BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: B. TECH. **SEMESTER : VII**
BRANCH: MECHANICAL ENGINEERING **SESSION : MO/2022**

SUBJECT: ME403 HYDRAULIC AND PNEUMATIC CONTROL

TIME: 3:00 Hours **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
***4*. Before attempting the question paper, be sure that you have got the correct question paper.**
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

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Q.1(a)	A hydraulic motor has a volumetric displacement of 82 cm^3/rev and operates with a pressure of 70 bar. The motor rotates at a speed of 600 rpm. The actual flow rate consumed by the motor is 0.0009 m^3/s and actual torque delivered by the motor is 80 N.m. Determine a) Theoretical torque b) Theoretical power c) Hydraulic efficiency (η_v) d) Mechanical efficiency (η_m) Overall efficiency (η_o)	[4]	6	I
Q.1(b)	Elaborate the effect of temperature and pressure variations on the oil viscosity in hydraulic system.	3]	2	I
Q.1(c)	Derive the theoretical torque of an ideal pump $T_t = \frac{\left(V_{gmax} - V_{gmin}\right) \times z \times i}{2\pi} \Delta P$, where V_{gmax} and V_{gmin} are the maximum and minimum chamber volume, respectively; z is number of pumping chamber; i is number of pumping stokes per revolution; ΔP is the pressure difference at pump outlet and inlet. Also derive the theoretical power deliver by the pump is $P_t = \frac{\left(V_{gmax} - V_{gmin}\right) \times z \times i}{60} \Delta P \times n$; n is the pump speed in rpm.	[3]	3	I
Q.2(a)	Describe working principle of an Electro-Hydraulic Servo Valve with a suitable sketch.	[4]	2	II
Q.2(b)	A pressure relief valve (PRV) contains a poppet with a 0.65 mm^2 area on which system pressure acts. During assembly, a spring with a spring constant of 200 N/m is installed in the valve to hold the poppet against its seat. The adjustment mechanism is then set so that the spring initially compresses 0.5 cm from its free-length condition. In order to pass full pump flow through the valve at the PRV pressure setting, the poppet must move 0.8 cm from its fully closed position. Determine the a) Cracking pressure b) Full pump flow pressure (PRV pressure setting) What should be the initial compression of the spring in the PRV if the full pump flow pressure is to be 40% greater than the cracking pressure?	[3]	6	II
Q.2(c)	Sketch and write four methods of actuation for a Directional Control Valve (DCV). Draw the symbol of a solenoid operated 4/2 DCV.	[3]	2	II
Q.3(a)	Design and discuss a hydraulic circuit to operate two reciprocating double acting hydraulic cylinders sequentially using two sequence valves and one DCV. Give two suitable examples for the application of sequential scheme in hydraulic system.	[3]	5	III
Q.3(b)	Distinguish differences between Meter-In and Meter-Out circuit.	[2]	4	III

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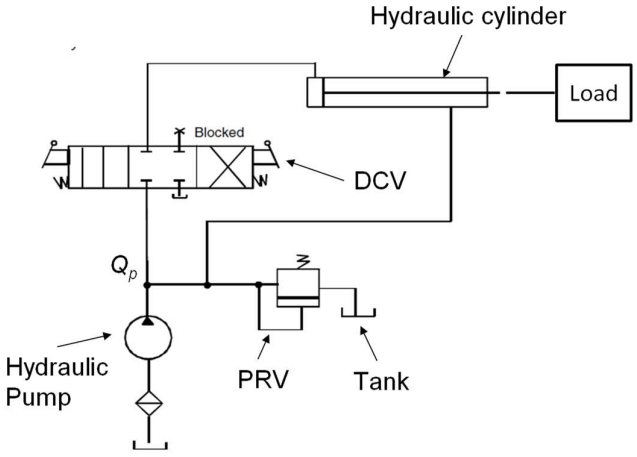
Q.3(c)	A double-acting cylinder is hooked up in the regenerative circuit (refer Figure). The area of the cylinder at piston end and rod end are 36 cm^2 and 24 cm^2, respectively. The pump flow (Q_p) is 600 LPM and regenerative flow is 0.00167 m^3/s. The force applied on the load by the piston during the extension is 200 N. Find the following parameters: a) Total flow rate enters the piston end of the cylinder during extension operation b) Piston speed during the retraction operation. c) Piston speed during the extension operation. d) Ratio of piston speed retraction to extension e) Estimate the power generated by the piston during extension.	[5]	6	III



Q.4(a)	A compressor is supplying high pressure air to a pneumatic system, which is operated at 5 MPa pressure. If the flow rate of the compressor is 0.5 m^3/s and its overall efficiency is 75%, then determine the theoretical power requirement and actual power requirement to drive the compressor. Consider, atmospheric pressure is 1×10^5 Pa.	[4]	6	IV
Q.4(b)	Describe the role of an accumulator in power hydraulic system and classify it categories.	[3]	2	IV
Q.4(c)	Write short note (any one) 1. Air filter 2. Gas-loaded type accumulator	[3]	2	IV
Q.5(a)	Find out the Beta efficiency of a Filter, where 250 particles are larger than the 2.5µm rating in upstream, and 210 particles are larger than the 2.5µm rating in downstream.	[2]	3	V
Q.5(b)	Describe Moving-part logic (MPL) control system with AND, OR and MEMORY FUNCTION.	[3]	2	V
Q.5(c)	Develop a Ladder Logic diagram to operate two reciprocating double acting pneumatic cylinders sequentially. The sequence of operations is as follow: 1. First cylinder extension 2. Delay 20 sec. 3. Second cylinder extension 4. Delay 20 sec. 5. First cylinder retraction 6. Second cylinder retraction 7. Delay 10 sec.	[5]	6	V

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