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IV/IV B.Tech (Regular/Supplementary) DEGREE EXAMINATION

November, 2022

Institutional Elective (Common to all branches)

Seventh Semester

Fluid Power & Control Systems

Time: Three Hours

Maximum: 50 Marks

Answer Question No. 1 Compulsorily.

(10X1 = 10 Marks)

Answer **ANY ONE** question from each Unit.

(4X10=40 Marks)

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|-------------------|--|----------|--------------|
| 1. | a) Define fluid power. What is the basic law used in fluid power systems. | CO1(BL1) | |
| | b) List out any three applications of fluid power system. | CO1(BL1) | |
| | c) What are the basic components of fluid power system? | CO2(BL1) | |
| | d) What is the purpose of check valve? | CO2(BL1) | |
| | e) Show the symbol for 4/2 direction control valve. | CO2(BL1) | |
| | f) Write the use of lubricator. | CO1(BL1) | |
| | g) What is the function of reservoir in a pneumatic system? | CO3(BL2) | |
| | h) What do you understand by FRL unit in Pneumatic system. | CO3(BL1) | |
| | i) Highlight the need of using an accumulator in hydraulic circuits. | CO4(BL2) | |
| | j) List four types of faults and causes of hydraulic system break down. | CO4(BL1) | |
| Unit - I | | | |
| 2. | a) List out the advantages and disadvantages of fluid power systems. | CO1(BL1) | 5M |
| | b) Differentiate between hydraulic fluid power and pneumatic fluid power. | CO1(BL3) | 5M |
| (OR) | | | |
| 3. | a) Explain the construction and working of vane pump with a neat sketch. | CO1(BL2) | 5M |
| | b) Explain different types of hydraulic actuators with neat sketches. | CO1(BL2) | 5M |
| Unit - II | | | |
| 4. | a) Explain the pilot-operated pressure relief valve with a neat diagram. | CO2(BL2) | 5M |
| | b) Write short notes on two-way direction control valve. | CO2(BL2) | 5M |
| (OR) | | | |
| 5. | a) Explain the sequential (A +B +A- B-) hydraulic circuit used in punching press. | CO2(BL4) | 5M |
| | b) Differentiate between series and parallel synchronization circuits. | CO2(BL3) | 5M |
| Unit - III | | | |
| 6. | a) With a neat sketch explain the structure of a pneumatic control system. | CO3(BL2) | 5M |
| | b) Explain the classification of pneumatic valves. | CO3(BL2) | 5M |
| (OR) | | | |
| 7. | a) Explain the operation of double acting cylinder with a neat sketch. | CO3(BL2) | 5M |
| | b) Explain the functioning of time delay pneumatic circuit. | CO3(BL2) | 5M |
| Unit - IV | | | |
| 8. | a) Briefly explain the uses of accumulators. | CO4(BL2) | 5M |
| | b) Explain the maintenance requirement for hydraulic power systems. | CO4(BL2) | 5M |
| (OR) | | | |
| 9. | A hydraulic cylinder is used for industrial application. It has been decided to use an accumulator as a leakage compensator. Design a circuit to fulfill these requirements. | | CO4(BL5) 10M |



Detailed Scheme of Evaluation

1. a) Define fluid power. What is the basic law used in fluid power systems

Fluid power is the use of fluids under pressure to generate, control, and transmit power. Fluid power is subdivided into hydraulics using a liquid such as mineral oil or water, and pneumatics using a gas such as air or other gases. Pascal's law is used as basic law in fluid power

b) List out any three applications of fluid power system.

Industrial (also known as fixed)

- metalworking
- injection molding
- controllers
- material handling

Aerospace

- landing gears
- brakes

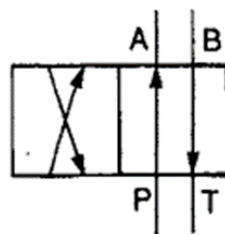
c) What are the basic components of a fluid power system?

Fluid power systems consist of four basic components: reservoir/receiver (fluid storage); pump/compressor (converts mechanical power to fluid power); valve (controls direction and amount of flow); and actuators (converts fluid power to mechanical power, that is, cylinder and pistons)

d) What is the purpose of check valve?

Check valves are generally installed in pipelines to prevent backflow. A check valve is basically a one-way valve, in which the flow can run freely one way, but if the flow turns, the valve will close to protect the piping, other valves, pumps etc.

e) Show the symbol for 4/2 direction control valve



(a) 4/2 valve

f) Write about the use of lubricator

A pneumatic lubricator injects an aerosolized stream of oil into an airline to provide lubrication to the internal working parts of pneumatic tools, and to other devices such as actuating cylinders, valves, and motors.

g) What is the function of reservoir in a pneumatic system?

