Internal Assessment test I - Sept 2006 - Scheme

Hydraulics & pneumatics - 10ME73

Note: Answer any 5 questions. Each question carries 10 marks

1. Explain pascals law. List basic components required in a hydraulic power system with a neat sketch and state the essential functions of each.

State the pascal law — 2

Brief explaination with a diagram. — 1

List basic components. — 3

Diagram of basic hydraulic system — 4

2. A hydraulic motor has a displacement of 164 cm^3 operates with a pressure of 70 bars and has a speed of 2000 rpm. If 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

a. Volumetric efficiency — 3 91.2%.

b. Mechanical efficiency — 3 93%.

c. Overall efficiency — 1 84.8%.

d. power developed by the motor. — 3 35.6 kW

3. a. With a neat sketch, explain the construction and working of an external gear pump.

Neat diagram of Gear pump - 3

Brief explanation - 2

b. Determine the volumetric efficiency displacement of a Vane pump having a rotor dia 60 mm, a cam ring dia of 90 mm and a vane width of 50 mm, if its eccentricity is 10 mm.

Formula to find out V_D – 2

Final answer – 3. 117854.74 mm³/rev

4. A pump has a displacement volume of 100 cm³. It delivers 0.0015 m³/s of oil at 1000 rpm and 70 bar. If the prime mover input torque is 120 Nm.

83.5% a. What is the overall efficiency of pump? 05

112 N.m b. What is the theoretical torque required? 05

(Note: Students must show all steps to obtain full marks)

5. With a neat sketch explain Second class lever System used in hydraulic System to drive a load. Given an example

Neat Sketch of SCL – 5

Explanation – 2

Expression – 2

Example for SCL – 1

6. Define a. Volumetric displacement – 3

b. Theoretical flow rate – 3

c. Mechanical efficiency. – 3

d. overall efficiency. – 1

7. Write a short note on

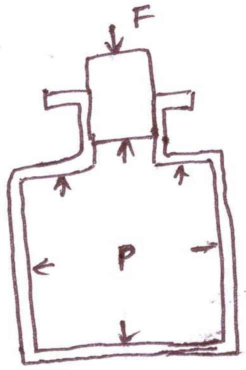
a. End cushioning in a hydraulic cylinder – 05

b. Linear hydraulic actuator – 05

Internal Assessment test - 1 → Solution.

Hydraulics & pneumatics. 10ME73

1. 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.



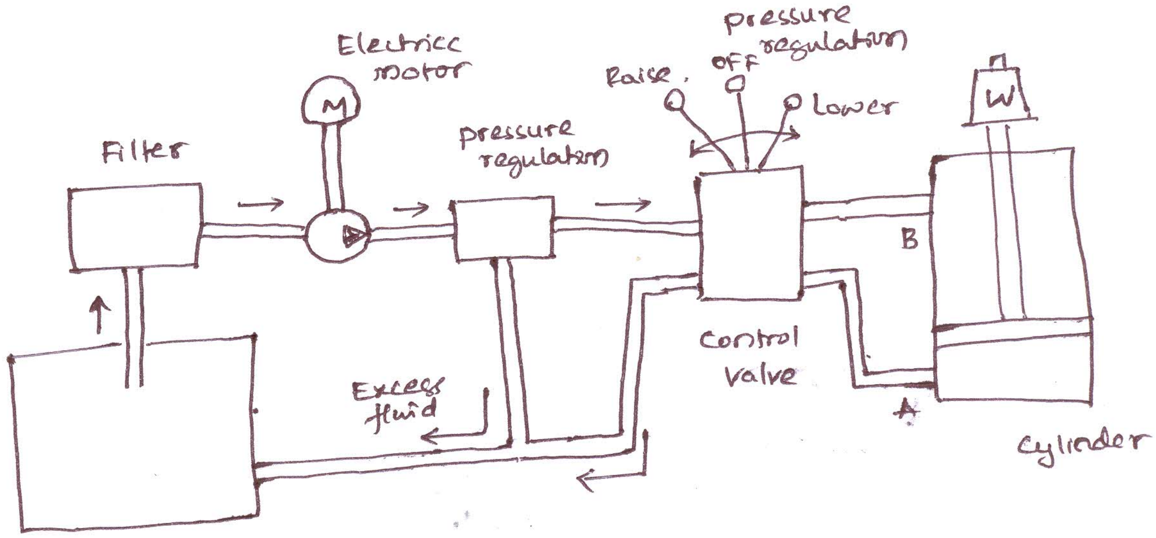
A bottle is filled with oil and closed with the cork, now if a force F is applied on cork the pressure will be same everywhere inside the bottle and it acts perpendicular to surface.

