Scheme of evaluation and Solution IA Test II – Oct. 2018

Sub:	Fluid Power Systems					Sub Code:	15ME72	Branch:	ME	
Date:	15/10/2018	Duration:	90 min's	Max Marks:	50	Sem / Sec:	7th sem A & B			

Answer any FIVE FULL Questions

MARKS

1 (a) Neat Sketch of check valve showing the construction features – 3 [06]

Explanation of working principles of check valve – 2

Graphical symbol of check valve - 1

(b) Various classifications of hydraulic valves – 3 [04]

Brief explanation - 1

2 (a) Working principle of simple pressure relief valve – 2 [06]

Neat sketch showing the working of simple PRV – 3

Graphical symbol of PRV - 1

(b) Any two types of center flow path configuration with brief explanation - 2 * 2 [4]

3 (a) Circuit diagram for controlling a single acting cylinder – 4 [06]

Explanation of the circuit diagram – 2

(b) Graphical symbol of 4 types of actuation method – 4 * 1 [04]

4 Hydraulic cylinders sequencing circuit [10]

Drawing the hydraulic circuit - 6

Explanation of the circuit - 4

5 Double pump circuit [10]

Drawing the hydraulic circuit - 6

Explanation of the circuit - 4

6 Regenerative circuit [10]

Drawing the hydraulic circuit - 6

Explanation of the circuit - 4

7 Automatic cylinder reciprocation [10]

Drawing the hydraulic circuit - 6

Explanation of the circuit - 4

Solution for FPS IAT 2

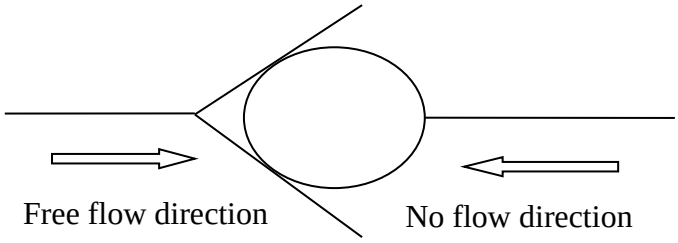
1 (a) **Check Valve**

2/2 DCV (Poppet design)

a. Valve Closed b. Valve Opened

Figure Shows a ball poppet type 2 / 2 DCV. It is essentially a check valve as it allows free flow of fluid only in one direction (P to A) as the valve is opened hydraulically and hence the pump Port P is connected to port A as shown in fig b. In the other direction the valve is closed by the ball poppet and hence the flow from the port A is blocked. A poppet is a specially shaped plug element held onto a seat by a spring. Fluid flows through the valve in the space between the seat and poppet. As shown, light spring holds the poppet in the closed position. In the free-flow direction, the fluid pressure overcomes the spring force at about 35kPa.

If flow is attempted in the opposite direction, the fluid pressure pushes the poppet along with the spring force in the closed position. Therefore no flow is permitted. The higher the pressure, the greater will be the force pushing the poppet against the seat. Thus, increased pressure will not result in any tendency to allow flow in the no flow direction. The symbol for this type of design is same as that of check valve.



Symbol of Check valve

(b) Directional control valves can be classified in a number of ways:

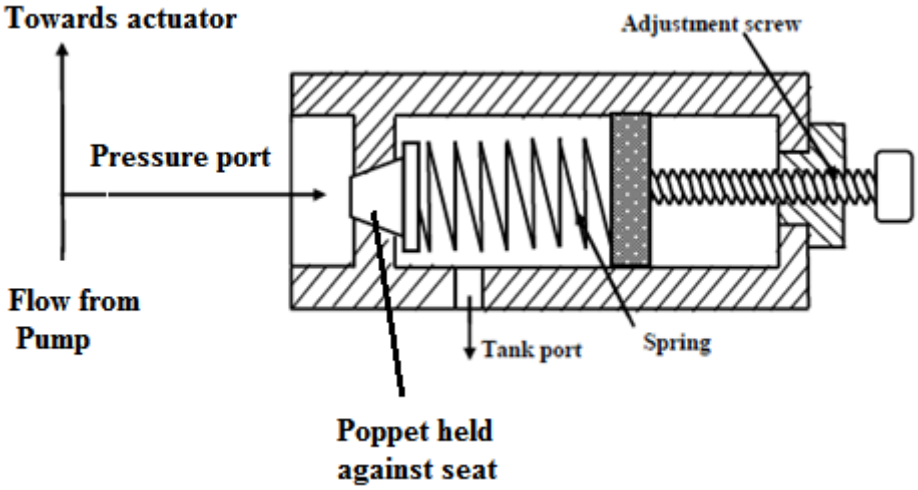
1. <u>According to type of construction:</u>
   - Poppet valves
   - Spool valves
2. <u>According to number of working ports:</u>
   - Two- way valves
   - Three – way valves

- Four- way valves

3. <u>According to number of switching position</u>:
   - Two – position
   - Three - position
4. Actuating mechanism:
   - Manual actuation
   - Mechanical actuation
   - Solenoid actuation
   - Hydraulic actuation
   - Pneumatic actuation
   - Indirect actuation

2 (a) The pressure relief valves are used to protect the hydraulic components from excessive pressure. This is one of the most important components of a hydraulic system and is essentially required for safe operation of the system. Its primary function is to limit the system pressure within a specified range. It is similar to a fuse in an electrical system. Pressure relief valve is normally a closed type and it opens when the pressure exceeds a specified maximum value by diverting pump flow back to the tank. The simplest type valve contains a poppet held in a seat against the spring force as shown in Figure

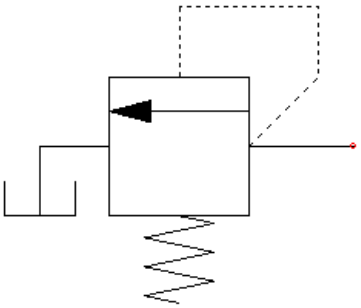
The fluid enters from the opposite side of the poppet. When the system pressure exceeds the preset value, the poppet lifts and the fluid is escaped through the orifice to the storage tank directly. It reduces the system pressure and as the pressure reduces to the set limit again the valve closes.



