

GOVT. POLYTECHNIC BALANGIR**Department of Mechanical Engineering****LESSON PLAN: 2025-26****Name of the Faculty: Rasmiranjan Jena (Lecture Stage-I)****Subject: ENTREPRENEURSHIP AND MANAGEMENT & SMART TECHNOLOGY (Th. 1)**

Program: Diploma in Mechanical Engineering

Semester: 5th

Total Contact Hours: 60

Total Marks: 100

Assessment: Progressive –20, End Term – 80

Credits: 4

COURSE OBJECTIVES:

After undergoing this course, the students will be able to :

1. Know about Entrepreneurship, Types of Industries and Startups
2. Know about various schemes of assistance by entrepreneurial support agencies
3. Conduct market survey
4. Prepare project report
5. know the management Principles and functional areas of management
6. Inculcate leadership qualities to motivate self and others.
7. Maintain and be a part of healthy work culture in an organisation.
8. Use modern concepts like TQM
9. Know the General Safety Rules
10. Know about IOT and its Application in SMART Environment.

Unit 1: Entrepreneurship (Total Classes: 10)				
Class No.	Topic	Subtopic (Elaborated)	Simple Teaching Aids/Activities	Course Objective
1	Concept of Entrepreneurship	Meaning of entrepreneurship, evolution of the term, and its importance in job creation and innovation.	Chalkboard definition writing, students repeat definitions, discussion on local entrepreneurs.	CO1
2	Need of Entrepreneurship	Role in national development, solving unemployment, encouraging innovation, and promoting regional balance.	Short video clip (if projector is available) or storytelling about entrepreneurs; group discussion on local employment issues.	CO1
3	Characteristics & Qualities	Key personal traits like self-confidence, innovation, goal-setting, persistence, and risk-taking with simple examples.	Students list qualities of a good entrepreneur in notebooks; classroom sharing.	CO6
4	Types of Entrepreneurs	Different types like innovative, imitative, Fabian, and drone entrepreneurs, explained with relatable everyday examples.	Draw simple table comparing types on board; students copy and fill in blanks.	CO1
5	Functions of Entrepreneurs	Functions such as idea generation, organizing resources, taking risks, managing enterprise, and innovation.	Teacher explains each function with example (e.g., starting a tea shop); students write 5 functions in their notebooks.	CO1
6	Barriers in Entrepreneurship	Common challenges: financial issues, family pressure, lack of	Ask students to share what difficulties they would face if	CO2, CO3

		confidence, government procedures.	they started a business; list their answers on board.	
7	Entrepreneurs vs. Managers	Comparison based on roles: Entrepreneur as a creator/innovator vs. Manager as an executor/organizer.	Teacher draws two columns on board to compare roles; students help fill based on examples given.	CO1, CO6
8	Forms of Business Ownership	Description of ownership types: Sole Proprietorship, Partnership, Cooperative Society, Company – with basic pros and cons.	Use simple chart or diagram on board showing business types; group activity: students categorize examples like bakery/shop etc.	CO4, CO5
9	Types of Industries & Startups	Classification of industries: Micro, Small, Medium. Difference between traditional industry and tech-based startups.	Use classroom examples (tailoring shop, tuition center) to categorize; students write types of industries they know.	CO1, CO3
10	Entrepreneurial Support Agencies	Introduction to DIC, NSIC, OSIC, SIDBI, NABARD, KVIC, TBI, STEP – their basic functions in supporting business ideas.	Teacher writes agency names and explains; students make a list in notebooks; quiz-style Q&A to recall full forms.	CO2

Unit 2: Market Survey and Opportunity Identification (Business Planning) (Total Classes: 8)				
Class No.	Topic	Subtopic	Teaching Aids/Activities	Course Objective
11	Business Planning	Introduction to business planning; Importance and purpose of business plans; Key components like mission, vision, goals, and financial overview.	Display of sample business plan formats, chalkboard explanation, real-life examples	CO3
12	SSI, Ancillary, Tiny & Service Units	Definitions and features of Small Scale Industries (SSI), Ancillary units, Tiny units, and Service sector enterprises with local examples.	Case-based discussion on successful SSI examples from Odisha	CO3
13	Government Schemes for Project Setup	Overview of agencies like MSME Dept, DIC, NSIC, SIDBI; Their roles in supporting project implementation and funding.	Printed handouts showing logos and roles of key support agencies	CO2
14	Time Schedule Plan	Steps involved in project planning; Creating a realistic timeline for project execution using Gantt charts or activity lists.	Activity: Create a sample time chart for a business startup	CO3
15	Demand and Supply Analysis	Methods to estimate market demand and supply; Tools for understanding customer needs and existing competition.	Class activity: Conduct a mock market survey among students	CO3
16	Growth Opportunities	Identification of emerging and high-potential business sectors like green energy, agri-business, mobile services, handicrafts, etc.	PPT presentation on trending business sectors in India and Odisha	CO3
17	Identifying Business Opportunity	Brainstorming and SWOT analysis for generating business ideas; Feasibility assessment and risk analysis.	Group brainstorming activity for local business ideas	CO3
18	Final Product Selection	Criteria for selecting a business idea: demand, affordability, skill availability, profitability, and scalability.	Student worksheet: Select a final product idea and justify choice	CO3

Unit 3: Project Report Preparation (Total Classes: 4)

Class No.	Topic	Subtopic	Teaching Aids/Activities	Course Objective
19	Preliminary Project Report	Meaning and importance of a preliminary project report; Basic contents like project idea, purpose, location, and cost overview.	Display sample of a preliminary project report on board or printed format	CO4
20	Detailed Project Report	Elements of a detailed project report: market analysis, technical aspects, financial estimates, organizational setup, and risk assessment.	Class discussion using real-world report samples; fill-in-the-blanks worksheet	CO4
21	Techno-Economic Feasibility	Explanation of technical feasibility (machinery, process, manpower) and economic feasibility (cost-benefit, break-even analysis).	Chalkboard summary; Classroom activity to assess a basic case scenario	CO4
22	Project Viability	Meaning of project viability; Parameters such as ROI, payback period, market acceptance, and resource availability.	Group task: Analyze a mock project to assess its viability	CO4

Unit 4: Management Principles (Total Classes: 5)

Class No.	Topic	Subtopic	Teaching Aids/Activities	Course Objective
23	Definitions of Management	Explanation of management as an art and science; Definition by various authors; Importance of management in organizational success.	Chalkboard explanation; Ask students to define management in their own words	CO5
24	Principles of Management	Overview of Henry Fayol's and Taylor's principles; Unity of command, division of work, discipline, etc.	Chart showing principles; Matching activity (principle vs. example)	CO5
25	Functions of Management – Part 1	Introduction to Planning and Organizing; Planning types and process; Organizing – structure, authority, responsibility.	Diagrammatic representation; Flowchart creation by students	CO5
26	Functions of Management – Part 2	Staffing, Directing and Controlling; Importance of each function with real-world examples.	Simple classroom role-play for staffing/directing; Video clip (if possible)	CO5
27	Levels of Management	Top, middle, and lower levels of management; Roles and responsibilities at each level.	Pyramid chart drawing; Case study of a small company's management structure	CO5

Unit 5: Functional Areas of Management (Total Classes: 10)

Class No.	Topic	Subtopic	Teaching Aids/Activities	Course Objective
28	Production Management	Functions and Activities of Production Management; Introduction to productivity and how it impacts efficiency and output.	Chalkboard discussion; Real-life example: Compare manual vs. automated production	CO5

