Content:

6.1 Hydraulic Circuits 10 Marks

- Hydraulic symbols
- Meter in, Meter out. Bleed off, Sequencing.
- Introduction to electro-hydraulics – concept, principles and applications
- Applications of hydraulic circuits – Hydraulic power steering, Hydraulic brakes, milling machine, hydraulic press,

6.2 Simple Pneumatic Circuits. 10 Marks

- Pneumatic symbols
- Speed control circuit (Meter in, Meter out), Sequencing.
- Applications of pneumatic circuits – Air brake, Low cost Automation in industries, Pneumatic power tools (drill, hammer, and grinder).
- Comparison of Hydraulic and pneumatic circuits.

6.1 Hydraulic Circuits 10 Marks

Hydraulic & Pneumatic Symbols
<table>
<thead>
<tr>
<th>Pump / Motor</th>
<th>Hydraulic Motor</th>
<th>Conversion of Mechn. energy to Hyd. energy</th>
<th>Energy Conversion Elements</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Components</td>
<td>Motor</td>
<td>e) Limited rotation</td>
<td>Fixed Variable Displacement</td>
<td></td>
</tr>
<tr>
<td>Pump and Motor</td>
<td>With two directional flow</td>
<td>a) With one directional flow</td>
<td></td>
<td></td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Drives</th>
<th>Air Motors</th>
<th>Conversion of Mech. energy to pressure of energy</th>
<th>Energy Conversion Elements</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal Combustion Engine</td>
<td>Motor</td>
<td>With two directional flow</td>
<td>Fixed Variable Displacement</td>
<td></td>
</tr>
<tr>
<td>Electric Motor</td>
<td>With two directional flow</td>
<td>a) With one directional flow</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Fluid Cylinders

<table>
<thead>
<tr>
<th>Description</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Telescopic</td>
<td>![Telescopic Cylinder Symbol]</td>
</tr>
<tr>
<td>2. Adjustable at both ends</td>
<td>![Adjustment Symbol]</td>
</tr>
<tr>
<td>3. Cylinder with end cushioning</td>
<td>![Cushioning Symbol]</td>
</tr>
<tr>
<td>4. Double acting</td>
<td>![Double Acting Symbol]</td>
</tr>
<tr>
<td>5. Single acting</td>
<td>![Single Acting Symbol]</td>
</tr>
<tr>
<td>6. Conversion of energy</td>
<td>![Energy Conversion Symbol]</td>
</tr>
<tr>
<td>7. Fluid exerted pressure</td>
<td>![Pressure Symbol]</td>
</tr>
</tbody>
</table>

### Fluid Power Symbols

<table>
<thead>
<tr>
<th>Description</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Fluid Storage Tank</td>
<td>![Storage Tank Symbol]</td>
</tr>
<tr>
<td>2. Rotating Joint</td>
<td>![Rotating Joint Symbol]</td>
</tr>
<tr>
<td>3. Quick Acting Coupling</td>
<td>![Quick Acting Symbol]</td>
</tr>
<tr>
<td>4. Line with Plug</td>
<td>![Line with Plug Symbol]</td>
</tr>
<tr>
<td>5. Line with No Connection</td>
<td>![Line with No Connection Symbol]</td>
</tr>
<tr>
<td>6. Line Junction</td>
<td>![Line Junction Symbol]</td>
</tr>
<tr>
<td>7. Main Working Line</td>
<td>![Main Working Line Symbol]</td>
</tr>
<tr>
<td>8. Pilot Control Line</td>
<td>![Pilot Control Line Symbol]</td>
</tr>
</tbody>
</table>

### Energy Transmitting Elements

<table>
<thead>
<tr>
<th>Description</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Air Tank or Reservoir</td>
<td>![Air Tank Symbol]</td>
</tr>
<tr>
<td>2. Oil Level Indicator and Air Bleeding</td>
<td>![Oil Level Indicator Symbol]</td>
</tr>
</tbody>
</table>

Note: The images are placeholders for the actual symbols and diagrams.
### FLUID POWER SYMBOLS

<table>
<thead>
<tr>
<th>Elements</th>
<th>Description</th>
<th>Flow Control Valves</th>
<th>Fluid Dividers</th>
</tr>
</thead>
<tbody>
<tr>
<td>e) Flow divider</td>
<td>Divides flow into two equal parts.</td>
<td>Flow divider with two coupled motors.</td>
<td>Flow divider with two coupled motors.</td>
</tr>
<tr>
<td>c) Throttle valve</td>
<td>Variable flow.</td>
<td>Fixed flow.</td>
<td>Short throttle segment.</td>
</tr>
<tr>
<td>b) Throttle valve</td>
<td>Variable flow.</td>
<td>Fixed flow.</td>
<td>Short throttle segment.</td>
</tr>
</tbody>
</table>

