WINTER – 15 EXAMINATION

Subject Code: **12242 (Industrial Fluid Power)** **Model Answer**

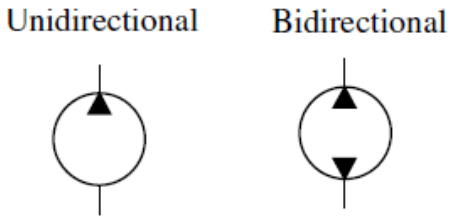
Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills).
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. 1. a) Applications of Hydraulic system: (1/2 x4= 2 marks) (1/2 mark for each application)

1) Earthmoving equipments: Excavator
2) Material handling equipments: Industrial hydraulic lifts
3) Hydraulically operated machines: milling, shaping, press and transfer lines
4) Agricultural Equipments: Harvesting corn – hydraulically operated elevator conveyor

b) Fixed displacement hydraulic pump (1 x 2=2)



c) Positive displacement pumps (1 x 2=2)

Positive displacement pumps eject a fixed amount of fluid into the hydraulic system per revolution of the pump shaft. These are also called as reciprocating pumps and have very little slips as compared to centrifugal pumps. They are self-priming and pump against very high pressures, but their volumetric capacity is low. Positive displacement pumps have a very close clearance between rotating and stationary parts and hence are self-priming.

d) Functions of Actuators: (1/2 x4= 2 marks) (1/2 mark for each function)

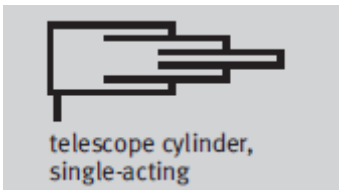
1) To produce motion in one line

2) To produce continuous rotary motion

3) To produce rotary or oscillatory motion less than 360^0

4) To apply a force and clamp the job.

e) Symbol of Telescopic cylinder **(2 marks)**



f) Materials for hydraulic pipe (1/2 x4= 2 marks) (1/2 mark for each type)

1) Seamless steel (S.A.E. 1010), fully annealed

2) Stainless steel, seamless fully annealed suitable for flaring and bending

3) Aluminum seamless

4) Copper seamless, fully annealed

5) Hose pipe

g) Seals: classification **(1 x2=2 marks)**

i. Static seal: A seal that is made between two stable and immovable components

ii. Dynamic seal: A seal required to prevent leakage past parts which are in relative motion

h) Sources of heat in hydraulic circuit: **(2 marks)**

High ambient temperature, restriction in hydraulic pipe and components, high pressures, high pressures being spilled through the relief valves.

i) Applications of synchronizing circuit: **(2 marks)**

i. Used for machines like hydraulic press with multiple cylinders which requires cylinder strokes be perfectly synchronized.

ii. Used for simultaneous linear movement of different machine elements.

j) Uses of compressed air: (1/2 x4= 2 marks) (1/2 mark for each use)

- Cleaning,
- filling air in tubes of the vehicle
- for pneumatic clamping,
- Operating pneumatic tools.

k) FRL unit: **(2 marks)**

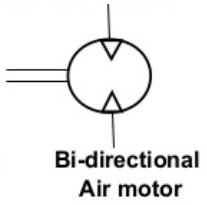
Air leaving a compressor is hot, dirty, and wet—which can damage and shorten the life of downstream equipment, such as valves and cylinders. Before air can be used it needs to be filtered, regulated and lubricated. FRL unit is used for this purpose.

Filter: To enable the supply of clean, pure and contamination free compressed air, the air is required to be filtered.

Regulator: The system performance and accuracy depends on the pressure stability of the air supply. The regulator maintains this pressure.

Lubricator: The air is supplied with a lubricating film of oil which helps in lubricating the various parts in the downstream.

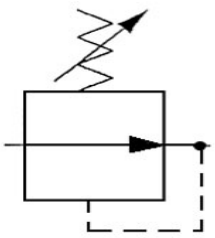
l**) Bi-directional air motor:** **(2 marks)**



m) **Pneumatic cylinder mounting: (1/2 x4= 2 marks) (1/2 mark for each type)**

1. CENTERLINE MOUNTING: Support the cylinder at the center.
2. FOOT MOUNTING: Designed to give a limited amount of movement on one foot only
3. ROD END FLANGE or FRONT FLANGE: Withstands extend stroke fluid pressure
4. REAR or BACK or HEAD END FLANGE: Load acts through the fluid onto the rear flange
5. TRUNNION MOUNTING: Allows angular movement
6. EYE or CLEVIS MOUNTING: Jack-knife under load

n) **Pressure reducing valve: Symbol** **(2 marks)**



o) **Types of hoses in pneumatic system: (1/2 x4= 2 marks) (1/2 mark for each type)**

