Roll No. | | | | | | | | | | |

B.E / B.Tech (Full Time) DEGREE END SEMESTER EXAMINATIONS, APR / MAY 2025

MECHANICAL ENGINEERING

Fourth semester

ME 23403 FLUID POWER AUTOMATION
(Regulation 2023)

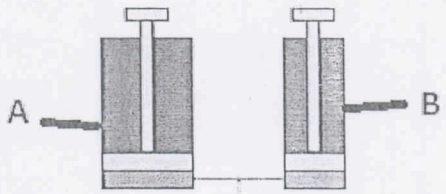
Time: 3 Hours | Answer ALL Questions | Max. Marks: 100

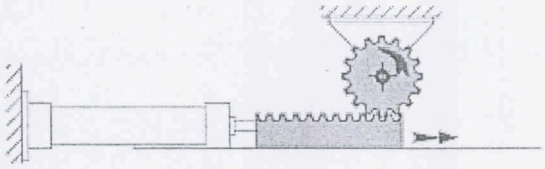
CO 1	Apply the principles of fluid power systems, and select relevant hydraulic pumps for the fluid power applications.
CO 2	Select necessary control components and hydraulic actuators for the fluid power applications.
CO 3	Design and develop hydraulic circuits and systems.
CO 4	Design and develop pneumatic circuits and systems.
CO 5	Solve problems and troubles in fluid power systems.

BL – Bloom's Taxonomy Levels

(L1 - Remembering, L2 - Understanding, L3 - Applying, L4 - Analysing, L5 - Evaluating, L6 -Creating)

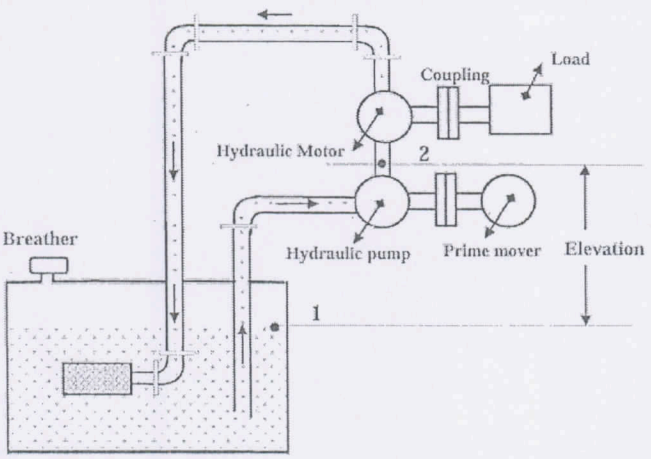
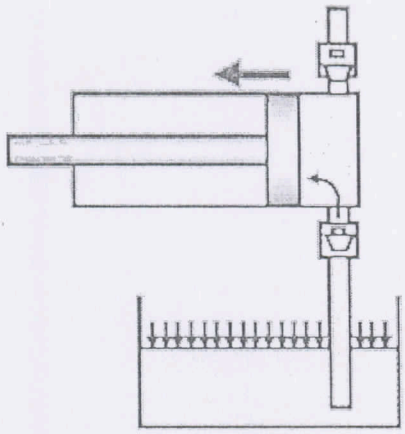
PART-A (10 x 2 = 20 Marks)