### FLUID POWER SYMBOLS

<table>
<thead>
<tr>
<th>Elements</th>
<th>Description</th>
<th>Directional Control Valves</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>6a directional control valve</td>
<td>Parts of Valves are named with letters. A = Power Pressure Port. B = Return Pressure Port. C = Pilot Port. L = Leakage Oil Port.</td>
<td>22 directional control valve</td>
<td>![Symbol 1]</td>
</tr>
<tr>
<td>53 directional control valve</td>
<td>Switching Positions shown by blocks. Internal connections shown by arrows.</td>
<td>413 directional control valve</td>
<td>![Symbol 2]</td>
</tr>
<tr>
<td>52 directional control valve</td>
<td>Number of Ports.</td>
<td>![Symbol 3]</td>
<td>![Symbol 4]</td>
</tr>
</tbody>
</table>

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### Fluid Power Symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Symbol 1" /></td>
<td>Manual Control lever with infinite position control</td>
</tr>
<tr>
<td><img src="image2" alt="Symbol 2" /></td>
<td>Manual Control lever with infinite position control</td>
</tr>
<tr>
<td><img src="image3" alt="Symbol 3" /></td>
<td>Additional parallel line are added on top &amp; bottom</td>
</tr>
<tr>
<td><img src="image4" alt="Symbol 4" /></td>
<td>Control column for directional control valves</td>
</tr>
<tr>
<td><img src="image5" alt="Symbol 5" /></td>
<td>Pilot Operated directional control valve with spring centering</td>
</tr>
<tr>
<td><img src="image6" alt="Symbol 6" /></td>
<td>Pneumatically actuated Hydraulic Pilot actuated</td>
</tr>
<tr>
<td><img src="image7" alt="Symbol 7" /></td>
<td>Spring Centered Return Spring Plunger Pedal</td>
</tr>
<tr>
<td><img src="image8" alt="Symbol 8" /></td>
<td>Way valve with infinite position control</td>
</tr>
</tbody>
</table>

### Fluid Conditioning Elements

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image9" alt="Symbol 9" /></td>
<td>a) Check valve with without closing check valve when oil pressure is reached</td>
</tr>
<tr>
<td><img src="image10" alt="Symbol 10" /></td>
<td>b) Pilot Operated check valve at oil line</td>
</tr>
<tr>
<td><img src="image11" alt="Symbol 11" /></td>
<td>c) Solenoid operated check valve in one direction only</td>
</tr>
<tr>
<td><img src="image12" alt="Symbol 12" /></td>
<td>d) Separator (removing water from oil)</td>
</tr>
<tr>
<td><img src="image13" alt="Symbol 13" /></td>
<td>e) Filter</td>
</tr>
<tr>
<td><img src="image14" alt="Symbol 14" /></td>
<td>b) Cooler</td>
</tr>
<tr>
<td><img src="image15" alt="Symbol 15" /></td>
<td>c) Heater</td>
</tr>
</tbody>
</table>

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CH.6 Hydraulic and Pneumatic Circuits/20M

1. Hydraulic Pack consist of reservoir, pump, pressure relief valve, filter.
2. 3. In any hydraulic application, hydraulic pack plays a vital role.
3. Reservoir is used to store hydraulic oil which is required for the further circuit. Pump is the component which is used to convert mechanical energy into pressure energy. Filter is used to remove dirt particles from oil. Pressure relief valve is used to relieve the pressure as per requirement of circuit.
4. 4. The main function of hydraulic pack is used to provide pressurized fluid to the hydraulic circuit.
5. Hydraulic pack is common to all hydraulic circuit.

* Meter-in circuit

- D.C. Cylinder
- Linear actuator
- Variable type F.C.V with check valve
- Solenoid operated 4/2 valve
- Pressure relief valve
- Hyd. pump
- Filter (Return line filter)
- Oil reservoir
Meter in circuit

1. Meter in circuit consist of Hydraulic pack, 4x2 directional control valve and flow control valve with check valve which are placed parallel to each other and piston cylinder arrangement.

2. Fig shows controlled forward stroke of piston when pressurized fluid is directed from pump. It is asked to port ‘P’ to D.C. valve and to Port ‘A’; entering of fluid to cylinder is metered through flow control valve, because there restriction of flow through check valve, so forward stroke is controlled stroke.

3. After completion of stroke oil is taken to reservoir through connection of port ‘B’ to R. Thus completing forward stroke.

4. For reverse stroke inlet Port ‘P’ is connected to ‘B’ and ‘A’ is connected to ‘R’. But this is uncontrolled reverse stroke, as there is no flow valve & check valve.