Most of the pneumatic and industrial hoses are made up of plastic materials as unreinforced, flexible and material homogeneous hoses. They are made up of -

i. Polyamide (nylon): have high strength but are rigid

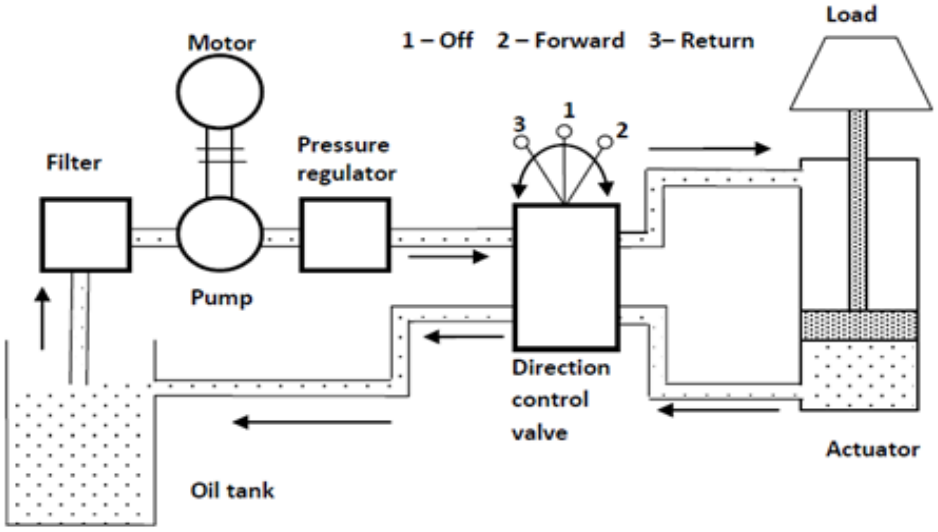
ii. Polyurethane (PUR): have good flexibility but have low mechanical properties.

iii. Polyethylene hoses (PE): have good chemical resistance but have low strength

iv. Polyvinylidene floride (PVDF): have high mechanical strength as well as high chemical and thermal resistance.

Q. 2 Attempt any four of the following.

a) General layout of hydraulic system: (2-sketch,2-label) (2x2=4)

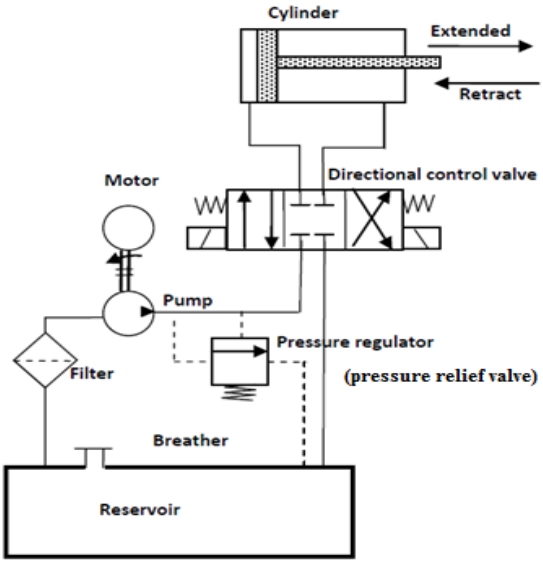


b) Pressure relief valve: (1 mark –use, 3-sketch) (1+3=4)

Use: it is used to maintain the constant pressure in the hydraulic circuit.

WINTER – 15 EXAMINATION

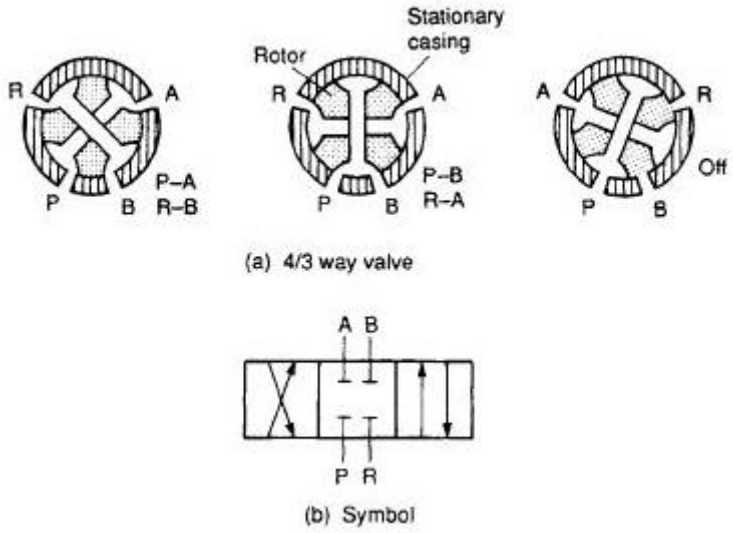
Subject Code: **12242 (Industrial Fluid Power)** **Model Answer**



c) Rotary spool type valve: (2-fig, 2-discription) (2x2=4)

A rotary spool valve consists of a rotating spool which aligns with ports in stationary valve casing, so that fluid is directed to required port. A/B/P/R are the ports in casing. The port 'P' is a pressure port though which pressurized oil is coming in the valve. 'R' port is the port through which used oil is returning to oil tank.