Also known as a compressed air tank or air receiver, the primary function of an air reservoir is to act as temporary storage to accommodate peak demands of compressed air

h) What do you understand by FRL unit in Pneumatic system.

F: Filter

R: Regulator

L: Lubricator

i) Highlight the need to use an accumulator in hydraulic circuits

A hydraulic accumulator is a pressure vessel that performs many tasks in a hydraulic system. They are used to maintain pressure, store, and recapture energy, reduce pressure peaks, power chassis suspensions, and dampen shock, vibration, and pulsations

j) List four types of faults and causes of hydraulic system breakdown

- Insufficient/No oil in the system: This is a common reason for an inoperative system. Fill the system with suitable oil as per the specification. Also, check for leakage.
- Dirty or clogged filter: Filters play a vital role in removing the contaminants present in the oil. This can be a reason for an inoperative system, slow operation, and unpredictable operation. To resolve this issue, you want to drain the oil and replace the filter or filter element. Other worn or dirty components will also cause these issues.
- Excess load: Excess load in the system will stop the operation or slow down the operation. Check the manual for load specification.
- Aeration/Cavitation: The presence of air bubbles will reduce performance. Repair the system if you find any leak in suction side.

UNIT - I

2. a) List out the advantages and disadvantages of fluid power systems.

5M

Advantages:

- Easy to control and use
- Multiplication of force
- Constant force/Torque
- Simplicity, safety, and economy
- High power to weight ratio
- Automatic overload protection
- Instantly reversible motion
- Infinitely variable speed
- Removal of heat generated

Disadvantages:

- ✓ Hydraulic fluids are messy
- ✓ Noisy systems
- ✓ Fire hazards
- ✓ Contamination
- ✓ Damage because of high pressures

b) Differentiate between hydraulic fluid power and pneumatic fluid power.

5M

Hydraulic System	Pneumatic System
A hydraulic system is a closed-loop system.	Pneumatic System is an open-loop system.
It is robust in construction and maintenance cost is high.	It is simple in construction and maintenance cost is less.
The working fluid is hydraulic oil.	The working fluid is air.
As oil is incompressible, it can be pressurized to very high pressure.	Air is compressible and hence air can be pressurized to lesser pressure.
The system is bulky due to high pressure.	The system is less bulky as compared to a hydraulic system.
The accuracy of the system is high.	The accuracy of the system is not high.
Hydraulic oil is flammable.	Air is inflammable.

To protect against rust, the system needs special attention.	This system does not require any special attention.
Contamination control is required in this system.	Contamination control is not required in this system.
The power to size ratio is more.	The power to size ratio is small.

(OR)

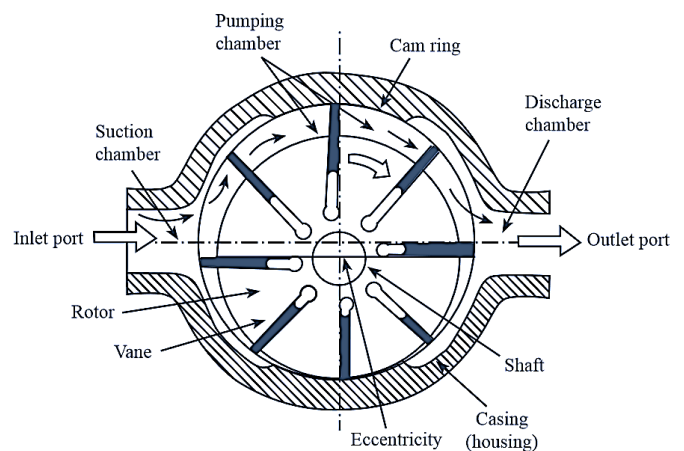
3. a) Explain the construction and working of vane pump with a neat sketch. 5M

Construction: A vane pump is a positive displacement pump that delivers a constant flow rate under different pressure conditions. It is a self-priming pump. It is known as a “vane pump” because it pressurizes the fluid due to the impact of the vanes.

This pump has a different number of vanes installed on a rotor that moves in the cavity. Sometimes, these vanes can be of variable length and tension to uphold contact with the wall as the pump derives. The pump also has a pressure relief valve that stops pressure build-up inside the pump that could break the pump.