Application of meter in circuit

1. For linear speed control
2. For moving load.
3. Resisting load activated by the cylinder
4. Industrial application grinding & milling machine
OR

**Meter in circuit:**

![Diagram of meter in circuit]

**Working:**

When spool valve is operated pump is connected to blind end of cylinder thus piston moves forward causing work done. During return stroke the fluid returns back through non return valve. Meter in circuit are generally used when load characteristics are constant and positive, in grinding and milling machine.

Figure shows circuit connections of a meter in circuit in which the flow control valve is placed in the primary line, directly after load. In meter in circuit speed control is achieved by changing the flow adjustment of flow control valve which controls the oil going to the blind end of the cylinder.

**Applications:** Meter in circuits are used in - **Surface Grinder, Milling machine.**

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OR

(a) identify the following circuits in figure No 1
(b) Make correction if any (Redraw)
(c) Label it and explain its working
(d) State its applications

a) The given figure is Meter in circuit.

Corrected fig as below
Working of Meter in Circuit:

Figure shows circuit connections of a meter in circuit in which the flow control valve is placed in the primary line, directly after load. In meter in circuit speed control is achieved by changing the flow adjustment of flow control valve which controls the oil going to the head end of the cylinder. Meter in circuit are generally used when load characteristics are constant and positive.
Advantages:

1) Used for higher pressure system.
2) Can achieve low piston speed.
3) The cylinder withstands one-sided pressure with a value corresponding to the real load.
4) Relatively small friction due to one-side pressure, hence reducing its long life.
5) Uniform motion of the piston rod even at very slow speed.
6) Flow rate estimation is made based on the large piston area.

Disadvantages:

1) Not suitable for low-pressure system.
2) Heating of oil due to flow.
3) Pressure acts on only one side of piston, so piston is not firmly held at position.

Diagram:

- Meter-Out
- Check valve
- 3x2 solenoid valve
- Pressure relief valve
- Return line filter
- Oil reservoir
In meter-out circuit the flow control valve is connected in the secondary line, directly after the load.

- In meter-out flow is metered after coming out from cylinder.
- For forward stroke, port P is connected to A & after completion of stroke R is connected to R.
- But in return line blow control valve with check valve is placed in parallel with each other so the flow is metered before going to reservoir.

In this fig, forward stroke is controlled stroke.

- For return stroke P is connected to B & blow is taken into cylinder directly opening spool of check valve without restriction of flow control valve. Hence return stroke is uncontrolled stroke.

Appr:

1) Drilling, boring, reaming mach.
2) Speed control of Hydraulic.

Advantages:

1) Stable movement of piston.
2) Heated oil is taken to Reservoir.

Disadvantages:

1) Higher friction between piston & cylinder.
2) Pump works against maximum pressure.
OR

**Meter out circuit:**

![Diagram of a hydraulic circuit with labels such as Double Acting Cylinder, Flow Control Valve, D.C. Valve, Pressure Relief Valve, Hydraulic Pump, Suction Line Filter, and Oil Reservoir. The diagram also includes a text tag: Meter-out speed control hydraulic circuit.]
<table>
<thead>
<tr>
<th>Meter in circuit</th>
<th>Meter out circuit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Flow is metered before entering into cylinder.</td>
<td>2) Flow is metered after leaving the cylinder.</td>
</tr>
<tr>
<td>2) Flow control valve &amp; check valve are placed in primary or pressure line.</td>
<td>3) Flow control &amp; check valve are placed in return line.</td>
</tr>
<tr>
<td>3) Heated oil is taken into cylinder after throttling reservoir after throttling.</td>
<td></td>
</tr>
<tr>
<td>4) Pump doesn't work against maximum pressure.</td>
<td>5) Pump works against maximum pressure.</td>
</tr>
<tr>
<td>6) Piston is not stable.</td>
<td>7) Piston is stable.</td>
</tr>
<tr>
<td>8) Used for linear speed control of piston.</td>
<td>9) Used for positive speed control.</td>
</tr>
<tr>
<td>10) e.g. Used in grinding, milling.</td>
<td>11) e.g. Used in drilling &amp; Reaming &amp; boring.</td>
</tr>
</tbody>
</table>
By pass (or) Bleed off speed controlling hydraulic circuit:

Working:

Bleed off circuit does not control the flow going to actuator or flow returning from the actuator. It controls diverted part of the fluid to control the flow. In this circuit Flow control valve are placed in the bypass line. In this circuit neither incoming nor outgoing flow is metered. In this method pressurized fluid coming out of pump is diverted and bypassed to oil reservoir. This circuit is used for controlling linear speed of piston in double acting cylinder. Here speed of piston is depends on difference between pump delivery flow and flow being by passed to tank through flow control valve.