The passages in the rotor connect or block-off the ports in the valve body to provide the four flow paths. The design shown above is a three-position valve in which the centered position has all the four ports blocked. Rotary valves are usually actuated either manually or mechanically. These valves are available in a variety of three-way and four-way and two- and three position flow path configuration.



d) Criteria for selection of hydraulic pump (any four,1 mark each) (1 x4=4)

1. Highest operating pressure
2. Maximum delivery
3. Type of control
4. Pump drive speed
5. Type of fluid
6. Pump noise
7. Size and weight of pump
8. Efficiency

e) Classification of hydraulic cylinder: (2 x2=4)

Common types

1) Single acting cylinder
2) Double acting cylinder

Special types

1) Plunger
2) Telescoping
3) Cable
4) Diaphragm
5) Bellow
6) Tandem
7) Duplex
8) Rotary

f) Difference between positive displacement pump and roto dynamic pumps **(any four points, 1 mark each) (1x4=4)**

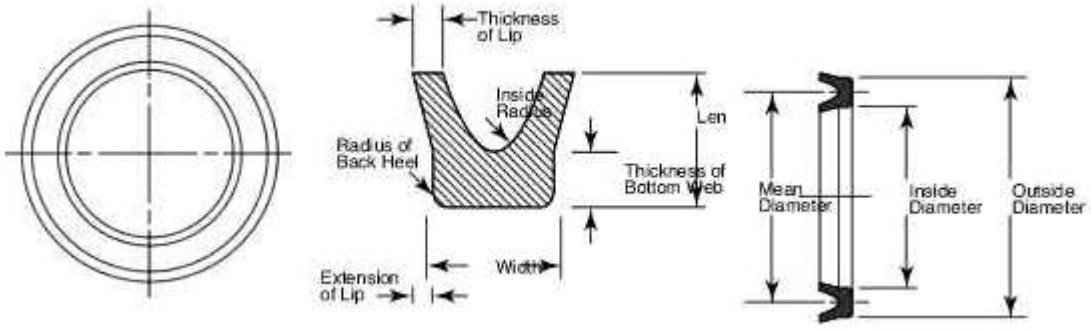
Sr. No.	Parameter	Roto dynamic pumps	Positive displacement pump
1	***Optimal flow and pressure applications***	Medium and high capacity Low/ medium pressure	Low capacity High pressure
2	***Requires relief valve***	No	Yes
3	***Flow type***	Smooth	pulsating
4	***Self priming***	No	Yes
5	***Space***	Requires more space	Requires less space
6	***Suitability***	Suitable for high viscous fluids	Not suitable for viscous fluids

Q,3 Attempt any four of the following: (2-sketch,uses ½ each use) (2 x2=4)

a) Cup Seal:

WINTER – 15 EXAMINATION

Subject Code: **12242 (Industrial Fluid Power)** **Model Answer**



Uses:

1. To maintain sealing contact in sliding motion between the cylinder and piston.
2. Rod and buffer seals maintain sealing contact in sliding motion between the cylinder head and the piston rod.
3. Used on rams or plungers in both hydraulic and pneumatic applications.
4. To seal blank side of the single acting cylinder.

b) (2 x2=4) (4-advantages, 4-disadvantages)

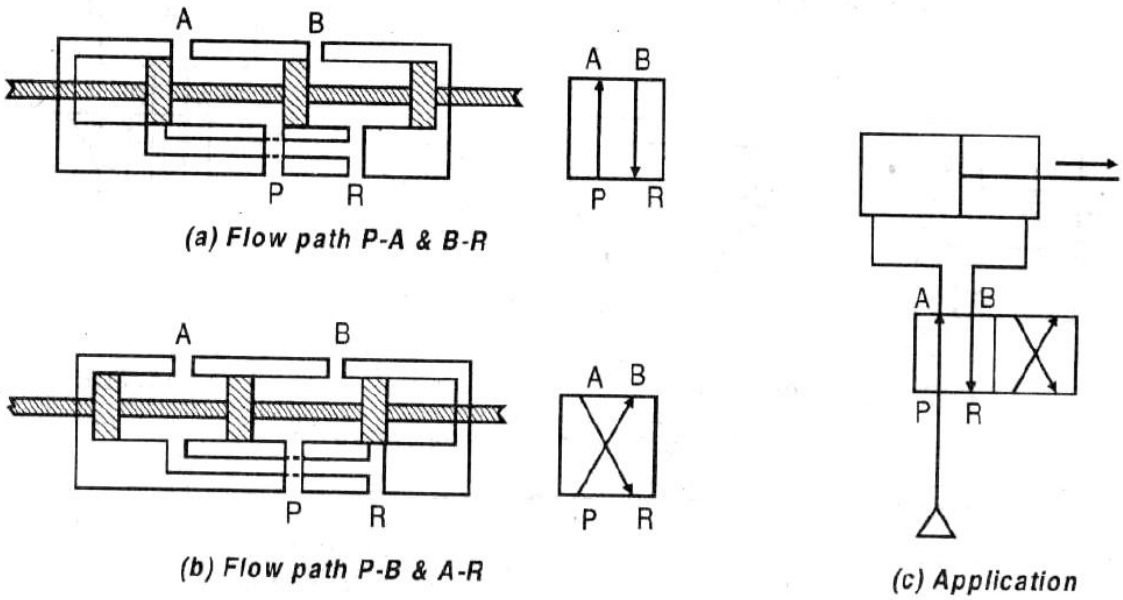
Advantages of gas pressurized accumulator:-

1. It is compact in size
2. It is light in weight
3. Gas bag is of flexible material like rubber, hence it is quick in response in the expansion & compression.
4. It has very few components hence it is cheap