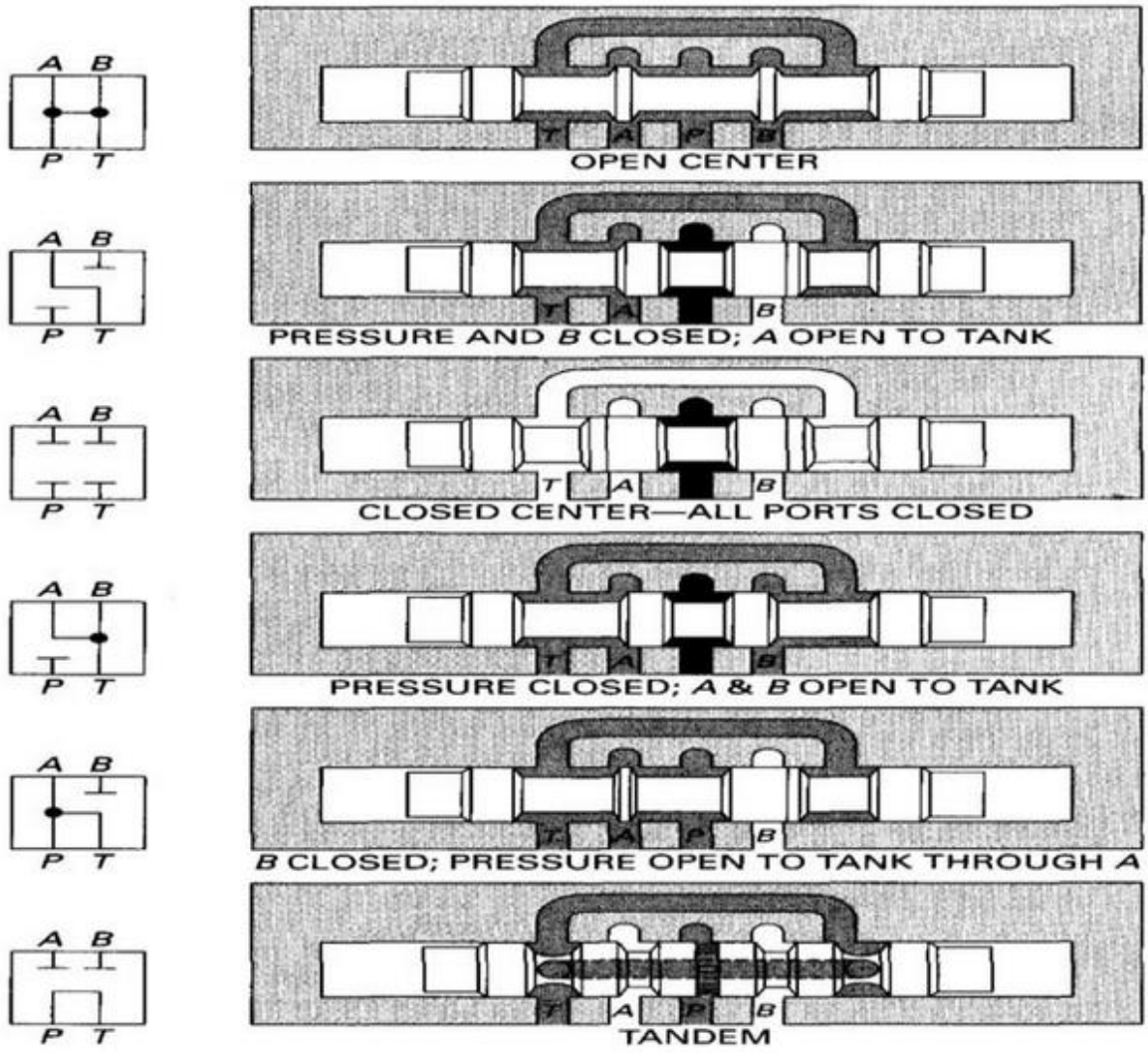
Schematic of simple pressure relief valve is shown in figure. This type of valves has two ports; one of which is connected to the pump and another is connected to the tank. It consists of a spring chamber where poppet is placed with a spring force. Generally, the spring is adjustable to set the maximum pressure limit of the system. The poppet is held in position by combined effect of spring force and

dead weight of spool. As the pressure exceeds this combined force, the poppet raises and excess fluid bypassed to the reservoir (tank). The poppet again reseats as the pressure drops below the pre-set value.

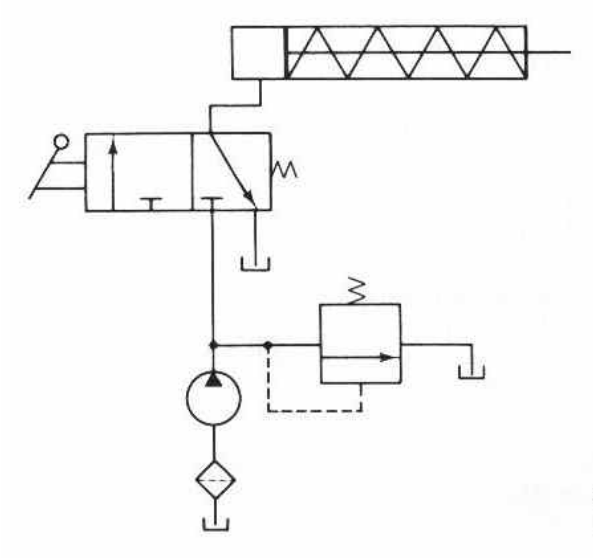
Symbolic representation of a simple pressure-relief valve



(b) Three- position, four- way DCV have different variety of center configurations. The common varieties are the open center, closed center, tandem center, floating center, & regenerative center with open, closed and tandem are the three basic types A variety of center configurations provides greater flexibility for circuit design.