Applications:

1. broaching machine
2. shaping machine
3. planing machine
4. hydraulic motor brake circuit
5. Concrete mixer on truck.
i) Identify the following circuit in figure No. 1
ii) label and explain its working
iii) state its applications

i) The figure shows a **bleed off circuit**.

ii) **Working**:

Bleed off circuit does not control the flow going to the actuator or flow returning from the actuator. It controls diverted parts of fluid to control the flow in this circuit. An adjustable throttle is placed bypass line. Bleed of circuit is also used for controlling the linear speed in double acting cylinder in this circuit neither incoming nor outgoing flow is metered in this method. Pressurized flow coming out of pump is diverted and bypassed to oil reservoir. The speed of piston is depends on difference between pump delivery flow and flow being bypass to reservoir through throttle valve.

iii) **Applications**:
1) Use in hydraulic shaping machine, planer machine.
2) Used for control of broach in broaching machine.
3) It is suitable in constant pressure.
   Used where precise speed control is not required.
* Sequencing circuit (Position based sequencing)

This circuit is used in Industrial hydraulic systems where mass production is required where more than one operations has to be done one after another.

Diagram:

- Travel dependent
- D.A. cylinder
- Check valve
- Pressure line
- Return line
- Suction line
- Pump
- Filter
- Reservoir
when more than one operation has to be done one after another then this circuit is used. Above fig shows two cylinder with two piston. Here there working is sequence type. 1

This circuit consist of 4x2 directional control valve, 2x2 d.c.v. & hydraulic pack.

When pump force high pressurized oil to inlet of 4x2 d.c.v. it activate the forward motion of piston through port A. Now further piston activate the forward stroke & used oil is taken to reservoir through port R via port B.

At the end of piston(1) cam is mounted which pushes the button of 2x2 d.c.v. and the position which closed at initial gets open and flow from pump is diverted to cylinder(2) and movement of piston is achieved.

* Advantages

- It achieves different operations in one circuit
- Time saving circuit
**Disadvantages**

- Pressure adjustment of cam has to be done
- Wearing of cam & roller is prominent

**Application**

- Lifting, pushing, clamping, bar feeding etc.

**Introduction to electro-hydraulic**

Nowadays in hydraulic system, different valves are operated by an electrically.

*E.g.* electro-hydraulic servo valve; proportional valve which are operated by transforming changing analogue (or) digital input signal into smooth set of movements in a hydraulic cylinders.

*E.g.:* Servo valve can provide precise control of position, velocity, pressure, force, etc. For that purpose low voltage is used to control. Here, the control voltage is passed into amplifier which provides power to alter the values position. The valve will then deliver a measured amount of fluid power to an actuator. The use of a feedback transducer on the actuator returns an electrical signal to the amplifier to condition the strength of the voltage to servo valve.
**Principle of Operation:**

An electric command signal is applied to the integrated position controller which, drives pilot stage. Thereby system produces pressure difference across the drive area of spool & effects its movement. The position transducers (LVDT) which is excited via an oscillator measured the position of the spool. This signal is then demodulated and fed back to the controller where it is compared with the command signal. The controller drives pilot stage until error between command signal & feedback signal will be zero. Thus position of the spool is proportional to the electric command signal.

**Applications:**

1. Axis motion control.
2. Synchronization of hydraulic axis in industry.
3. Provide a close loop control of position, speed, force, pressure etc.
4. In plastic wood working equipment.
5. In the injection process.
6. CNC & fatigue test systems.
- **Sequencing can be obtained by using:**
  (a) Sequencing valve
  (b) Rollar actuated DC valve with cam
  (c) Time delay valve
- **Sequencing can be used for obtaining actions like bar feeding, ejecting, lifting, pushing clamping, in predetermined order.**

(a) **Pressure Dependent Sequencing Circuit:**
The circuit is used for drilling a hole in workpiece. The sequence operation is:
(a) Clamping of workpiece
(b) Drilling
(c) Declamping and drill taken out from hole.

![Diagram of Hydraulic and Pneumatic Circuit]

- The DC valve takes centre position (No. 3). No oil is supplied to either of cylinders $C_1$ or $C_2$. Now undrilled workpiece is kept on fixture seat. The oil from pump is going to oil tank via DC valve and return line filter. So no moment of cylinder $C_1$ or $C_2$. 
Applications of hydraulic circuits:

- When steering wheel is turned, hydraulic oil enters double-acting cylinder through port A. A small amount of oil also flows to B. Two plunger pistons are inside the cylinder, one in each end. Oil pressure acts on both pistons equally.