Disadvantages of gas pressurized accumulator:-

1. Pressure of outgoing oil will not be constant. As gas bag goes on expanding, the pressure of oil reduces.
2. Volume of oil stored in the accumulator is small
3. The gas bag is required to be changed after certain period of time
4. High temperature fluids cannot be handled in this accumulator

c) 4/2 way DC valve **(2 sketch, 2 symbol) (2 x2=4)**



(a) Flow path P-A & B-R

(b) Flow path P-B & A-R

(c) Application

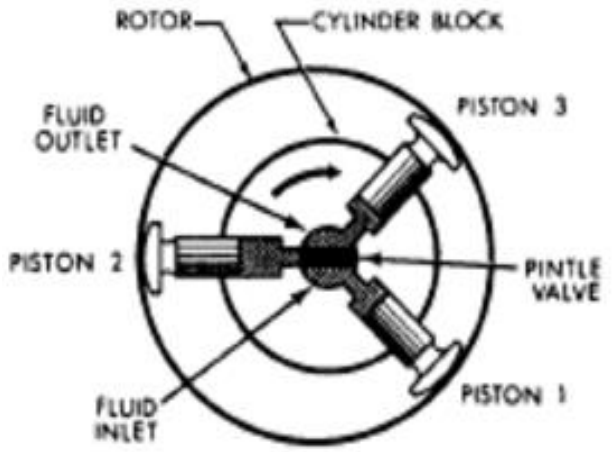
d)Piston type pneumatic motor. **(2 sketch, 2-discription) (2x2=4)**

The radial-piston motor operates in reverse of the radial-piston pump. In the radial-piston pump, as the cylinder block rotates, the pistons press against the rotor and are forced in and out of the cylinders, thereby receiving fluid and pushing it out into the system. In the radial motor, fluid is forced into the cylinders and drives the pistons outward. The pistons pushing against the rotor cause the cylinder block to rotate. The operation of a radial-piston motor is shown in figure. This motor is shown with three pistons for simplicity. Normally it contains seven or nine pistons. When air is forced into the cylinder bore containing piston 1, the piston moves outward since the air cannot be compressed. This causes the cylinder to rotate in a clockwise direction. As the force acting on piston 1 causes the cylinder block to rotate, piston 2 starts to rotate and approach the position of piston 3. (Note that the distance between the cylinder block and the reaction ring of the rotor gets progressively shorter on the top and right half of the rotor.)

As piston 2 rotates, it is forced inward and, in turn, forces the fluid out of the cylinder. Since there is little or no pressure on this side of the pintle valve, the piston is easily moved in by its contact with the reaction ring of the rotor. The fluid is easily forced out of the cylinder. As the piston moves past the midpoint, or past the shortest distance between the cylinder block and the rotor, it enters the pressure side of the pintle valve and fluid is forced into the cylinder. Piston 3 then

becomes the pushing piston and in turn rotates the cylinder block. This action continues as long as fluid under pressure enters the cylinders.

The direction of rotation of the motor is changed by reversing the flow of fluid to it. Admitting fluid under pressure on the top side of the pintle valve forces piston 3 out of the cylinder block. This causes the cylinder to rotate in the counter clockwise direction.



d) Bleed off circuit (2 sketch, 2- explanation) (2x2=4)

Speed Control of DA Cylinder – Bleed-Off-Circuit

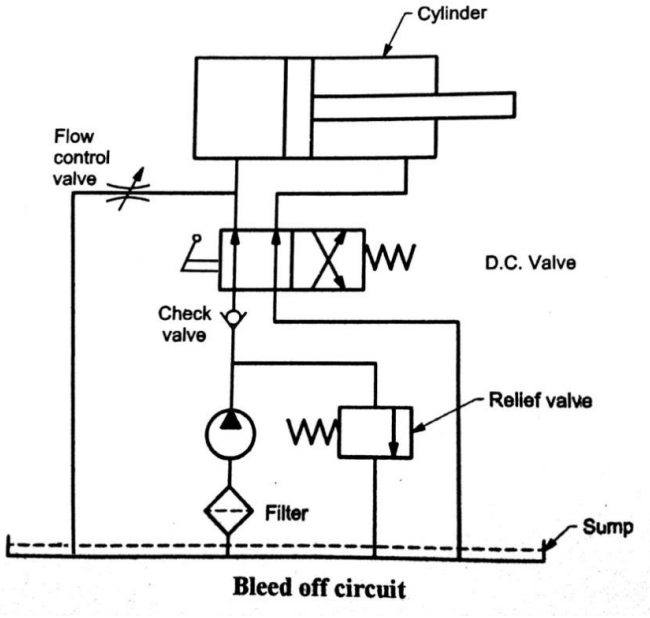
- This is still another method of controlling the linear speed of piston of DA cylinder.
- This is slightly different circuit than 'meter-in' and 'meter-out' circuit.
- In this circuit neither the 'inflow' to the actuator nor the 'out flow' from the actuator is controlled. Instead of this, the pressurized fluid coming out of pump is diverted and bypassed to the oil reservoir. In this circuit the flow of control valve is placed in this by-pass line.
- Due to by-pass arrangement, the speed of piston is given by,

The speed of piston ⇒ Difference between pump delivery flow and flow being by-passed to tank through flow control valve

- The oil is being by-passed immediately after pump. Another English word for by-pass flow is 'Bleed-off'. Hence this circuit is known as bleed-off circuit. It is also called as by-pass control circuit.
- **Important :** In this circuit, we can control the speed of position in advance stroke as well as return stroke.

