COLLEGE OF ENGINEERING & TECHNOLOGY

Department : MECHANICAL ENGINEERING

Lecturer : Prof. Dr. Ashraf S. Ismail

Course : Hydraulic Systems

Course No. : ME 464 Marks : 40

Date : 5/1/2013 Time : 2 hours

FINAL EXAMINATION PAPER

Question (1)

a) Mention three common varieties of hydraulic fluids found on the market today. [3M]

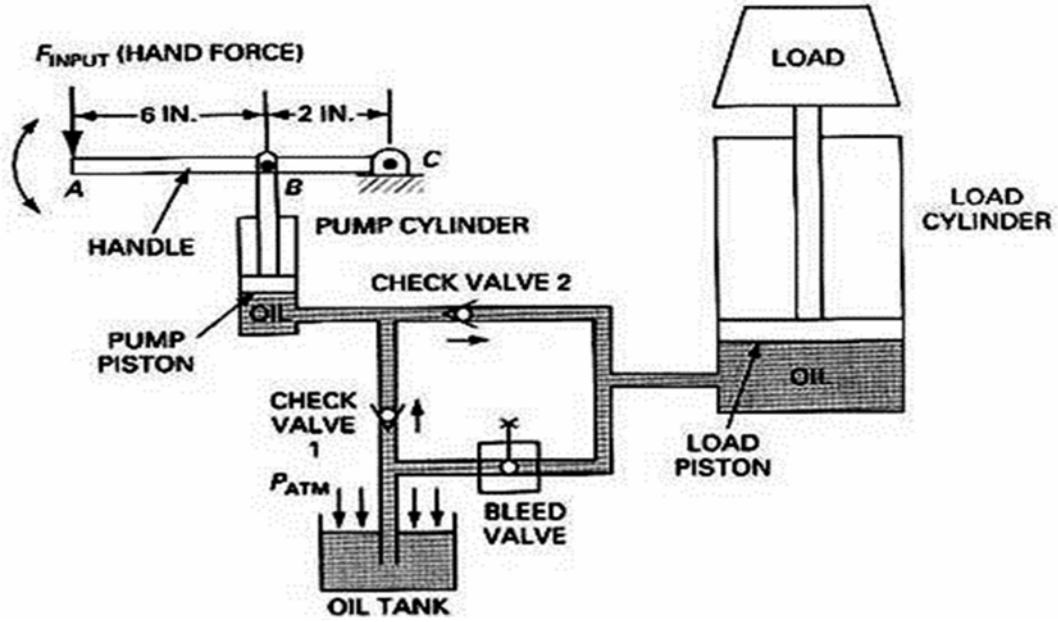
b) When a hydraulic fluid should be Changed?, and why? [3M]

c) An operator makes one complete cycle per second interval using the hydraulic jack in the figure. Each complete cycle consists of two pump cylinder strokes (intake and power). The pump cylinder piston has a 2.5 cm diameter piston and the load cylinder has a 9 cm diameter piston. If the average hand force is 110 N during the power stroke,

i) How much load can be lifted? [2M]

ii) How many cycles are required to lift the load 25 cm assuming no oil leakage? [2M]

The pump piston has a 5 cm stroke.



Question (2)

a) For Axial Piston pump (Bent-Axis design) when the cylinder block centerline is parallel to the drive shaft centerline, the produced flow is:

i) Zero ii) Average iii) Maximum [1M]

b) Which type of Gears [Spur, Helical, Herringbone] is the noisy one? and Which type develops excessive end thrust? [1M]

e) Which of the following valves are used for Direction control?

i- Needle valve ii- Pressure-reducing valve iii- Check valve iv- Sequence valve v- Shuttle valve vi- Unloading valve vii- Relief valve viii- Four-way, two position valve [3M]

d).Find the flow rate that an axial piston pump delivers at 1000 rpm. The pump has nine 15-mm-diameter pistons arranged on a 125-mm-diameter piston circle. The offset angle is set at 10° and the volumetric efficiency is 94%. [5M]

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Question (3)

a) What is the function of cylinder cushion? Use schematic drawings to support your answer. [5M]

b) A Hydraulic Motor has a displacement of 164 cm^3 and operates with a pressure of 70 bars and a speed of 2000 rpm. The actual flow rate consumed by the motor is 0.006 m^3/s and the actual torque delivered by the motor is 170 N.m. Find the Volumetric, Mechanical, and Overall Efficiencies and the Actual Power delivered by the Motor. [5M]

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) Mention three common varieties of hydraulic fluids found on the market today. [3M]

1-Petroleum-based or mineral-based fluids
2-Water-based fluids
3-Synthetic fluids

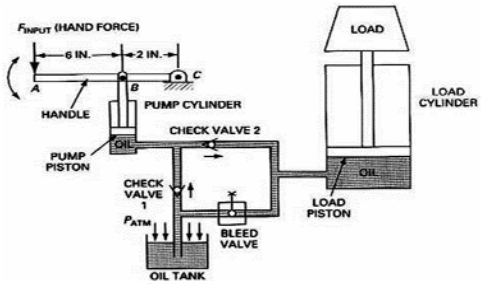
b) Why a hydraulic fluid should be changed periodically? [3M]

