COLLEGE OF ENGINEERING & TECHNOLOGY

Department : MECHANICAL ENGINEERING

Lecturer : Prof. Dr. Sadek Z. Kassab
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Course : Hydraulic Systems

Course No. : ME 464 Marks : 40

Date : 12/6/2012 Time : 2 hours

FINAL EXAMINATION PAPER

Question (1)

a)What are the basic components of a hydraulic power system? [3M]

b)What are the primary functions of a hydraulic fluid?[2M]

c) Explain briefly, using illustrations, what is meant by Pascal's Law? [3M]

d) When analyzing or designing a hydraulic circuit, what are the important considerations must be taken into account? [2M]

Question (2)

a) Why does the rod of a double-acting cylinder retract at a greater velocity than it extends for the same input flow rate? [3M]

b) What is happening to the volumetric efficiency of the Gear Pump as the pressure increases? Support your answer by a drawing. [2M]

c) A hydrostatic transmission operating at 70 bars pressure has the following characteristics: Pump (V_D = 82 cm^3, η_v = 82%, η_m = 88%, N = 500 rpm) and Motor (η_v = 92%, η_m = 90%, N = 400 rpm). Find the displacement of the motor and the motor output torque. [5M]

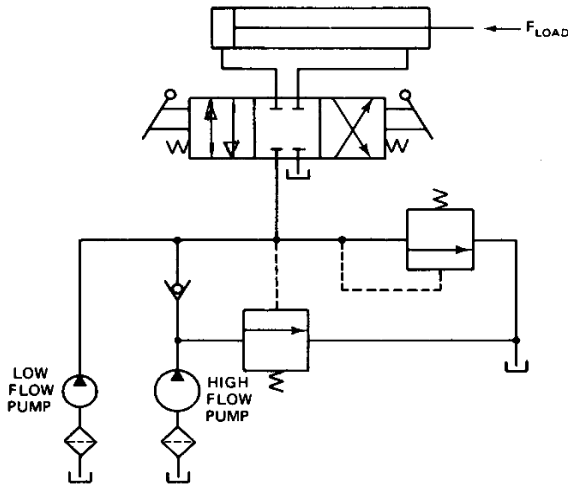
Question (3)

a) What is the function of: i- Simple relief valve ii- Pressure-reducing valve. [3M]

b) Which of the following valves are used for Direction Control?

i- Needle Valve ii- Check Valve iii- Pressure-Reducing Valve iv- Sequence Valve v- Shuttle Valve vi- Unloading Valve vii- Relief Valve viii- Four-way, Two position Valve. [3M]

c) Redraw the shown Hydraulic Circuit and write the name of each component.[4M]



Question (4)

a) Discuss, with the aid of a free hand sketch, the operation of a Regenerative circuit. Name one application for this circuit. [5M]

b) A double-acting cylinder is hooked up in a regenerative circuit. The relief valve setting is 105 bars. The piston area is 130 cm^2 and the rod area is 65 cm^2. If the pump flow is 0.0016 m^3/s, find the cylinder speed and load-carrying capacity for the extending stroke and the retracting stroke.[5M]

Answer sheet

Question (1)

a)What are the basic components of a hydraulic power system? [3M]

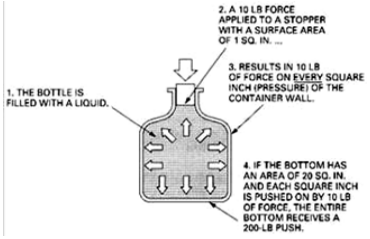
1. A Tank
2. A Pump
3. An Electric Motor or other Power Source to drive the pump
4. Valves to control oil Direction, Pressure, and Flow rate
5. An Actuator
6. Piping

b)What are the primary functions of a hydraulic fluid?[2M]

1. Transmit Power
2. Lubricate Moving Parts
3. Seal Clearances between mating parts
4. Dissipate Heat

c) Explain briefly, using illustrations, what is meant by Pascal's Law? [3M]

This law can be slated as follows: Pressure applied to a confined Fluid is transmitted Undiminished in All Directions throughout the Fluid and acts perpendicular to the surfaces in contact with the Fluid.



d) When analyzing or designing a hydraulic circuit, what are the important considerations must be taken into account? [2M]

1-Safety of Operation
2-Performance of desired Function
3-Efficiency of Operation

Question (2)

a) Why does the rod of a double-acting cylinder retract at a greater velocity than it extends for the same input flow rate? [3M]

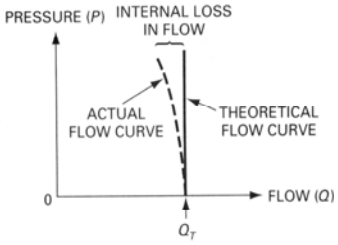
$$v_{ext} = \frac{Q}{A_p}$$

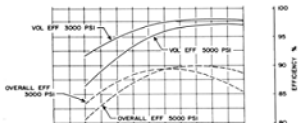
$$v_{ret} = \frac{Q}{(A_p - A_r)}$$

$A_p > (A_p - A_r)$, thus $v_{ret} > v_{ext}$

b) What is happening to the volumetric efficiency of the Gear Pump as the pressure increases? Support your answer by a drawing. [2M]