3 (a) **Control of a Single-Acting Hydraulic Cylinder**

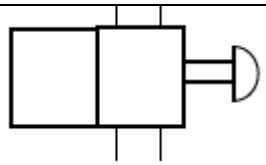
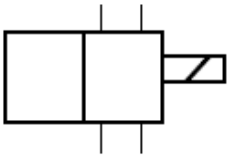
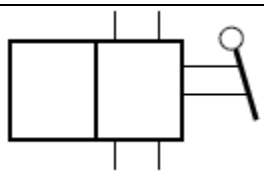
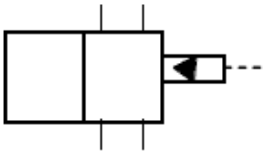


Control of a single-acting cylinder

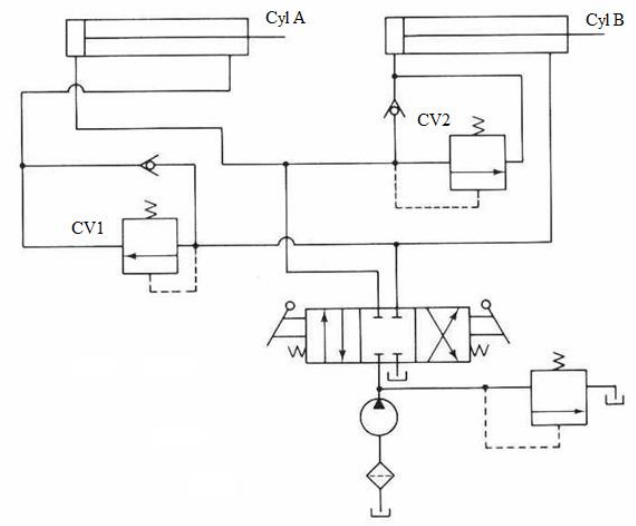
Figure shows that the control of a single-acting, spring return cylinder using a three-way two-position manually actuated, spring offset direction-control valve (DCV). In the spring offset mode, full pump flow goes to the tank through the pressure-relief valve (PRV). The spring in the rod end of the cylinder retracts the piston as the oil from the blank end drains back into the tank. When the valve is manually actuated into its next position, pump flow extends the cylinder.

After full extension, pump flow goes through the relief valve. Deactivation of the DCV allows the cylinder to retract as the DCV shifts into its spring offset mode.

(b)

	Push button operated
	Solenoid actuated
	Manual operated (Lever)
	Pilot actuated

4 **Sequencing circuit**

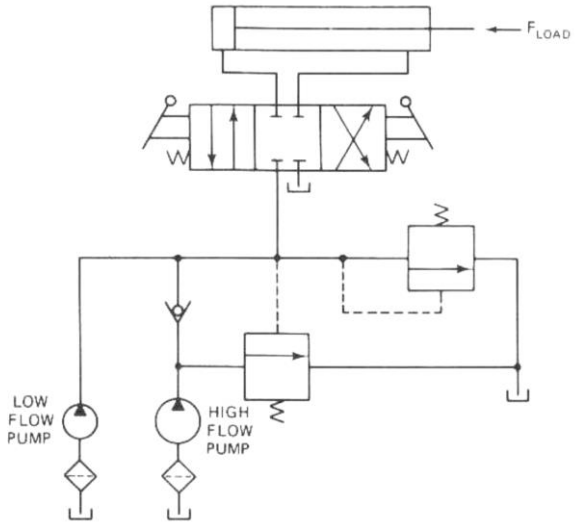


In many applications, it is necessary to perform operations in a definite order. Hydraulic cylinders can be operated sequentially using a sequence valve. Figure shows that two sequence valves are used to sequence the operation of two double-acting cylinders. This sequence of cylinder operation is controlled by sequence valves. This hydraulic circuit can be used in a production operation such as drilling. Cylinder A is used as a clamp cylinder and cylinder B as a drill cylinder. Cylinder A extends and clamps a work piece. Then cylinder B extends to drive a spindle to drill a hole. Cylinder B retracts the drill spindle and then cylinder A retracts to release the work piece for removal.