Working of Vane Pump:

- First, the power is delivered to the shaft through an electric motor or engine.
- The shaft is connected with the rotor, which rotates according to the rotation of the shaft.
- This rotor has multiple vanes which rotate as the rotor rotates.
- As the rotor rotates, a vacuum generates inside the pump; due to that, it sucks external water into the pump.
- As the water enters the rotor area, the rotor blades move the water outward due to the centrifugal force.
- When the water hits the vanes, these vanes convert the K.E of the water into speed and send it toward the diffuser or volute casing area.
- The volute casing has a reducing area; due to that, it converts the speed of the water into pressure and increases the pressure according to the requirements.
- After pressurizing the water, the water discharges and delivers to the desired area



b) Explain different types of hydraulic actuators with neat sketches. 5M

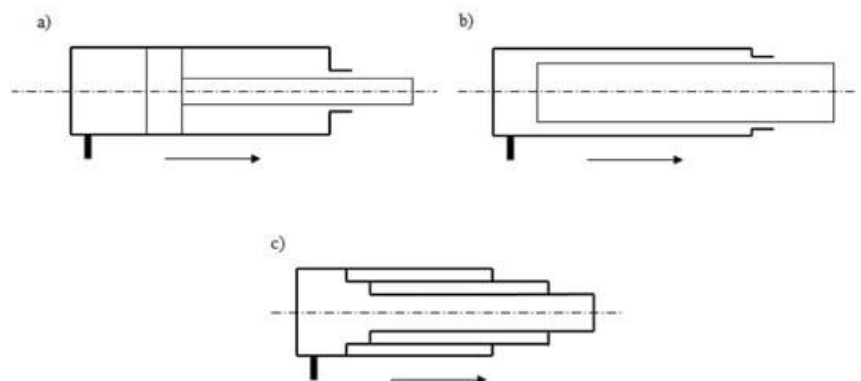
Hydraulic actuators are elements converting the energy of the working fluid into mechanical energy related to the reciprocating motion. The pressure of the working fluid acts on the piston and creates a force causing the piston assembly to move. As a result, the piston rod can perform useful work.

Hydraulic actuators are an executive element in power hydraulic systems

They are classified as Single acting and double acting cylinders

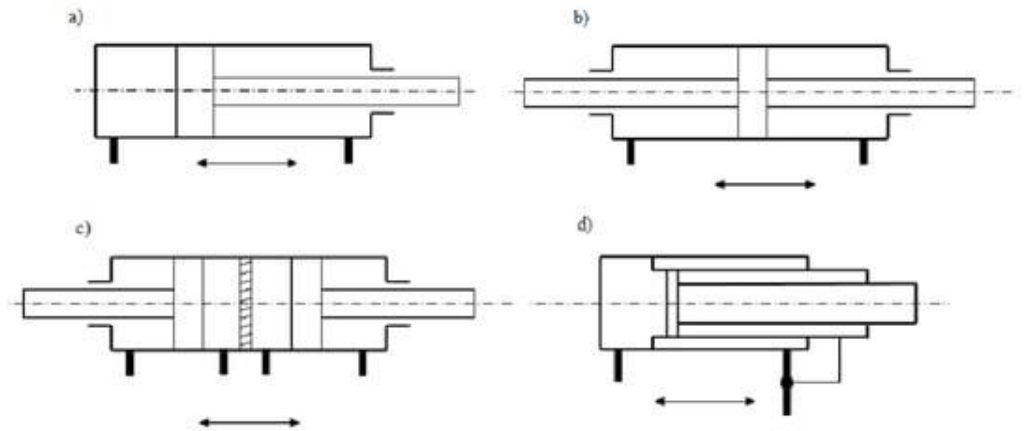
Single acting cylinder: A characteristic feature of single-acting actuators is the presence of one working chamber and the possibility of executive (active) movement only in one direction. The return movement can be carried out by an external force or a spring force.

Types of single-acting actuators: (a) piston, (b) plunger, (c) telescopic.



Double acting cylinders: Double-acting actuators, in turn, are characterized by a working stroke in both directions.

Types of double-acting actuators: (a) with one-sided piston rod, (b) two-sided piston rod, (c) multi-piston (double piston), (d) telescopic.