A Fluid should be Changed When its Viscosity and Acidity Increase due to fluid Breakdown or Contamination.

c) An operator makes one complete cycle per second interval using the hydraulic jack in the figure. Each complete cycle consists of two pump cylinder strokes (intake and power). The pump cylinder piston has a 2.5 cm diameter piston and the load cylinder has a 9 cm diameter piston. If the average hand force is 110 N during the power stroke,
i) How much load can be lifted? [2M]
ii) How many cycles are required to lift the load 25 cm assuming no oil leakage? [2M]
The pump piston has a 5 cm stroke.

i)F_B x 5 = F_A x 20
F_B= 110 x 20/5 = 440 N
$F_B/A_P = F_L/A_C$
F_L= 440 x $(9/2.5)^2$ = 5702.4 N

ii) F_B x $S_P = F_L$x S_L
S_L = 440 x 5/5702.4 = 0.3858 cm
No. of cycles = 25/ S_L = 65 cycle



Question (2)

a) For Axial Piston pump (Bent-Axis design) when the cylinder block centerline is parallel to the drive shaft centerline, the produced flow is
:

i) Zero

[1M]

b) Which type of Gears [Spur, Helical, Herringbone] is the noisy one? and
Which type develops excessive end thrust? [1M]

Spur is the noisy one
Helical type develops excessive end thrust

c) Which of the following valves are used for Direction control?

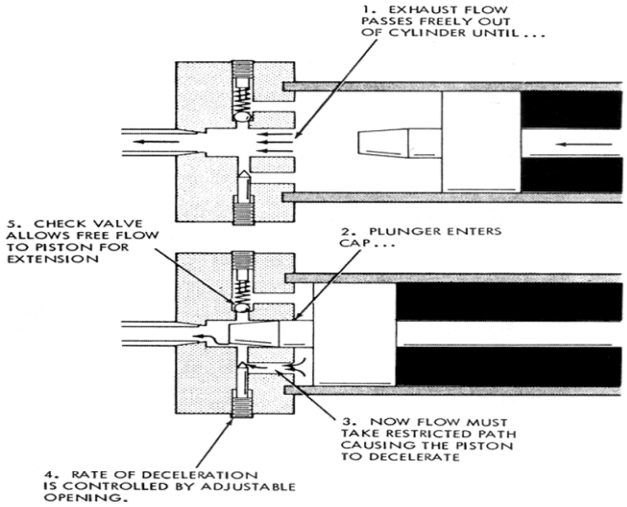
iii- Check valve v- Shuttle valve viii- Four-way, two position valve [3M]

d).Find the flow rate that an axial piston pump delivers at 1000 rpm. The pump has nine 15-mm-diameter pistons arranged on a 125-mm-diameter piston circle. The offset angle is set at 10° and the volumetric efficiency is 94%. [5M]

$Q_T = A_p \times Y \times S \times N = A_p \times Y \times D \tan\theta \times N = 0.0351\ m^3/min$
$Q_A = \eta_v \times / Q_T = 0.033\ m^3/min$

Question (3)

a) What is the function of cylinder cushion? Use schematic drawings to support your answer. [5M]
Slow the piston down near the ends of the stroke.



b) A Hydraulic Motor has a displacement of 164 cm^3 and operates with a pressure of 70 bar and a speed of 2000 rpm. The actual flow rate consumed by the motor is 0.006 m^3/s and the actual torque delivered by the motor is 170 N.m. Find the Volumetric, Mechanical, and Overall Efficiencies and the Actual Power delivered by the Motor. [5M]

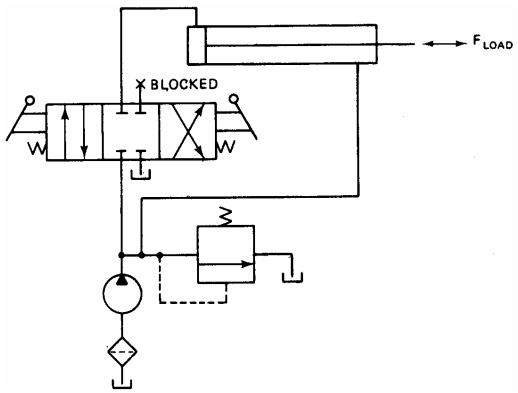
P= 70 bar
N_m= 2000 rpm
Q_A=0.006 m^3/s
V_D=164 cm^3 , $Q_T = V_D \times N_m = 164 \times 10^{-6} \times 2000/60 = 0.00546\ m^3/s$
$\eta_v = Q_T / Q_A = 0.91$
T_A = 170 N.m
$T_T = P \times V_D / 2\pi = 70 \times 10^5 \times 164 \times 10^{-6}/2\pi = 182.8$ N.m
$\eta_m = T_A/T_T = 0.93$

$\eta_o = \eta_m \times \eta_v = 0.846$

Actual power= $T_A \times \omega = 170 \times 2\pi \times 2000/60 = 35586.6$ w

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]



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