- Oil flows to pump, where it is circulated and returned to the reservoir. This cycle continues, providing steering assistance.

- Advantages include reduced steering effort, improved vehicle stability, and enhanced driving safety.

- Diagrams illustrate the hydraulic steering system, showing the flow of oil and the movement of pistons.
Hydraulic circuit for Milling machine:

fig. 12.18 Hydraulic circuit for milling machine
Hydraulic Milling Machine:

In fig. show hydraulic circuit for a milling m/c which is a different from shaping & grinding m/c etc.

We know working of milling m/c in which cutter is situated at fixed location & rotate with high speed & workpiece is clamped on table which is move linearly in to & fro motion. Table movement in milling operation is comparatively slower, so adjustable feed are required so additional f.c.v.(con metering) valve is used.

It has a main pump which is a low pressure & high discharge pump & one booster pump is to boost hydraulic pressure to a level above that provided by main pump thus combination saves the power as well as use a high flow & high discharge pump is avoided.

There are two sets of flow control valve & check values fitted on a both supply & return line to cylinder to achieve speed control in both direction.

A manually operated speed valve decides the direction of flow to the cylinder.

The stroke length of the cylinder is adjustable through limit switches (not shown in fig) thru switch disconnect supply of oil to cylinder whenfully reaches the set position.
Diagram for Hydraulic Press:

- D/A Cylinder
- Forward Stroke
- Solenoid Operated 4/2 D.C.V.
- PRV
- Filter
- Reservoir

*Note: Pump and other hydraulic components are also present.*
Working:

In this circuit we have to use double acting cylinder. Here construction & working is similar to that of meter out circuit.

The flow control valve is connected in secondary line directly after load. In this operation retraction stroke should be rapid one, but for achieving forward stroke it should be controlled, so that flow is metered after coming out from cylinder. For forward stroke post 'p' is connected to 'A'. After completion of stroke 'B' is connected to 'P'. But in return line flow control valve with check valve is placed in parallel with throttle valve. So the flow is metered before going to reservoir. In this forward stroke is controlled stroke. For return stroke 'P' is connected to 'B' & flow is taken into cylinder directly opening spool of check valve. Without restriction of flow control valve; hence return stroke is uncontrolled stroke.
6.2 Simple Pneumatic Circuits.  

Draw general layout of pneumatic circuit and label all the parts.  4m
Explain with sketch and label pneumatic circuit for speed control of a double acting cylinder. 6m

Speed control circuit is used to control the speed of pneumatic actuator; this is achieved by controlling air supplied to the actuators. The air flow to actuator is controlled either the supply line or drain line.

In speed control of a cylinder, a flow control valve along with a check valve is normally used, but this combination provides speed control in one direction. In case of speed control in both direction of double acting cylinder, two sets of combination flow control and check valve are used. Speed in a extension and retraction can be changed independently. It should be noted that position of check valves permits free flow of air to the cylinder chambers and throttled flow of air from the chamber.
Actuation of unidirectional pneumatic motor

Fig (1)

Unidirectional motor

Push button operated

3x2 B.C. Valve

Muffler (or) Silencer

FRL Unit

Compressor

Fig (2)

Unidirectional motor

Muffler (or) Silencer

FRL Unit

Compressor
P = Pressure Port (from compressor / pump)
R = Return to reservoir / vent

Fig. 6 shows:

1. 2x2 D.A. valve
2. F.R.L. Unit
3. Unidirectional motor

Fig. (a) shows zero movement because compressed air from compressor is not directed to port 2A through port P.

Fig. (b) when button of D.C valve is pushed, the pressure port P will be connected to port A & motor starts rotating.

3. Due to this only clockwise movement of motor is achieved.

A speed control of double acting cylinder

Fig. (c) → Control forward stroke

Flow control of check valve

Push button operated D.C valve
Fig (b) Uncontrolled return stroke

Piston movement:

Check valve

Push button

4x2 direction control valve

Vent (or) muffler

F.R.L. compressor

Speed control circuit for double acting cylinder consists of 4x2, DC valve, compressor, flow control valve with check valve.

Fig (a) shows forward movement of piston where incoming air checked.

Here pressurized air is taken from compressor & further is taken into cylinder by connecting point P to point A.

Fig (b) shows uncontrolled return stroke because there is no flow control and check valve in secondary line.
speed control of bi-directional air motor

Fig (a) speed control for clockwise direction

Fig (b) speed control for anticlockwise direction
1) Fig. (a) & Fig. (b) shows speed control circuit for clockwise & anticlockwise movement of motor.

2) Above circuit shows HX2 D.C. valve, FRL unit, compressor used for controlling speed of bi-directional motor.