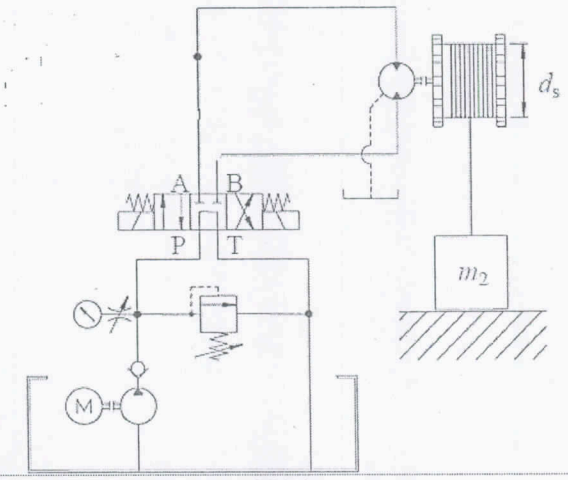
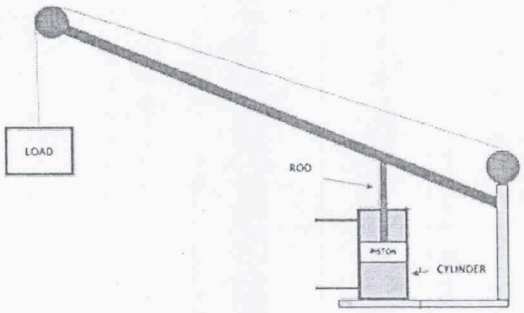
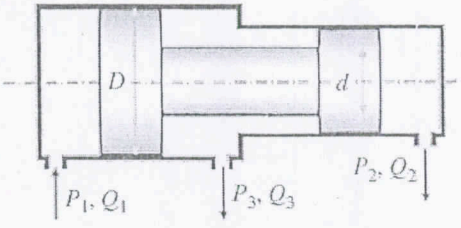
Q.No.	QUESTIONS	Marks	CO	BL
1.	Two cylinders, A and B, with diameters of 200 mm and 100 mm respectively, are connected as shown in the figure below. If each cylinder is carrying a load of 50 kN, which cylinder will move first? State the reason. 	2	1	L2
2.	A pipe carries oil of density 800 kg/m3. At a given point 1 the pipe has a bore area of 0.005 m^2 and the oil flows with a mean velocity of 4 m/s with a gauge pressure of 800 kPa. Point 2 is further along the pipe and there the bore area is 0.002 m^2 and the level is 50 m above point 1. Calculate the pressure at this point 2.	2	1	L2
3.	A single vane motor has volumetric discharge of $2\pi x10^{-6}$ m^3 and pressure is 10 MPa. Find the torque developed by the vane motor.	2	2	L2
4.	What is pressure override in a pressure relief valve and state its significance?	2	2	L2

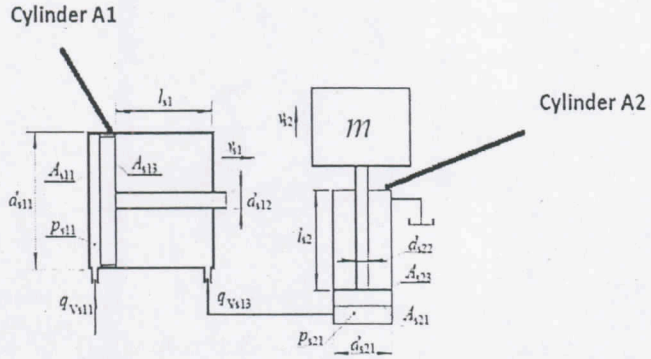
Q.No.	QUESTIONS	Marks	CO	BL
5.	 A hydraulic circuit is designed to convert linear motion of the cylinder is in to a rotary motion using rack and pinion mechanism as shown in the above figure. The number of teeth on the rack is 40. In order to get a 720 degree rotation, how many teeth should be there in the pinion?	2	3	L2
6.	Among proportional and servo valve which one be used to position a part accurately? Justify your answer.	2	3	L2
7.	Air is used at a rate of 2 m^3/min from a receiver at 40°C and 1000 kPa (gauge). If the atmosphere pressure is 101 kPa (abs.) and the atmospheric temperature is 20°C. How many m^3/min of free air (standard) must the compressor provide?	2	4	L2
8.	In a sequence, two double acting cylinders A and B have their movements in successive manner as $A^+A^-B^+B^-$ .State the methods to overcome fighting signal pneumatically and electro-pneumatically.	2	4	L2
9.	Suggest possible remedies to overcome cavitation in a hydraulic pump.	2	5	L2
10.	List the components in the hydraulic power pack.	2	5	L2