29	Quality Control	Basic concept of quality; Quality control techniques used in industries; Importance of maintaining standards.	Simple quality check demo (e.g., size comparison); Discussion on local product quality issues	CO5
30	Production Planning & Control	Introduction to planning and controlling production flow; Importance of scheduling and resource allocation.	Classroom activity: Create a basic weekly production schedule for a product	CO5
31	Inventory Management	Why inventory is maintained; Concepts of stock levels and types of inventories.	Use classroom materials to simulate inventory tracking; Chart on inventory types	CO5
32	Inventory Techniques	Techniques: EOQ, ABC analysis (only concept level); Real-life importance in cost control.	Show example of ABC chart using common items (chalk, duster, lab tools)	CO5
33	Financial Management – I	Functions of financial management; Managing working capital; Introduction to costing concepts.	Use simple example of a tea stall budget to explain working capital and costing	CO5
34	Financial Management – II	Break-even analysis and its importance; Introduction to accounting terms like Bookkeeping, Journal entry, P&L Account, Balance Sheet (concepts only).	Break-even chart demo with graph on board; Flashcards of accounting terms	CO5
35	Marketing Management – I	Marketing and its role in business; Overview of marketing management and key techniques (only concepts).	Group activity: Identify how local businesses use marketing strategies	CO5
36	Marketing Management – II	Introduction to 4Ps: Product, Price, Place, Promotion – with simple real-life product example.	Discuss 4Ps for a popular product like Parle-G; Group makes their own product's 4P plan	CO5
37	Human Resource Management	Functions of HRM; Manpower planning; Recruitment & selection process; Introduction to training, testing, and payment methods.	Role-play on recruitment; Create flowchart for training and development process	CO5

Unit 6: Leadership and Motivation (Total Class: 6)				
Class No.	Topic	Subtopic	Teaching Aids / Activities	Course Objective
38	Leadership – Basics	Definition, need & importance of leadership, functions and qualities of a leader	PPT with leader profiles (e.g., Ratan Tata, A.P.J. Abdul Kalam); group discussion – “Who is a good leader and why?”	CO6
39	Manager vs. Leader & Styles	Difference between manager and leader; Leadership styles – Autocratic, Democratic, Participative	Role play activity for each style; chart comparison of manager vs. leader	CO6
40	Motivation – Concept	Definition, characteristics, and importance of motivation	Short video or TED Talk; motivational quotes match game	CO6
41	Factors & Theories	Factors affecting motivation (internal/external); Maslow's Hierarchy of Needs theory	Pyramid drawing activity (Maslow's model); identify student motivation case examples	CO6
42	Improving Motivation	Methods to improve motivation – recognition, incentives, communication, working conditions	Group brainstorming – “How can we motivate students/employees?”; mini case study	CO6

43	Communication in Business	Importance of communication in business; Types (verbal/non-verbal/formal/informal); Barriers to effective communication	Classroom game "Chinese Whisper" for barriers; draw and explain communication cycle; real-world communication breakdown	CO6
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Unit 7: Work Culture, TQM & Safety (Total Classes: 5)				
Class No.	Topic	Subtopic	Teaching Aids / Activities	Course Objective
44	Work Culture	Human relationships and performance: Importance of teamwork, attitude, and organizational behavior in building a positive work environment.	Brainstorm examples of good vs. bad workplace behavior; role play on team communication.	CO7
45	Workplace Relations	Maintaining effective relationships with peers, superiors, and subordinates; professional communication and mutual respect.	Chart: Do's and Don'ts in communication with different levels; mock scenarios in class for practice.	CO7
46	Total Quality Management	Concepts of TQM – Quality policy, quality management principles (customer focus, continuous improvement), quality systems (ISO, audits).	Draw TQM wheel on board; case study on TQM in a successful company; class Q&A.	CO8
47	Workplace Safety	Causes of workplace accidents, preventive measures, and importance of safety training and awareness in an industrial setup.	Short video/slide on industrial accidents; student discussion on how they could've been prevented.	CO9
48	PPE and Safety Rules	Importance of PPE (helmet, gloves, safety shoes, goggles); general safety rules in workshops and industries.	Display real/dummy PPE items or images; students list and present one safety rule each.	CO9

Unit 8: Legislation (Total Classes: 6)				
Class No.	Topic	Subtopic	Teaching Aids / Activities	Course Objective
49	Introduction to IPR	Definition of Intellectual Property; importance in protecting innovation; overview of IPR types.	Display simple real-world examples (e.g., logo, product designs); video or image slides on IPR.	CO2
50	Patents	What is a patent? Procedure for filing; criteria (novelty, usefulness); term of protection; examples of patents.	Roleplay: Student "invents" something and explains why it should be patented; discussion.	CO2
51	Trademarks and Copyrights	Definitions and examples; how trademarks protect brand identity; how copyrights protect creative work; symbols (™ © ®).	Class discussion on local brands/logos and their trademarks; write a short paragraph and discuss copyright.	CO2
52	Factories Act, 1948	Salient features: working hours, health and safety, welfare measures, restrictions on employment of young persons and women.	PPT with key clauses; match-the-column or quiz on rights & duties under the Act.	CO9
53	Payment of Wages Act, 1936	Salient features: timely payment, permissible deductions, authorities involved, grievance handling.	Case study or newspaper clipping discussion; group activity: "Be the employer – follow the Act".	CO9

54	Wrap-up and Application	Summary of key legislation and IPR; practical implications for entrepreneurs; how to legally safeguard a startup or product.	Create a checklist for legal compliance when starting a business; Q&A or quiz game.	CO2, CO9
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Unit 9: Smart Technology (Total Classes: 6)				
Class No.	Topic	Subtopics Covered	Teaching Aids / Activities	Course Objective
55	Introduction to IoT	Concept and definition of IoT (Internet of Things), brief history and evolution, basic architecture	Real-life analogy (smartphone as an IoT hub), introductory video, class brainstorming "Where do we see IoT around us?"	CO10
56	How IoT Works	Explanation of working – sensors, network, data processing, user interface; real-time communication and control	Animated PPT flowchart of IoT working; activity: Match the step (sensor–processing–action) to a real device like smart bulbs	CO10
57	Components of IoT	Sensors/actuators, connectivity, data processing unit, cloud storage, user interface	Show physical devices/components if available; or image-based explanation; student groups label block diagram of IoT system	CO10
58	Characteristics & Categories of IoT	Characteristics: connectivity, efficiency, automation, integration, scalability, intelligence Categories: Consumer, Industrial, Commercial, Infrastructure	Table activity: Identify and categorize devices (e.g., smartwatch, industrial robot); discussion on "What makes IoT smart?"	CO10
59	Applications of IoT – Part 1	Smart Cities, Smart Transportation, Smart Homes	PPT with real-world case studies; interactive map showing smart traffic systems; demo videos of Alexa/smart switches	CO10
60	Applications of IoT – Part 2	Smart Healthcare, Smart Industry, Smart Agriculture, Smart Energy Management	Poster-making group activity on any one application; YouTube video snippets showing IoT in farms, hospitals, factories	CO10

Signature of the Faculty

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H.O.D.

Dept. of Mechanical Engg.
Govt. Polytechnic Bolangir

GOVT. POLYTECHNIC BALANGIR**Department of Mechanical Engineering****LESSON PLAN: 2025-26****Name of the Faculty: Paresh Kumar Mishra (Lecture Stage-I)****Subject: DESIGN OF MACHINE ELEMENTS (Th. 2)**

Program: Diploma in Mechanical Engineering

Semester: 5th

Total Contact Hours: 60

Total Marks: 100

Assessment: Progressive –20, End Term – 80

Credits: 4

COURSE OBJECTIVES:

At the end of the course the students will be able to

1. Understanding the behaviours of material and their uses.
2. Understanding the design of various fastening elements and their industrial uses.
3. Understanding the different failures of design elements.
4. Understanding the change of design to accomplish the different field of applications.
5. Design shafts, keys, couplings required for power transmits Design closed coil helical spring

Unit I – Introduction (Design of Machine Elements) (Total Classes: 12)