3) In Fig. (a) compressed air coming from compressor is taken to motor through connection of post ‘P’ & post ‘R’. This incoming air rotate motor in clockwise direction. Its speed can be controlled by flow control valve & check valve. Post P and the motor is connected to the exhaust from which the air will be removed.

4) In this speed will be controlled in clockwise direction.

5) In anticlockwise direction of motor blow control & check valve placed in secondary line. While in clockwise it is in primary line.

6) Due to such arrangement clockwise or anticlockwise direction can be obtained.
Pneumatic Sequencing Circuits:

Generally in mass type production industries when two (or) more than two operations / activities are done sequentially then sequencing circuit is used. For getting output we use double acting actuators in a predetermined sequence.

Sequencing is done by two methods namely pressure dependents and position dependent. In position based sequencing the cams attached to the actuators (cylinders) operate the valves censing another actuator to move. This method is commonly used in pneumatics. A simple position dependant sequencing of two double acting cylinders is shown in fig when start button is pushed by the operator the cylinder one is extended when it reaches the desired position a 2/2 D.C. valve is actuated which provides impulse to the 4/2 D.C. valve of second cylinder causing it also to extend. Thus the position based sequencing is achieved.
**Pressure dependent Pneumatic Sequencing circuit:**

Construct the pneumatic circuit using sequence valve to control two applications performed in a proper sequence and describe its working. 8m

Pressure dependent sequencing circuit:

The circuit is used for drilling a hole in work piece. The sequence operation is

a) Clamping of work piece
b) Drilling
c) Decamping and drill taken out from hole.
The DC valve takes centre position (no 3.) no compressed air supplied to either of cylinder C1 or C2. Now undrilled work piece is kept on fixture seat. The compressed air from compressor is going to vent via DC valve so no movement of cylinder C1 or C2. Now compressed air start supplying directly to C2 and through sequence valve to C1. When compressed oil enters through port A2 of cylinder C2 piston will advance and immediately clamps the work piece.

**At the same time compressed air flow towards port A1 of cylinder C1 but through the sequence valve.**

Some higher pressure is set at pressure relief valve of sequence valve when the pressure of flowing air reaches this set value the sequence valve opens and air enters through port A1 into cylinder C1 due to this piston advances comes down so that drilling starts.

When operator again operate foot lever of DC valve it takes position 2 and both piston retracts and work piece de-clamps and drill comes out of drilled hole.
Application of compressed air in power tools like:

i) Pneumatic rock drill.

ii) Pneumatic torque wrench.

i) Pneumatic rock drill:

Generally in all pneumatic rotary tools, rotary vane motor is used, which is nothing but a rotary actuator; with the help of compressed air it provide rotary motion to spindle. (Speed up to 25000 rpm)
Pneumatic Hammer:

In the above fig. shows a basic construction of pneumatic hammer which contains double acting cylinder with single piston rod.

When pressurised air enters intermittently in double acting cylinder through port (A) when valve (V1) is opened, due to pressure of air piston moves intermittently towards left giving hammering action. When valve (V1) is closed & (V2) is open, the piston of double acting cylinder will move towards right and will return to original position. Instead of two valves, we can use combined direction control valve.

Pneumatic Grinder:

It works on the same principle as that of pneumatic drill. Only difference is that, instead of tool-like drill, we have to use a grinding wheel. Here also, pressure energy of compressed air is converted into rotary motion of spindle i.e., mechanical useful work for that purpose, we use air motors in the assembly, which...
Application of Compressed Air in Braking System:

Figure: Air Braking System
Fig shows complete layout of Air Brake System. It consists of Air filter, unloading valve, Air compressor, Air reservoir, Brake valve and 4 numbers brake chamber.

**Working**: The compressor takes atmospheric air through air filter, and compresses the air. This air is stored under pressure in air reservoir. From this reservoir air goes to various accessories of vehicle which operates on compressed air. Part of air goes to brake valve. The control of brake valve is done by driver who controls the intensity of braking according to emergency.

