53 (IE 711) FPCN

2019

FLUIDIC POWER AND CONTROL

Paper : IE 711

Full Marks : 100

Time : Three hours

The figures in the margin indicate full marks for the questions.

*Answer **any five** questions.*

1. *(a)* *(i)* What are the desirable features of AIR as a Power fluid ? 3

(ii) What are the disadvantages of using AIR versus using hydraulic oil ? 3

(iii) Name the *six* basic components required in a hydraulic system. 4

(iv) Why we do not use water to measure Barometric Pressure ? Justify your answer with calculation. 4

Contd.

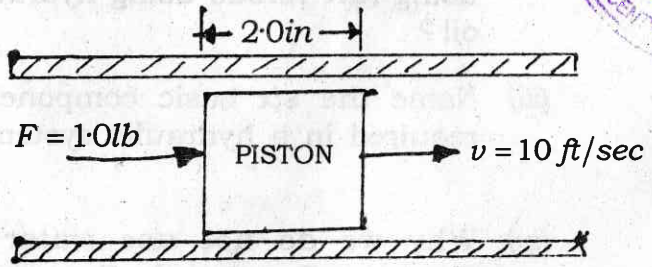
(v) Define the following terms 6

(i) Bulk Modulus

(ii) Kinematic viscosity.

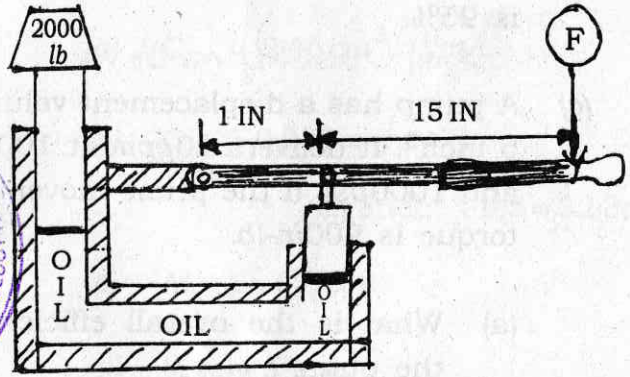
2. (a) A cylindrical container has a diameter of 0·5*m* and a height of 1*m*. If it is to be filled with a liquid having a specific weight of $2000\,N/m^3$, how much *kg* of this liquid must be added? 5

(b) A 1·0*lb* force moves a piston inside a cylinder at a velocity of 10*ft/sec*. The 4·0*inch* diameter piston is centrally located in the 4·004*inch* inside diameter cylinder. An oil film separates the piston from the cylinder. Find the absolute viscosity of the oil in units of *lb-s/ft*^{2}. 5



(c) What is the Continuity Equation and what are its implication relative to fluid flow? 5

(d) The hydraulic jack is filled with oil. The large and small pistons have diameters of 3*inch* and 1*inch* respectively. What force *'F'* on the handle is required to support the 2000*lb* weight? If the force moves down 5 inch, how far will the weight be lifted? 5



3. (a) (i) What is the physical difference between laminar and turbulent flow? 2

(ii) What are the important conclusions resulting from Reynold's number? 2

(iii) Find the head loss due to friction in units of *psi* for a 100*ft* length of pipe. The oil has a SG of 0·90, $N_R = 774$. 6

(b) Find the offset angle for an axial piston pump that delivers 16*gpm* at 3000 *rpm*. The pump has nine, ½ inch diameter pistons arranged on a 5 inch diameter piston circle. The volumetric efficiency is 95%. 5

(c) A pump has a displacement volume of 5 inch^3. It delivers 20*gpm* at 1000*rpm* and 1000*psi*. If the prime mover input torque is 900*in-lb*. 5

(a) What is the overall efficiency of the pump ?

(b) What is the theoretical torque required to operate the pump ?