UNIT - II

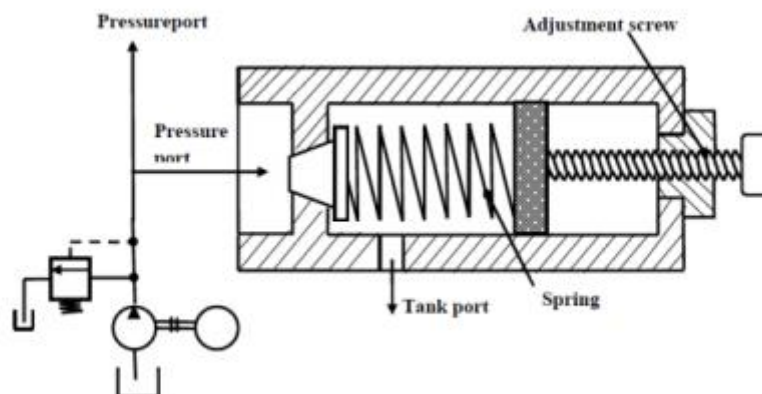
4. a) Explain the pilot-operated pressure relief valve with a neat diagram.

5M

Pilot-operated relief valves (PORV) are used for emergency relief during overpressure events (e.g., a tank gets too hot, and the expanding fluid increases the pressure to dangerous levels). PORV are also called pilot-operated safety valve (POSV), pilot-operated pressure relief valve (POPRV), or pilot-operated safety relief valve (POS RV), depending on the manufacturer and the application.

Technically POPRV is the most generic term, but PORV is often used generically (as in this article) even though it should refer to valves in liquid service.

In conventional PRVs, the valve is normally held closed by a spring or similar mechanism that presses a disk or piston on a seat, which is forced open if the pressure is greater than the mechanical value of the spring. In the PORV, the valve is held shut by piping a small amount of the fluid to the rear of the sealing disk, with the pressure balanced on either side. A separate actuator on the piping releases pressure in the line if it crosses a threshold. This releases the pressure on the back of the seal, causing the valve to open.

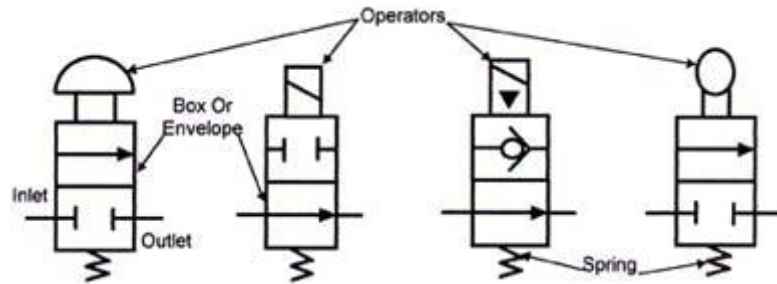


b) Write short notes on two-way direction control valve.

5M

2-way directional control valves: A 2-way directional valve has two ports normally called inlet and outlet. When the inlet is blocked in the at-rest condition, it is referred to as "normally closed" (NC). The at-rest box or the normal condition is the one with the flow lines going to and from it.