WINTER – 15 EXAMINATION

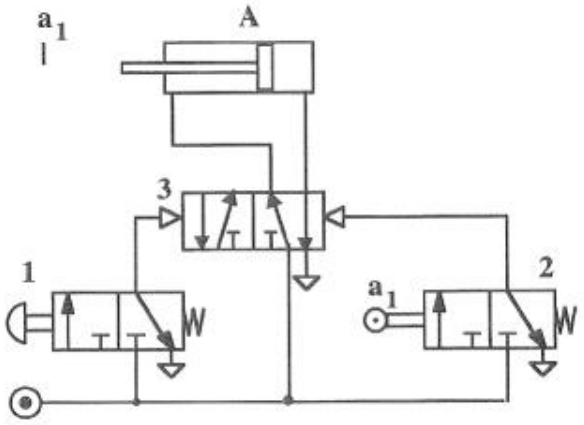
Subject Code: **12242 (Industrial Fluid Power)** **Model Answer**



Bleed off circuit

e) Impulse pneumatic circuit: (2-sketch, 2 explanation) (2x2=4)

Figure shows a symbol circuit of an impulse-valve controlled double acting pneumatic cylinder (**A**). The position of the impulse-valve (**3**), which is controlled by the start/stop-valve (**1**) and the end position valve (**2**), determines if the cylinder piston shall make a positive (A^+) or negative (A^-) stroke. Positive piston stroke is initiated by manual activation of the start-valve (**1**). Negative piston stroking takes place when valve (**2**) is activated by the cylinder rod at the position $\mathbf{a_1}$.



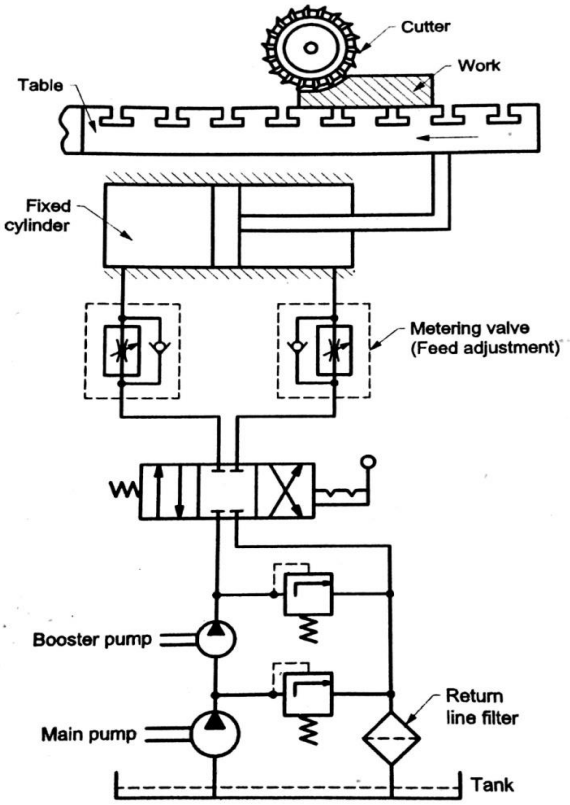
Impulse control of a pneumatic cylinder.

Q. 4 Attempt any two of the following (4-labeled sketch, 4-explanation) (4+4=8)

a) Hydraulic circuit for milling machine to control its table movement:

WINTER – 15 EXAMINATION

Subject Code: **12242 (Industrial Fluid Power)** **Model Answer**



Hydraulic circuit for milling machines

Hydraulic Circuit for Milling Machines

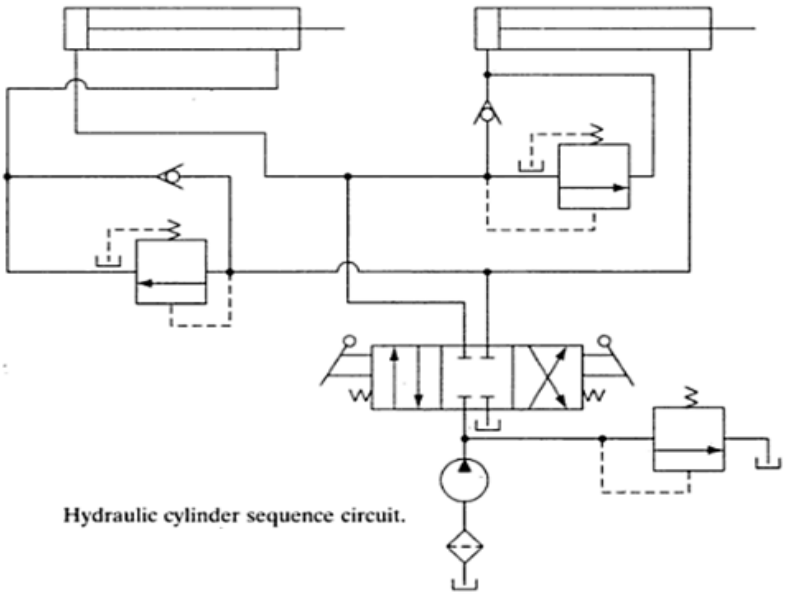
- Hydraulic circuit for milling machine is some what different than the other machines.
- It is having three motions such as longitudinal motion, cross motion, up down motion of table.
- Fig. shows details of hydraulic circuit for milling machine.
- It has main pump, which is a low pressure, and high discharge pump and one booster pump, which is a low discharge high pressure pump. The function of booster pump is to boost the hydraulic pressure to a level above that of provided by main pump. (this combination saves the power as well as use of a high flow and high discharge pump is avoided).
- There are two sets of flow control valve and check valve fitted in both supply and return line cylinder, to achieve speed control in both direction.
- A manually operated spool valve decides the direction of flow to the cylinder. The stroke length of cylinder is adjustable through limit switches (not shown in Fig.). The limit switch disconnects the supply of oil to the cylinder when the table reaches the set position.