4. (i) Draw a neat diagram of an electro hydraulic servo system (closed loop system). 2

(ii) Explain the following terms :

- System Accuracy (Repeatable Error) 2
- Open loop gain 2
- Tracking Error 2
- Dead band and hysteresis 2

(iii) An electro hydraulic servo system contains the following characteristics : 10

(a) $G_{SV} = (2{\cdot}46\,cm^3/s)/mA$

(b) $G_{cyl} = 0{\cdot}031\,cm/cm^3$,

Cylinder area $= 32{\cdot}3\,cm^2$

(c) $M = 1{\cdot}57\,V/cm$

(d) $V_{oil} = 819\,cm^3$

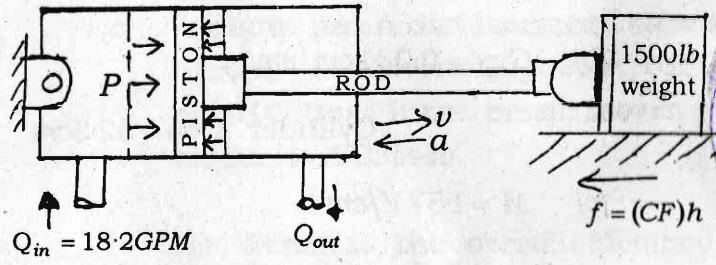
(e) Mass of Load $= 450\,kg$

(f) System Deadband $= 4\,mA$

(g) Bulk Modulus of oil $= 1200\,MPa$

Determine the System Accuracy.

5. *(a)* A pump delivers oil at a rate of 18·2*gpm* into the blank end of the 3-*in*-diameter hydraulic cylinder. The piston contains a 1-*in*-diameter cushion plunger that is 0·75*in.* long and therefore the piston decelerates over a distance of 0·75*in.* at the end of its extension stroke. The cylinder drives a 1500*lb* weight, which slides on a flat horizontal surface having a coefficient of friction (CF) equal to 0·12. The pressure relief valve settings equals 750*psi*. Find the maximum pressure (P_2) developed by the cushion. 10



(b) For a hydraulic motor, define

(i) Volumetric, *(ii)* Mechanical

(iii) Overall Efficiency. 3

Why does a hydraulic motor use more flow than it should theoretically? 2

(c) A hydraulic motor has a 5-in^3 volumetric displacement. If it has a pressure rating of 1000*psi* and it

receives oil from a 10*gpm* theoretical flow-rate pump, find the motor 5

(i) Speed *(ii)* Theoretical Torque

(iii) Theoretical HP.

6. *(a)* A needle valve is used to control the extending speed of a hydraulic cylinder.

The needle valve is placed in the outlet line of the hydraulic cylinder the following data are given: 5

1) Desired cylinder speed = 10*in/s*

2) Cylinder Piston diameter = 2*in*

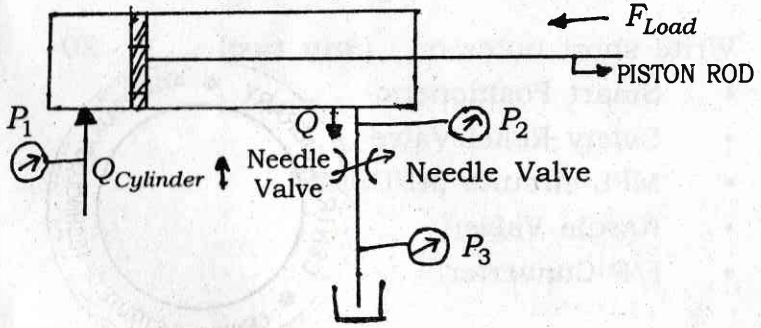
3) Cylinder rod diameter = 1*in*

4) Cylinder load =1000*lb*

5) Specific gravity = 0·90

6) Pressure relief valve setting=500*psi*

Determine the required capacity coefficient of the needle valve?



(b) (i) What is the difference between a flared fitting and a compression fitting? 2

(ii) What are the various sealing devices? Discuss the characteristics of a O-Ring and common materials used for seals. 4

(iii) What are the probable causes of hydraulic system problems for the following operations?

— Noisy Pump 2

— Overheating of hydraulic fluid. 2

(c) A steel tubing has a 1·250 inch diameter (OD) and a 1·060 inch inside diameter (ID). It is made of SAE1010 dead soft cold drawn steel having a tensile strength of 55,000 *psi*. What would be the safe working pressure for this tube assuming a factor of safety 8? 5

7. Write short notes on : ***(any two)*** 20

- Smart Positioners
- Safety Relief Valve
- MPL circuits (AND, OR)
- Needle Valve
- I/P Converter.