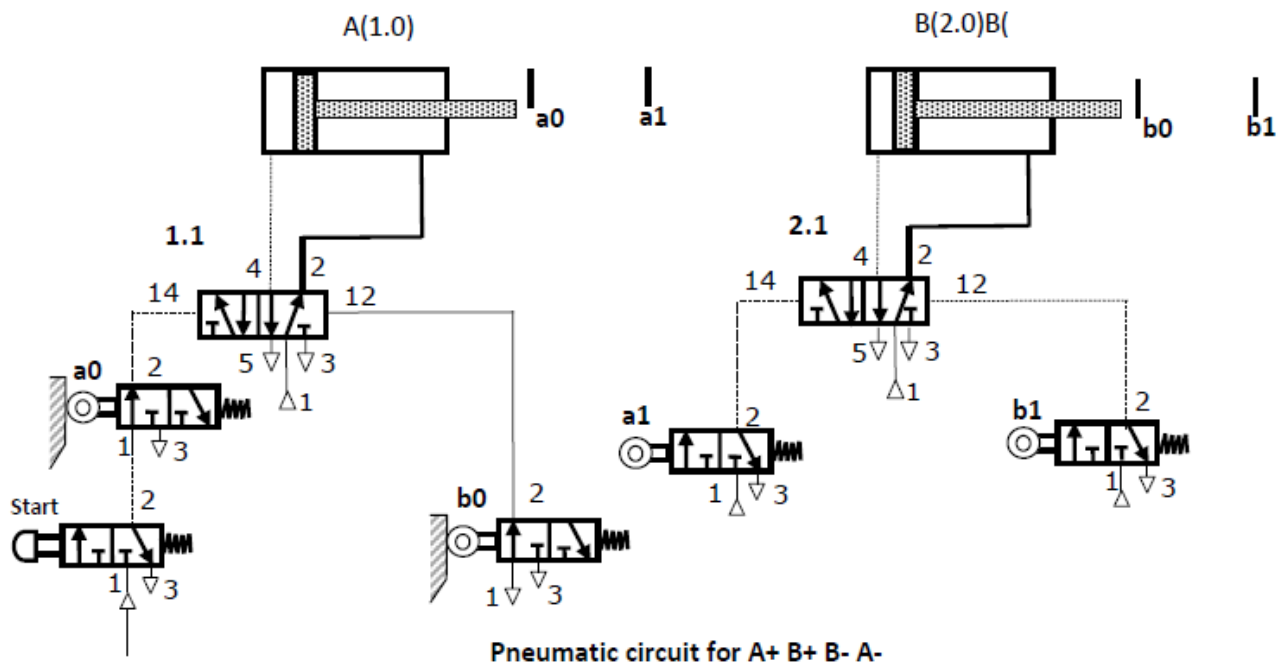
The boxes or enclosures represent the valve's positions. The active box shows blocked ports, or a closed condition, while the upper box shows a flow path. When an operator shifts the valve, it is the same as sliding the upper box down to take the place of the lower box. In the shifted condition there is flow from inlet to outlet. Releasing the palm button allows the valve spring to return to the normal stop flow condition. A 2-way valve makes a blow-off device or runs a fluid motor in one direction. By itself, a 2-way valve cannot cycle even a single acting cylinder.



(OR)

5. a) Explain the sequential (A +B +A- B-) hydraulic circuit used in punching press.

5M

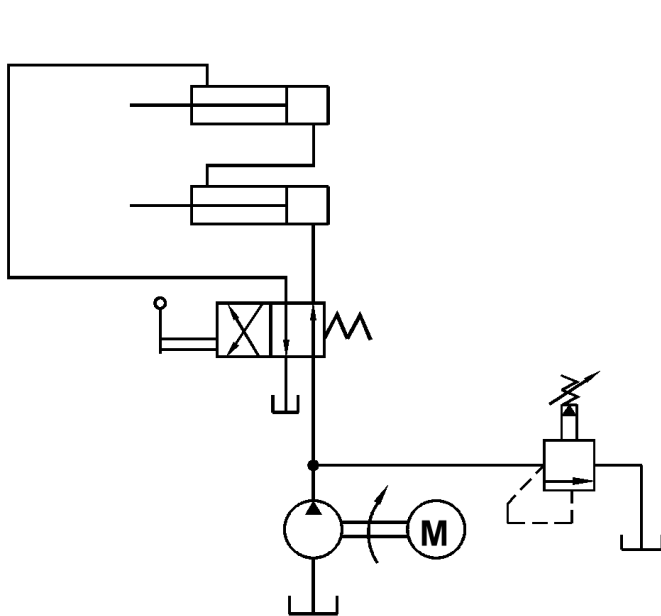


1. When the start button is pressed, the signal appears at port 14 of valve 1.1 through limit switch signal a0.
2. Check for the presence of the signal at the other end (12) of valve 1.1. Notice that the signal is also present at port 12 of valve 1.1. (Because b0 is also pressed). This results in signal conflict and valve 1.1 is unable to move.

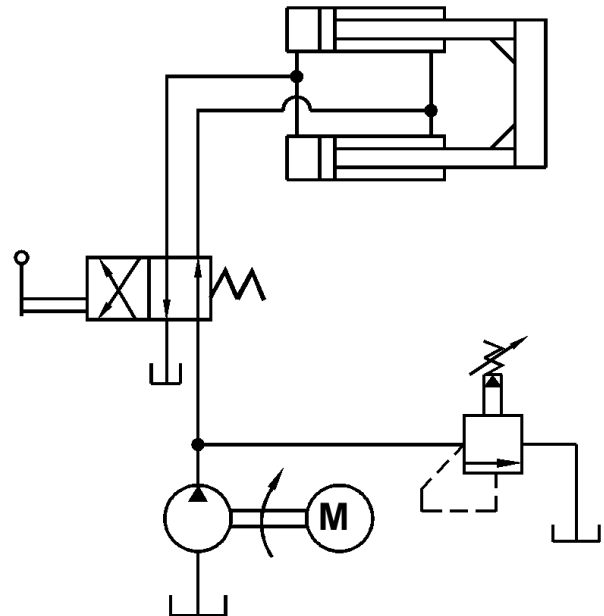
b) Differentiate between series and parallel synchronization circuits.