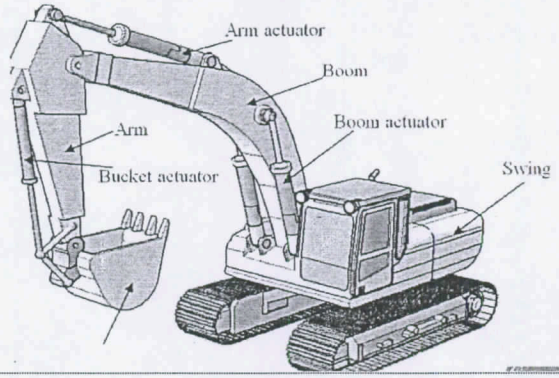
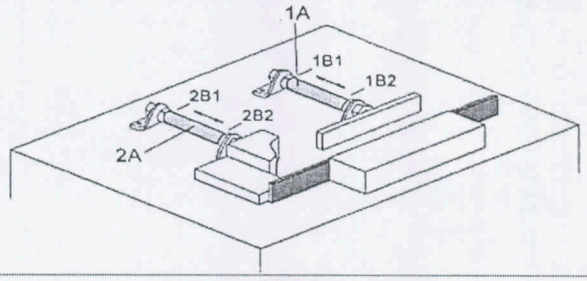
Part – B (5 x 13 = 65 Marks)

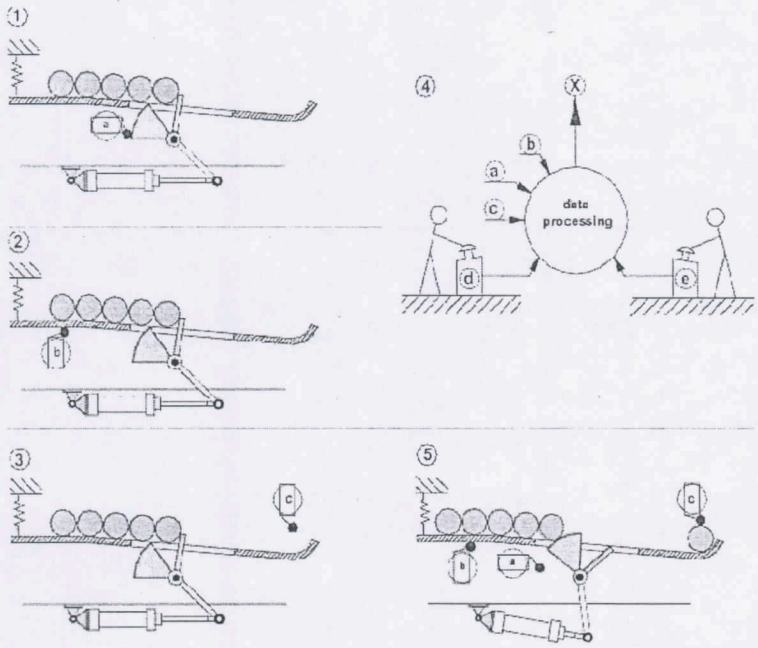
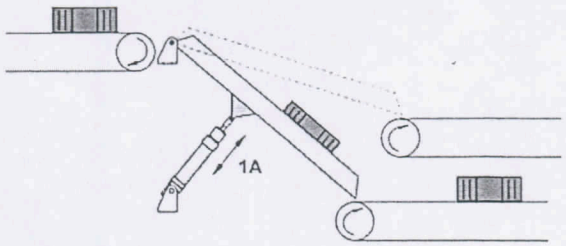
Q.No.		QUESTIONS	Marks	CO	BL
11.	a)	For the hydraulic system shown in the Figure below., the following data are given: i. A pump adds 2.984 kW to a fluid (pump hydraulic power = 2.984 kW). ii. The elevation difference between stations 1 and 2 is 6.096m. iii. The pump flow rate is 0.00158 m^3/s. iv. The specific gravity of oil is 0.9. v. The kinematic viscosity of oil is 75 cS. vi. The pipe diameter is 19.05 mm. vii. Pipe lengths are as follows: 0.305, 1.22 and 4.88 m. viii. Find the pressure available at the inlet to the hydraulic motor. The pressure at the oil top surface level in the hydraulic tank is atmospheric (0 Pa gauge). (assuming all the energy losses are negligible).	13	1	L3