Class No.	Topic	Subtopic	Teaching Aids/Activities	Course Objective
1	Introduction to Machine Design	Meaning of machine design, its purpose in engineering; classification into adaptive, developmental, and creative design	Real-life product demo, chalkboard explanation	CO1
2	Design Materials	Types of engineering materials: metals, polymers, ceramics, composites; criteria for selection	Samples of materials, classification chart	CO1
3	Material Properties	Explanation of physical and mechanical properties: strength, ductility, hardness, resilience, etc.	Posters showing property curves, real object demos	CO1
4	Stress Terms	Definitions and comparison of stresses: working stress, yield stress, ultimate stress, factor of safety	Numerical problems, visual stress models	CO1
5	Stress-Strain Curve (MS)	Complete stress-strain diagram of mild steel: elastic limit, yield point, ultimate strength, breaking point	Stress-strain chart, projected graph animation	CO1
6	Stress-Strain Curve (CI)	Stress-strain behaviour of cast iron compared to mild steel, brittle vs. ductile failure	Side-by-side graph comparison, material test videos	CO1
7	Modes of Failure	Elastic deformation, yielding, brittle fracture, fatigue, creep	Animated clips showing failure, failure part models	CO3
8	Types of Loading	Static, dynamic, impact, fluctuating loads and their effects on failure modes	Diagrams showing loading conditions, simple load experiment	CO3
9	Design Considerations	Factors affecting design: load conditions, service life, manufacturability, aesthetics, cost	Industrial case examples (gear/shaft design discussion)	CO4
10	Selection of Materials	Factors for material selection: strength, corrosion resistance, cost, availability, etc.	Group discussion on selecting material for a fan blade or bike frame	CO4

11	Machine Design Procedure	General steps: problem identification, need analysis, synthesis, modeling, analysis, optimization, testing	Flowchart of design process, simplified real-world example	CO4
12	Revision and Assessment	Recap of full unit through Q&A, MCQ quiz, and discussion on real-world applications	Quiz activity, group discussion, design-thinking recap	CO1, CO3, CO4

Unit II – Design of Fastening Elements (Total Classes: 12)

Class No.	Topic	Subtopic	Teaching Aids/Activities	Course Objective
13	Introduction to Joints	Definition and need of joints in machine design; classification: permanent (welded/riveted) and temporary (bolted/pinned)	Chart of joint types, physical demo of bolted vs welded joint	CO2
14	Welded Joints	Types: butt, lap, fillet, corner, edge joints; symbols as per BIS	Welding symbol charts, welded metal samples	CO2
15	Advantages of Welded Joints	Over riveted and bolted joints: better appearance, lighter, less stress concentration, ease of fabrication	Comparison table, classroom discussion	CO2
16	Design of Welded Joint	Concepts of direct and eccentric loading; calculating throat thickness, weld length, moment arm; weld sizing	Numerical example using diagram on board	CO2
17	Riveted Joints & Rivets	Types of riveted joints (lap, butt, single/double); rivet heads (snap, pan, countersunk); applications	Sample riveted plates, rivet head models	CO2
18	Failure of Riveted Joints	Modes: tearing of plate, shearing of rivet, crushing of rivet; failure paths in chain/zig-zag joints	Diagrams and failure models (paper rivet experiment)	CO2
19	Strength & Efficiency	Strength of joint based on weakest failure mode; joint efficiency = (strength of joint / strength of solid plate) × 100	Board derivation, example with numerical data	CO2
20	Riveted Joint Design	Design principles for pressure vessels: diameter & pitch of rivet, plate thickness, margin; BIS standards	Solve a design problem using a vessel diagram	CO2
21	Numerical: Welded Joint	Solve numerical problems on eccentric loading in welded joints; calculate throat thickness, size of weld	Numerical worksheet, step-by-step problem solving	CO2
22	Numerical: Riveted Joint	Numerical problems on riveted joints: strength calculation, efficiency, pitch, margin, failure check	Practice problems, group activity with peer checking	CO2
23	Revision & Application	Summary of all types of fastening elements; real-world examples like bridges, boilers, automotive frames	Case studies, joint design analysis from engineering field	CO2
24	Class Test/Assignment	Conduct assessment with design-based and numerical questions on welded and riveted joints	Test paper, viva discussion, reinforcement activity	CO2

Design of Shafts and Keys (Total Classes = 12)

Class No.	Topic	Subtopic (with elaboration)	Teaching Aids/Activities	Course Objective
25	Design of shafts and keys	Functions of shafts in mechanical systems, e.g., transmitting torque, supporting rotating parts, etc.	Real examples of shafts from lab or machines, photos, videos	CO5
26	Materials for shafts	Discuss commonly used shaft materials like mild steel, alloy steel, carbon steel. Compare their mechanical properties and cost.	Chart showing properties of shaft materials	CO5
27	Design of shafts (strength)	Design of solid and hollow shafts using shear stress and combined bending and tension stress equations.	Whiteboard derivations, sample problems, problem-solving worksheet	CO5

28	Design of shafts (rigidity)	Angle of twist, torsional deflection, modulus of rigidity, and related formulas. Conditions for rigidity-based design.	Torsion shaft setup demonstration or simulation	CO5
29	Standard shaft sizes	Introduce IS standards related to standard diameters and tolerances of shafts.	IS code sample or PDF, shaft catalogues	CO5
30	Keys: function and types	Purpose of keys, types like sunk, saddle, tangent, splines. Materials used for different key types.	Display of various keys, actual samples from workshop	CO5
31	Failure and keyway effect	Shear and crushing failure of keys, weakening of shaft due to keyway, stress concentration issues.	Failure charts, shaft-key assemblies, animations of failure modes	CO5
32	Design of sunk key (theory)	Design for strength using shear and crushing failure theories. Assumptions in design.	Formula derivation and example calculation	CO5
33	Design using empirical formula	Empirical relation for key length: $l = (1.5 \text{ to } 2)d$; application for fast key sizing in industry.	Design chart, empirical formula tables, practice sheet	CO5
34	IS specification of keys	Standard dimensions, designation of keys: parallel key, gib-head key, taper key. Reading specifications from IS code.	IS chart and catalog, measuring tools demonstration	CO5
35	Numerical on shaft design	Solved problems involving shaft design based on strength and rigidity. Power transmission at given RPM.	Whiteboard calculations, assignments	CO5
36	Numerical on key design	Solved examples on design of rectangular sunk key for given shaft torque. Verification against failure criteria.	Worksheets, group activity on numerical problems	CO5

Unit5: Design of Coupling (Total Classes: 12)

Class No.	Topic	Subtopic (with elaboration)	Teaching Aids/Activities	Course Objective
37	Design of Shaft Coupling	Introduction to shaft couplings. Their necessity in transmitting power between shafts, maintaining alignment, and absorbing shocks and vibrations.	Physical demo of couplings, machine animations	CO5
38	Requirements of good coupling	Discuss functional, mechanical, and economic requirements — alignment, ease of assembly/disassembly, maintenance, cost, and strength.	Chalkboard discussion, posters showing good vs. bad coupling examples	CO5
39	Types of Coupling	Rigid (sleeve, clamp, flange) and flexible (Oldham, universal joint, etc.) couplings. Compare their applications and suitability.	Real samples, models or cut-sections of different coupling types	CO5
40	Sleeve/Muff Coupling: intro & construction	Constructional features, operation principle. Application in aligned shafts. Load transfer via key.	Cross-sectional diagrams, exploded view animation	CO5
41	Design of Sleeve/Muff Coupling	Design procedure: Torque transmission, sleeve dimensions, key dimensions, and materials.	Step-by-step design derivation on board, real-case example	CO5
42	Clamp Coupling: intro & construction	Construction and function of clamp or split-muff coupling. Bolted connection for easy assembly and disassembly.	Physical coupling sample, lab videos	CO5
43	Design of Clamp Coupling	Design calculations involving bolts, sleeve, key, and shaft. Consideration of crushing and shear stresses.	Example problems, simplified bolt design exercise	CO5
44	Numerical on Coupling Design – 1	Solve a numerical on muff coupling for given power, RPM, and material properties. Design sleeve and key.	Worksheet with a solved example	CO5