b) Sequencing circuit diagram for double acting hydraulic cylinders: (4-labeled sketch,4-explanation) (4+4=8)

Sequencing Circuit

As stated earlier, a sequence valve causes operations in a hydraulic circuit to behave sequentially. Figure 9-9 is an example where two sequence valves are used to control the sequence of operations of two double-acting cylinders. When the DCV is shifted into its left envelope mode, the left cylinder extends completely, and then the right cylinder extends. If the DCV is then shifted into its right envelope mode, the right cylinder retracts fully, and then the left cylinder retracts. This sequence of cylinder operation is controlled by the sequence valves. The spring-centered position of the DCV locks both cylinders in place.

One application of this circuit is a production operation. For example, the left cylinder could extend and clamp a workpiece via a power vise jaw. Then the right cylinder extends to drive a spindle to drill a hole in the workpiece. The right cylinder then retracts the drill spindle, and then the left cylinder retracts to release the workpiece for removal. Obviously these machining operations must occur in the proper sequence as established by the sequence valves in the circuit.



Hydraulic cylinder sequence circuit.

c) Time delay circuit to actuate double acting cylinder: (4-labeled sketch,4-explanation)(4+4=8)

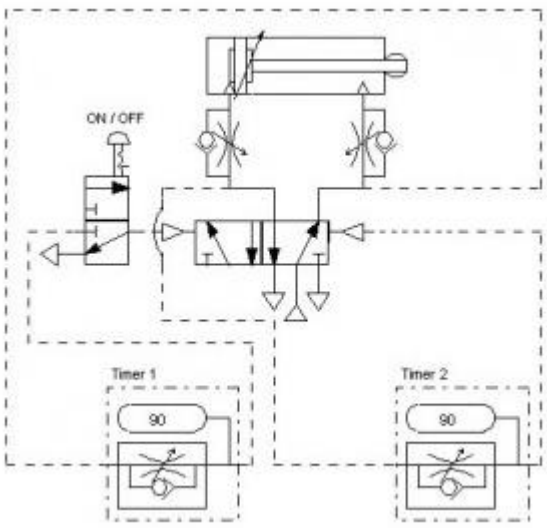
Working:

1) As the push button of 3/2 D.C. valve is pressed, 5/2 D.C. valve is actuated. Due to this P is connected A and the DA cylinder will cause extension.
2) At the same time, air is diverted to Timer 2. As soon as pressure is built up, signal is sent to right side of 5/2 DC valve.
3) Actuation of 5/2 DC valve will connect P to B of DA cylinder. This will cause retraction of the cylinder.
4) Air on B side of cylinder is now diverted to Timer 1. As soon as pressure is built up, signal is sent to left side of 5/2 DC valve.

WINTER – 15 EXAMINATION

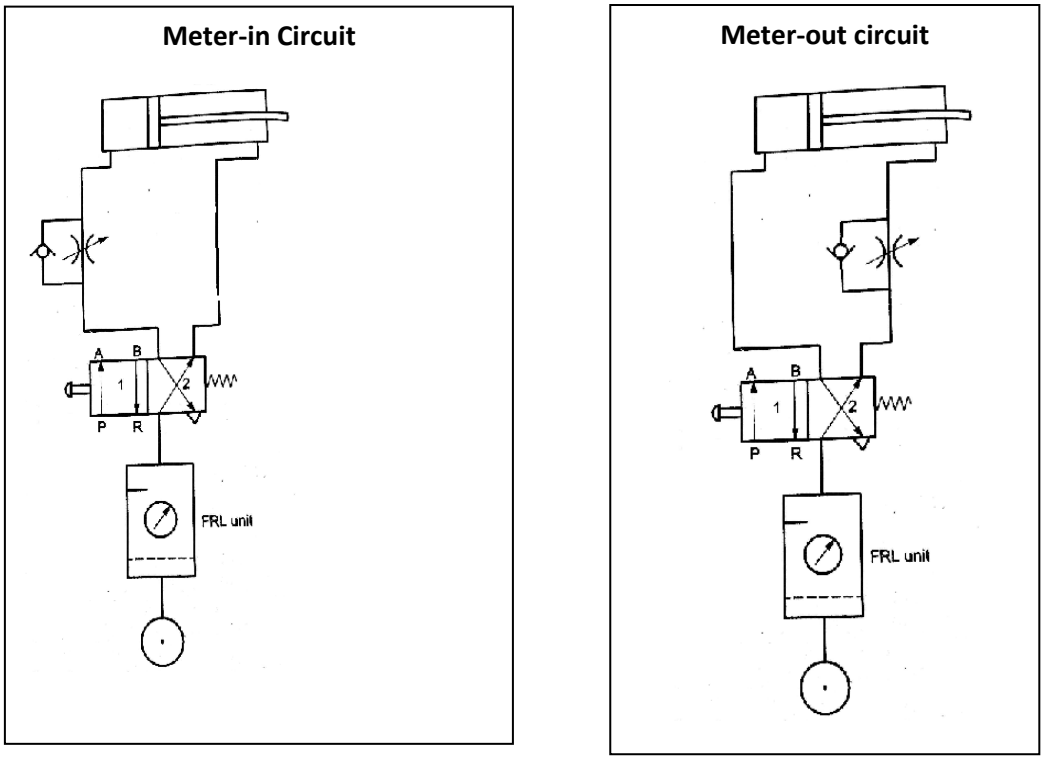
Subject Code: **12242 (Industrial Fluid Power)** **Model Answer**