What are applications of pneumatic circuit? Draw a circuit of any one. 6m

(02 marks for application, 03 for figure, 01 for label)

applications of pneumatic circuit:

1. Air suspension system.
2. Air braking system
3. Boring machine
4. Pneumatic drill
5. Pneumatic gun
6. Pneumatic wood cutter
7. Pneumatic hammer
8. Pneumatic chain saw

Note: credit to suitable diagram of any one appropriate application of pneumatics circuit.
Figure: Air Braking System

OR

Pneumatic Drill (Pistol Drill)
Give the application of hydraulics and pneumatics in automobiles. Explain any one of them with neat sketch. 8m

(applications - 2 Marks, Sketch - 3 Marks, Suitable explanation - 3 Marks)

Application of hydraulics and pneumatics in automobiles

1. Hydraulic braking system.
2. Hydraulic power steering system
3. Air suspension system.
4. Air braking system.

**Note:** credit to suitable explanation of any one appropriate application of hydraulics and pneumatics in automobiles.

2. Hydraulic power steering: Rotary valve type power steering

![Rotary valve type power steering gear](image)

This is used to reduce the turning effort required to steer the wheels. It consists of hydraulic pump, gear box, rotary spool type D.C. valve and hoses. The steering wheel is connected to the one end of rotary spool valve while at other end of valve worm is connected. The worm rotates the nut making the sector to turn which turns the road wheels at angle.

When driver turns the steering wheel, the spool valve turns directing the pressurized oil from pump to appropriate side of the nut applying the effort on that side. This helps in reducing the effort of driver.
OR

Explain hydraulic power steering with neat labeled sketch. (Optional)

Rotary valve type power steering

This is used to reduce the turning effort required to steer the wheels. It consists of hydraulic pump, gear box, rotary spool type D.C. valve and hoses. The steering wheel is connected to one end of rotary spool valve while at other end of valve worm is connected. The worm rotates the nut making the sector to turn which turns the road wheels at angle.

When driver turns the steering wheel, the spool valve turns directing the pressurised oil from pump to appropriate side of the nut applying the effort on that side. This helps in reducing the effort of driver.

OR

Reaction piston type hydraulic steering system (Optional)

It consists of piston connected to chassis, a moving cylinder, ball joint connected to drop arm and sliding spool valve. The spool valve is operated by ball joint. When the steering wheel is moved to right, the ball joint connected to the drop arm moves the spool valve to right against spring pressure. This allows hydraulic pressure to pass to the rear of the piston. As piston is stationary the pressurized fluid reacts against the piston and pushes the cylinder to the right. The fluid from front of piston is returned to the reservoir. Thus it helps in reducing the effort applied by Driver.
3. Air suspension system:
4) **Air Braking System:**

![Air Braking System Diagram]

Fig shows complete layout of Air Brake System. It consists of Air filter, unloading valve, Air compressor, Air reservoir, Brake valve and 4 numbers brake chamber.

**Working:** The compressor takes atmospheric air through air filter, and compresses the air. This air is stored under pressure in air reservoir. From this reservoir air goes to various accessories of vehicle which operates on compressed air. Part of air goes to brake valve. The control of brake valve is done by driver who controls the intensity of braking according to emergency.
Compare hydraulic and pneumatic circuit (any six points) 6m

