



UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 6 Examination in Engineering: November 2022

Module Number: ME6205

Module Name: Power Hydraulics

[Three Hours]

[Answer all questions, each question carries 12 marks]

Q1 (a) Briefly mention the primary and secondary tasks of using hydraulic fluid in a hydraulic system. [2.0 Marks]

(b) Figure Q1 (b) shows a regenerative circuit in which an 18.5 KW electric motor drives a 90% efficient pump. The pump discharge pressure is 6800 kPa. Other required data of the hydraulic circuit are indicated in Tables Q1(b)-1 and Q1(b)-2. Determine,
i) The external load F that the hydraulic cylinder can sustain in the regenerative mode (spring centered position of DVC)
ii) The cylinder speed for each position of the DVC.

Note: Take following equation for frictional head losses, symbols are given usual notations.

$$\Delta H_L = \left(4f \frac{L}{d_e} + \sum K \right) \left(\frac{V^2}{2g} \right), \quad \text{where } f = \frac{16}{Re}$$

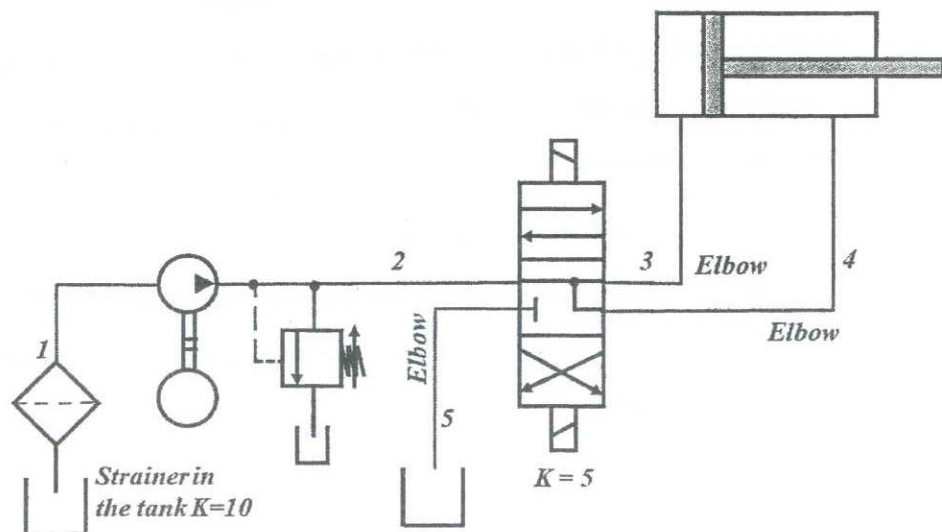


Figure Q1 (b)

Table Q1(b)-1

Kinematic viscosity of oil	0.0000930 m ² /s
Specific weight of oil	7850 N/ m ³
Cylinder piston diameter	0.203 m
Cylinder rod diameter	0.102 m
All elbows are 90° with k factor	0.75

Table Q1(b)-2

Pipe number	Length (m)	Diameter (m)
1	0.6	0.05
2	6.1	0.04
3	9.2	0.04
4	9.2	0.04
5	6.1	0.04

[10.0 Marks]

- Q2 (a) Explain with clear graphs, why a circuit with Fixed Capacity Pump (FCP) - Variable Capacity Motor (VCM) combination are applicable for constant power load applications and not applicable in constant torque applications.

[4.0 Marks]

- (b) In a fluid power system, a Fixed Capacity Pump (FCP) supplies oil to a Variable Capacity Motor (VCM). The pump is directly coupled to an electric motor and it is driven at a constant speed of 1800 rpm. The capacity of the pump is 50 ml/rev. The maximum capacity and speed of the motor are 60 ml/rev and 3600 rpm respectively. Hydraulic losses in pipes and between the pump and motor are estimated as 7.5 bar. For both pump and motor the volumetric efficiency and overall efficiency are 90% and 80% respectively. The relief valve pressure is set as 40 bar.

- i) Determine the minimum capacity of the motor to be set mechanically for safety of the fluid power system.
- ii) Determine maximum power load of the motor.
- iii) Calculate the speed range of the motor activated with a 15 Nm torque load

[8.0 Marks]

- Q3 (a) Briefly describe the following properties of hydraulic fluids used in fluid power systems.

- i) Lubricity
- ii) Thermal stability
- iii) Oxidative stability
- iv) Foaming Tendency

[4.0 Marks]

- (b) Discuss the advantages of the energy conversion process of a hydraulic power transmission system comparing to that of a mechanical power transmission system.

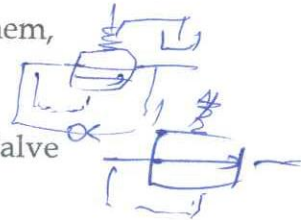
[2.0 Marks]

- (c) Discuss the functions of Directional Control Valves (DCVs) in a power hydraulic circuit. Also, with clear sketches explain the three different Centre positions of a 4/3 way spool valve.

