

GOVT. POLYTECHNIC BALANGIR

Department of Mechanical Engineering

LESSON PLAN: 2024-25

Name of the Faculty: *Sachidananda Padhi*

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

Signature of the Faculty

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Signature of the HOD