45	Numerical on Coupling Design – 2	Solve a numerical on clamp coupling — including bolt design and torque transmission. Evaluate safety against failure.	Assignment for students, collaborative peer-solving session	CO5
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Design of a Closed Coil Helical Spring (Total Classes: 12)

Class No.	Topic	Subtopic	Teaching Aids/Activities	Course Objective
49	Design a closed coil helical spring	Introduction to spring design, types and importance of springs in mechanical systems	Physical models of various springs, charts showing applications	CO5
50	Materials used for helical spring	Discuss spring materials like high-carbon steel, stainless steel, and their selection criteria	Sample material swatches, comparison table of properties	CO5
51	Standard size spring wire (SWG)	Explain Standard Wire Gauge (SWG), use charts to relate SWG to wire diameter	SWG chart, real spring wire samples	CO5
52	Terms used in compression spring	Define free length, solid length, pitch, spring index, coil diameter etc.	Chart showing spring terminology, labelled diagrams	CO5
53	Stress in helical spring	Torsional shear stress, direct shear stress, Wahl's factor for stress correction	Formula derivation on board, numerical example demonstration	CO5
54	Deflection of helical spring	Deflection formula derivation and factors affecting deflection	Graph of deflection vs. load, animation showing spring compression	CO5
55	Deflection of helical spring (Contd.)	Solve numerical problems on deflection using given parameters	Practice worksheet, calculator-based session	CO5
56	Surge in spring	Explain surge phenomenon, resonance in springs, ways to reduce surge	Video demonstration of spring vibration, example of dampers	CO5
57	Design procedure summary	Combine stress and deflection formulas into design methodology	Step-by-step design flowchart, board explanation	CO5
58	Numerical Problem – I	Solve a design problem involving given load, number of coils, material etc.	Problem solving with board and group participation	CO5
59	Numerical Problem – II	Solve another practical design problem (variation in spring index or material)	Group worksheet, discussion of alternate solutions	CO5
60	Revision and Class Test	Recap of spring design concepts, brief quiz or class test	Question paper handout, oral quiz round	CO5

Signature of the Faculty

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Dept. of Mechanical Engg.
Govt. Polytechnic Bolangir

GOVT. POLYTECHNIC BALANGIR**Department of Mechanical Engineering****LESSON PLAN: 2025-26**

Name of the Faculty: Paresh Kumar Mishra (Lecture Stage-I)
& Rasmiranjan Jena (Lecture Stage-I)

Subject: HYDRAULIC MACHINES & INDUSTRIAL FLUID POWER (Th. 3)

Program: Diploma in Mechanical Engineering

Semester: 5th

Total Contact Hours: 60

Total Marks: 100

Assessment: Progressive –20, End Term – 80

Credits: 4

COURSE OBJECTIVES:

At the end of the course the students will be able to

1. Distinguish the working principle of pumps and turbines
2. Explain the working of centrifugal pumps and gear pumps.
3. Compare pneumatic system with hydraulic system.
4. Draw pneumatic circuits for industrial application.
5. State the properties of hydraulic system.
6. Develop hydraulic circuit for machine tool operation.

Unit 1: Hydraulic Turbines (Total Classes: 15)

Class No.	Topic	Subtopic (with elaboration)	Teaching Aids/Activities	Course Objective
1	Hydraulic Turbines	Definition of turbine; classification into impulse and reaction turbines based on energy conversion and operating principle	Diagram charts, turbine models, videos of impulse and reaction turbines	CO1
2	Impulse Turbine	Construction of Pelton turbine; description of nozzle, runner, buckets, casing, braking jet	Animated diagrams, labeled 3D models, cross-sectional videos	CO1
3	Impulse Turbine	Working principle of Pelton wheel – high-velocity jet impact, energy conversion process, water exit	Simulation video, whiteboard drawing explanation	CO1
4	Impulse Turbine	Velocity diagram of Pelton wheel – inlet/outlet velocity triangles; derive formula for work done	Step-by-step derivation using whiteboard or slide deck	CO1
5	Impulse Turbine	Derivation of hydraulic efficiency, mechanical efficiency, overall efficiency	Formula chart, efficiency comparison table	CO1
6	Francis Turbine	Construction of Francis turbine – spiral casing, guide vanes, runner, draft tube; axial and radial flow	Cutaway model, diagrams from textbooks, schematic animation	CO1
7	Francis Turbine	Working principle of reaction turbines; energy conversion due to both pressure and velocity head	Slow-motion animation of internal water flow in Francis turbine	CO1
8	Francis Turbine	Velocity diagram; derivation of work done and expressions for efficiencies	Derivation steps on board/slides, problem-solving session	CO1
9	Kaplan Turbine	Construction of Kaplan turbine – axial flow type; adjustable runner blades	Kaplan turbine animation, physical demo model	CO1

10	Kaplan Turbine	Velocity diagram and derivation of work done and efficiencies	Handout of velocity triangles, guided derivation session	CO1
11	Numerical Problems	Numerical problems on Pelton, Francis, Kaplan turbines – calculating power, efficiency, and blade angles	Problem worksheet, calculator use, class discussion	CO1
12	Numerical Problems	Continued problem solving on turbine design parameters, efficiency calculations, and discharge	Chalk and board, interactive peer solving	CO1
13	Comparison	Comparison between impulse and reaction turbines – working medium, pressure variation, installation, efficiency, cost	Comparative chart, table, Q&A session	CO1
14	Review & Recap	Summary of construction, working, and velocity diagrams of turbines	Mind map creation, flashcards, quiz	CO1
15	Assessment	Class test covering theory and numerical from Unit 1	Written test and evaluation	CO1

Unit 2: Centrifugal Pumps (Total Classes: 5)

Class No.	Topic	Subtopic (with elaboration)	Teaching Aids/Activities	Course Objective
16	Centrifugal Pumps	Construction of centrifugal pumps: Impeller, casing, suction pipe with foot valve, and delivery pipe – arrangement and material selection.	Diagrammatic explanation using charts, cut-section model, and videos	CO2
17	Centrifugal Pumps	Working principle: Conversion of mechanical energy to pressure energy by centrifugal force. Water enters the eye of impeller and thrown out by centrifugal action.	Animated working video, real-life demonstration (if lab available)	CO2
18	Centrifugal Pumps	Work done by impeller: Derivation of expression for work done on water by the impeller using velocity triangles at inlet and outlet.	Derivation on board with step-by-step velocity diagrams	CO2
19	Centrifugal Pumps	Efficiencies: Definition and formula of manometric efficiency, mechanical efficiency, and overall efficiency with related explanation.	Numerical formulas displayed via chart/slide, explanation of how they are measured	CO2
20	Centrifugal Pumps	Numerical on above topics: Problems based on work done, head developed, and efficiencies of centrifugal pumps.	Solve sample problems with class interaction and board discussion	CO2

Unit 3: Reciprocating Pumps (Total Classes: 5)

Class No.	Topic	Subtopic (with elaboration)	Teaching Aids/Activities	Course Objective
21	Reciprocating Pumps	Single Acting Reciprocating Pump: Construction (cylinder, piston, crank, valves) and working – suction and delivery strokes explained.	Pump cut-section diagram, animation showing strokes	CO2
22	Reciprocating Pumps	Double Acting Reciprocating Pump: Construction and working – continuous flow achieved; comparison with single acting.	Animated video showing both pumps; comparison chart	CO2

23	Reciprocating Pumps	Power Required Derivation: Step-by-step derivation of power formula for single and double acting pumps (using $Q = ALN$, $Work = P \times Q$).	Derivation on board with formulas, interactive Q&A	CO2
24	Reciprocating Pumps	Slip in Pumps: Definition of slip, positive and negative slip; derivation of relation between slip and coefficient of discharge.	Graphical explanation with charts, real-life examples	CO2
25	Reciprocating Pumps	Numerical Problems: Solve problems based on discharge, slip, and power calculations for single and double acting pumps.	Sample problems on board, peer solving in pairs, worksheet provided	CO2