5M

In series circuit, Fluid from the pump is delivered to the blank end of cylinder 1, and fluid from the rod end of cylinder 1 is delivered to the blank end of cylinder 2. Fluid returns to the tank from the rod end of cylinder 2 via the DCV. Thus, the cylinders are hooked in series. For the two cylinders to be synchronized, the piston area of cylinder 2 must equal the difference between the areas of the piston and rod for cylinder 1.



Series connection

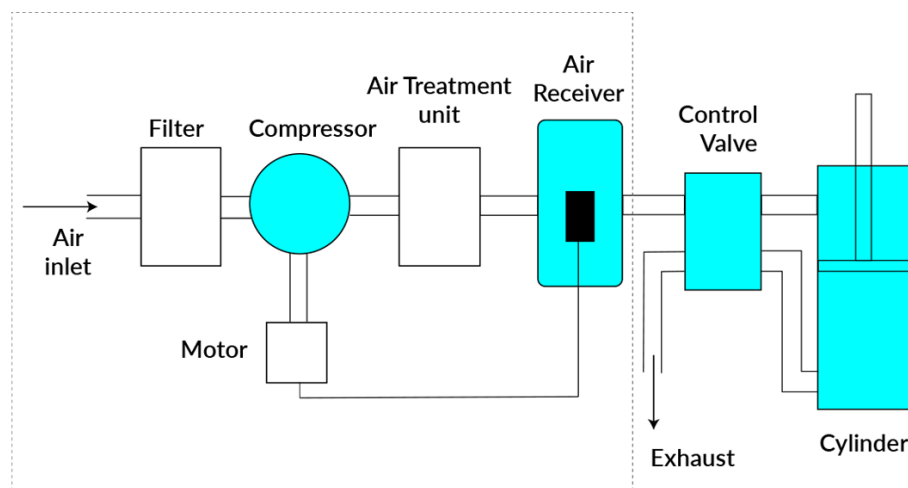


Parallel synchronization

UNIT - III

6. a) With a neat sketch explain the structure of a pneumatic control system. 5M

Pneumatic cylinders, rotary actuators and air motors provide the force and movement for most pneumatic systems, for holding, moving, forming, and processing of materials. To operate and control these actuators, other pneumatic components are needed such as air service units for the preparation of the compressed air and valves for the control of the pressure, flow, and direction of movement of the actuators. A basic pneumatic system consists of the following two main sections. The main components of the compressed air production, transportation, and distribution system consist of air compressor, electric motor and motor control centre, pressure switch, check valve, storage tank, pressure gauge, auto drain, air dryer, filters, air lubricator, pipelines, and different types of valves. The main components of air consuming system consist of intake filter, compressor, air take off valve, auto drain, air service unit, directional valve, actuators, and speed controllers



b) Explain the classification of pneumatic valves.

5M

Types of Pneumatic Valves:

Based upon the function and internal mechanism, the valves are classified as follows:

- ✓ Flow control valves
- ✓ Pressure regulator
- ✓ Pressure relief valve
- ✓ Sequence valve
- ✓ Pressure reducing valve
- ✓ Direction control valve
- ✓ Two-way valve
- ✓ Three-way valve
- ✓ Four-way valve

(OR)

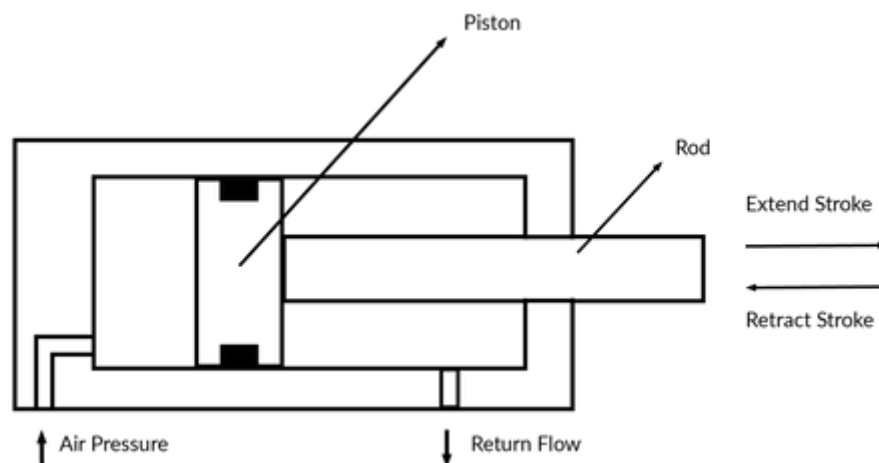
7. a) Explain the operation of double acting cylinder with a neat sketch.