<table>
<thead>
<tr>
<th>SR. NO.</th>
<th><strong>Hydraulic circuit</strong></th>
<th><strong>pneumatic circuit</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>01</strong></td>
<td>Used for circuits up to <strong>700 bar</strong> pressure.</td>
<td>Operative below <strong>10 bar</strong> pressure.</td>
</tr>
<tr>
<td><strong>02</strong></td>
<td>Uses hydraulic <strong>oil</strong> as a medium.</td>
<td>Uses <strong>air</strong> as a medium.</td>
</tr>
<tr>
<td><strong>03</strong></td>
<td><strong>Pump</strong> is used to pressure the oil.</td>
<td><strong>Compressor</strong> is used to pressurize the air.</td>
</tr>
<tr>
<td><strong>04</strong></td>
<td>Since hydraulic oil is reused in the circuit, hydraulic oil tank is a must and <strong>there are return lines</strong>.</td>
<td>Air is taken from atmosphere and is vented to atmosphere after use. Hence <strong>no return lines</strong>. Air reservoir is used to store pressurized air.</td>
</tr>
<tr>
<td><strong>05</strong></td>
<td>The <strong>rigidity</strong> of the system using hydraulic circuit is <strong>good</strong>.</td>
<td>The <strong>rigidity</strong> of the system using pneumatic circuit is <strong>poor</strong>.</td>
</tr>
<tr>
<td><strong>06</strong></td>
<td><strong>Moderate</strong> operating cost.</td>
<td>Operating cost is <strong>low</strong>.</td>
</tr>
<tr>
<td><strong>07</strong></td>
<td>Maintenance is <strong>critical</strong>.</td>
<td>Maintenance is <strong>simple</strong>.</td>
</tr>
<tr>
<td><strong>08</strong></td>
<td>Very suitable for <strong>accurate speed/feed</strong> movement of cutting tool mechanism. Due to non compressibility of oil.</td>
<td>No accuracy in movement. Due to compressibility of air.</td>
</tr>
<tr>
<td><strong>09</strong></td>
<td>The system using hydraulic circuit is <strong>not clean</strong> due to oil leakages.</td>
<td>Pneumatic circuits are very <strong>clean</strong>.</td>
</tr>
<tr>
<td><strong>10</strong></td>
<td>Weight to pressure ratio is <strong>small</strong>.</td>
<td>Weight to pressure ratio is <strong>high</strong>.</td>
</tr>
<tr>
<td><strong>11</strong></td>
<td>Problem of <strong>cavitations is serious</strong> in hydraulic circuit.</td>
<td>No problem of cavitations.</td>
</tr>
<tr>
<td><strong>12</strong></td>
<td><strong>Oil is changed</strong> as per schedule.</td>
<td>No need of change of air as per schedule.</td>
</tr>
<tr>
<td><strong>13</strong></td>
<td>Limited energy is stored in accumulator.</td>
<td>Large amount of energy stored in air tank.</td>
</tr>
<tr>
<td><strong>14</strong></td>
<td><strong>Speed</strong> is always <strong>limited</strong>.</td>
<td>A very <strong>high speed</strong> is possible.</td>
</tr>
<tr>
<td><strong>15</strong></td>
<td>While working <strong>less noise</strong>.</td>
<td>While working <strong>more noise</strong>.</td>
</tr>
<tr>
<td><strong>16</strong></td>
<td>Oil treatment by oil filter takes place in <strong>power pack</strong>.</td>
<td>Air treatment is required so use of <strong>FRL unit</strong> in this system.</td>
</tr>
<tr>
<td><strong>17</strong></td>
<td>Leakage problem identify by observation of dirty and sleepry place.</td>
<td>Leakage problem easily identify by sound/noisy operation.</td>
</tr>
<tr>
<td><strong>17</strong></td>
<td><strong>Applications</strong>: Hydraulic circuits are used in tackling heavy loads, hence used in earthmoving equipments, CNC-VMC machines. Hydraulic braking, Material handling, etc.</td>
<td><strong>Applications</strong>: Pneumatic circuits are used when loads are much lighter. Hence used in transferring the light weight components, vacuum handling in printing press, food industry. Special purpose tools, Air braking, etc.</td>
</tr>
</tbody>
</table>
Question Bank: Ch no. 6 Hydraulic and Pneumatic circuits

6.1 Hydraulic Circuits 10 Marks

1) Draw a symbol for pressure relief valve and variable speed unidirectional pump. 4m
2) Draw the symbols for following i) Filter ii) Hydraulic pump iii) Double acting cylinder iv) 3/2 DC valve. 4m (Q 1&2 E-Scheme)
3) Explain meter in type hydraulic circuit. 4m
4) Draw meter-in circuit and explain its working. 8m
5) Draw a neat label sketch of meter-out hydraulic circuit. 4m
6) Explain with neat sketch bleed off circuit. 4m
7) Sketch the bleed-off-hydraulic circuit and state any two applications of it. 8m
8) Explain construction and working of hydraulic power steering.

9) Explain hydraulic power steering with neat labeled sketch.

10 Draw layout of hydraulic steering system. Explain its working. 6m
11 Draw the neat labeled layout of hydraulic braking system and explain its working. 8m
12 a) identify the following circuits in figure No 1
    b) Make correction if any (Redraw)
    c) Label it and explain its working
    d) State its applications

![Figure No. 1 Q. 6 (3)](image-url)
13) i) Identify the following circuit in figure No. 1
ii) label and explain its working
iii) state its applications.

6.2 Simple Pneumatic Circuits. 10 Marks

14) Draw pneumatic symbols of following i) 4x3 DC valve ii) Tandem cylinder
    iii) Variable flow control valve iv) Bi-directional air motor. (E - Scheme)

15) Sketch and label pneumatic circuit for speed control of a double acting cylinder. 6m

16) Explain sequencing pneumatic circuits with neat sketch. 8m

17) Draw general layout of pneumatic circuit and label all the parts. 4m

18) Explain with neat sketch pneumatic speed control circuits. 4m

19) What are applications of pneumatic circuit? Draw a circuit of any one. 6m

20) Draw and explain pneumatic circuit to control the speed of double acting cylinder. 6m

21) Construct the pneumatic circuit using sequence valve to control two applications
    performed in a proper sequence and describe it's working. 8m

22) Draw general layout of pneumatic system and label the components. 4m

Combination Questions: (On Hydraulics & Pneumatics System)

23) Compare hydraulic and pneumatic circuit on the basis of - fluid used, ease of
    operation, noise, speed, cost, application. 6m

24) Give the application of hydraulics and pneumatics in automobiles. Explain any one
    of them with neat sketch. 8m

25) Compare hydraulic and pneumatic circuit (any six points) 6m