

## LECTURE 4-GOVERNING PRINCIPLES AND LAWS

### FREQUENTLY ASKED QUESTIONS

**1. Define hydraulic power. Derive an expression for the hydraulic power if the flow is in LPS and pressure in kPa.**

Hydraulic power = fluid power = pressure x volume flow rate

Hydraulic power (watts) = P (N/m<sup>2</sup>) x Q (m<sup>3</sup>/s)

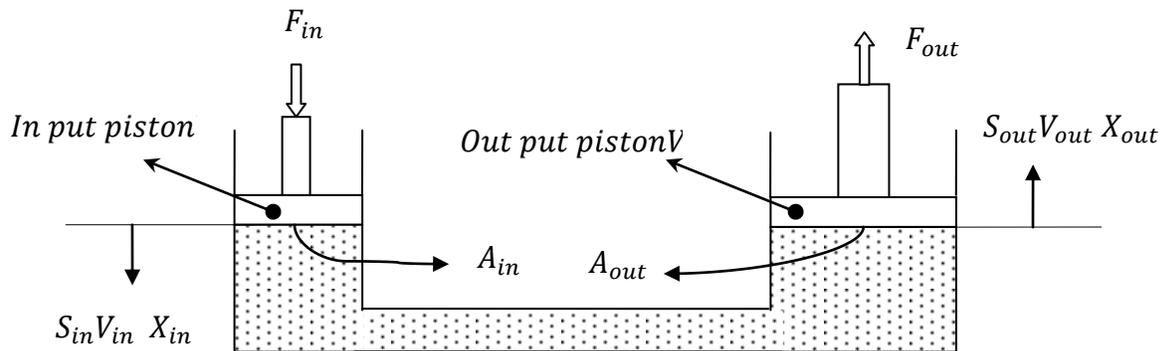
Q(LPS) = 1000 m<sup>3</sup>/sec

P(kPa) = 100 (N/m<sup>2</sup>)

Hydraulic power (watts) = P (N/m<sup>2</sup>) x Q (m<sup>3</sup>/s) =  $\frac{P \text{ (kPa)}}{100} \times \frac{Q \text{ (LPS)}}{1000}$  watts

**2. How will you explain the Pascal's law, with reference to working of a hydraulic cylinder?**

Pascal's law states that the pressure exerted on a confined fluid is transmitted undiminished in all directions and acts with equal force on equal areas and at right angles to the containing surfaces



$$\frac{F_{out}}{F_{in}} = \frac{A_{out}}{A_{in}} = \frac{S_{in}}{S_{out}}$$

### 3 State Daniel Bernoulli's theorem

Bernoulli's theorem states that in a steady flow of fluid, the sum of the potential head, velocity head and pressure head remains constant throughout.

### 4. What is continuity equation and what are its implications relative to fluid power

Continuity equation states that the weight flow rate is same for all cross sections of pipe. Larger pipe gives smaller velocity and smaller pipes give larger velocity.

### 5. What is the significance of each term in the energy equation?

Velocity head signifies the kinetic energy of the fluid per unit weight .pressure head signifies pressure energy of the fluid per unit weight and elevation head is potential energy per unit weight of fluid.

### 6. Define: Pressure head, elevation head and kinetic head

Velocity head signifies the kinetic energy of the fluid per unit weight .pressure head signifies pressure energy of the fluid per unit weight and elevation head is potential energy per unit weight of fluid.

$$Z_1 + \frac{v_1^2}{2g} + \frac{P_1}{\gamma} + H_p - H_m - H_L = Z_2 + \frac{v_2^2}{2g} + \frac{P_2}{\gamma}$$

### 7. State Torricelli's theorem and mention its significance

Torricelli's Theorem is Bernoulli's equation with certain assumption made. Torricelli's theorem states that the velocity of the water jet of liquid is directly proportional to the square root of the head of the liquid producing it. This deals with the set up where you have a large tank with a narrow opening allowing for the liquid to flow out. Both the Tank and the narrow opening (nozzle) are open to the atmosphere.

$$v_2 = \sqrt{2gh}$$

$v_2$ =jet velocity (m/s),  $g$ = acceleration due to gravity ( $m/s^2$ ); $h$ = pressure head (m).

## 8. Explain how a siphon operates

The Siphon is a familiar hydraulic device. It is commonly used to cause a liquid to flow from one container in an upward direction over an obstacle and then flow downwards into a second lower container. As shown in Figure above, a siphon consists of a U-tube with one end submerged below the level of the liquid surface , and the free end lies below it on the outside of the container.

For the fluid to flow out of the free end, two conditions must be met:

1. The elevation of the free end must be lower than the elevation of the liquid surface inside the container.
2. The fluid must initially be forced to flow up from the container into the center portion of the U- tube. This is normally done by temporarily providing a suction pressure at the free end of the siphon. For example, when the siphoning gasoline from automobile gas tank, a person can develop this suction by momentarily sucking on the free end of the hose. This allows atmospheric pressure in the tank to push the gasoline up the U- tube hose, as required. For continuous flow operation, the free end of the U-tube hose must lie below the gasoline level in the tank.