5M

When looking for a device to move loads in both directions, double acting cylinders are a useful application when your machine requires more than one movement. Unlike single acting air cylinders, double acting cylinders can extend and retract without the need of a spring. Instead of applying pressurized air into one port, double acting cylinders have two ports where air can enter in and out.

Air enters through one port moving the piston forward and then applies pressurized air into the other port retracting the piston back into the cylinder. Double acting cylinders are the most widely used pneumatic actuators compared to single acting cylinders given their ability to extend and retract within a shorter time period, thus, becoming more efficient and precise.

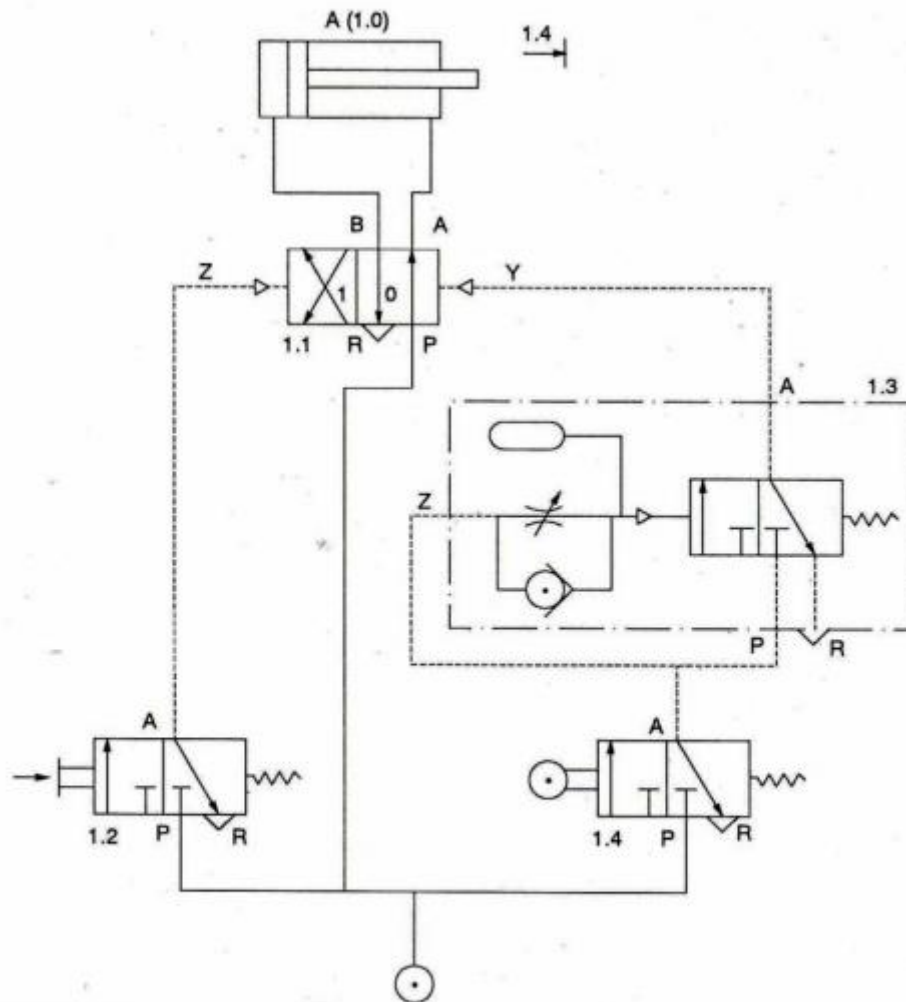
Double acting pneumatic cylinders are mostly used in industrial and robotics industries. They perform tasks such as opening/closing doors and lifting and moving merchandise off conveyor belts. Other uses include medical applications, earth-moving equipment, and space programs.



b) Explain the functioning of time delay pneumatic circuit.