Unit 4: Pneumatic Control System (Total Classes: 15)

Class No.	Topic	Subtopic (with Elaboration)	Teaching Aids/Activities	Course Objective
26	Pneumatic Elements	FRL Unit (Filter-Regulator-Lubricator): Construction, working, function of each element in pneumatic system	Actual FRL unit demo or model, diagram explanation	CO3
27	Pressure Control Valves	Introduction to Pressure Valves; Classification and need	Chart showing types, video demonstration	CO3
28	Pressure Relief Valve	Pressure Relief Valve: Working principle, function in limiting pressure in system	Cut section diagram, animation of PRV operation	CO3
29	Pressure Regulating Valve	Pressure Regulation Valve: Types, working, difference from relief valve	Real-life applications and symbolic representation	CO3
30	Direction Control Valves	Intro to DCVs and 3/2 DCV: Construction, spool position, normal open/close explanation	Physical valve demo, animations of DCV operation	CO3
31	Direction Control Valves	5/2 and 5/3 DCV: Functionality, applications, operation with actuators	Symbol diagrams, videos of applications	CO3
32	Flow Control Valves	Flow Control Valve: Working principle, use in regulating actuator speed	Real valve demo, schematic symbols	CO3
33	Throttle Valves	Throttle Valve vs Flow Control Valve, working, application in speed regulation	Comparative chart, industrial video clip	CO3
34	ISO Symbols	Standard Symbols of FRL unit, DCV, cylinders, flow valves, throttle, etc.	Handout of ISO symbols chart, symbol sketching quiz	CO4
35	Pneumatic Circuits	Direct Control of Single Acting Cylinder: Basic circuit diagram, sequence of operation	Circuit diagram drawing, animation or simulation on software	CO4
36	Pneumatic Circuits	Operation of Double Acting Cylinder: Control circuit diagram, switching, advantages	Group circuit drawing activity, mini project demo	CO4
37	Pneumatic Circuits	Metering-in Control of Double Acting Cylinder: Flow restriction at inlet side, impact on speed	Valve setup simulation, practical experiment if kit available	CO4
38	Pneumatic Circuits	Metering-out Control of Double Acting Cylinder: Restriction at outlet, difference from metering-in	Comparison chart, animated simulation	CO4
39	Practice Class	Symbol Practice & Circuit Drawing Revision: Students draw circuits and symbols independently	Whiteboard practice, peer review of diagrams	CO4

40	Problem Solving Class	Troubleshooting & Quiz on Pneumatic Circuits and Valves	Group quiz, sample troubleshooting circuit-based questions	CO3, CO4
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Unit 5: HYDRAULIC CONTROL SYSTEM (Total Classes: 20)

Class No.	Topic	Subtopic (with Elaboration)	Teaching Aids/Activities	Course Objective
41	Hydraulic systems	Introduction to hydraulic systems, their constructional features, basic components, and significance in fluid power applications.	Chart showing layout of hydraulic system	CO5
42	Advantages & disadvantages	Discuss the merits like high force-to-size ratio, smooth operation, and demerits like leakage and maintenance challenges in hydraulic systems.	Comparative table, Whiteboard discussion	CO5
43	Hydraulic accumulators	Working principle and function of accumulators in energy storage, shock absorption, and pressure maintenance in hydraulic circuits.	2D diagrams, cut-section animation	CO5
44	Pressure control valves	Concept and classification of pressure control valves. Explain their purpose in maintaining desired system pressure.	Actual valve sample, board explanation	CO5
45	Pressure relief valves	Function and working of pressure relief valves to protect hydraulic systems from overpressure.	Demo model or animation	CO5
46	Pressure regulation valves	Explain the use of pressure regulation valves for maintaining constant pressure regardless of flow changes.	Charts, simulation using animation	CO5
47	Direction control valves	Explain working principles of 3/2, 5/2, and 5/3 Direction Control Valves (DCVs), applications in actuator control.	Cut section demo, ISO symbolic drawing practice	CO5
48	Flow and throttle valves	Explain the need and function of flow control and throttle valves to manage speed and actuator response.	Flow control valve demonstration	CO5
49	Fluid power pumps	Introduction to types of hydraulic pumps used in systems, their importance in fluid delivery.	Pump cut models, comparison charts	CO5
50	Gear pumps	Construction, working of external and internal gear pumps, efficiency, and applications.	Internal & external gear pump diagrams	CO5
51	Vane pumps	Explain working of vane-type hydraulic pumps with rotating vanes used for consistent flow and low noise.	Animated video showing vane movement	CO5
52	Radial piston pumps	Discuss radial piston pumps, their advantages in high-pressure applications.	Cross-sectional diagram, pump specifications chart	CO5
53	ISO symbols	Interpret and draw standard ISO symbols of various hydraulic components like pumps, valves, actuators, and tanks.	Worksheet activity – "Name that Symbol"	CO5
54	Actuators	Define actuators and explain different types such as single-acting and double-acting cylinders used for mechanical output.	Pneumatic actuator cut-section video	CO5

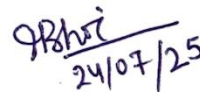
55	Direct control circuit	Demonstrate simple hydraulic circuit involving direct control of a single acting cylinder.	Circuit simulation in Fluidsim or animation	CO6
56	Double acting cylinder operation	Show circuit and explanation for operation of double acting cylinders using directional valves.	Working circuit diagram and live drawing	CO6
57	Metering-in circuit	Operation of double acting cylinder with metering-in control to regulate inflow and speed of piston.	Circuit animation showing meter-in configuration	CO6
58	Metering-out circuit	Operation of double acting cylinder with metering-out control to regulate outflow, enhance control of piston movement.	Fluidsim demo of metering-out circuit	CO6
59	Comparison of systems	Discuss key differences between pneumatic and hydraulic systems in terms of pressure, application, components, safety, and cost.	Comparative chart activity	CO3, CO5
60	Review & practice	Quick recap of major topics and demonstration of circuits, followed by student activity to interpret and explain real-life examples.	Class quiz, group problem solving, symbol game	CO5, CO6



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GOVT. POLYTECHNIC BALANGIR**Department of Mechanical Engineering****LESSON PLAN: 2025-26****Name of the Faculty: Paresh Kumar Mishra (Lecture Stage-I)****Subject: MECHATRONICS (Th. 4)**

Program: Diploma in Mechanical Engineering

Semester: 5th

Total Contact Hours: 60

Total Marks: 100

Assessment: Progressive –20, End Term – 80

Credits: 4

COURSE OBJECTIVES:

At the end of the course the students will be able to

1. To study the definition and elements of mechatronics system.
2. To learn how to apply the principle of mechatronics for the development of productive systems.
3. To learn the CNC technology and applications of mechatronics in manufacturing automation.
4. Define different type of system and Sensors and solve the simple problems.
5. Explain the concept of Mechanical actuation, Electrical actuation and solve the simple problems.
6. Find out the various types of System Models & Input /Output parts and solve the problems.
7. Describe the programmable Logic Controller and develop programme in PLC. 8. To learn the Industrial robotics

Unit 1: Introduction to Mechatronics (Total Classes: 5)

Class No.	Topic	Subtopic (Elaborated)	Teaching Aids / Activities	Course Objective
1	Meaning and Definition of Mechatronics	Explain Mechatronics as a multidisciplinary field integrating mechanical, electrical, electronics, and computer systems for automation. Discuss how systems interact.	PPT with definition, block diagram of mechatronic system, examples (ABS, ATMs)	CO1
2	Advantages and Disadvantages	Discuss benefits like improved performance, reliability, accuracy, and compactness. Cover limitations such as high cost, complexity in repair, and training requirements.	Whiteboard discussion, comparative table (Traditional vs. Mechatronic systems)	CO1
3	Applications in Daily Life	Cover real-world uses: automotive systems (airbags, ABS), medical (MRI machines), consumer electronics (washing machines), and defense (guided missiles, drones).	Video demonstration, object-based learning using home appliances	CO1
4	Scope in Industrial Sector	Describe the role of mechatronics in smart manufacturing, Industry 4.0, robotics, CNC machines, and automated inspection systems.	Case study of automation in car manufacturing; factory automation videos	CO1
5	Components and Role in Automation	Discuss basic components: sensors, actuators, controllers, software. Explain their coordination in automatic systems and the importance of feedback loops in automation.	Block diagram drawing activity; class interaction on "what automates a system?"	CO1