Q.No.		QUESTIONS	Marks	CO	BL
					
		(OR)			
	b)	i. With a neat sketch, explain the working principle of a variable displacement vane pump. Describe the design changes that allow displacement variability, and derive an expression to prove its variable volumetric displacement.	8	1	L3
		ii. What is the theoretical flow rate discharged from a positive displacement pump illustrated in figure below, if the diameter of the cylinder is 50 mm, the stroke of the piston is 180 mm, and the piston made 30 reciprocating cycles in one minute? 	5	1	L3
12.	a)	i. Classify direction control valves and explain how different central positions of a 4/3 direction control valve are selected based on application requirements.	6	2	L3
		ii. The hydraulic system in the underlying figure is used for lifting masses using a hydraulic motor operated winch. The hydraulic motor receives 85 L · min^{-1} flow at a pressure of 21 MPa to drive the motor operating at a constant speed of 850 rpm. If the motor has a power	7	2	L3

Q.No.		QUESTIONS	Marks	CO	BL
		loss of 3 kW, estimate the actual torque output from the motor and the overall efficiency of the pump. 			
		(OR)			
	b)	i. A boom carrying a heavy mass vertically. Design a pressure control valve which provides safety to the system by preventing the load from accidentally moving down. 	8	2	L3
		ii. An intensifier is used in a water jet machining setup to augment the pressure of the fluid as depicted in fig below. The diameters of the larger and smaller pistons in a pressure intensifier are 150 mm and 100 mm, respectively. When a 50 L · min−1 flow of 30 MPa is supplied to the larger piston chamber, what are the rate and pressure of the output flow from the smaller piston chamber. 	5	2	L3

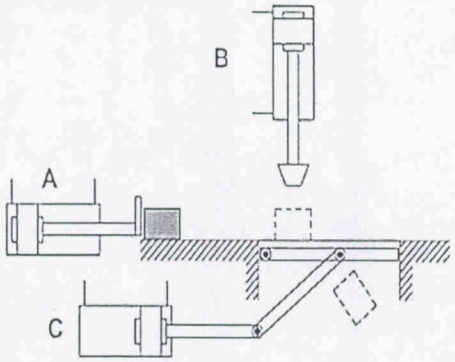
Q.No.		QUESTIONS	Marks	CO	BL
13.	a)	In a hydraulic system as shown in the figure, the lift Cylinder A2 hoisting the load m is operated by utilizing another cylinder (actuating cylinder) A1.  The Parameter values of cylinder A1 are: • q_{Vs11}(quantity of flow) = 10 L/min, • d_{s11} (piston dia.) = 63 mm, • d_{s12} (rod dia.) = 30 mm • l_{s1} = 250 mm • ls1 (stroke length) = 250 mm The Parameter values of cylinder A2 are • d_{s21}(piston dia.) = 40 mm, • d_{s22}(rod dia.) = 25 mm, • l_{s2} (stroke length) = 500 mm • m = 5000 kg. Determine the following: i. Calculate the piston velocities for both cylinders. (3) ii. What would be required for the velocities to be equal? (2) iii. What is the maximum lifting height? (2) iv. What would the maximum lift height be if the stoke length l_{s1} of the actuating cylinder would be doubled? (3) v. Calculate the pressure P_{s11} required for lifting the load (system assumed to be ideal; no losses). (3)	13	3	L3
		(OR)			
	b)	i. In a punch press a high-volume pump moves the ram quickly till it touches the workpiece and also returns quickly after finishing the punching operation, while the high-pressure pump provides the force needed for punching. Design a hydraulic circuit to provide the variable motion to the ram and explain it.	7	3	L3
		ii. The two boom actuators in the excavators as shown in the figure has to be provided parallel movement with equal velocity for a smooth operation. Draw a hydraulic circuit and explain the same.	6	3	L3