The sequence of operation realized by the circuit shown in Figure is:
Step A – Extend Cylinder A (To clamp the work piece)
Step B – Extend Cylinder B while holding pressure on Cylinder A (To perform drilling operation)
Step C – Retract Cylinder B (To retract the spindle after drilling)
Step D – Retract Cylinder A (To unclamp the work piece)
When the DCV is shifted into its left envelope mode, the cylinder A extends completely. When the pressure reaches the pressure setting of sequence valve (SV1), the valve opens and fluid flow is allowed to the cylinder B as a result cylinder B extends. If the DCV is then shifted into its right envelope mode cylinder B retracts fully, and then the cylinder A retracts. Hence this sequence of cylinder operation is controlled by the sequence valves. The spring cantered position of the DCV locks both cylinders in place.

5 **Double-pump hydraulic circuit.**

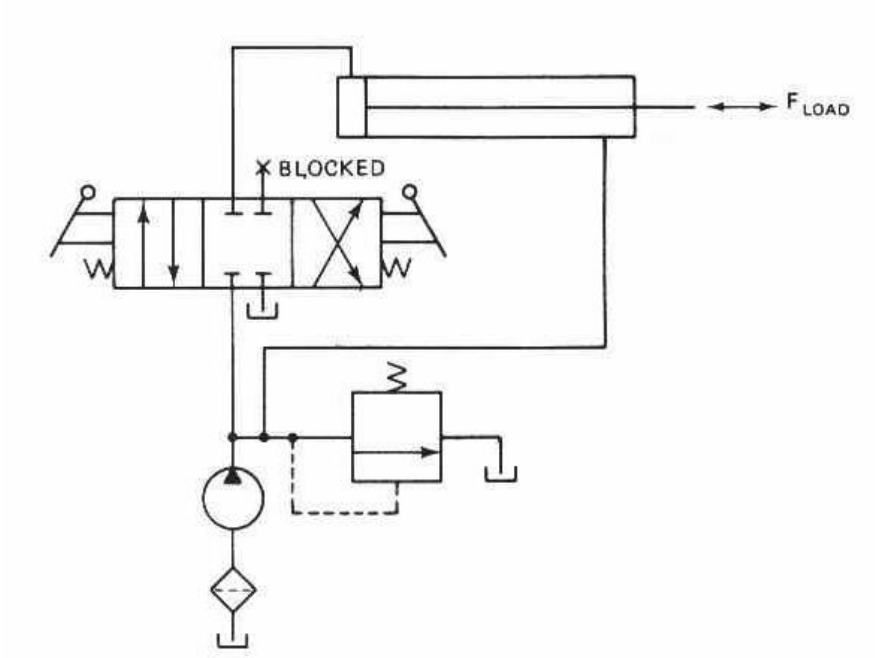
Figure shows an application for an unloading valve. It is a circuit that uses a high-pressure, low-flow pump in conjunction with a low-pressure, high-flow pump. A typical application is a sheet metal punch press in which the hydraulic cylinder must extend rapidly over a great distance with low-pressure but high-flow requirements. This occurs under no load. However during the punching operation for short motion, the pressure requirements are high, but the cylinder travel is small and thus the flow requirements are low. The circuit eliminates the necessity of having a very expensive high-pressure, high-flow pump.



