: Flow Arrangement; Fluid Allocation; Orientation; Design Parameters; Tube Side & Shell Side Design Procedure; ϵ - NTU Method, Factors Governing Material Selection; Corrosion Monitoring Methods; Case Examples on Material Selection; Liquid-Liquid, Gas-Gas, & Gas-Liquid Heat Exchangers; Two Phase & Phase Change Heat Exchangers

Problem-Solving:

- *Pressure Drop and Heat Transfer Calculation in Shell Side & Tube Side*

Unit – III Double Pipe Heat Exchangers, Reboilers

Double Pipe Heat Exchangers: Design with & without Longitudinal Fins; 2 Heat Exchangers – Cold Fluid in Parallel & Hot Fluid in Series; Fluid Coupled Indirect Heat Exchange Equipment; Modeling & Analysis

Reboilers: Classification; Thermosyphon Reboiler; Case Study; Kettle Type Reboiler

Problem-Solving:

- *Thermal Hydraulic Design of Double Pipe Heat Exchangers with and without Fouling*
- *Industrial Practices in Sizing Typical Thermosyphon Reboiler*

Unit - IV Condensers, Evaporators, Vibration Issues, Non-Tubular Heat Exchangers

Condensers: Classification; Thermal Design; Applications

Evaporators: Classification; Laminar Falling Film & Wavy Falling Film Evaporation; Falling Film Evaporator; Climbing Film Evaporator

Vibration Issues: Mechanical Vibration of Tubes; Acoustic Vibrations in Shell

Non-Tubular Heat Exchangers: Air Cooled Heat Exchangers; Plate Type Heat Exchangers

Problem-Solving:

- *Thermal Design of Evaporators*

Case Studies:

- *Design Methodologies to Eliminate Flow-Induced Vibration in Shell and Tube Heat Exchangers*

Unit – V Cooling Towers, Agitated Vessels, Fouling, O&M, Case Studies

Cooling Towers: Counter & Cross Flow Cooling Towers; Merkel Method; Pressure Drop

Agitated Vessels: Types; Description; Heat Transfer; Pressure Drop

Fouling: Effect of Fouling; Types; Fouling Mechanisms & Prediction; Fouling Control & Penalties

O&M: Accessories required for Smooth Operation; Start up & Shutdown Procedure; Chemical & Mechanical Cleaning Methods

Problem-Solving:

- *Thermal Design Calculation for Cooling Tower and Agitated Vessels*

Case Studies:

- *Troubleshooting - Thermosyphon Reboiler*
- *Fouling in Heat Exchanger*
- *Vibration in Heat Exchanger*
- *Under Performance of Heat Exchanger*

Project Management for Professionals

Unit – I Contract Management and Scope Management

Introduction to Project Management, Project and Project Lifecycle – Process, Phases, Organization, Project Financial Feasibility Methods, Non-numerical Feasibility Methods.

Basic Concepts of Contract Management, Essential elements, Contract Types, Tendering and Proposal Preparation, Key Commercial Terms and Conditions, Bid Evaluation and Contract Award, Contract Administration, Claim Management. Work Breakdown Structures- Creation & Case Study

Unit – II Schedule and Resource Management

Approach to schedule management, Charts, Sequencing and Dependency, Network Diagram, Activity Duration, Critical Path Method, Float, Case study, Relationships, Case Study, Precedence Diagramming Method.

Resource Allocation and Resource Levelling, Case Study on Schedule Compression, PERT to Predict the Probability of Project Completion.

Unit – III Project Cost and Quality Management

Cost Estimation, Budget and Variance Analysis, Monitoring and Control, Cash Flows, Case Study.

Occupational Health, Safety and Environment, Barriers, Quality Management System – Chart and tools.

Unit – IV Procurement, Subcontracts and Stakeholder Management

Supply Chain Management, Logistics and Transportation, Vendor and Inventory Management.

Stakeholder Analysis and Engagement, Project Communication, Dealing with Difficult Stakeholders.

Unit – V Project Risk Management and Project Monitoring

Process, Terminology, Identification, Analysis and Response Strategy

Analysis Techniques, Monitor and Control Schedule, Cost, Resources, Quality and risks

Creating schedules, Assigning Resources, Cost, Evaluation, Optimization and Tracking.