5) Thus extension and retraction continues with the given time delay which is controlled by adjustable flow control valve.



Q.5 Attempt any two of the following

a) Pneumatic meter-in and meter-out circuit (4-labeled sketch)(4+4=8)



b)Seat type and spool type valve

1) Differentiation (4-diff,2-advantages,2-disadvantages) (4+2+2=8)

	Seat valve	*Spool valve*
1.	The valving element sits on specially machined and finished seat. The element is either a ball, or a poppet, or a cone. Construction is complicated.	The valving element is a sliding spool sliding inside a finely finished bore in the valve housing. Contruction is simple.
2.	Valve finishing is difficult and costlier.	Valve-bore and spool finishing is easier and simple.
3.	Wear and tear of the valving area is not uniform.	The valve spool and bore generally get uniform wear and tear.
4.	Valve actuation possibility is limited.	All types of actuation are easily adaptable.

2) Applications

Seat type valve-used in flow control & check valves.

Spool type valve-used in direction control & pressure regulating valves.

3) Advantages

Seat type valve-suited for very high pressure applications and very minor leakages.

Spool type valve-simple in construction, low cost & are permanently balanced.

Q.5 c) Functions of air compressor (4-function,2-classification,2-working) (4+2+2=8)

i. To compress and pressurize air for pneumatic application

ii. To supply high pressure clean air to fill gas cylinders.

iii. To supply moderate pressure clean air to a submerged surface supplied diversely.

iv. To supply moderate pressure clean air for driving some office & school building pneumatic HVAC control system valves.

Compressor classification

- According to pressure delivered

1. Low pressure compressor (upto 150 psi)
2. Medium pressure compressor (151 to 1000 psi)
3. High pressure compressor (above 1000 psi)

- According to design

i. Rotary screw compressor

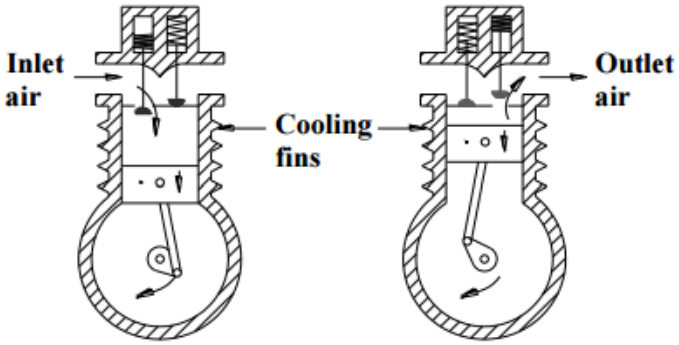
ii. Turbo screw compressor

- According to principle of operation

i. Positive displacement type

ii. Non positive displacement type

Reciprocating air compressor



Working: It comprises of following two strokes

Inlet stroke: -suction or inlet stroke begins with piston at top dead centre (a position providing a minimum or clearance volume). During the downward stroke, piston motion reduces the pressure inside the cylinder below the atmospheric pressure. The inlet valve then opens against the pressures of its spring and allows air to flow into the cylinder. The air is drawn into the cylinder until the piston reaches to a maximum volume position (bottom dead centre).The discharge valve remains closed during this stroke

Outlet stroke: During compression stroke piston moves in the opposite direction (Bottom dead centre to top dead centre), decreasing the volume of the air. As the piston starts moving upwards, the inlet valve is closed and pressure starts to increase continuously until the pressure inside the cylinder is above the pressure of the delivery side which is connected to the receiver. Then the outlet valve opens and air is delivered during the remaining upward motion of the piston to the receiver.

Q 6 Attempt any four of the following

a) Merits and Limitations of Pneumatic system(2-merits,2-limitations)(2+2=4)
Merits:-

• Infinite availability of the source

Air is the most important thing in the pneumatic system, and as we all know, air is available in the world around us in unlimited quantities at all times and places.

• Easy channeled

Air is a substance that is easily passed or move from one place to another through a small pipe, the long and winding.