Unit 2 – Sensors and Transducers (Total Classes: 10)

Class No.	Topic	Subtopic with Elaboration	Teaching Aids / Activities	Course Objective
6	Introduction to Transducers	Define transducers as devices that convert one form of energy into another. Differentiate between sensors (input) and actuators (output). Discuss real-life examples.	PPT, real object demo (e.g., microphone, thermometer), sensor-actuator analogy chart	CO2
7	Classification of Transducers	Discuss types: active vs. passive, analog vs. digital, contact vs. non-contact. Explain the basis of classification using examples like thermocouple, LVDT, and proximity sensor.	Chart activity showing types, group discussion on advantages of each class, classification flowchart	CO2
8	Electromechanical Transducers	Explain how electromechanical transducers convert electrical energy into mechanical or vice versa. Use examples like LVDT, strain gauge, and piezoelectric sensors.	Animated diagram of LVDT working, YouTube demo video of strain gauge in use	CO2
9	Actuating Mechanisms	Cover types of actuators: hydraulic, pneumatic, electrical. Discuss how actuators work in automation and the concept of control signals and mechanical motion.	Physical demo of solenoid, video on pneumatic actuator, classroom sketching of actuation loop	CO2
10	Displacement Sensors	Discuss sensors used for linear and angular displacement: LVDT, potentiometer, optical encoder. Explain their construction, working, and output characteristics.	Potentiometer with multimeter activity, simulation of encoder in software or video	CO2
11	Position Sensors	Differentiate displacement vs. position sensing. Explain use of proximity sensors (inductive, capacitive, optical) in automation.	Real-life demonstration of IR sensor, object-detection experiment with Arduino (if available)	CO2
12	Velocity and Motion Sensors	Explain tachometers, encoder-based velocity sensors. Include velocity measurement in rotating and linear systems. Discuss real-time applications.	Speed sensor demo in bike/vehicle, animation on encoder speed sensing	CO2
13	Force Sensors	Introduce strain gauge, load cell working. Explain Wheatstone bridge concept and how force gets converted into an electrical signal.	Lab setup video or digital load cell demonstration, circuit diagram explanation	CO2
14	Pressure Sensors	Explain diaphragm-based, piezoelectric, and capacitive pressure sensors. Show how pressure is sensed and converted into signal for display/control.	Real-world examples (tyre pressure sensor), PPT slides with cross-sectional view of pressure sensors	CO2
15	Temperature and Light Sensors	Discuss thermocouples, RTD, thermistors, and LDRs. Explain working principles and their use in industry and homes (e.g., HVAC, smart lighting).	Live demo: LDR & torch, temperature sensor with hot object, digital thermometer display	CO2

Unit 3: Actuators – Mechanical, Electrical (Total Classes: 10)				
Class No.	Topic	Subtopic (with elaboration)	Teaching Aids/Activities	Course Objective
16	Mechanical Actuators	Introduction to machine elements; definition of machine, kinematic link and pair with examples	Diagrammatic explanation using board and mechanical components	CO5
17	Mechanical Actuators	Mechanism: slider-crank mechanism and its application in engines and actuators	3D model or animation of slider-crank mechanism	CO5
18	Mechanical Actuators	Gear drives: working of spur, bevel, helical, and worm gears; torque and speed relations	Physical gear models or animated gear simulation	CO5
19	Mechanical Actuators	Belt and belt drive types: flat, V-belt, timing belt; advantages and applications	Belt drive kits and videos showing real-world usage	CO5
20	Mechanical Actuators	Bearings: types like ball, roller, and sleeve; function and usage in rotating systems	Real bearing samples and exploded mechanical diagrams	CO5
21	Electrical Actuators	Switches and relays: construction, operation, and industrial use	Actual components, relay logic demos, switch circuit	CO5
22	Electrical Actuators	Solenoids: working principle, construction, and application in automation	Animated video and practical solenoid demo	CO5
23	Electrical Actuators	DC and AC motors: types, construction, and working with industrial examples	Chart comparison, motor cut section, videos	CO5
24	Electrical Actuators	Stepper motors: principle, construction, step angle, and applications	Stepper motor kits, video showing motion control	CO5
25	Electrical Actuators	Servo motors (DC & AC): working principle, feedback control, and applications	Control setup demonstration using Arduino/PLC	CO5

Unit 4: Programmable Logic Controllers (PLC) –(15 Classes)				
Class No.	Topic	Subtopics with Elaboration	Teaching Aids/Activities	Course Objective
26	Introduction	What is a PLC, its history, need in automation, basic role	Video on PLC evolution and real-time use cases	CO6
27	Advantages of PLC	Over conventional relay-based systems: flexibility, speed, diagnostics	Comparative diagram of relay vs PLC systems	CO6
28	Selection of PLC	Criteria: I/O needs, memory, processor, environment, cost	Case-based classroom activity: Choose a PLC for a mini project	CO6
29	Applications of PLC	Common uses: manufacturing, conveyor, elevator, bottling plant	Case studies with YouTube examples of PLC in action	CO6
30	Architecture of PLC	Basic block diagram, internal structure: CPU, memory, power supply	Use cutaway models or animated block diagrams	CO6
31	Internal working	Scan cycle: input scan, logic execution, output scan, housekeeping	Flowchart explanation, live simulation video	CO6
32	Input Processing	Digital vs analog input types, isolation, wiring diagrams	PLC input module demonstration	CO6

33	Output Processing	Output module types: relay, transistor, triac; examples	Output terminal board model, lab demo	CO6
34	Programming Basics	Ladder logic fundamentals: contacts, coils, rungs	Simulator software (like ZelioSoft or LogixPro) demo	CO6
35	Mnemonics	Standard instructions: LD, AND, OR, OUT, timers and counters	Mnemonic table handout and conversion exercises	CO6
36	Timer Instructions	ON-delay, OFF-delay, retentive timer – Ladder + Mnemonic	Practice timer program in simulator	CO6
37	Counter Instructions	Up/down counters, preset, reset logic	Live simulation activity using ZelioSoft	CO6
38	Master Control	Use of Master control relay (MCR) zone in ladder logic	Sample circuit building on projector with explanations	CO6
39	Jump Instruction	JMP, LBL (Label), and their use in skipping routines	Demo using simple jump logic in software	CO6
40	Revision + Assignment	Recap of full PLC module; problem-solving, debug faulty logic	In-class assignment & group activity	CO6

Unit 5: Elements of CNC Machines (15 Classes)				
Class No.	Topic	Subtopic (with Elaboration)	Teaching Aids / Activities	Course Objective
41	Introduction to NC Machines	Concept of Numerical Control, manual vs automated control, history and development	Chalkboard illustration, animation of old NC machines	CO3
42	CNC Machines	Types of CNC machines (Turning, Milling, EDM), importance in automation	Video demonstration of CNC turning center	CO3
43	CAD/CAM Overview	Introduction to CAD/CAM; integration of design and manufacturing	CAD software demo (AutoCAD/Fusion 360)	CO3
44	CAD Elements	CAD tools, coordinate systems, design-to-manufacture workflow	Live screen demonstration using AutoCAD or Creo	CO3
45	CAM Elements	Introduction to CAM – tool paths, simulation, CNC code generation	CAM toolpath simulation activity	CO3
46	CAD/CAM System Functioning	Hardware (controllers, servers), Software (CAD tools), networking	Real-life system demo or block diagram presentation	CO3
47	Features & Applications of CAD/CAM	Key features like parametric modeling, Application areas: Die making, PCB, Automobile	Real industry application case study	CO3
48	Elements of CNC Machines – Overview	Key components: structure, guideways, drives, spindle	Chart of machine layout and parts	CO6
49	Machine Structure	Bed, column, carriage, mechanical rigidity, base materials	Physical parts demo or photo visuals	CO6
50	Guideways/Slideways	Types – box, linear, dovetail; advantages, accuracy requirements	Comparison table, diagram	CO6
51	Design Factors of Guideways	Friction, load capacity, alignment, wear resistance	Short class quiz/discussion	CO6

