



College of Engineering & Technology

Department: Mechanical Engineering

Marks: 15

Lecturer: Dr. Rola Afify

Time: 1.15 - 2.00

Course Code: ME464

Date: 26/3/2013

Name: Model Answer

Answer the following questions:

Question one (5 marks)

Explain pump theory with giving examples.

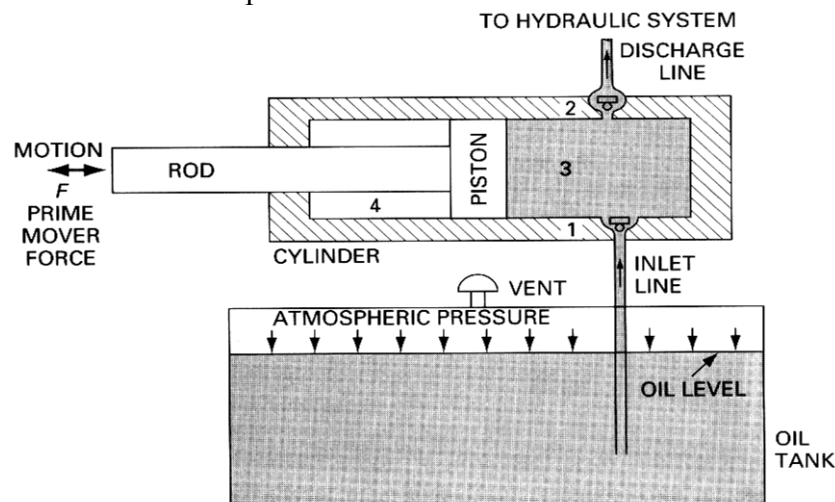
A Pump, which is the Heart of a Hydraulic System, converts Mechanical Energy into Hydraulic Energy. The Mechanical Energy is delivered to the Pump via a Prime Mover such as an Electric Motor. Due to Mechanical Action, the Pump Creates a Partial Vacuum at its Inlet. This permits Atmospheric Pressure to Force the Fluid through the inlet line and into the Pump. The Pump then pushes the Fluid into the Hydraulic System.

Pumps operate on the Principle whereby a Partial Vacuum is created at the Pump Inlet due to the Internal Operation of the Pump. This allows Atmospheric Pressure to push the Fluid out of the Oil Tank (Reservoir) and into the Pump Intake. The Pump then mechanically pushes the Fluid out the Discharge Line.

For Example

Note that this Pump contains Two Ball Check Valves, which are described as follows:

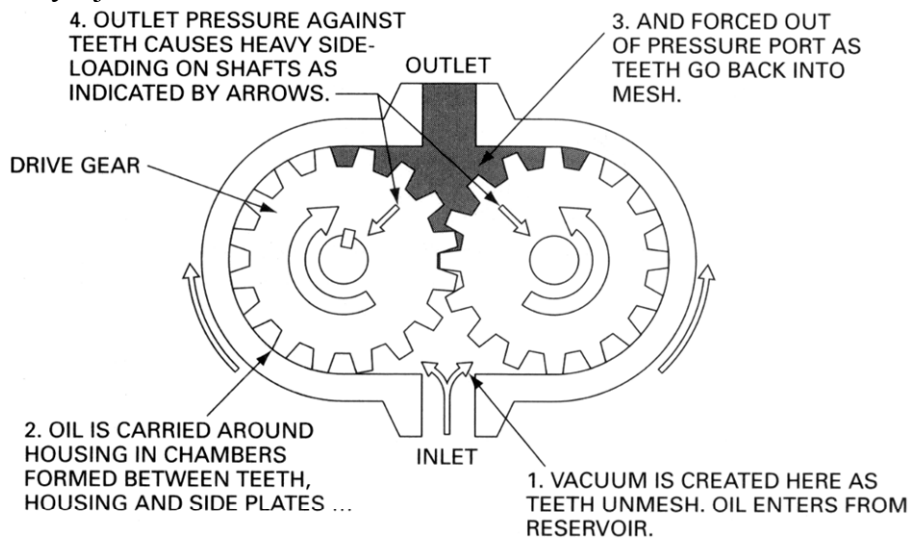
Check Valve 1 is connected to the Pump Inlet Line and allows fluid to enter the pump only at this location. Check Valve 2 is connected to the Pump discharge Line and allows fluid to leave the pump only at this location. As the Piston is pulled to the Left, A Partial Vacuum is generated in Cavity 3, because the close tolerance between the Piston and Cylinder (or the use of Piston Ring Seals) prevents Air inside Cavity 4 from traveling into Cavity 3. This Flow of Air, if allowed to occur, would Destroy the Vacuum. This Vacuum holds the Ball of Check Valve 2 against its seat (lower position) and allows Atmospheric Pressure to push Fluid from the Reservoir into the Pump via Check Valve 1. This Inlet Flow occurs because the Force of the Fluid pushes the ball of Check Valve 1 Off its Seat. When the Piston is pushed to the Right, the fluid movement closes Inlet Valve 1 and Opens Outlet Valve 2. The Quantity of Fluid, displaced by the piston, is forcibly ejected Out the Discharge Line leading to the Hydraulic System. The Volume of Oil displaced by the Piston during the Discharge Stroke is called the Displacement Volume of the Pump.



Question two (10 marks)

Compare between External Gear Pump and Vane Pump using neat sketches.

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 Chambers 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 Pressure to Below Atmospheric Pressure Fluid is pushed into this Void by Atmospheric Pressure because the Oil Supply Tank is vented to the Atmosphere. The Discharge Side is where Teeth Go into Mesh and it is here that the Volume decreases between Mating Teeth. Since the Pump has a Positive Internal Seal against Leakage, the Oil is Positively Ejected into the Outlet Port.



In Vane Pumps, The Rotor, which contains Radial Slots, is splined to the Drive Shaft and Rotates inside a Cam Ring. Each Slot contains a Vane designed to mate with the surface of the Cam Ring as the Rotor Turns. Centrifugal Force keeps the Vanes Out against the Surface of the Cam Ring. During One-Half Revolution of Rotor Rotation, the Volume increases between the Rotor and Cam Ring. The resulting Volume Expansion causes a Reduction of Pressure. This is the Suction Process, which causes Fluid to Flow through the Inlet Port and Fill the Void. As the Rotor Rotates through the Second Half Revolution, the Surface of the Cam Ring pushes the Vanes Back into their Slots, and the Trapped Volume is reduced. This Positively ejects the Trapped Fluid through the Discharge Port.