5M

- When valve 1.2 is manually actuated, pilot operated valve 1.1 is shifted in position 1 which brings the forward stroke of the DAC A.
- The end of the forward stroke is sensed by the roller operated valve 1.4 which can start the return stroke of the piston by shifting valve 1.1 to 0 position.
- However, the return stroke is delayed by time delay valve 1.3 by certain time which can be adjusted.
- As soon as the signal pressure in the time delay valve reaches the adjusted value of spring force of air operated 3/2 DCV, the valve opens and passes the signal to main pilot operated DCV 1.1 which resets, and cylinder retracts after a particular dwell time.



Use of time delay valve: A (1.0)—DA cylinder 1.1—Pilot operated 4/2 D.C. valve 1.2—Manual operated 3/2 D.C. valve 1.3—Time delay valve 1.4—Roller operated D.C. valve

UNIT - IV

8. a) Briefly explain the uses of accumulators.

5M

Accumulators come in a variety of forms and have important functions in many hydraulic circuits. They are used to store or absorb hydraulic energy.

When storing energy, they receive pressurized hydraulic fluid for later use. Sometimes accumulator flow is added to pump flow to speed up a process. Other times the stored energy is kept in reserve until it is needed and may be independent of pump flow. This could be for emergency power when pump flow is not available. It could be used to hold pressure in a system when pump flow has stopped by providing fluid to compensate for leakage.

There are several ways in which accumulators are used to absorb energy. The returning flow from a large-bore cylinder may be greater than should be conducted by the plumbing. A low-pressure accumulator can receive a portion of the flow and then discharge it at an appropriate rate for the plumbing. Hydraulic fluid has a relatively high rate of thermal expansion. If a volume of fluid is confined and unable to expand or contract due to temperature changes, there could be very high pressure that could damage equipment or low pressure that could cause air bubbles in the hydraulic fluid. Accumulators can be used to absorb the expanding fluid and/or supply the contracting fluid. They also absorb and dissipate energy when used to dampen pressure pulses, reducing noise and vibration.

b) Explain the maintenance requirement for hydraulic power systems.

5M

Lack of maintenance of hydraulic systems is the leading cause of component and system failure yet most maintenance personnel don't understand proper maintenance techniques of a hydraulic system. The basic foundation to perform proper maintenance on a hydraulic system has two areas of concern. The first area is Preventive Maintenance which is key to the success of any maintenance program whether in hydraulics or any equipment which we need reliability. The second area is corrective maintenance, which in many cases can cause additional hydraulic component failure when it is not performed to standard.

There are three main types of hydraulic maintenance: reactive maintenance (RM), preventive maintenance (PM) and predictive maintenance (PdM).

Reactive maintenance stands for breakdown maintenance and involves the repairs that are done to fix the equipment that is already broken.

Preventive maintenance is regular maintenance that is performed on the equipment to prevent it from breaking down. Preventive Maintenance is implemented through a Preventive Maintenance Program.

Predictive Maintenance or condition-based maintenance uses sensor devices to collect information about the system and components and prompts the personnel to perform maintenance at the exact moment when it's needed. Due to high costs and technical requirements, it is still new to the market and not used very often.

(OR)

9. A hydraulic cylinder is used for industrial application. It has been decided to use an accumulator as a leakage compensator. Design a circuit to fulfill these requirement

10M

In this application, the accumulator acts as a compensator, by compensating for losses due to internal or external leakage that might occur during an extended period of time, when the system is pressurized, but not in operation.

The pump charges the accumulator and the system, until the maximum pressure setting on the pressure switch is obtained. When the system is not operating, it is required to maintain the required pressure setting, to accomplish which the accumulator supplies leakage oil to the system during a lengthy period of time. Finally, when the system pressure falls below the minimum required pressure setting, the pump starts to automatically recharge the system. This saves electrical power and reduces heat in the system.

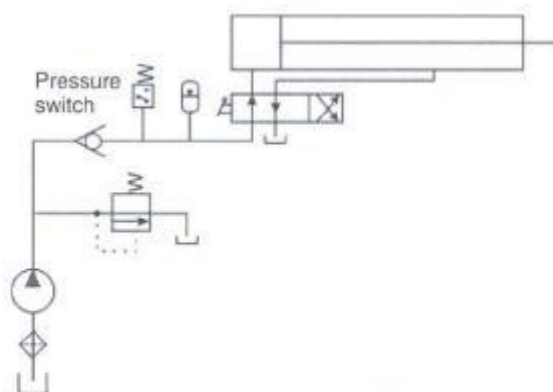


Figure 7.23

Accumulator as a leakage compensator

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