52	Drives – Overview	Functions, types of drives: hydraulic, electrical, servo	Schematic diagram of drive system	CO6
53	Spindle Drives & Feed Drives	Motor types, torque-speed characteristics, feed mechanism	Video clip or animation of feed drive working	CO6
54	Spindle and Bearings	Spindle configuration, types of spindle bearings, alignment	Physical sample or cross-section animation	CO6
55	Summary & Application-Based Case	Recap all components with an application in a CNC lathe/mill	Real-world system walk-through, MCQ quiz	CO8

Unit 6: Robotics (Total Classes: 5)

Class No.	Topic	Subtopic (with elaboration)	Teaching Aids/Activities	Course Objective
56	6.1 Definition, Function and Laws of Robotics	Define robot; explain basic functions (manipulation, sensing, control); Discuss the Three Laws of Robotics by Isaac Asimov and their relevance.	Video of industrial robots performing tasks, Chart with laws of robotics	CO8
57	6.2 Types of Industrial Robots	Classify robots based on configuration: Cartesian, SCARA, Articulated, Cylindrical, Polar etc. Explain with diagrams.	Animated PPT with robot types; real robot model video	CO8
58	6.3 Robotic Systems	Describe subsystems: controller, manipulator, end effector, sensor, power supply. Explain degrees of freedom, work envelope.	Interactive diagram; Sample robotic system layout	CO8
59	6.4 Advantages of Robots	Benefits like precision, speed, safety in hazardous conditions, cost-saving, continuous operation.	Group activity: list advantages of robots in different industries	CO8
60	6.4 Disadvantages of Robots	Limitations: High cost, limited flexibility, unemployment, programming complexity. Real-life limitations in Indian industries.	Classroom debate: “Can robots replace human labor entirely?”	CO8



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GOVT. POLYTECHNIC BALANGIR**Department of Mechanical Engineering****LESSON PLAN: 2025-26****Name of the Faculty: Manabhanjan Bhoi (Lecture Stage-II)****Subject: REFRIGERATION AND AIR CONDITIONING (Th. 5)**

Program: Diploma in Mechanical Engineering

Semester: 5th

Total Contact Hours: 60

Total Marks: 100

Assessment: Progressive –20, End Term – 80

Credits: 4

COURSE OBJECTIVES:

At the end of the course the students will be able to

- 1.Explain the working of open & closed air system of air refrigeration system
- 2.Describe the working and construction of compressor, Condenser, evaporator, expansion valve used for air conditioning and refrigeration.
- 3.Explain Vapor Compression refrigeration system.
- 4.Explain Vapor Absorption refrigeration system.
- 5.Compare different refrigerants properties.
- 6.Describe equipment for air conditioning.
- 7.Explain the cooling load for the given requirement.

Unit 1: Air Refrigeration Cycle (Total Classes: 5)

Class No.	Topic	Subtopic	Teaching Aids/Activities	Course Objective
1	Definition of Refrigeration and Unit of Refrigeration	Define refrigeration. Explain the unit of refrigeration (1 ton = 210 kJ/min), and historical background and importance in various industries.	Chart showing refrigeration applications; Short video of cold storage units	CO1
2	COP & Refrigerating Effect	Explain Coefficient of Performance (COP) with formula and units; Refrigerating Effect – its significance and relation to system efficiency.	Numerical examples on COP and R.E; Conceptual comparison of Heat Engine vs. Refrigerator	CO1
3	Principle of Open Air Refrigeration System	Explain components: compressor, cooler, turbine. Explain working cycle with T-S and P-V diagrams of open system.	PPT with cycle diagrams; Video of aircraft air cooling system	CO1
4	Principle of Closed Air Refrigeration System	Explain closed system with schematic diagram and comparison to open cycle.	Animated flowchart; Comparison table between open and closed systems	CO1
5	Review & Numerical Problems	Solve basic problems on COP and R.E; Recap of open and closed air systems with group quiz.	Whiteboard problem-solving; Group quiz using flash cards	CO1

Unit 2: Simple Vapour Compression Refrigeration System (Total Classes: 10)				
Class No.	Topic	Subtopic (with elaboration)	Teaching Aids/Activities	Course Objective
6	Introduction and Schematic Diagram	Define vapour compression system, discuss major components: compressor, condenser, expansion valve, evaporator. Present schematic diagram.	Diagram on board; Animated working video	CO3
7	Cycle with Dry Saturated Vapour after Compression	Explain dry saturated condition, draw T-s and p-h diagrams, discuss process flow.	Charts of T-s and p-h diagrams; Animated cycle transition	CO3
8	Cycle with Wet Vapour after Compression	Explain wet vapour compression effects, comparison with dry saturated condition.	Group discussion on efficiency implications; Diagram drawing exercise	CO3
9	Cycle with Superheated Vapour after Compression	Define superheating after compression, effect on system performance, visualized using diagrams.	Comparative chart of enthalpy and entropy change	CO3
10	Cycle with Superheated Vapour before Compression	Discuss purpose of superheating before compressor, impact on COP.	Roleplay of cycle using physical cards representing each state	CO3
11	Cycle with Sub-Cooling of Refrigerant	Explain subcooling, benefits in reducing vapourisation loss, increasing refrigerating effect.	Comparison video of system with/without subcooling	CO3
12	Temperature-Entropy Diagram Representation	Illustrate T-s diagrams for each type of cycle, explanation of changes in each process.	T-s diagram worksheet; Projection drawing on board	CO3
13	Pressure-Enthalpy Diagram Representation	Plot p-h diagrams for all variants, explain how enthalpy changes reflect system performance.	p-h chart plotting activity; Reference enthalpy table	CO3
14	Numerical on COP and Mass Flow – Part 1	Solve sample problems on COP and mass flow rate. Reinforce concepts via units and equations.	Numerical worksheet; Whiteboard solving	CO3
15	Numerical on COP and Mass Flow – Part 2 & Recap	Practice numericals in group format. Recap differences in cycle types with table.	Group quiz; Flowchart summary handout	CO3

Unit 3: Vapour Absorption Refrigeration System (Total Classes: 7)				
Class No.	Topic	Subtopic	Teaching Aids/Activities	Course Objective
16	Simple Vapour Absorption Refrigeration System	Define vapour absorption refrigeration; working principle using heat instead of mechanical energy; basic components: generator, absorber, pump, condenser, evaporator.	Chalk diagram on board; Animated video of system flow	CO3
17	Practical Vapour Absorption System	Explain modifications in practical systems (Aqua-Ammonia or Li-Br water system), use of analyzers, rectifiers, etc.	Comparative table between simple & practical systems; Industrial setup video clip	CO3

18	Comparison: Vapour Compression vs. Vapour Absorption	Highlight key differences: energy input, moving parts, COP, maintenance.	Venn diagram on board; Group discussion on real-world applications	CO3
19	COP of Ideal Vapour Absorption System – Concept	Introduce coefficient of performance (COP), derive COP for ideal absorption cycle using energy balance.	Derivation steps on board; COP formula card distribution	CO3
20	COP of Ideal Vapour Absorption System – Graphical Representation	Explain COP variation using T-s diagrams and system behavior. Compare with compression cycle.	T-s diagram on projector; Chart showing COP vs. temperature	CO3
21	Numerical on COP – Part 1	Solve numericals based on enthalpy and heat balance. Emphasize units and application of formula.	Worksheet; Group solving exercise	CO3
22	Numerical on COP – Part 2 & Recap	More practice problems; summarize the working of absorption systems and compare with compression.	Summary chart; Cycle flashcards; Quiz	CO3