Structure of hydraulic control system

There are six basic components required in a hydraulic system:

1. A tank (reservoir) to hold the hydraulic oil.
2. A pump to force the oil through the system.
3. An electric motor to drive the pump.
4. Valves to control oil direction, pressure, and flow rate.
5. An actuator to convert the pressure of the oil into mechanical force or torque to do the useful work.

6. piping which carries the oil from one location to another.



2. Given data:

$V_D = 164\ cm^3 = 164 \times 10^{-6}\ m^3/rev$

$p = 70 \times 10^5\ N/m^2$

$N = 2000\ rpm$

$Q_A = 0.006\ m^3/s$

$T_A = 170\ N.m$

a. To find η_v

$$Q_T = V_D \times N = 0.000164 \times \frac{2000}{60} = 0.00547\ m^3/s$$

$$\therefore \eta_v = \frac{Q_T}{Q_A} = \frac{0.00547}{0.006} = 0.912 \Rightarrow 91.2\ \%$$

b. To find η_m

$$T_T = \frac{p \times V_D}{2\pi} = \frac{0.000164 \times 70 \times 10^5}{2\pi}$$

$$= 182.8\ N.m$$

$$\therefore \eta_m = \frac{T_A}{T_T} = \frac{170}{182.8} = 0.93 \Rightarrow 93\%$$

c. Overall efficiency

$\eta_o = \eta_v \times \eta_m$

$= 0.912 \times 0.93 = 0.848$

$\Rightarrow 84.8\%$

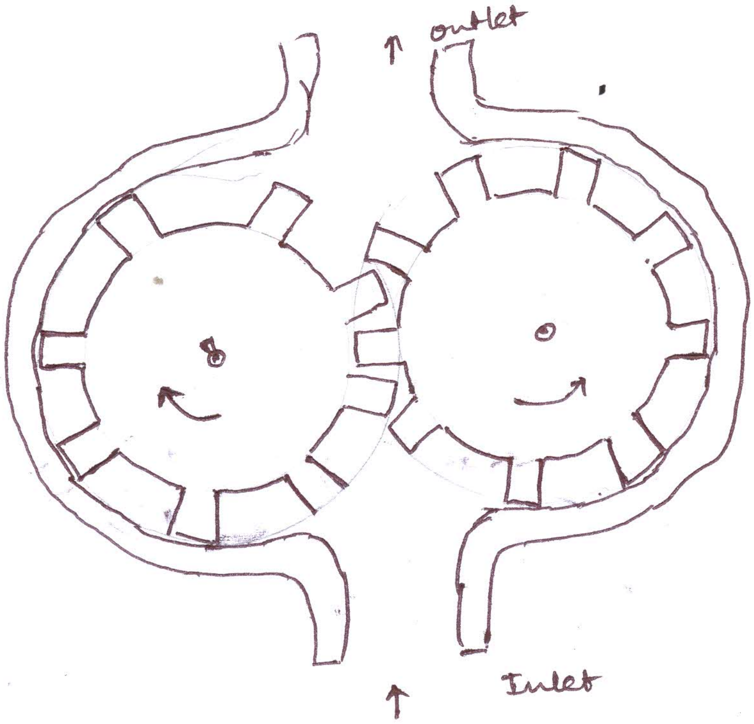
d. Actual power $= T_A \times \omega$

$= 170 \times 2000 \times \frac{2\pi}{60}$

$= 35600 \ W$

$= 35.6 \ kW$

3.