When the punching operation begins, the increased pressure opens the unloading valve to unload the low-pressure pump. The purpose of relief valve is to protect the high-pressure pump from over pressure at the end of cylinder stroke and when the DCV is in its spring-centered mode. The check valve protects the low-pressure pump from high pressure, which occurs during punching operation, at the ends of the cylinder stroke and when the DCV is in its spring-centered mode.

6 Regenerative Cylinder Circuit

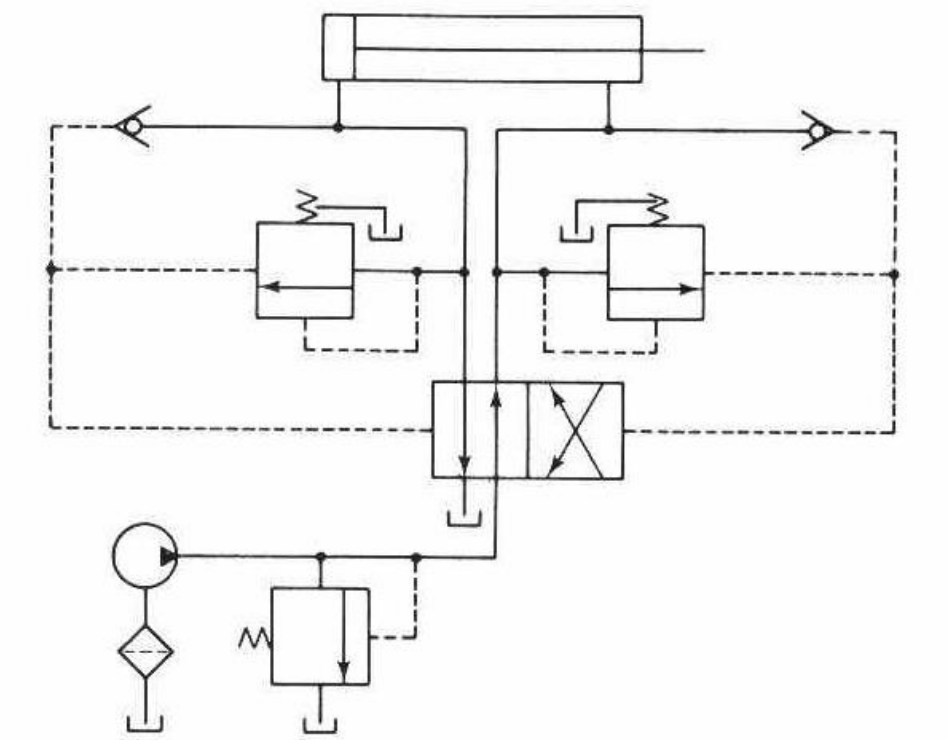
Figure shows a regenerative circuit that is used to speed up the extending speed of a double-acting cylinder. The pipelines to both ends of the hydraulic cylinder are connected in parallel and one of the ports of the 4/3 valve is blocked by simply screwing a thread plug into the port opening. During retraction stroke, the 4/3 valve is configured to the right envelope. During this stroke, the pump flow bypasses the DCV and enters the rod end of the cylinder. Oil from the blank end then drains back to the tank through the DCV.



When the DCV is shifted in to its left-envelope configuration, the cylinder extends as shown in Fig.

1.3.The speed of extension is greater than that for a regular double-acting cylinder because the flow from the rod end regenerates with the pump flow Q_P to provide a total flow rate Q_T.

7 **Automatic cylinder reciprocating system**



The hydraulic circuit shown in Fig. 1.9 produces continuous reciprocation of a double-acting cylinder using two sequence valves. Each sequence valve senses the completion of stroke (end of extension or end of retraction) by the corresponding build-up pressure. Each check valve and the corresponding pilot line prevent the shifting of the four-way valve until the particular stroke of the cylinder is completed. The check valves are needed to allow pilot oil to leave either end of the DCV while the pilot pressure is applied to the opposite end. This permits the spool of the DCV to shift as required.