[4.0 Marks]

- (d) Draw clear sketches of the following Pressure Control Valves (PCVs) and explain the features and functions of them,

- i) Sequence Valve
- ii) Pressure Reducing Valve



[2.0 Marks]

- Q4 (a) With reference to the hydraulic circuit shown in Figure Q4(a), identify the numbered components and write down that in the answer scripts against the numbers.

[2.0 Marks]

- (b) Describe the operation of the circuit shown in Figure Q4(a).

[2.0 Marks]

- (c) Explain the operation of the actuators with different switching positions of the valve 3 in the Figure Q4(a)

[2.0 Marks]

- (d) Study the circuit shown in Figure Q4(d). Determine the readings for all gauges and write down against the indicated Roman letters in the answer scripts.

[6.0 Marks]

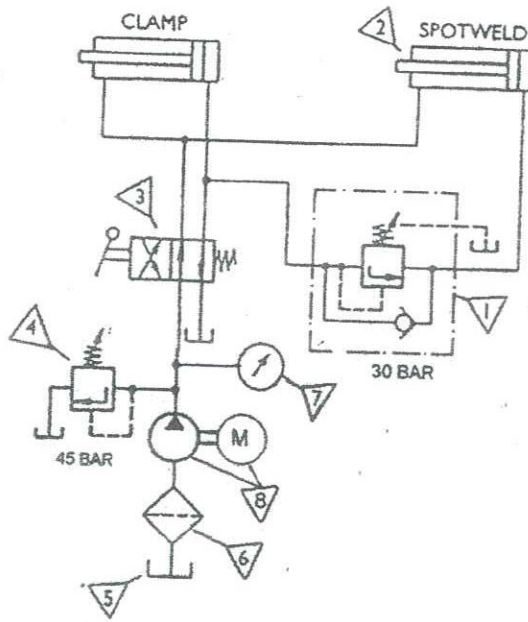


Figure Q4(a)

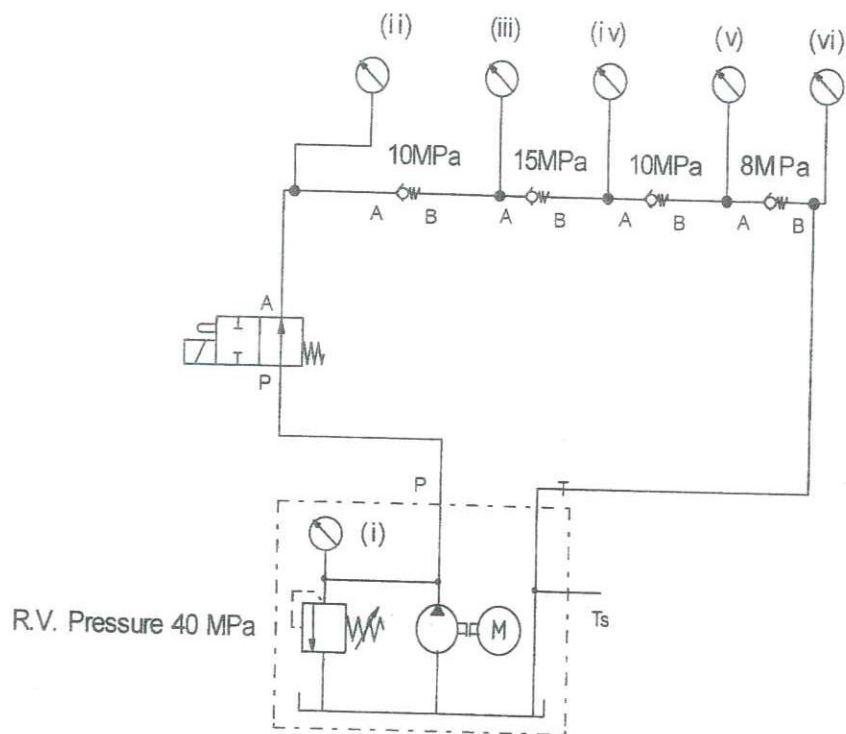


Figure Q4(d)

Q5

In a metal product manufacturing process, three operations are to be carried out by the actuators such as loading, clamping and cutting. After completing the cutting process, cutting tool is removed and unclamp the workpiece for next loading. All the processes need to be automatic. Three double-acting cylinders and number of sequence valves are recommended to get the above operations. Other necessary

hydraulic equipment can be chosen freely as per the requirements. Design a hydraulic circuit to accomplish the automated cutting operations with a suitable 4/3 DCV by facilitating automatic repetition of the operations.

[12.0 Marks]