External gear pump develops flow by carrying fluid between the teeth of two meshing gears one of the gears is connected to a drive shaft connected to the prime mover. The second gear is driven as it meshes with the driver gear. Oil chambe are formed between the gear teeth, the pump housing and the side wear plates. The suction side is where teeth come out of mesh and it is here that the volume expands, bringing about a reduction in pressu to below atmospheric pressure. Fluid is pushed into this void by atmospheric pressure. because the oil supply is vented to atmosphere. The discharge side is where teeth go into mesh, and it is here the volume decreases between mating teeth. since the pump has a positive internal seal against leakage the oil is positively ejected into the outlet ports.

b. Given data

$d_r = 60\,mm$

$d_c = 90\,mm$

$L = 50\,mm$

$e = 10\,mm$

$\therefore$ Volumetric displacement $= V_D = \frac{\pi}{2}(D_c + D_r)\,e\,L$

$= \frac{\pi}{2}(90+60) \times 10 \times 50$

$= 117857.14\ mm^3$

4. Pump:

$V_D = 100 \times (10^{-2})^3\ m^3$

$Q_A = 0.0015\ m^3/s$

$N = 1000$ rpm.

$p = 70$ bars

$T_A = 120\ Nm$

To find η_V

$$Q_T = V_D \times N = 0.0001 \times \frac{100}{60} = 0.00167 \ m^3/s$$

$$\eta_V = \frac{Q_A}{Q_T} = \frac{0.0015}{0.00167} = 0.898 = 89.8\%$$

$$\eta_M = \frac{P Q_T}{T_A N} = \frac{70 \times 10^5 \times 0.00167}{120 \times 1000 \times \frac{2\pi}{60}} = 0.93$$

$$\therefore \eta_M = 93\%$$

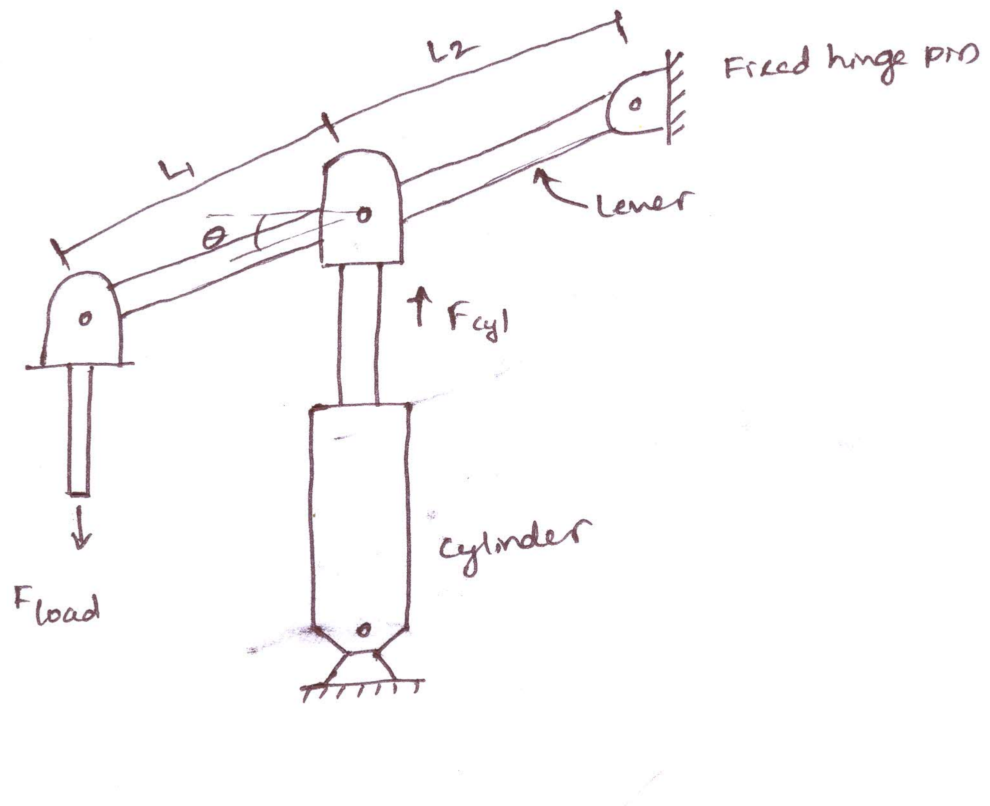
Now $\eta_o = 83.5\%$

To find T_T

$$T_T = T_A \times \eta_m = 120 \times 0.93 = \underline{112 \ N.m}$$

5. Second class lever system.

It is characterised by the load rod pin being located between the fixed-hinge pin and cylinder rod pin of the lever.