Unit 4: Refrigeration Equipments (Total Classes: 8)				
Class No.	Topic	Subtopic	Teaching Aids/Activities	Course Objective
23	Refrigerant Compressors	Principle of working and constructional details of reciprocating and rotary compressors	Board diagram, compressor cut-section video, comparison table	CO3
24	Refrigerant Compressors	Centrifugal compressor – theory only	Animated video of centrifugal action, PPT with labeled diagram	CO3
25	Refrigerant Compressors	Important terms: compression ratio, volumetric efficiency, clearance volume, displacement	Formula sheet, concept-based worksheet, quiz	CO3
26	Refrigerant Compressors	Hermetically and semi-hermetically sealed compressors: construction, differences, applications	Sample images/video, tabular comparison chart	CO3
27	Condensers	Principle of working and constructional details of air-cooled and water-cooled condensers	Board diagram, image of finned tube condenser, demo video	CO3
28	Condensers	Heat rejection ratio: definition, formula, practical implications	Derivation on board, numerical examples	CO3
29	Condensers	Cooling towers and spray ponds: types, function, construction	Chart showing types, photo-based examples, small documentary	CO3
30	Evaporators	Working principle and constructional details, types – bare tube, finned, shell & tube	Diagram, video of shell & tube evaporator, comparison table	CO3

Unit 5 – Refrigerant Flow Controls, Refrigerants & Applications of Refrigerants (Total Classes: 10)				
Class No.	Topic	Subtopic	Teaching Aids/Activities	Course Objective
31	Expansion Valves	Introduction to refrigerant flow control devices. Function and importance of expansion valves in the refrigeration cycle.	Refrigeration system diagram, classroom discussion	CO5

32	Capillary Tube	Working principle of capillary tubes, advantages, disadvantages, and typical applications in domestic refrigeration systems.	Cut-section of capillary tube, flow animation	CO5
33	Automatic Expansion Valve	Construction and working of AEV. Application in constant load systems. Comparison with thermostatic valve.	Schematic diagram, whiteboard explanation	CO5
34	Thermostatic Expansion Valve	Detailed construction and operation using sensing bulb, spring mechanism. Use in variable load systems. Advantages over AEV.	Real/virtual demo, working animation, comparative chart	CO5
35	Classification of Refrigerants	Types of refrigerants – primary/secondary; CFC, HCFC, HFC, natural refrigerants. Classification based on chemical structure and application.	Classification chart, flash cards, brainstorming session	CO5
36	Properties of Refrigerants	Thermodynamic (latent heat, boiling point), physical (density, viscosity), and chemical (toxicity, flammability) properties of ideal refrigerants.	Tabulated comparison, infographic sheet	CO5
37	Common Refrigerants & Codes	Refrigerant nomenclature (R-11, R-12, R-22, R-134a, R-717), substitute refrigerants. Environmental impact (ODP, GWP).	PPT on refrigerant codes, environmental video clip	CO5
38	Applications of Refrigeration – I	Industrial & commercial uses: cold storage, dairy refrigeration, ice plant – working principles and layout.	Case studies, equipment photos, process diagrams	CO5
39	Applications of Refrigeration – II	Domestic applications: water coolers, frost-free refrigerators – system arrangement and working.	Real-life appliance demonstration, video-based walkthrough	CO5
40	Revision & Problem Solving	Quick recap of all subtopics. Numerical questions on refrigerant properties and flow control systems.	Group quiz, problem-solving worksheet, student Q&A	CO5

Unit 6: Psychometrics & Comfort Air Conditioning Systems (Total Classes: 10)

Class No.	Topic	Subtopic	Teaching Aids/Activities	Course Objective
41	Psychometric Terms	Introduction to psychometrics. Definitions: Dry bulb temp, wet bulb temp, dew point, specific humidity, relative humidity, enthalpy, etc.	Chart of terms, thermometers demo, basic psychometric scale chart	CO5
42	Adiabatic Saturation	Concept of adiabatic saturation using evaporative cooling. Applications in desert coolers and cooling towers.	Demo with wet cloth fan setup, schematic diagrams	CO5
43	Psychometric Chart	Construction, layout, and features of a psychometric chart. Explanation of coordinates and how to read various properties.	Large psychometric wall chart, animated overlay demo	CO5
44	Psychometric Processes – I	Sensible heating and cooling: changes in dry bulb temp without change in moisture content. Use of chart to represent processes.	Chart plotting demo, classroom activity to plot SH/SC processes	CO5
45	Psychometric Processes – II	Cooling with dehumidification and heating with humidification. Concept of	Animated moisture removal diagram, plotted processes on chart	CO5

		latent heat and its effect on moisture content.		
46	Psychometric Processes – III	Adiabatic cooling with humidification; total heating and cooling processes; examples in HVAC applications.	Multimedia HVAC animation, chart overlay with process lines	CO5
47	SHF, BPF	Explanation of Sensible Heat Factor and Bypass Factor. Calculations and importance in air conditioning design.	Formula sheet, numerical examples, class problems	CO5
48	Adiabatic Mixing	Concept of adiabatic mixing of two air streams. Use of psychometric chart to find resultant properties.	Demo problem, psychometric chart plotting, animated flow diagrams	CO5
49	Problems on Above	Numerical problems on psychometric processes including SHF, BPF, mixing, and process plotting.	Problem sheet, guided solution walkthrough, student board work	CO5
50	Effective Temp & Comfort Chart	Definition of effective temperature, comfort zone, ASHRAE comfort chart. Factors affecting human comfort: humidity, air velocity, temp.	Comfort chart display, discussion on classroom and office HVAC examples	CO5

Unit 7: Air Conditioning Systems (Total Classes: 10)

Class No.	Topic	Subtopic	Teaching Aids/Activities	Course Objective
51	Introduction to Air Conditioning	Concept of air conditioning, objectives, scope and importance in daily life and industries	Simple intro with examples (home, office AC), short video on HVAC	CO5
52	Factors Affecting Comfort	Physical, physiological and psychological factors – dry bulb temperature, humidity, air velocity, mean radiant temp, activity, clothing etc.	Comfort condition demo (fan speed/temp setting), class interaction	CO5
53	Equipment Used in AC	Description and function of: filters, blowers, cooling coils, heating coils, humidifiers, dehumidifiers, ducts, sensors, controllers	Real parts images or videos, model of HVAC system	CO5
54	Classification of AC Systems	Classification based on purpose (comfort, industrial), working (window, split, packaged), and control (manual, automatic)	Chart/table of classifications, photos of systems	CO5
55	Winter Air Conditioning System	Layout and working of a winter air-conditioning system – heating and humidifying the air	Schematic diagram, animated video of airflow process	CO5
56	Summer Air Conditioning System	Layout and working of a summer air-conditioning system – cooling and dehumidifying the air	Flow diagram, animation of cooling cycle	CO5
57	Psychrometric Considerations	Relevance of psychrometry in AC systems: SHF, BPF, RSHF and room conditions analysis	Psychrometric chart use, sample problems	CO5
58	Duct Design and Air Distribution	Basic idea of duct layout, types (rectangular/circular), air flow pattern, velocity and losses in ducts	Duct model or diagram, airflow measurement app demo	CO5
59	Numerical on AC Load	Problems related to sensible/latent heat, total heat load, CFM calculations	Board work on numerals, handout for student practice	CO5

60	Case Study/Review Session	Review of full unit with an industrial or domestic case study of AC system (e.g. office building, hospital, mall)	Case study handout, video tour of large AC installation	CO5
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 Signature of the Faculty


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