• Temperature is flexible

Air can be used flexibly at various temperatures are required, through equipment designed for specific circumstances, even in quite extreme conditions, the air was still able to work.

• Safe

The air can be loaded more safely than it is not flammable and does not short circuit occurs explode, so protection against both of these things pretty easily, unlike the electrical system that could lead to fires

• Clean

The air around us are tend to clean without chemicals that are harmful, and also, it can be minimized or cleaned with some processes, so it is safe to use pneumatic systems to the pharmaceutical industry, food and beverages and textiles.

• Easy utilized

Easy air either directly utilized to clean surfaces such as metal and machinery, or indirectly, ie through pneumatic equipment to produce certain movements.

Limitations:

• Requires installation of air-producing equipment.

Compressed air should be well prepared to meet the requirements. Meet certain criteria, such as dry, clean, and contain the necessary lubricant for pneumatic equipment. Therefore require installation of pneumatic systems are relatively expensive equipment, such as compressors, air filter, lube tube, dryer, regulators, etc.

• Easy to leak

One of the properties of pressurized air is like to always occupy the empty space and the air pressure is maintained in hard work. Therefore we need a seal so that air does not leak. Seal leakage can cause energy loss. Pneumatic equipment should be equipped with airtight equipment that compressed air leaks in the system can be minimized.

• Potential noise

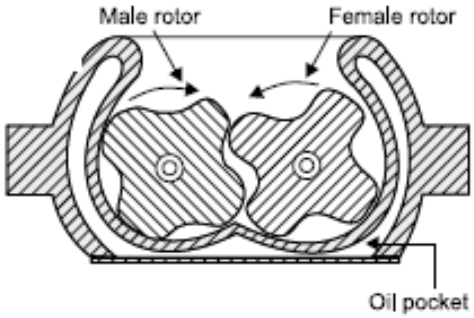
Pneumatic using open system, meaning that the air that has been used will be thrown out of the system, the air comes out pretty loud and noisy so will cause noise, especially on the exhaust tract. The fix is to put a silencer on each dump line.

• Easy condenses

Pressurized air is easily condensed, so before entering the system must be processed first in order to meet certain requirements, such as dry, have enough pressure, and contains a small amount of lubricant to reduce friction in the valves and actuators.

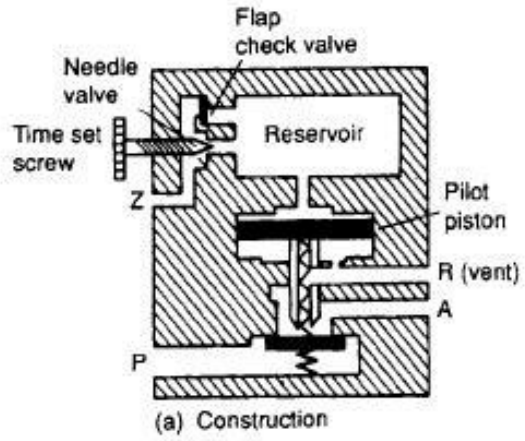
b) Twin Screw Compressor:- (2-sketch,2-working) (2+2=4)

Working:- The name implies two screws are used in this compressor to compress the air. The screw rotates with constant speed and naturally the compressed air is discharged is smooth and not pulsating. The screws are rotated by external timing gear fitted on shaft of each screw and meshing with each other. As the screw rotates, air is drawn in to the housing, trapped between the screws and carried along the discharge port, which then goes to air receiver.



c) Working Of Time Delay Valve (2-sketch,2 explanation) (2+2=4)

Working:- Time delay valves are used to delay operations where time-based sequences are required. Figure shows construction of a typical valve. This is similar in construction to a 3/2 way pilot-operated valve, but the space above the main valve is comparatively large and pilot air is only allowed in via a flow reducing needle valve. There is thus a time delay between application of pilot pressure to port Z and the valve operation. The time delay is adjusted by the needle valve setting..



d) Comparison of Air Motor with Electric Motor (any four points, 4 marks)

S. No.	Air Motor	Electric Motor
1	Needs compressed air	Needs electric supply
2	Used for low torque work	Used for high torque work
3	The motor is explosion proof	Can be explode or Burn
4	Temperature of motor remains constant in long run	Temperature is increasing
5	The power to weights ratio is high	The power to weights Ratio is low
6	Air motors are less efficient	Efficiency of electric motor is high

e) Tips for Good piping system:- (any four points, 4 marks)

1) Use narrow open ducts; do not embed the main pipe in bricks.
2) The air mains must be given slight slope in the direction of flow of air.
3) Do not terminate Air main near branching.
4) Use water traps and air dryers at all possible points.
5) Use proper size of pipes.

f) **Intercooler**: - **(2-def,2-functions) (2+2=4)**

An intercooler is an intake air cooling device used commonly on turbocharged and supercharged engines.

Function: - An **intercooler** extracts heat from the compressed air by passing it through its network of tubes with cooling fins. As the compressed air is pushed through the intercooler it transfers the heat to the tubes and, in turn to the cooling fins. The cool air

from outside, traveling at speed, absorbs the heat from the cooling fins reducing the temperature of the compressed air. This system's advantages are simplicity, lower cost and light weight. These factors make it by far the most common form of intercooling.

……xxxxxxxxxxxxxxxxx…….