As the gear pump pressure increase, the volumetric efficiency decrease due to leakakge.





c) A hydrostatic transmission operating at 70 bars pressure has the following characteristics: Pump (V_D = 82 cm^3, η_v = 82%, η_m = 88%, N = 500 rpm) and Motor (η_v = 92%, η_m = 90%, N = 400 rpm). Find the displacement of the motor and the motor output torque. [5M]

P= 70 bar
N_p= 500 rpm
V_{Dp}=82 cm^3 , $Q_T = V_D \times N_p = 82 \times 10^{-6} \times 500/60 = 0.000683$ m^3/s
η_{vp}=82% = Q_A/Q_T , Q_A= 0.82x 0.000683 = 0.00056 m^3/s
η_{mp}=88%= $PQ_T/T_A\,\omega$
η_{vm}=92%=Q_{Tm}/Q_{Am}
η_{mm}=90%=T_{Am}/T_{Tm}
N_m= 400 rpm
Since, $Q_{Ap}=Q_{Am}$= 0.00056 m^3/s
Then, motor theoretical flow rate
$Q_{Tm} = Q_{Am} \times \eta_{vm}$= 0.00056 x 0.92=0.000515 m^3/s
Motor volumetric displacement =
$Q_{Tm}/(N_m/60)$= 0.000515/(400/60)=0.000077 m^3

b. hydraulic power delivered to motor = system pressure × actual flow-rate to motor

$$= (70 \times 10^5)(0.000560) = 3920 \text{ W}$$

$$\text{brake power delivered by motor} = (3920)(0.92)(0.90) = 3246 \text{ W}$$

$$\text{torque delivered by motor} = \frac{\text{power delivered by motor}}{\text{motor speed}}$$

$$= \frac{3246}{400 \times 2\pi/60} = 77.5 \text{ N} \cdot \text{m}$$

Question (3)

a) What is the function of: i- Simple relief valve ii- Pressure-reducing valve. [3M]

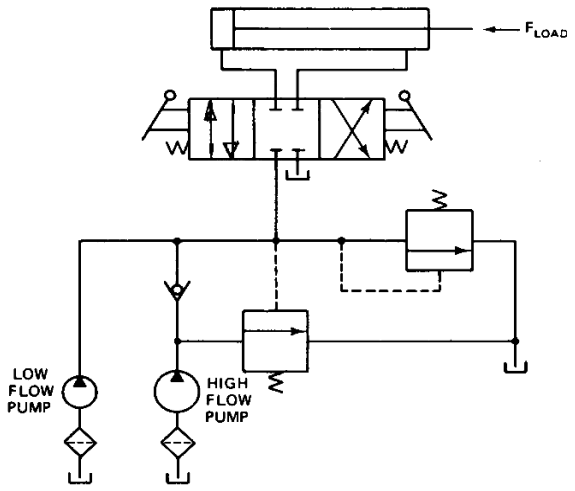
i- Simple relief valve
It is normally a closed valve whose function is to limit the pressure to a specified maximum value by diverting pump flow back to the tank.

ii- Pressure-reducing valve
This type of valve (which is normally open) is used to maintain reduced pressures in specified locations of hydraulic systems. It is actuated by downstream pressure and tends to close as this pressure reaches the valve setting.

b) Which of the following valves are used for Direction Control?

ii- Check Valve v- Shuttle Valve viii- Four-way, Two position Valve. [3M]

c) Redraw the shown Hydraulic Circuit and write the name of each component.[4M]



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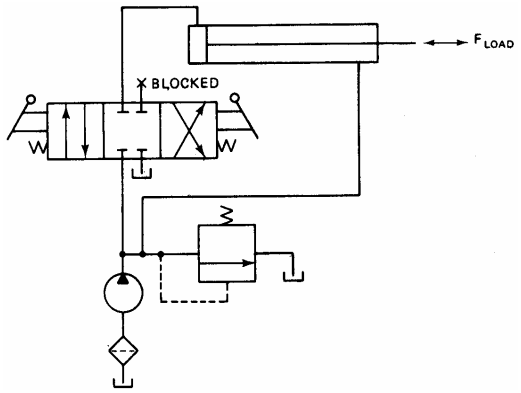

The speed of extension is greater than that for a regular double-acting cylinder because flow from the rod end (QR) regenerates with the pump flow (Qp) to provide a total flow rate (Qr), which is greater than the pump flow rate to the blank end of the cylinder
The operation of the cylinder during the retraction stroke is the same as that of a regular double-acting cylinder.

The application is for a drilling machine.

b) A double-acting cylinder is hooked up in a regenerative circuit. The relief valve setting is 105 bars. The piston area is 130 cm^2 and the rod area is 65 cm^2. If the pump flow is 0.0016 m^3/s, find the cylinder speed and load-carrying capacity for the extending stroke and the retracting stroke.[5M]

$Vp_{ext} = Q_p/A_r$

$= 0.0016/0.0065 = 0.246$ m/s

$Vp_{ret} = Q_p/(A_p - A_r)$

$= 0.0016/0.0065 = 0.246$ m/s

$Vp_{ext}/Vp_{ret} = A_p/A_r - 1$

$F_{Load} = P \times A_r$

$= 105 \times 10^5 \times 0.0065 = 68250$ N