Q.No.		QUESTIONS	Marks	CO	BL
					
14.	a)	i. Explain the various stages of conditioning the compressed air.	5	4	L2
		ii. Design an electro-pneumatic ladder diagram for the following sheet metal operation. A sheet-metal bending device positional sketch shown below has two double-acting pneumatic cylinders drives 1A ,2A and are actuated by double solenoid 5/2 direction control valves. Cylinder 1A is used to clamp the workpiece Proximity switches a_1 (forward end position) and a_0 (retracted end position) and a 5/2-way valve with solenoid coils 1Y1 and 1Y2 are assigned to this cylinder. Cylinder 2A (forward end position: proximity switch 2B2, rear end position: proximity switch 2B1, 5/2-way valve with solenoid coil 2Y1 executes the bending process. and returns by energising 2Y2) Four steps are required for the bending operation: Step 1: Advance piston rod of cylinder 1A (clamp workpiece) Step 2: Advance piston rod of cylinder 2A (bend metal sheet) Step 3: Retract piston rod of cylinder 2A (retract bending fixture) Step 4: Retract piston rod of cylinder 1A (release workpiece) 	8	4	L3
		(OR)			
	b)	i. What is PLC? Explain the parts of the PLC with a block diagram.	5	4	L2
		ii. Design a pneumatic logic circuit to separate bars for a subsequent selection. Schematic representation of the sequence of activities to load a bar is shown below. Use 3/2 roller actuated limit switches for a, b and c, and 3/2 push button limit switches for d and e to control the single acting cylinder. Pos. 1: information "a" indicates whether the separator has loaded the bar.	8	4	L3

Q.No.		QUESTIONS	Marks	CO	BL
		Pos. 2: information "b" verifies that there are bars present in the stock. Pos. 3: information "c" indicates that the discharge zone is free without any bar. Pos. 4: Two operators (d and e) are operating the separator, signal from any one of them initiate the process Pos. 5: One bar descends the rail. 			
15.	a)	i. Design an electro-hydraulic circuit with ladder diagram for an industrial surface grinding machine.	9	5	L3
		ii. Design a pneumatic timer circuit for the following control problem. Cylinder (1A) feeds the parts to an upper or lower conveyor alternativley by means of acutating a 5/2 pilot operated DCV. The upward motion of the double-acting cylinder (1A) is to take place in 3 seconds; the downward motion in 2.5 seconds. In the initial position, the cylinder assumes the retracted end position. 	4	5	L3
		(OR)			

Q.No.		QUESTIONS	Marks	CO	BL
	b.	Discuss the practical application or implementation of any two of the following systems in real-world industrial scenarios: (2 x 6.5) i. Metering circuits in metal cutting machines ii. Forklift circuit iii. Troubleshooting of pneumatic cylinders	13	5	L3

Part – C (1 x 15 = 15 Marks)

Q.No.	QUESTIONS	Marks	CO	BL
16.	a) Design a pneumatic cascading sequencing circuit ta automate a punching operation. The component is manually positioned and a hole is punched and discharged into a container. Three cylinders A, B and C are performing the operations in successive phases as detailed below: Phase 1: cylinder A extends to place the component under the hole punch Phase 2: cylinder A clears the working area Phase 3: cylinder B punches & rectums directly after the punching operation Phase 4: cylinder C retracts to discharge the component-c Phase 5: cylinder C returns to position  Draw travel step diagram for the above stated problem identify the fighting signal and draw the circuit. (12) Include an emergency circuit to retrieve all the cylinders to their initial position. (3)	15	4	6