The analysis is accomplished by equating moments about the fixed hinge pin as follows.

$$F_{cyl} \cos\phi \,(L_1+L_2) \cos\theta = F_{load} \, L_2 \cos\theta$$

$$\therefore F_{cyl} = F_{load} \frac{L_2}{(L_1+L_2)\cos\phi}$$

6\. a. Volumetric efficiency indicates the amount of leakage that takes place within the pump. This involves considerations such as manufacturing tolerances and flexing of the pump casing under design pressure operating conditions.

$$\eta_v = \frac{\text{Actual flow-rate produced by pump}}{\text{Theoratical flow-rate pump should produce}}$$

$$= \frac{Q_A}{Q_T}$$

b. Theoratatical flow rate is the quatity of flow a pump should produce: It is the product of volumetric displacement and speed of the pump.

$$Q_T = V_D \times N$$

c. Mechanical efficiency indicates the amount of energy losses that occur for reasons other than leakage.

$$\eta_m = \frac{\text{Pump output power assuming no leakage}}{\text{Actual power delivered to pump}}$$

$$\eta_m = \frac{P\,Q_T}{T_A\,N}$$

d. Overall efficiency is the ratio of actual power delivered by pump and actual power delivered to pump.

$$\eta_o = \frac{\text{Actual power delivered by pump}}{\text{Actual power delivered to pump.}}$$

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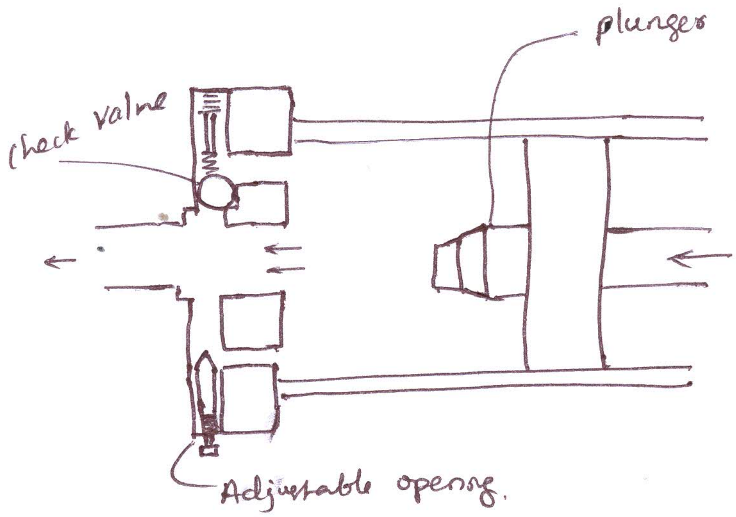
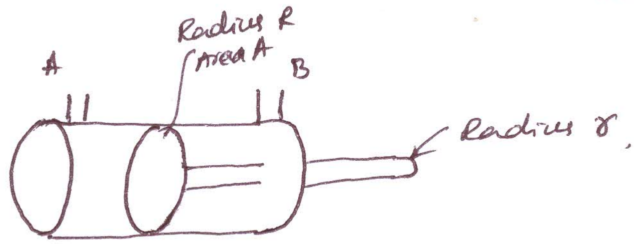
7. a. End cushioning in a hydraulic cylinder.



6. Linear hydraulic actuators.

The basic linear actuator is the cylinder or ram the cylinder consists of a piston, radius R, moving in a bore. The piston is connected to a rod of radius r. which drives the load.



A simple cylinder

obviously if pressure is applied to port A ~~the~~ (port B venting), the piston extends. Similarly if pressure is applied to port Y with (port B venting) the piston retracts.

The simplest type hydraulic cylinder is the single acting design. It consists of a piston inside a cylindrical housing called barrel. Attached to one end of the piston is a rod. which extends outside one end of the cylinder. At the other end is a port for the entrance and exit of oil.